Detailed Project Report
for
Personal Rapid Transit (PRT) System
in
Haridwar (Uttarakhand)

Client: UTTARAKHAND METRO RAIL, URBAN INFRASTRUCTURE & BUILDING CONSTRUCTION CORPORATION LIMITED (UKMRC)

Prepared by: DELHI METRO RAIL CORPORATION LTD

June - 2021

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Salient Features

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0.2 Track Guideway

0.3 Traffic Summary

0.4 System Design (PRT)

0.5 Power Demand Estimation

0.6 Maintenance Facilities

0.7 Signalling, Telecommunication & PRT Control

0.8 Estimated Cost (September ,2020 price level)

0.9 Financial Indies

SALIENT FEATURES

0.1 PROPOSED CORRIDORS

S. No.	Corridor No	PRT Corridors	Route Length (km)	No. of Station
1	Corridor 1	Sitapur-Bharat Mata Temple	14.55	14
2	Corridor 2	City Hospital to Daksh Temple	3.10	4
3	Corridor 3	Valmiki Chowk to Laltaro Bridge	0.69	1
4	Corridor 4	Ganeshpuram to DAV School	2.40	2
		Total	20.74	21

0.2 TRACK GUIDEWAY

Minimum 4.2 m width for accommodating two PODs running in both directions.

0.3 TRAFFIC SUMMARY

Parameters	2021	2031	2041	2051
Section Length (in km)	20.74	20.74	20.74	20.74
Daily Ridership including Induced Traffic on Normal Day	81,641	1,27,917	1,69,828	2,18,317
Average Trip Length including Induced Traffic on Normal Day (in km)	3.89	3.89	4.45	4.49
Daily Ridership on Mela (Poornima) Day	1,89,057	2,66,470	3,52,839	4,56,749
Average Trip Length for Mela (Poornima) Day (in km)	3.23	3.50	3.99	4.03
Weighted Average Daily Ridership with Induced Traffic	**1,03,712**	**1,56,387**	**2,07,433**	**2,67,310**
Weighted Average Trip Length with Induced Traffic (in km)	**3.75**	**3.81**	**4.36**	**4.40**

Note - *Weighted Average Daily Ridership of PRT system in Haridwar has been calculated by considering 75 Mela Days and 290 Normal Days in a Year.*

0.4 SYSTEM DESIGN (PRT)

POD Dimensions	
Length	3500 mm to 4000 mm
Width	1400mm to 2000 mm
Height	1800 mm to 2400 mm
Designed- Passenger Loading	
POD carrying capacity	6 passengers
Weight (kg)	
Tare weight (minimum)	As Low as possible

Gross weight	Tare Weight + Weight of 6 passengers
Speed	
Design Speed	100 kmph
Operating Speed (Maximum)	90 kmph
Average Speed	40 ~60 kmph

0.5 POWER DEMAND ESTIMATION

PRT Corridors	Load	Total Power Consumption (Year)				
		2021	2025	2031	2041	2051
All 4 Corridor's total power Demand	AUX.	7.0 MW	7.0 MW	7.0 MW	7.7 MW	8.5 MW

0.6 MAINTENANCE FACILITIES

Maintenance Depot is planned at Rishikul.

0.7 SIGNALLING, TELECOMMUNICATION & PRT CONTROL

a) The Signalling system shall be designed so as to provide the highest level of safety &security along with efficiency in PRT services / operations. It consists of following functions:

- Central control
- Autonomous Vehicle Control
- Automatic Vehicle Protection System (AVP)

b) Telecommunication System

The communication system handles the transmission of critical control and status messages and exchange of other information between the control system and PRT vehicles. The communications system is a vital part of the PRT operation, delivering routing and scheduling instructions to the vehicles from a central control centre, and communicating their progress and status back to control. For the communication among vehicles as well as with the elements of the network infrastructure (stations, intersections etc.) the wireless communication system is used. Therefore, the control structure of PRT is a complex, distributed, real-time system.

0.8 ESTIMATED COST INCLUDING ALL TAXES & LAND COST

As per June 2021 price level, total estimated cost including all taxes and land cost is Rs. 1,419 Crore.

0.9 COMPLETION COST INCLUDING ALL TAXES & LAND COST

Completion by October 2025

(i) SPV Model: Rs. 1,612 Crores (IDC Rs. 19 Crore)

(ii) PPP(DFBOT): Rs. 1775 Crores (IDC Rs. 182 Crore)

0.10 FINANCIAL INDICES

a) Financial Internal Rate of Return (FIRR): 16.16 % and 16.85% with and without PD Income from 10 ha. Land.

b) Economic Internal Rate of Return (EIRR): 11.71%

Executive Summary

0.1 Background

0.2 Travel Demand Forecast

0.3 Mass Rapid Transit Modes and Mode Choice

0.4 Civil Engineering and Geometric Design Parameters and Alignment Description

0.5 Station Details

0.6 Operation Plan, Depot & Maintenance Facilities

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0.10 EIA and SIA Study for the PRT System

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EXECUTIVE SUMMARY

0.1 BACKGROUND

Uttarakhand formerly known as 'Uttaranchal' became the 27th state of India on November 09, 2000 carved out from Himalayan and north-western parts of Uttar Pradesh.

The state of Uttarakhand is broadly divided into two divisions namely (i) Garhwal and (ii) Kumaon and has 13 districts in all with its capital as Dehradun. The official language of the state is Hindi. Uttarakhand has a total area of 53,483 sq. kms out of which 86% is mountainous and 65% is covered by forests. Most of the northern parts of the state are covered by high Himalayan peaks and glaciers. Two of most important rivers originate in the region i.e., the Ganga at Gangotri and the Yamuna at Yamunotri.

According to the 2011 Census of India, Uttarakhand has a population of 10,086,292 comprising 5,137,773 males and 4,948,519 females, with 69.77% of the population living in rural areas. The state is the 20th most populous state of the country having 0.83% of the population on 1.63% of the land. The population density of the state is 189 people per square kilometre having a 2001–2011 decadal growth rate of 18.81%. The gender ratio is 963 females per 1000 males.

Uttarakhand has 28,508 km of roads, of which 1,328 km are national highways and 1,543 km are state highways. As of 2020, approximately 2164 buses are being plied by the State Transport Corporation on 36 nationalized routes and non-nationalized routes apart from private transport operators. For local travel, the state, like most of the country, has auto rickshaws, cycle rickshaws, etc. Uttarakhand's high rate of visitors has resulted in an ever increasing demand for transport creating excessive pressure on the existent transport system. With high growth in transport demand over the years, congestion on roads has been increasing due to phenomenal rise in private transport. Absence of an efficient full-fledged public transport system coupled with rapid growth in the use of personalized vehicles has led to high consumption of fossil fuel and increase in the level of environmental pollution.

The inter-city traffic volumes in the state of Uttarakhand necessitated the initiation of full-fledged integrated multi modal mass rapid passenger system. Governments of Uttarakhand (GoUK) vide their letter no. 494/UHUDA-142/2016-17 dated 29-11-2016 and 516/UHADA/-142/2016-17, dated. 08-12-2016 desired DMRC to prepare the Detailed Project Report (DPR) for Metro Rail Project in the state of Uttarakhand connecting the three cities namely, (i) Dehradun, (ii) Rishikesh and (iii) Haridwar under phase-I of Uttarakhand Metro.

DMRC prepared and submitted Detailed Project Report for Metro Rail project in the state of Uttarakhand connecting the three cities namely, (i) Dehradun, (ii) Haridwar and (iii) Rishikesh under phase-I of Uttarakhand Metro to UKMRC in Oct. 2019 , After analysis of DPR, Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited (UKMRC), has requested DMRC to revise Detailed Project Report for Metrolite Project in Dehradun, Haridwar & Rishikesh (Uttarakhand) which was duly submitted to UKMRC in Feb. 2020.

Subsequently Vide letter No. 398/U.M.-118/2019-20 dated 01.10.2019 (Annexure-A 1.3) UKMRC has requested DMRC to provide Terms of Reference (TOR) for preparation of Personal Rapid Transit (PRT) system in Haridwar City. MoU/Agreement for the Preparation of Detailed Project Report (DPR) for Personalized Rapid Transit System (PRT) in Haridwar signed on 20th October, 2019 between UKMRC& DMRC.

0.1.1Haridwar City

Haridwar also spelled ‘Hardwar’ is an ancient city and one of the districts of Uttarakhand State. The River Ganga, after flowing for 253 km from its source at Gaumukh at the edge of the Gangotri Glacier, enters the Indo-Gangetic Plains of North India for the first time at Haridwar, which gave the city its ancient name, Gangadwára. It is well connected to Delhi through NH-58. It is important pilgrimage centre and entry/starting point of Char DhamYatra. Haridwar is also famous for its temples, Ashrams and Har-ki-Pauri (a ghat at the bank of River Ganga). A heaven for nature significant others, Haridwar presents a kaleidoscope of Indian culture and development. In the sacred writings it has been differently specified as Kapilsthan, Gangadwar and Mayapuri. It is additionally a passage indicating the Char Dham (the four principles focus of journey in Uttarakhand viz, Badrinath, Kedarnath, Gangotri, and Yamunotri).

Haridwar district has an area of about 2360 Square km with co-ordinates of 29.945°N 78.163°E and located in the south-western part of Uttarakhand state. Haridwar is situated at height of 314 meters from the sea level, between Shivalik Hills in the North and North-east and the Ganges River in the South. As of 2011 India census, Haridwar Urban Agglomeration has the population of 3,20,892 comprising 54% Males and 46% Females. Haridwar has an average literacy rate of 70%, which is higher than the national average of 59.5%.

Haridwar has the important pilgrim places namely Mansa Devi Temple, Chandi Devi temple and Har Ki Pauri. In addition to these religious attractions, numbers of Satsang Houses are also located In Haridwar Area. Patanjali Vidyapeeth is also come up at the distance of about 8 km from Haridwar. Bharat Heavy Electricals limited (BHEL) also has its largest establishment near Haridwar.

0.1.2 Demographics

As per census of 2001 India census, Haridwar district had population of 18, 90,422 (2011) and 14, 47,187 in 2001. Haridwar city has 3, 20,892 population in 2011. As per Census 2001, average household size is about 5.4 persons. The male population constitutes 54% and and females 46% of the total population. Haridwar has an average literacy rate of 70%, higher than the national average of 59.5%. Haridwar hosts about 8 million religious tourists every year. The giant public sector unit BHEL a large unit of Hindustan Lever and three engineering units have their impact on the tertiary sector of the economy of the town. In private sector also, some large industrial units are functioning in the fringes of Haridwar, which have impact on the economy of the town; and many more units which are in the offing, will also indirectly strengthen the economy of this town. As the economy grows, the rate of in-migration of workers will grow concomitantly, which will reflect on the growth of population. Besides the tourist population, a large number of daily religious visitors and visitors who come on different business in this head quarter town (Haridwar town is the Head Quarter of District Haridwar) constitute the floating population.

Table 0-1: Demographic Data of Haridwar

Region	Population (Census 2011)	Density (in PPSQKM)	No of Household	Household Size	Male Population	% of Total Population	Female	% of Total Population	Sex Ratio	Literacy Rate	Decadal Growth Rate
Rawali Mahdood (CT)	17,467	3,130	3,464	5.04	9,438	54.03	8,029	45.97	851	68.73	140.70
Bahadarabad (CT)	10,096	3,913	1,903	5.31	5,366	53.15	4,730	46.85	881	70.39	33.63
Jagjeetpur (CT)	15,043	3,270	3,090	4.87	7,917	52.63	7,126	47.37	900	74.32	110.50
Hardwar (NPP+OG)	231338	9,819	47,251	4.9	1,23,455	53.37	1,07,883	46.63	874	73.69	30.32
Bharat Heavy Electricals Limited Ranipur (ITS)	46,948	1,743	10,381	4.52	24,893	53.02	22,055	46.98	886	80.16	8.53

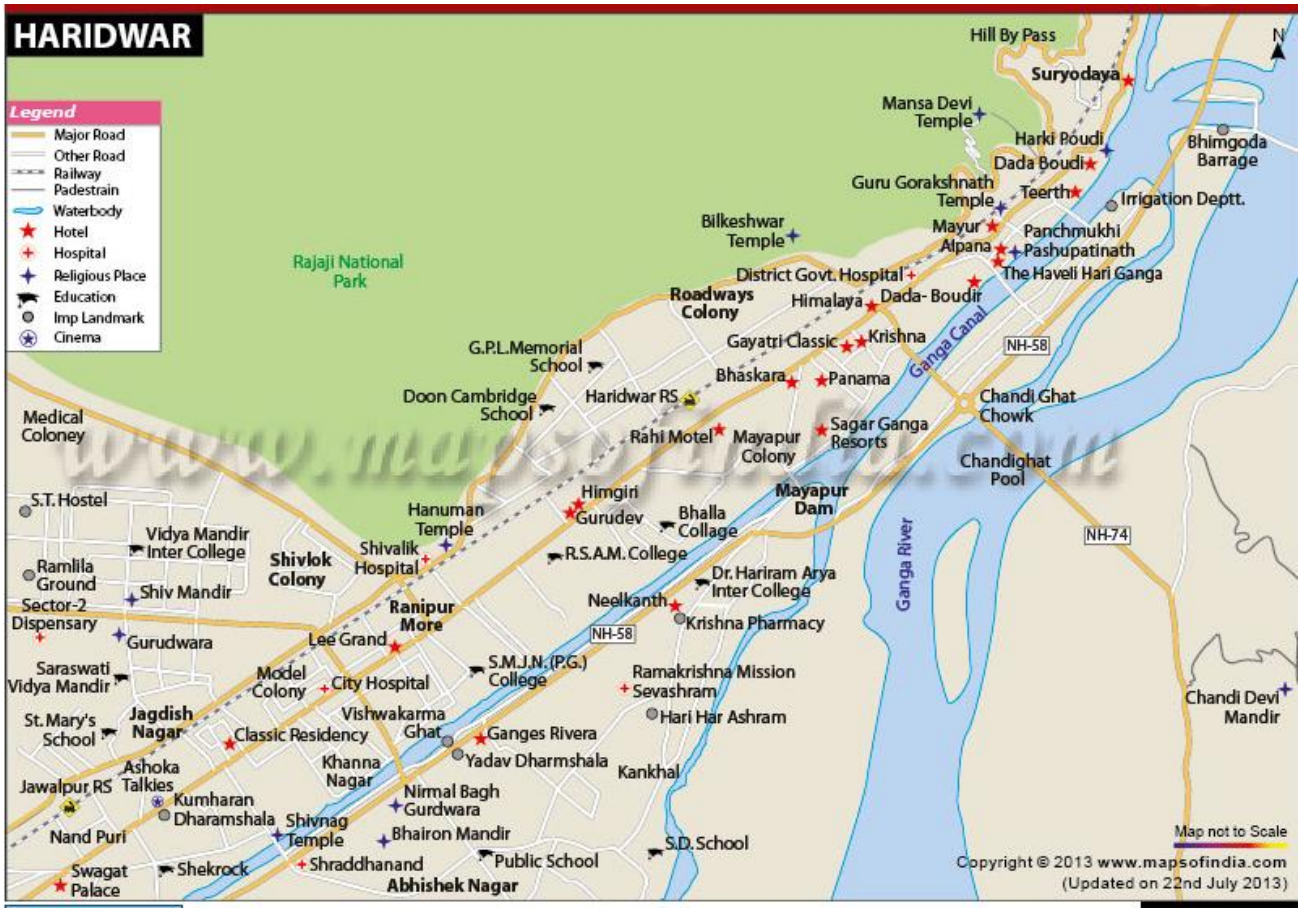

Figure 0-1: Map of Haridwar

Total population (as per census 2011) falling under, Haridwar City and their respective areas have been tabulated in Table 0.2 given hereunder:

Table 0-2 : Population of Haridwar

Description	Population (as per census 2011)	Total workers	Non-workers/ Dependents
Town	2,28,832	75,263	1,53,569
Outgrowth	92,060	29,993	62,067
Village	1,55,009	49,481	1,05,528
Total	**4,75,901**	**1,54,737**	**3,21,164**

Source: Internet

0.1.3Present Scenario of Transport in Haridwar City

Presently, the proposed region does not have adequate public transport system in Haridwar City. Only mode of transport in the city is either through State transport buses or through un-organized private operated buses/mini buses, auto and tempos. Also, people use their private vehicles to commute their journeys in Haridwar city through private taxi / mini bus. Due to the

growth of this region being very rapid and increasing number of tourists there is an urgent need of a proper mass rapid transit system for this area. The dedicated personal rapid transit system will not only make the journey comfortable and time saving, but it will also be eco-friendly and energy efficient. The existing road network is already over loaded and the time taken to travel through this road network is not only on higher side but also prone to accidents and creates more pollution. Provision of efficient and comfortable public transport is likely to give further boost to tourism of State. Being a eco sensitive zone, it is much more essential that a proper dedicated eco-friendly transit system is developed in this region immediately.

0.1.4 Present Study

Based on the traffic study of various options the following corridors have been selected for provision of PRT System.

Table 0-3 Proposed PRT Corridors in Haridwar City

.S. No	PRT Corridor	Length (km)
1.	Bharat Mata Temple – Sitapur	14.55
2.	City Hospital – Daksha Temple	3.10
3.	Valmiki Chowk – Laltaro Bridge	0.69
4.	Ganeshpuram – DAV School	2.40
	Total	**20.74 km**

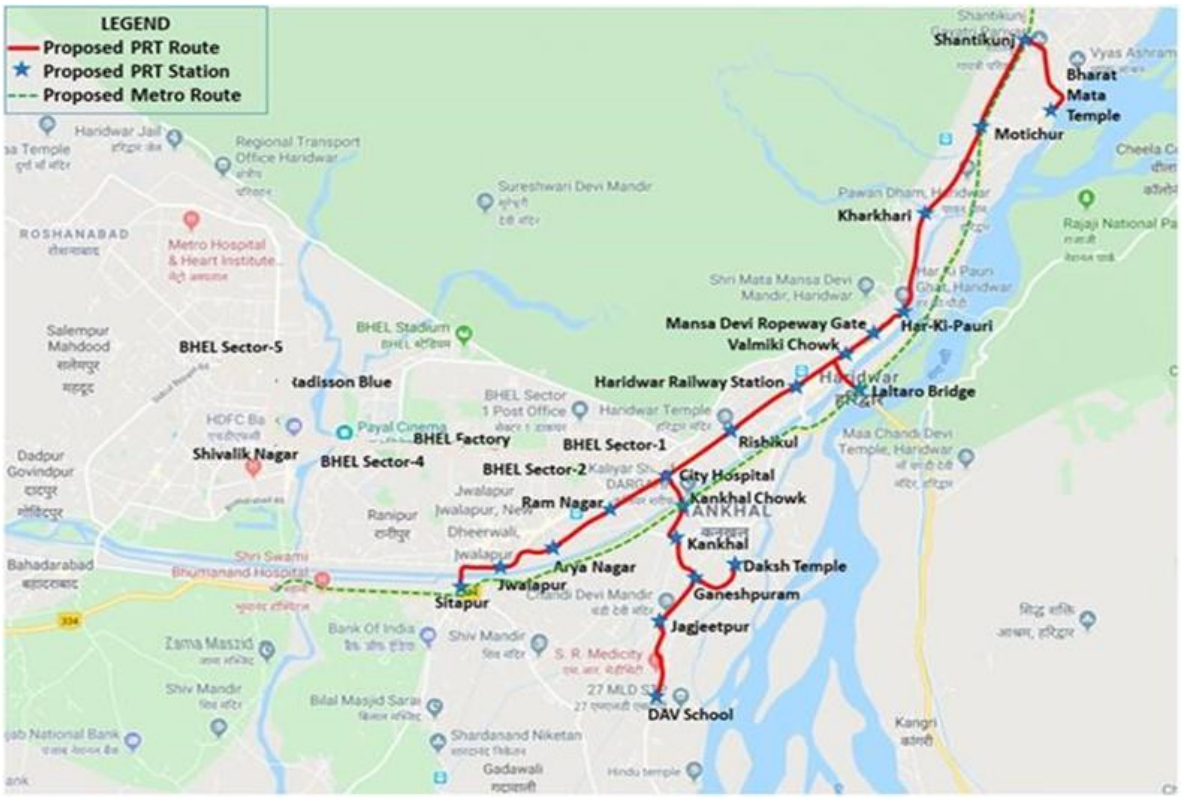

Figure 0-2: Map showing the Proposed PRT Corridors in Haridwar City

0.2 TRAVEL DEMAND FORECAST

The estimation of traffic demand for Personal Rapid Transit system for Haridwar City (Uttarakhand) has been carried out by M/s “ICRA, Management and Consulting Services Limited, New Delhi who were entrusted this assignment by DMRC. The important highlights are summarized below.

0.2.1 Study Area

The study area comprising of Haridwar is located in the Garhwal region of Uttarakhand. Haridwar is the most prominent religious and spiritual centre of the state of Uttarakhand. Haridwar is the headquarters and the largest city of the district. The total geographical area of the Haridwar Township is about 42.01 sq. km and is situated at the height of 249 m above mean sea level.

Haridwar is the gateway to the four pilgrimages of Uttarakhand. History depicts that it is the starting point of the two holy rivers Ganga and the Yamuna. Haridwar’s chief object of pilgrimage is Har-Ki-Pauri—the bathing ghat, or steps, along the river. Haridwar is also one of the four places where Kumbh Mela occurs after rotation of every twelve Years and Ardh Kumbh Mela is organised after six years of every Kumbh. Large numbers of pilgrims gather there annually at the beginning of the Hindu solar year in April.

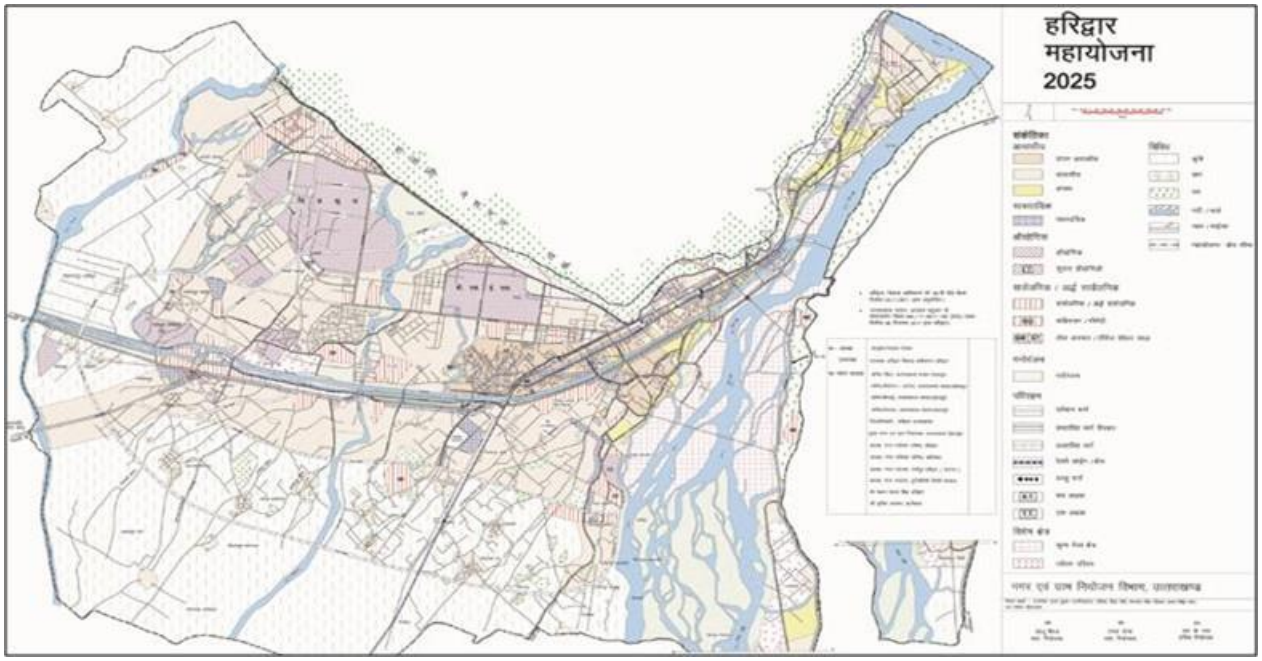

Figure 0-3: Study Area Map

Today, the city is developing beyond its religious importance, with the fast developing industrial estate of State Infrastructure and Industrial Development Corporation of Uttarakhand Limited

(SIIDCUL), and the close by township of Bharat Heavy Electricals Limited (BHEL) as well as its affiliated ancillaries. Being one of the seven holiest cities in India, Haridwar often bustles with devotees. Its propitious location near the holy River Ganga has made it to gain more popularity.

0.2.2 Planning Variables

The travel demand in an area depends on land use distribution and its intensity. The variables that describe the travel demand traditionally have been the population, employment and vehicle ownership. The growth of population, employment and vehicles in study area and their projection into the future.

0.2.3 Primary data Collection

Various primary traffic surveys for the study area are executed in order to assess the baseline traffic condition and to achieve desired results for future proposals. The primary surveys are conducted at the selected locations with respect to the proposed PRT corridor in the study area.

(i) Traffic Volume Count including Occupancy Survey

Traffic Volume Count (TVC) surveys (including occupancy surveys) provide information regarding traffic characteristics and the average Occupancy on the study corridor. Manual Classified Traffic Volume Count Surveys was undertaken at 6 identified locations across the study corridor, while video-graphic TVC Survey was also carried out across 2 locations. TVC survey details are listed in the following table.

Table 0-4: Traffic Volume Count (TVC) Survey Locations

Survey	Location ID	Location	Duration	Date
Manual TVC	MB1	Sanjay Colony	24 hours for 3 days	15/12/2019
	MB3	Rishikul	24 hours for 3 days	12/12/2019
	MB5	Har-ki-Pauri	24 hours for 3 days	12/12/2019
	MB6	Vaidik Mohan Ashram	24 hours for 3 days	12/12/2019
	MB7	Gandhi Park	24 hours for 3 days	15/12/2019
	MB8	Laksar Road	24 hours for 3 days	15/12/2019
Video graphic TVC	MB2	Aurobindo Ashram	24 hours for 3 days	15/12/2019
	MB4	Railway Station	24 hours for 3 days	15/12/2019

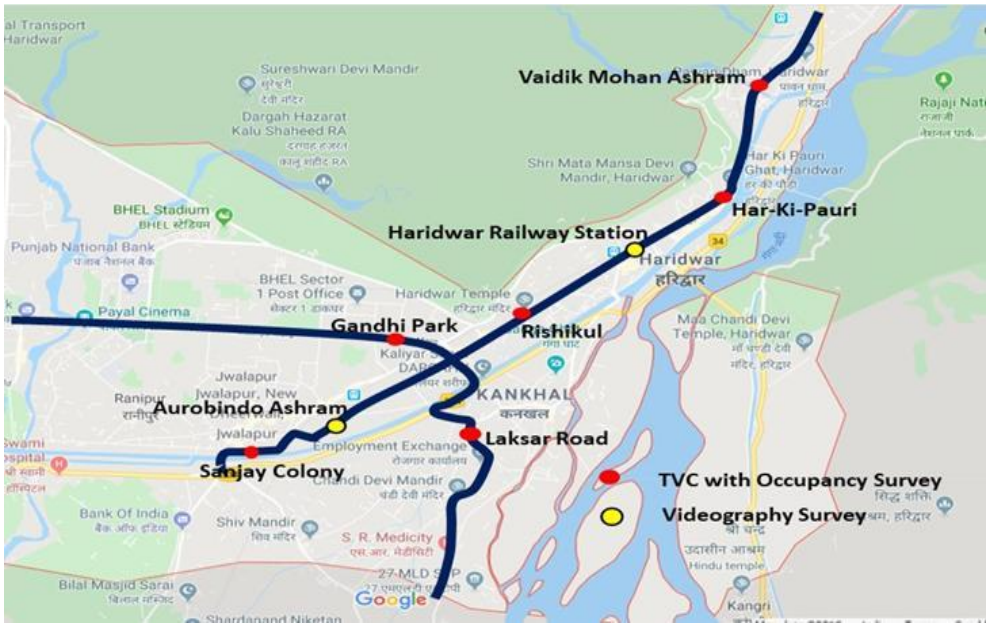

Figure 0-4: Survey Locations

Traffic Volume counts conducted at various locations along the project corridor provided an insight to the amount of traffic moving on various stretches of the corridor. Table below shows the average traffic volume observed at all individual locations.

Table 0-5: Traffic Volume Count (TVC) at Midblock Location (24 Hours)

Location ID	Mid-Block	Direction	Vehicles	PCUs	Total Vehicles	Total PCUs
MB1	Sanjay Colony	Towards Rishikesh	13,050	8,962	26,483	18,277
		Towards Sitapur	13,434	9,315		
MB2	Aurobindo Ashram	Towards Rishikesh	14,613	9,733	29,168	19,588
		Towards Sitapur	14,555	9,855		
MB3	Rishikul	Towards Rishikesh	14,891	11,453	30,206	23,186
		Towards Sitapur	15,314	11,734		
MB4	Railway Station	Towards Rishikesh	15,698	13,430	28,570	23,768
		Towards Sitapur	12,872	10,339		
MB5	Har-ki-Pauri	Towards Rishikesh	5,394	3,764	10,750	7,487
		Towards Sitapur	5,357	3,723		
MB6	Vaidik Mohan Ashram	Towards Rishikesh	7,151	5,064	13,779	9,781
		Towards Sitapur	6,628	4,717		
MB7	Gandhi Park	Towards Rishikul	14,611	10,135	28,871	20,054
		Towards BHEL	14,260	9,919		
MB8	Laksar Road	Towards Haridwar Main Road	16,167	11,442	31,286	22,019
		Towards Laksar	15,119	10,577		

The above Table represents average daily passenger traffic volume observed at individual locations for 24 hours. It can be noted that highest vehicular flow on Haridwar Old Road as 30,206 (23,186 PCUs) is observed at Midblock location MB3 i.e. Rishikul. However, vehicular traffic volume on Laksar Road is highest among all traffic volume count locations. Average daily vehicular traffic at Laksar Road is observed as 31,286 (22,019 PCUs). Due to narrow ROW and congestion of pedestrian pilgrimages, vehicular traffic volume on Haridwar Old Road after Valmiki Chowk towards Har-Ki-Pauri reduces to 10,750 vehicles (7,487 PCUs) per day.

(ii) Modal Split

Mode share of person trips was considered from OD survey conducted by the consultant. According to the observed modal split, it was found that only 6% daily trips are by bus and majority of trips consists of IPT (32%), two wheeler (39%) and car/ four wheeler (21%).

Table 0-6: Mode Share (%) of Motorized Trips

Mode	Percentage Share
Two Wheeler	38.5%
Car	21.3%
Tempo/Shared Auto	20.3%
E-Rickshaw	11.6%
Bus	5.9%
Cycle Rickshaw	2.4%
Total	**100%**

(iii) Pedestrian Count

Haridwar is visited by millions of tourists every year. It is the place where fairs are being organized with full enthusiasm round the year, such as Somwati Amavasya, Kartik Poornima, Shravan Poornima, Ganga Dussehra and other important bathing dates of Hindu calendar. To understand the impact of Poornima and Mela days, pedestrian count was conducted between Valmiki Chowk and Har-Ki-Pauri on Kartik Purnima day (11th November evening to 12th November evening) in 2019. Kartik Purnima was on 12th November in 2019. Har-Ki-Pauri is the most sacred ghat in Haridwar, where every pilgrim comes to take their holly bath, to sing their praises, to float earthen diyas, to see the Ganga Aarti and to enjoy the mela. It has been observed that the total pedestrian movement including both directions at that particular location was around 1.5 lakh in 24 hours. Occasional day (Poornima/ mela day) traffic for Haridwar Railway Station to Har-Ki-Pauri section is observed as 4.3 times of normal day average. Peak movement of 14,158 pedestrians is observed between 11:00 am to 12:00pm. The peak hour factor is 9.3%. The pedestrian movement is high during the daytime between 10 am to 4 pm.

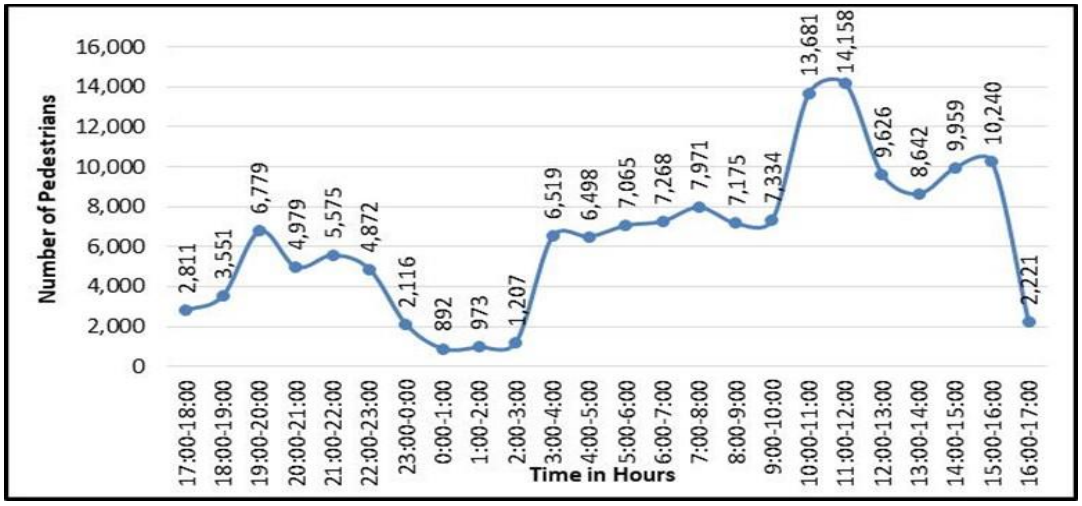

Figure 0-5: Hourly Variation of Pedestrians near Har-Ki-Pauri on Kartik Poornima Day, 2019

0.2.4 Option Evaluation and selection of Corridors

Initially the proposed PRT corridor in Haridwar city was conceptualised from Sitapur to Har-Ki-Pauri. However, estimated ridership for this independent Sitapur to Har-Ki-Pauri section found very low. Therefore, this corridor is proposed to extend till Motichur area from Har-Ki-Pauri and another corridor from Shivalik Nagar (BHEL Township) to DAV School on Laksar Road has also been proposed. Shivalik Nagar (BHEL Township) to DAV School corridor intersects the Sitapur to Motichur corridor at Chandra Arya Chowk near City Hospital. One more option is also conceptualised connecting Bharat Mata Temple and Daksh Temple to capture the additional potential pilgrims or tourists. With these different combinations of proposed PRT networks, a set of 7 possible alternative options have been conceptualised. These 7 options have been deliberated in detail in Chapter 2. Final stage evaluation based on passenger-km per unit of network-km for each option. After making detailed analysis and deliberations & discussions with the concerned authorities of Uttarakhand Metro Rail, Urban Infrastructure and Building Construction Corporation Ltd, it was decided that 20.74 km PRT network connecting all major temples and religious places were recommended for preparation of DPR as detailed below.

Table 0-7 Traffic Demand Forecast

Horizon Year	Corridor	Route Length (km)	Normal Day			Mela Day		
			Ridership	PHPDT	Average Trip Length in km	Ridership	PHPDT	Average Trip Length in km
2021	Sitapur - Bharat Mata Temple	14.55	54,608	1,819	5.03	1,25,059	4,393	4.1
2021	City Hospital - Daksh Temple	3.10	16,295	858	1.65	33,766	1,812	1.66
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,723	191	0.65	13,412	690	0.65
2021	Ganeshpuram - DAV School	2.40	7,015	366	1.9	16,821	905	1.98

Horizon Year	Corridor	Route Length (km)	Normal Day			Mela Day		
			Ridership	PHPDT	Average Trip Length in km	Ridership	PHPDT	Average Trip Length in km
	Total		**81,641**	**2,739**	**3.89**	**1,89,058**	**5,888**	**3.23**
2031	Sitapur - Bharat Mata Temple	14.55	84,449	1,412	5.08	1,71,530	2,828	4.57
2031	City Hospital - Daksh Temple	3.10	26,671	283	1.64	52,457	836	1.65
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,612	603	0.65	16,656	1427	0.65
2031	Ganeshpuram - DAV School	2.40	11,185	3,681	1.92	25,827	7,894	1.98
	Total		**1,27,917**	**1,892**	**3.89**	**2,66,470**	**3,741**	**3.50**
2041	Sitapur - Bharat Mata Temple	14.55	1,12,558	364	5.74	2,28,185	1,090	5.14
2041	City Hospital - Daksh Temple	3.10	35,642	776	2.06	69,355	1,857	2.08
2041	Valmiki Chowk - Laltaro Bridge	0.69	7,256	4,849	0.65	21,752	10,462	0.65
2041	Ganeshpuram - DAV School	2.40	14,372	2,446	2.24	33,547	4,862	2.32
	Total		**1,69,828**	**471**	**4.45**	**3,52,839**	**1,423**	**3.99**
2051	Sitapur - Bharat Mata Temple	14.55	1,45,939	953	5.78	2,97,100	2,360	5.18
2051	City Hospital - Daksh Temple	3.10	45,574	1,819	2.02	89,220	4,393	2.06
2051	Valmiki Chowk - Laltaro Bridge	0.69	9,393	858	0.65	28,337	1,812	0.65
2051	Ganeshpuram - DAV School	2.40	17,412	191	2.28	42,092	690	2.36
	Total		**2,18,318**	**366**	**4.495**	**4,56,749**	**905**	**4.03**

Table 0-8: Traffic Summary for PRT System in Haridwar City

Parameters	2021	2031	2041	2051
Section Length (in km)	20.74	20.74	20.74	20.74
Daily Ridership including Induced Traffic on Normal Day	81,641	1,27,917	1,69,828	2,18,317
Average Trip Length including Induced Traffic on Normal Day (in km)	3.89	3.89	4.45	4.49
Daily Ridership on Mela (Poornima) Day	1,89,057	2,66,470	3,52,839	4,56,749
Average Trip Length for Mela (Poornima) Day (in km)	3.23	3.50	3.99	4.03
Weighted Average Daily Ridership with Induced Traffic	**1,03,712**	**1,56,387**	**2,07,433**	**2,67,310**
Weighted Average Trip Length with Induced Traffic (in km)	**3.75**	**3.81**	**4.36**	**4.40**

Note - *Weighted Average Daily Ridership of PRT system in Haridwar has been calculated by considering 75 Mela Days and 290 Normal Days in a Year.*

0.3 MASS RAPID TRANSIT MODES AND MODE CHOICE

0.3.1 Comparison of Various Options

It is felt that a comparison of various modes needs to be done for taking decision for Personal Rapid Transit (PRT) system in Haridwar City. Such comparison is given in the table below.

Table 0-9: Comparison of Different Types of Mass Rapid Systems

Parameter	Heavy Metro	Medium Metro	Light Metro	LRT/ Metrolite	Electric Bus	PRT
Axle Load	17 T	16T	11T to 12T	12 T	10 T	1.5T
PHPDT range	More than 45000	More than 25000 and up to 45000	Up to 30000	More than 2000 and up to 15000	Up to 8000	Up to 10000
Number of cars	6 cars or more	4 to 6 cars	3 to 4 cars	3 to 9 units /cars train	Electric Bus	Pods
Car dimensions	2.9 m - 3.2 m wide, 22 m long	2.9 m - 3.2 m wide, 22 m long	2.65 m - 2.9 m wide, 22-23 m long	2.5 m to 2.65 m wide, length 11-12 m and unit length 33 m	Length 24 m, width 2.5 m	Length 3.7 m, width 1.47 m, height 1.8 m
Car capacity	300 persons per car	300 persons per car	300 persons per car	300 per train	150 per bus	6 persons/ pod
Viaduct particulars	Box Girder/ U-Girder/ double U-Girder/ I-Girder	Box Girder/ U-Girder/ double U-Girder /I-Girder	Box Girder/ U-Girder/ double U Girder /I-Girder	Box Girder/ U-Girder/ I- Girder	Box Girder/ U-Girder/ I-Girder	Steel Structure
Length of platform required	185 m to 210 m	140 m	80 m	50- 80 m	50 m	21m (4 Berth Station & 2 Sleeping Pod Bay)
CAPEX/km (Approx. ₹)	250 Crore	225 Crore	175 Crore	120 Crore	80 Crore	70 Crore
O&M/km	Depends on No. of passengers carried/ day and number of train trips.					
Deck width of viaduct	9 m to 10 m	8.5 m to 9.0 m	7.0 m to 8.5 m	7.0 m to 8.5 m	7.0 m to 8.5 m	4.2 m
Distance between pillars	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	18 m span
Speed (Maximum)	85 kmph	85 kmph	85 kmph	60 kmph	50 kmph	100 kmph

0.3.2 Recommendations

The screening has been done and concluded that PRT is the most suitable mode of transport for the second order transit system in Haridwar.

0.4 CIVIL ENGINEERING AND GEOMETRIC DESIGN PARAMETERS AND ALIGNMENT DESCRIPTION

0.4.1 General

This chapter deals with planning, design, civil elevated structure, station design, Geotechnical investigation, construction methods, land requirements, Utility services and Traffic diversion during construction etc.

0.4.2 Planning and Design

Planning:

Mobility and accessibility in particular, is an important element for people in the selection of their housing or place of work. Hence PRT system will be an integral part of the urban planning. The PRT network needs to be planned to provide the required capacity, while also minimizing its footprint to ensure space can be used for other activities. To be able to ensure the throughput of PRT system, avoiding the congestion on 'normal' roads and avoiding using the space at grade, leaving it for other activities such as walking, for other modes of traffic, parks etc. should be considered. PRT system requires a dedicated, grade-separated infrastructure (guideway). For PRT the popular choice is an elevated infrastructure, a result of the costs of underground installation and working within existing spatial planning in build-up areas. The elevated infrastructure ensures that many locations are easily reached. The design of the infrastructure is a vital element to ensure the width and visual intrusion are minimized. One clear aspect needing to be addressed is the accessibility of the stations. Where cars (and bikes) provide door-to-door transit (if parking is available at both origin and destination), the best effort for PRT requires a network with a high station density. Walking distances should be kept relatively small to improve the accessibility and the network will become more attractive to use for people in the catchment area of a station. This could impact the costs of the network, as stations are not located at grade.

Design:

The transit system is one of many elements within a city, with each element influencing and being influenced by all of the other elements. The PRT network needs to take into account that:

- Stations need to be featured near main attractors of traffic,
- Stations need to be spaced such that the walking distance is minimized,
- The exact location for a station is based on the space available at each location,
- The routes may be restricted by the current spatial planning,

- PRT tracks should preferably be one way,
- The junctions of the PRT network should preferably allow only merge/diverge manoeuvres,
- On- and off ramps are required near stations and at turns

The complexity in the design is matching the architectural needs of the city with the attraction of traffic to the characteristics of the PRT system. In parallel with the design of the route network, the locations of the PRT stations have to be determined, based on the requirement to ensure the maximum accessibility.

The construction of the guide way and the stations is a vital phase. Any problems for the public and the existing services taking place in the implementation environment should be minimized. This means flexibility is required: the ability to fit within the demanding space constraints and the ability for reconfiguration after installation.

Flexibility is an important issue in many developments. Cities are constantly changing and are subject to extensive and extended growth – especially in developing countries. Thus the flexibility to easily reconfigure a transport system to meet new needs is vital. The basic design approach and small scale of PRT systems provide considerable flexibility. The disturbance to operations caused by major rebuilding programs is a fact of life for most applications, but nevertheless remains a major issue and is a significant negative factor for larger scale systems. By comparison disruption caused by PRT is minimal. This is due to the far smaller scale of the infrastructure which can be largely prefabricated as modules off-site. Although some small scale ground works are inevitable the infrastructure as a whole can be installed in months. PRT offers the opportunity to alter column spacing with the same superstructure to overcome local ground features such as services, footways and roadways, and can operate on smaller radius curves so that fitting into existing built environments is more readily achieved.

The modular construction also allows elements to be removed and replaced within a short time (such as overnight) as part of route modification or extension. Stations are perhaps the more complex elements relative to the guide way. A station needs to accommodate the throughput expected, but can also be limited in its footprint and/or shape by the spatial planning in the area of realization. A ‘standard design’ for a PRT station (one-size-fits-all) is very unlikely and the stations most of the time will be designed to the surroundings. Although the need for multiple station designs can impact the design and construction costs, this is (partly) offset by being able to integrate the system in the most favourable location. Within stations there are different types of configurations, also dependent on the technology of the PRT system that also influences shape and size. Berths to allow arrival and departure of PRT PODs independently from each berth.

An important aspect to take into account is station access. With the guideway typically

constructed on an elevated level, there is a requirement for either the track to come down or the stations to be constructed elevated as well. Because of the space constraints the spatial planning in existing cities pose, bringing the track to grade level is typically not an option – the length of the guideway to reach ground level becomes restrictive of achieving this. Hence stations are constructed elevated, which means stairs, escalators and elevators need to be integrated – increasing the costs of the system. There are however opportunities to integrate the stations directly into buildings & pedestrian bridges. With the small cross section of the vehicles combined with low weight, the structural load can be easily accommodated on first or second floors in most buildings. Which means the existing stairs, escalators and elevators can also be used. For commercial buildings, this can generate similar store- front value to these upper floors as is often attributed today to the ground floor.

0.4.3 Station Design

PRT Stations are critical elements in PRT systems and ensuring that station capacity matches demand with limited passenger waiting time is an essential part of the system design process and each station should be designed for its specific location and passenger throughput characteristics.

An essential feature of PRT stations is that these are located “off line”, vehicles destined for the station, leave the online track and utilise track dedicated to the station function. This design of station must deal with track and structures used for:

- deceleration from the Online track line speed,
- vehicle queuing,
- vehicle berth(s) aligned to provide access to the passenger boarding area,
- the passenger waiting/ boarding area,
- ticketing area
- staircases, escalators, elevators
- public amenities such as toilet & shops
- vehicle manoeuvring space to re-join station track,
- Acceleration to re-join the online track at line speed.

Station Track Configuration

The components of station track should include;

- turnout from Online track,
- deceleration track leading up to queue point and low speed vehicle manoeuvring area,
- acceleration track, and
- merge track to re-join the online track

PRT systems use offline stations so that all vehicles can have very short headway. An Offline Station is a station which allows a vehicle to stop while other vehicles pass without stopping at PRT Stations.

PRT stations are typically created off-line because of the number of vehicles and the short headways. For both off-line and on-line stations there are several standard designs that can be readily implemented.

All stations should be designed individually to ensure optimal integration within the local spatial planning (space available) for that particular station.

The size (length and width), platform and track layout for each station will always be based on the capacity required, the traffic intensity expected and the desired image of the location. When capacity requires, a station can feature multiple (independent) berths – allowing for multiple vehicles being boarded at the same time, ensuring a higher throughput, eliminating single-point-of-failure vulnerability and thus increasing system availability.

Each station might have multiple births, with perhaps one-third of the vehicles in a system being stored at stations waiting for passengers. Elevators and escalators have been provided for accessibility to the concourse level.

The nearest PRT station will be approximately 600-800 m away, so that the commuters can easily walk there. To reach the platform level, passengers have to take stairs or elevator from the footpath level. They can buy the ticket or can use the smart card / Mobile apps. Further they need to feed the information for their destination and based on it the system programs the vehicle with passenger's trip information.

Moving to the boarding turnstile, a vehicle is either waiting (empty pods would be lined up at stations until needed) or will arrive shortly, as the pod requirement button is pressed and the destination is fed in the system. As the passenger board the vehicle, the door closes, and the push button is pressed to signal that the passenger is ready to go. PRT offers a non-stop trip, which is faster and takes lesser time in reaching the desired destination. After finishing the first journey, the pod immediately becomes available for the next rider.

Stations may be located above, at, or below ground, or, due to the system's virtually silent nature, inside the buildings. Stations can be enclosed or open-air, will always provide at least a minimal covering above the berth area and are designed to be suitable for 24-hour operation.

0.4.4 Station Elements

The PRT Station design comprises the following elements:

- **Berth** - (vehicle docking point, interfaces, buffer + charging equipment). Berths are the docking point where the vehicles wait for the passengers and from where passenger can board the vehicle.
- **Passenger Interface** (at each berth): Destination selection console,
- **Plinth** (where required, raised floor for passenger level access to vehicles)
- **Envelope** (passenger weather protection + vehicle movement area segregation screen)
- **Canopy** passenger area roof + vehicle solar shading)

0.4.5Description of Route Alignment of PRT Corridor

The details of the proposed PRT corridors are as follows:

Table 0-10 : Proposed PRT Corridors

S. No.	PRT Corridors		Route Length (km)	Station Details
1	Corridor 1	Sitapur to Bharat Mata Temple	14.55	14 Stations including two interchanges
2	Corridor 2	City Hospital to Daksh Temple	3.10	4 Stations including two interchanges
3	Corridor 3	Valmiki Chowk to Laltaro Bridge	0.69	2 Stations including one interchange
4	Corridor 4	Ganeshpuram to DAV School	2.40	2 Stations including one interchange

- **Corridor 1- : Sitapur to Bharat Mata Temple**

This Corridor is planned as fully elevated corridor starts from Sitapur runs along Jwalapur Road, Haridwar Main Road, Upper Road, Haridwar-Motichur Road, Haridwar – Rishikesh Road (NH 334) and Sapta Rishi Road and terminates at Bharat Mata Temple. The total length of the Corridor is 14.55 km with 14 stations.

- **Corridor 2- : City Hospital to Daksh Temple**

This Corridor is planned as fully elevated corridor starts at City Hospital and have interchange

connectivity with Sitapur – Bharat Mata Temple PRT Corridor at this location runs along Bye pass road crosses Ganga canal and Roorkee - Haridwar Road (NH-334) and further runs along Bhairav Mandir Road, take left turn and runs along Jwalapur Road, take right turn and runs along Laksar Road, take further left turn and run along Gurubaksh Vihar Road and thereafter take right turn, runs along Daksh Mandir Road, and terminates near Daksh temple. The total length of the Corridor is 3.10 km with 4 stations.

- **Corridor 3- : Valmiki Chowk to Laltaro Bridge**

This Corridor is planned as fully elevated corridor starts at Valmiki Chowk and have interchange connectivity with Sitapur – Bharat Mata Temple PRT Corridor at this location The alignment starts at Valmiki Chowk runs towards Laltaro Bridge crosses Ganga canal and take left turn runs alongside of Roorkee - Haridwar Road (NH-334) and an off–road PRT station viz bridge is planned near parking area. This station is planned to be integrated with proposed Haridwar – Rishikesh MetroLite Corridor at this location. The total length of the Corridor /spur is 0.69 km with 1 PRT station.

- **Corridor 4- : Ganeshpuram to DAV School**

This Corridor is planned as fully elevated corridor starts at Ganeshpuram and has interchange connectivity with City Hospital –Daksh Temple PRT Corridor at this location. The alignment starts at Ganeshpuram runs along Laksar Road for about 2.38 km upto DAV school. On this stretch 2 PRT stations are planned namely Jagjeetpur and 'DAV School 'at Chainages 895 m and 2280 m respectively. The corridor terminates at Chainage 2379.30m. The total length of the Corridor /spur is 2.4 km with 2 PRT station.

Index plan showing the route alignment and station locations of above PRT corridors is given in Annexure 0.1.

0.4.6 Guideway

PRT system uses a dedicated guide way, which can be constructed elevated, underground, embedded in buildings. The dedicated guide way ensures the congestion of normal city streets is avoided and supports system safety. PRT system uses a simple, completely flat guide way – comparable to normal roads. Optionally the track only consists of two asphalt rails (instead of paving the entire track width). Standard elevated Guideways to be fabricated in steel would be 6 m to 9 m high with ramping up and ramping down depending on locations as and wherever required as non-standard ones. Online tracks bypass the stations without any turning by just moving to 10 mtr over the stations and station entry / exits happen at 6 m level.

Guideways will be of various designs, such as, single guideway, double guideway on single stack, single guideway with double stack, double guideway with double stack, triple guideway, triple guideway with double stack, etc. depending on site context. Broadly, both track at same

level or tack above other track (F type) will commonly use along the entire route. F-type track will majorly be implemented on the single road (without a median) and will be placed on the side pathway. Apart from this all the track will be laid on the road median. The exact locations of placement of columns with various combinations would be worked out only after detailed engineering is finalized. However, in general the columns would be designed for standardized span length of 18 m to 20 m and non-standard spans would be used in the curved stretch and to clear any site specific conflict.

Guideway supports will be of different types, namely, single column, double columns as portal frame, columns with cantilever support, etc. depending upon the road widths available, underground existing storm water and sewerage lines alignment and building projections etc.

To enable automated operations, passive reference points (magnets) are embedded in the road surface every 4 meters. There is no requirement for any physical guidance (rail) or other guiding infrastructure elements (kerbs and/or walls), making the system less vulnerable (more reliable) and ensuring reduced capital and maintenance costs.

Where spatial planning allows the track can be constructed at grade, realizing significant cost advantages and avoiding visual intrusion. Although the PRT system is equipped with obstacle detection systems to prevent collisions, people should be discouraged from entering the track as this will disturb operations.

PRT system allows for customization of (each section of) the guide way to achieve a natural fit with the environment. Typically, a PRT system will be build-up of multiple (intersecting) single lane loops. Depending on the area of operation, a section of a loop could be constructed elevated or at grade. Even though systems are engineered to maximize safety and reliability performance, the eventuality of evacuation should be taken into account.

0.4.7 Road width required during construction

As most of the construction is to be carried out on the middle of the road, a width of about 5 to 7 m will be required for construction activities, during piling and open foundation work and the same will be barricaded. It is proposed that necessary traffic management plan during construction by diversion/rerouting of traffic, if necessary. In certain cases, one-way traffic may be resorted to. The implementing agency has to take up the following preliminary works on priority to ensure no delay in implementing the project:

- Preliminary action for diversion of utility and preparation of estimates thereof.
- Reservation of land along the corridor, identification and survey for acquisition

0.4.8 Land

In order to minimise land acquisitions and to provide good accessibility form either directions, the PRT alignment is located mostly along the centre of the roads, which lie on the corridor. But, at some locations the geometrics of the roads especially at road turnings may not match with geometric parameters required for PRT systems. In such cases, either the alignment will be off the road or some properties abutting the road would get affected. Further, some land is required for various purposes as detailed below:

0.4.9 Land Requirement for following Major Components

- PRT Structure (including Route Alignment), Station Building, Platforms, Entry/Exit Structures, Traffic Integration Facilities, Depots, etc.
- Temporary Construction Depots and work sites.
- Maintenance Depot and operation control centre (OCC)

0.4.10 Summary of Land Requirements

Abstract of land requirements for different components of this corridor is given in the Table below.

Table 0-11: Summary of Permanent Land Requirement *

S. No.	Corridors	Stations (sq. m)	Depot (sq. m)	Running Section (sq. m)	PD Land (Ha) #
1	Sitapur to Bharat Mata Temple	1867.20	17370.00	2442.10	10.00
2	City Hospital to Daksh Temple	326.80			
3	Valmiki Chowk to Laltaro Bridge.	2288.10			
4	Ganeshpuram to DAV School	398.00			
	Total	**4880.10**	**17370.00**	**2442.10**	**10.00**

Govt land near DAV school will be provided by GoUK free of Cost

S. No.	Description	Govt. Land (sq. m)	Private land (sq. m)	Total (sq. m)
1	Stations	3815.80	1064.30	4880.10
2	Running Section	1632.50	809.60	2442.10
3	Depot	17370.00	0	17370.00
		Gross Total Land		**24692.20**

*Apart from land required as mentioned in above table, in case Entry/Exit structure of stations constructed outside Master plan ROW, then 1-1.5 Hectare additional land will be required.

0.5 STATION DETAILS

The proposed Haridwar PRT system will comprise of 4 PRT Corridors aggregating to 20.74 km with 21 stations. The main purpose is to provide seamless connectivity across the city, commercial zones, Railway Station, Bus Stand, tourist places like Har-Ki-Pauri Mansa Devi Temple, Bharat Mata Temple, Daksh Temple etc. PRT stations are located at major transit

area with high footfall and are planned for to connect important tourist attractions at Haridwar. Stations are planned within the walkable distances for the passengers from their origin/destinations. Maintenance yard and a control room for the operation and maintenance of the full system are planned at Maintenance Depot near Rishikul.

List of Stations for the Haridwar PRT Systems are given below:

Table 0-12: Stations along the corridors

S. No.	Station Name	Chainage	Inter station Distance (m)	Track Level from Ground (m)*	Platform Type	Alignment
Corridor 1: Sitapur to Bharat Mata Temple (14 Stations including Two interchange)						
1	Sitapur	-29.90	75.1	10.309	Type-1	Elevated
2	Jwalapur	398.6	428.5	10.052	Type-2	Elevated
3	Arya Nagar	1704.1	1305.5	9.979	Type-2	Elevated
4	Ram Nagar	2762.6	1058.5	10.178	Type-2	Elevated
5	City Hospital	3760.2	997.6	10.927	Type-1, Interchange	Elevated
6	Rishikul	4709.5	949.3	10.278	Type-1	Elevated
7	Haridwar Trackway Station	6119.5	1410.0	10.030	Type-2	Elevated
8	Valmiki Chowk	6781.2	661.7	10.626	Type-1A, Interchange	Elevated
9	Mansadevi Ropeway Gate	7638.2	857.0	12.601	Type-4	Elevated
10	Har-Ki-Pauri	8130.0	491.8	12.645	Type-4	Elevated
11	Kharkhari	9519.6	1389.6	10.054	Type-2	Elevated
12	Motichur	10925.2	1405.6	10.374	Type-1	Elevated
13	Shantikunj	13278.4	2353.2	12.052	Type-3	Elevated
14	Bharat Mata Temple	14382.4	1104.0	13.559	Type-1B	Elevated
Corridor 2:City Hospital to Ganeshpuram (Terminal) (4 Stations including two Interchange)						
15	Kankhal Chowk	598.4	598.4	28.751	Type-3	Elevated
16	Kankhal	1127.8	529.4	12.225	Type-3	Elevated
17	Ganeshpuram	1976.8	849.0	10.952	Type-1A, Interchange	Elevated
18	Daksh Temple	3018.2	1041.4	8.047	Type-3	Elevated
Corridor 3: Valmiki Chowk to Laltaro Bridge (1 Stations including one interchange)						

S. No.	Station Name	Chainage	Inter station Distance (m)	Track Level from Ground (m)*	Platform Type	Alignment
19	Lal Taro Bridge	620.6	620.6	10.472	Type-1	Elevated
Corridor 4: Ganeshpuram to DAV School (2 Stations including one interchange)						
20	Jagjeetpur	860.1	860.1	12.025	Type-3	Elevated
21	DAV school	2275.0	1414.9	12.049	Type-2	Elevated

0.6 OPERATION PLAN, DEPOT & MAINTENANCE FACILITIES

0.6.1 Introduction

The mobility factor and required transport demand forecast is the governing factor for the choice of the PRT Pods. As per the Alternatives Analysis Study Report, Dehradun, Haridwar and Rishikesh &as per Comprehensive Mobility Plan for the Metropolitan Area, Final Report, January, 2019 prepared by M/s UMTC, recommended for the PRT system on this alignment. The proposed Personal Rapid Transit (PRT) system is an innovative on-demand system for urban environments. The system uses driverless electric vehicles that run on a dedicated network of guide ways. The lightweight and flexible nature of the system enables it to be retrofitted into a broad range of environments and provide seamless transportation that is environmentally friendly and operationally efficient.

0.6.2 Optimization of Car Size

The following optimum size of the car, as opted for this corridor, has been chosen for this corridor as mentioned in the Table below.

Table 0-13: Size of the car

Description	Length	Width	Height
POD (PRT) Cars	3.5 m to 4 m	1.4m to 2 m	1.8m to 2.4 m

0.6.3 Passenger Carrying Capacity

The seats are facing front and rear of the cars proving flexible accommodations for 4 to 6 passengers.

Passenger capacity of a car is maximized in a PRT System by providing front & rear of cars for seating and utilizing the remaining space for using the passenger bags or the wheel chair of specially-abled passenger. Therefore, all the equipment's are mounted on the under frame for maximum space utilization. Interior panel is well flushed with high glass acrylic capping. Interior panel have equipped with sufficient lighting and vehicle signs, symbols, warnings & other passenger safety information. All safety switches should have illuminated for passenger's

usage.

0.6.4 Operation Philosophy

The underlying operation philosophy is to make the PRT System more attractive and economical, the main features being:

- Selecting the most optimum frequency of Pod Car services to meet sectional capacity requirement during peak hours on most of the sections.
- Economical & optimum train service frequency not only during peak period, but also during off-peak period.
- Optimization of system reliability for achieving best possible availability on line.
- A Pod Car of having 4 to 6 passenger capacity with high frequency service.
- Multi-tasking of operation and maintenance staff.

0.6.5 PRT Operation Plan

PRT operation plan with Pod Cars with carrying capacity of 6 persons for the Haridwar PRT Systems are being planned: for all the 4 corridors in the year 2021, 2025, 2031, 2041 and 2051 are given below:

Table 0-14 : Planned rakes as per TOP

Year	No. of Pod Cars
2021	462
2025	514
2031	659
2041	829
2051	1003

The PHPDT capacity provided on the route in different years of operation is tabulated below:

Table 0-15 : Capacities Provided for Haridwar PRT System for Normal day

Corridors	Particular	2021	2025	2031	2041	2051
All Corridors	Car	1	1	1	1	1
Corridor 1a (Sitapur – City Hospital)	Headway(sec.)	22	16	12	8	6.5
	Max. PHPDT Demand	654	894	1253	1707	2225
	PHPDT Capacity available	655	900	1200	1800	2215

Corridors	Particular	2021	2025	2031	2041	2051
Corridor 1b (City Hospital – Har-Ki-Pauri)	Headway(sec.)	8	6.5	5	4	3
	Max. PHPDT Demand	1819	2187	2739	3681	4849
	PHPDT Capacity available	1800	2215	2880	3600	4800
Corridor 1c (Har-Ki-Pauri – Bharat Mata Temple)	Headway(sec.)	12	11	9	6.5	5
	Max. PHPDT Demand	1124	1322	1619	2155	2799
	PHPDT Capacity available	1200	1309	1600	2215	2880
Corridor 2 (City Hospital – Daksh Temple	Headway(sec.)	17	13	10	7.5	6
	Max. PHPDT Demand	858	1080	1412	1892	2446
	PHPDT Capacity available	847	1108	1440	1920	2400
Corridor 3 (Valmiki Chowk – Laltaro Bridge)	Headway(sec.)	75	63	50	40	30
	Max. PHPDT Demand	191	228	283	364	471
	PHPDT Capacity available	192	229	288	360	480
Corridor 4 (Ganeshpuram – DAV School)	Headway(sec.)	39	31	24	18	15
	Max. PHPDT Demand	366	461	603	776	953
	PHPDT Capacity available	369	465	600	800	960

Note:- Corridor 1 has been divided in 3 loops to optimize the PHPDT demand and capacity.

Table 0-16: Capacities Provided for Haridwar PRT System for Mela Days

Corridors	Particular	2021	2025	2031	2041	2051
All Corridors	Car	1	1	1	1	1
Corridor 1a (Sitapur – City Hospital)	Headway(sec.)	10	7.5	5	4	3
	Max. PHPDT Demand	1429	1953	2739	3745	4949
	PHPDT Capacity available	1440	1920	2880	3600	4800 (7200) #
Corridor 1b (City Hospital – Har-Ki-Pauri)	Headway(sec.)	3	3	2.5	2	2
	Max. PHPDT Demand	4393	4991	5888	7894	10462
	PHPDT Capacity available	4800	4800	5760	7200 (10800) #	7200 (10800) #
Corridor 1c	Headway(sec.)	13	10.7	9	7	5

Corridors	Particular	2021	2025	2031	2041	2051
(Har-Ki-Pauri – Bharat Mata Temple)	Max. PHPDT Demand	1141	1343	1645	2191	2837
	PHPDT Capacity available	1108	1346	1600	2057	2880
Corridor 2 (City Hospital – Daksh Temple	Headway(sec.)	8	7	5	4	3
	Max. PHPDT Demand	1812	2218	2828	3741	4862
	PHPDT Capacity available	1800	2057	2880	3600	4800
Corridor 3 (Valmiki Chowk – Laltaro Bridge)	Headway(sec.)	20	20	17	13	10
	Max. PHPDT Demand	690	748	836	1090	1423
	PHPDT Capacity available	720	720	847	1108	1440
Corridor 4 (Ganeshpuram – DAV School)	Headway(sec.)	16	13.5	10	8	6
	Max. PHPDT Demand	905	1114	1427	1857	2360
	PHPDT Capacity available	900	1067	1440	1800	2400

Note: - Corridor 1 has been divided in 3 loops to optimize the PHPDT demand and capacity.

 # The maximum capacity has been considered with 4 passengers per car only, however the maximum passenger capacity in a car/Pod is 6, so for Year 2051& 2041 Mela Day Passenger Carrying capacity with 6 passengers per car is more than the traffic demand requirements.

0.6.6 PRT Maintenance Depot

It is proposed to establish one depot- cum- workshop with following functions and facilities:

- Major overhauls of all the Cars.
- All minor schedules and repairs.
- Lifting for replacement of heavy equipment and testing thereafter.
- Repair of heavy equipment.
- Layout of Parking area, Inspection area, minor repairs and heavy repair overhauling workshop and cleaning of Pod cars.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage

The Depot planning is based on following assumptions

- Enough space should be available for establishment of a Depot-Cum-workshop.
- All inspection, workshop and parking area are designed to accommodate Maximum no. of cars.
- Only 1/4th of Pod cars parking facilities are planned in the proposed depot-cum-workshop and other 3/4th Pod cars parking facility should be provided on mainline to reduce the dead mileage and maintained the high frequency of headways in seconds.
- In case of space constraint for depot two storied parking area can also be planned.

0.7 POWER REQUIREMENTS

Power supply is required for charging of Pod cars, station services (e.g., lighting, lifts, escalators, signalling & telecom, fire-fighting, etc.) and workshops, depots & other maintenance infrastructure within premises of PRT system.

The report consists of providing the detail for Electrical Power consumption of the 21 nos. of PRT Stations and a maintenance yard including control room for the PRT system of Haridwar. There are three type of station 1st type having 2 berths platform, 2nd type having 4 berths platform and 3rd is 6 berths platform stations. In which 7 no's of stations of 2 berths, 4 berths & 6 berths platform are planned.

It has been assumed to take the power supply feeder from local distribution agency to feed each PRT stations. All the PRT stations shall take electricity supply from the existing Distribution company substation. For emergency supply, UPS & Inverter shall be provided on each station and interchange and terminal station have facility of Diesel Generator.

The Maintenance yard has its own 11 KV HT Panel, Transformer & LT Panel. The power requirement of the maintenance yard is higher due to the 50 Nos. of charging points will be provided for Pod cars charging. Diesel Generator shall be provided for essential requirement of the Maintenance Yard.

The power requirements of a PRT system are determined on peak-hour demands of power requirements. Broad estimation of power demand is made based on the following requirements:

- Elevated station load with 250 – 370 KW (each)
- Depot load – 870 KW

Keeping in view of the PRT operation plan and demand of power requirements projected for the year 2021, 2025, 2031, 2041 and 2051 are summarized in table 0.16 below:

Table 0-17: Power Demand Estimation*

PRT Corridors	Load	Total Power Consumption (Year)				
		2021	2025	2031	2041	2051
All Corridor's total power Demand	AUX.	7.0 MW	7.0 MW	7.0 MW	7.7 MW	8.5 MW

**The demand estimation for year 2041 & 2051 has been escalated 10 % from 2031 and 2041 respectively due to Pod car requirements and the detailed calculations of power demand estimation are provided in chapter 7.*

0.7.1 Need for High Reliability of Power Supply

The proposed Haridwar PRT system is being designed to handle about 4393 passengers per direction during peak hours when cars are expected to run within seconds of intervals in 2021 or so. Interruption of power at night is likely to cause alarm and increased risk to travelling public. Lack of illumination at stations, non-visibility of appropriate signage's, disruption of operation of lifts and escalators is likely to cause confusion, anxiety and ire in commuters, whose tolerance level are low on account of stress. Effect on signal and communication may affect PRT operation and passenger safety as well. Therefore, uninterrupted power supply is mandatory for efficient operation of this PRT system to ensure reliability of power supply, it is essential that two sources of power Supply at each station with auto transfer switch for reliably and have adequate redundancies.

0.8 SIGNALING AND PRT CONTROL SYSTEM

The Signalling system shall be designed so as to provide the highest level of safety &security along with efficiency in PRT services / operations. It consists of following functions:

- Central control
- Autonomous Vehicle Control
- Automatic Vehicle Protection System (AVP)

0.8.1 System Description and Specifications

Requirements of the PRT are planned to be achieved by adopting Central control system based Autonomous Vehicle Control and Automatic vehicle Protection System as detailed below:

0.8.2 Central Control

The central control system is heart of the PRT concept. Each POD has its own control system which is driving the POD but there is a central control system which acts a bit like air traffic control.

Once the passenger has confirmed their destination, central control immediately begins the process for carrying out their chosen journey.

It ensures all vehicles launched on non-conflicting paths. The central control system responds to the passenger's request by allocating a vehicle for the journey and instructing the vehicle on the required path and timing for that journey. The Major functions of central control system are as follows:

- Routing and scheduling of vehicles
- Empty vehicle movement management
- Fault detection and response
- Display of system information to Network Controllers

0.8.3 Autonomous Vehicle Control

The system will maintain vehicle to prescribed path using sensors. Once the vehicle has received its instructions from central control it will continue to its destination without any need for further central control input. On arrival at the destination station further instructions are received to specify the berth or wait point for the vehicle to go to.

Sensing technology is used in the existing PRT system to provide both lateral and longitudinal navigation information that the vehicle uses to determine its exact location within the guideway and so follow a specified path and speed profile to complete the desired journey. Additionally, embedded guideway transponders are also used to confirm vehicle locations when required, for example at station berths. The vehicle control system is also fed a variety of inputs from sensors that allows it to constantly monitor the vehicle status. A HUMS (Health and Usage Monitoring System) processes these inputs to confirm that all vehicle systems are operating within normal limits. If any of these parameters fall outside the expected range this is flagged, and the vehicle can perform any appropriate response. This allows many vehicle problems to be captured early, before they become critical and have any effect on the vehicle, so minimising impact on network operations.

In order to ensure the better & effective control mechanism, tests of existing & new vehicle control technologies should be carried out. We should examine various control methods based

on next generation GPS Lateral/Longitudinal Guidance, embedded guideway magnets, latest's optical and radar sensing technologies, embedded guideway transponders and local sensors based on Ultrasonic or appropriate sensors.

Once allocated a route by the central control system, each vehicle exploits telematics and IT technology to operate relatively autonomously. For instance, ultrasonic and appropriate sensors embedded around the outside of the vehicle read indentations on the sides of the track and, enabling the vehicle to know its exact position both laterally and longitudinally.

0.8.4 Automatic Vehicle Protection System

The system will use moving block signalling to ensure vehicle separation. Vehicles far enough behind the stopped vehicle would either be pulled into a nearby station or be rerouted onto a different branch of the network before reaching the incident, in order that they could avoid the blocked link.

0.8.5 Headway

Spacing of vehicles on the guideway influences the maximum passenger capacity of a track, so designers prefer smaller headway distances. Computerized control theoretically permits headway up to two-second recommended for cars at an operating speed (Maximum) of 90 kmph and max, since multiple vehicles can be braked simultaneously.

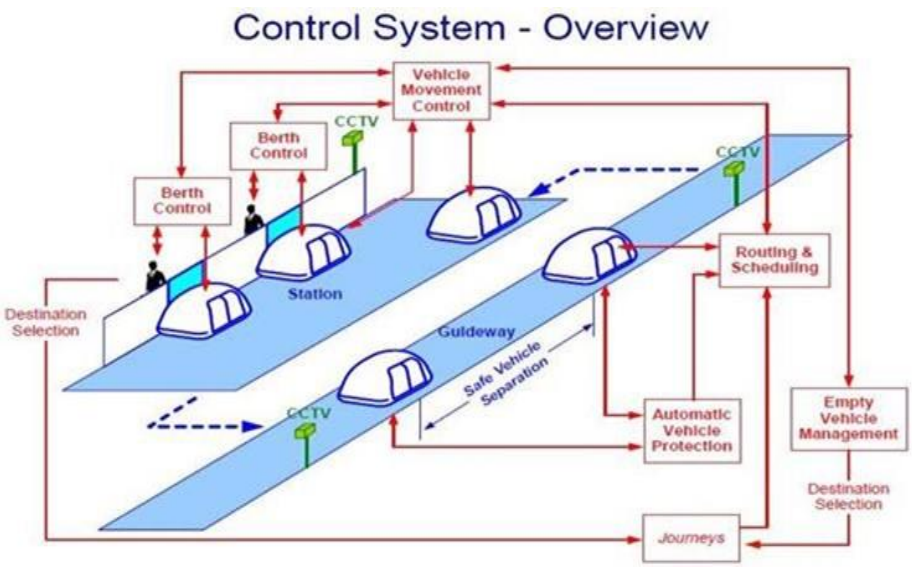

Figure 0-6: Overview of Heathrow PRT Control System

0.8.6 Telecommunication System

The communication system handles the transmission of critical control and status messages

and exchange of other information between the control system and PRT vehicles. The communications system is a vital part of the PRT operation, delivering routing and scheduling instructions to the vehicles from a central control centre, and communicating their progress and status back to control. For the communication among vehicles as well as with the elements of the network infrastructure (stations, intersections etc.) the wireless communication (Radio based) system is used. Therefore, the control structure of PRT is a complex, distributed, real-time system.

0.8.7Fare Collection System

The PRT stations, in all the locations will be integrated. The ticket management system will curtail the time spent by passengers in procuring tickets before boarding the PRT vehicle. All conventional ticketing methodologies are possible including:

- Automatic Ticketing machines
- Manned Ticket offices
- Smartcard systems

0.9 DISABLED FRIENDLY FEATURES

The objective of making this chapter is to create a user-friendly Personal Rapid Transit (PRT) system in India which can ensure accessibility to persons with disabilities, people travelling with small children or are carrying hand bag, as well as people with temporary mobility problems (e.g., a leg in plaster) and the elderly persons.

The design standards for universal access to Public Transport Infrastructure including related facilities and services, information, etc. would benefit people using public transport.

The access standards given here are extracted from Indian Roads Congress Code, IRC 103: 2012, Guidelines for Pedestrian Facilities; Model Building Bye-Laws, 2011 and National Building Code, 2005. Central Public Works Department's (CPWD) "Space Standards for Barrier Free Built Environment for Disabled and Elderly Persons", 1998 and 2013 edition (under revision by MoUD), and international best practices / standards. Further, it has also been attempted to provide guidelines/ standards for alighting and boarding area, approach to station, car parking area, drop-off and pick-up areas, taxi/auto rickshaw stand, bus stand/stop, footpath (sidewalk), kerb ramp, road intersection, median/pedestrian refuge, traffic signals, subway and foot over bridge etc. to achieve a seamless development around PRT stations.

0.10 EIA AND SIA STUDY FOR THE PRT SYSTEM

The present study has been carried out for assessing the Environmental and Social Impacts for the proposed corridor. The report is prepared on the basis of primary data collection at site, in addition to secondary data. The environmental study is carried out for the PRT alignment in Haridwar City (Uttarakhand).

0.10.1 Project Proponent and Proposal

Uttarakhand Metro Rail Corporation (UKMRC) is the project proponent for the proposed PRT project. Detailed Project Report (DPR) is being prepared by DMRC. The proposed corridor interconnects various religious sites in Haridwar where people visit from different parts of country. The route length of the PRT corridors is 20.74 km with 21 stations.

0.10.2 Objective and Scope

- The objective of the EIA &SIA study is to identify potential environmental and social impacts of the proposed Personalized Rapid Transport (PRT) and formulate strategies to avoid / mitigate the same.
- The scope of work to accomplish the above objective, comprise the following.
- Review literature and to collect data relevant to the study area;
- Conducting reconnaissance survey, field visits and study of Google earth maps for selection of sampling and monitoring locations for various environmental components;
- Understanding, collection compilation and collation of the baseline environmental data and conditions of the project area;
- Identifying the potential environmental impacts of the project proposal;
- Recommending appropriate mitigation measures to avoid/ minimise the environmental impacts; and
- Preparing an environmental management plan for implementation.

The environmental studies have been confined to the situation around the deemed areas of direct influence caused by constructional and operational facilities along the proposed alignment. The report is prepared on the basis of collection of primary data at site, in addition to secondary data.

0.10.3Approach and Methodology

The alignment was fixed based on technical feasibility, socio-economic acceptability, and environmental sustainability for PRT Corridor. The environmental study is carried out for the alignment proposed by DMRC. The approach is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in

different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analysed and quantified, wherever possible. The analysis of assessment depends upon the reliable data generated/ available on environmental attributed. This study has documented the baseline data for various parameters of physical, ecological and environmental pollution (air, water, noise and vibration). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,
- Impacts due to project design,
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs were estimated and budgeted for.

0.10.4 Loss of Vegetation/ Trees

Trees have been counted along the PRT alignment including station areas. Tree with Girth at Breast Height (GBH) 30 cm have been counted in Right of Way (ROW) as per the alignment drawing. The alignment does not pass through any forest area. A total of 244 trees have been found in the project area including station areas and corridor running section. The details are given in the Table below.

Table 0-18 : Details of Trees on PRT Corridor

S. No.	Corridor	Number of Trees
1	Sitapur	25
2	Sitapur to Ram Nagar	15
3	Ram Nagar to Railway Station	59
4	Valmiki Chowk	12
5	Lal Taro Bridge	19
6	Motichur	3
7	City Hospital to Daksha Temple	104
8	Ganeshpuram	3
9	Jagjeetpur	4
	Total	**244**

A total 244 trees are located in the Right of Way (ROW) of corridor. An attempt will be made to minimize the tree felling by cutting only those trees which will be essentially required for the working. Trees are assets in purification of urban air, which by utilizing CO_2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

- Total number of Trees: 244
- Decrease in CO_2 absorption @ 21.8 kg/year/ tree : 42.55 tonnes
- for 8 years
- Oxygen production @ 49 kg/year per tree for 8 years: 95.65 tonnes

The average consumption of oxygen for a person is about 182 kg/ year. It means these trees will meet the requirement of about 525 people round the year. There will be plantation of three times of felled trees as compensatory a forestation which will exceed the generation of oxygen and absorption of carbon dioxide over time.

0.10.5 Environmental Monitoring Plan

Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels and water quality. The number could be modified based on need when the construction actually commences. The monitoring Schedule for Water Air, noise and ecology are presented below:

Table 0-19 : Construction Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM_{2.5}$	2×24hours Twice/month During entire civil construction stage or even later, if directed by UKMRC	21 locations (at station)
Water	Ground-water quality (IS 10500:2012)	Once a months During entire civil construction stage	7 locations
Noise	Noise Level (Leq and Lmax)	24hours Once/ Month During entire civil construction stage or even later, if directed by UKMRC	21 locations

Operation Phase

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, water, waste water, solid waste and ecology during operation phase of the project. The parameters monitored during operation will be PM 2.5 and PM10 for air, pH, TSS, BOD, COD, oil and grease for waste water. However, water quality parameters that will be monitored will be as per BIS 10500:2012. The monitoring program shall be conducted by an external agency under the supervision of UKMRC officials. The UKMRC will be responsible for successful environmental monitoring of the proposed project during operation phase in the Table below.

Table 0-20 : Operation Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM_{2.5}$	24hours twice a year for 1.5 years	10 locations
Noise	Noise Level (Leq)	24hours Twice a year for 1.5 years	10 locations

The results of Air quality, water quality, noise and vibrations will be submitted to management quarterly during construction phase and as per schedule during operation phase.

The proposed PRT Corridor is proved to have significant positive effects for the development of Haridwar. Benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, and air quality improvement are the obvious positive effects from these PRT corridors. Appropriate mitigation measures have been developed for consideration. The ESIA concludes that project impacts from both construction and operation will be minimal, and can be mitigated through the use of prevailing current practices and appropriate technologies. With the implementation of the EMP and the monitoring plan, the Project is not expected to have significant environmental impacts.

0.11 SECURITY MEASURES

Personal Rapid Transport (PRT) system is emerging as the most favoured mode of urban transportation system. The inherent characteristics of PRT system make it an ideal target for terrorists and miscreants. PRT systems are typically open and dynamic systems which carry thousands of commuters. Moreover, the high cost of infrastructure, its economic impotence, being the life line of city high news value, fear & panic and man casual ties poses greater threat to its security. Security is a relatively new challenge in the context of public transport. It addresses problems caused intentionally. Security differs from safety which addresses problems caused accidentally. Security problems or threats are caused by people whose actions aim to undermine or disturb the public transport system and/or to harm passengers or staff. These threats range from daily operational security problems such as disorder, vandalism and assault to the terrorist threat.

0.11.1 Necessity of Security

It is well known that public transportation is increasingly important for urban areas to prosper in the face of challenges such as reducing congestion and pollution. Therefore, security places an important role in helping public transport system to become the mode of choice. Therefore, excellence in security is a prerequisite for the system for increasing its market share. Uttarakhand Government/ Administration must ensure that security model must keep pace rapid expansion of the Transport System and changing security scenario.

0.11.2 Three Pillars of Security

Security means protection of physical Human and intellectual assets either from criminal interference, removal of destruction by terrorists or criminals or incidental to technological failures or natural hazardous events. There are three important pillars of security as mentioned under:

- The human factor;
- Procedures; and
- Technology

Staff engaging with the passengers creates a sense of re-assurance which cannot fully be achieved by technology. For human factor to be more effective staff has to be qualified, trained, well equipped and motivated. They should be trained, drilled and tested. The security risk assessment is the first step for understanding the needs and prioritizing resources. The organization of security should be clear and consistent. Security incidents, especially major ones, often happen without warning. Emergency and contingency plans must be developed communicated and drilled in advance.

There are number of technologies which can be used to enhance security e.g., surveillance systems. The objectives of the security systems are to differ i.e., making planning or execution of on attack too difficult, detect the planned evidence before it occurs deny the access after in plan of attack has been made and to mitigate i.e., lessen the impact severity as the attack by appropriate digits.

0.12 DISASTER MANAGEMENT MEASURES

0.12.1 Need for Disaster Management Measures

The effect of any disaster spread over in operational area of PRT System would deal with thousands of passengers daily in viaducts and stations. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of PRT System. Therefore, there is an urgent need to provide for an efficient disaster management plan.

0.12.2 Provisions at PRT Stations/ Other Installations

To prevent emergency situations and to handle effectively in case ‘one arises’ there needs to be following provisions for an effective system which can timely detect the threats and help suppress the same.

- Fire Detection and Suppression System
- Smoke Management
- Station Power Supply System
- DG Sets & UPS
- Lighting System
- Station Area Lights
- Water Supply and Drainage System
- Sewage System
- Station Evacuation System
- Any Other System Deemed Necessary

The above list is suggestive not exhaustive actual provisioning has to be done based on site conditions and other external and internal factors.

0.13 MULTI MODAL TRAFFIC INTEGRATION AT PRT STATION

The proposed PRT in Haridwar City has four corridors totalling approx. 20.74 km, consisting of 21 stations. Its four corridors cover many important origins and destinations. However, its reach will not be enough to reach all origins and destinations in the city. Fortunately, these corridors are planned for a multi-modal system, where the proposed PRT will be complemented by the Railway Station, Bus Station and Metrolite which are currently under implementation and feeder services to be deployed by Uttarakhand Government. The need is now to ensure that people have safe, comfortable and secure access to the above modes as well as seamless integration facilities.

0.13.1 Multi-Modal Integration

The concept of Multi Modal integration involves a holistic approach for providing an integrated transport solution to the users of public transport. The Planning of Multi Modal integration is an approach to ease of the journey of the users using different modes, by offering seamless transfer from one mode to another, using common ticketing system. However, while planning for a well-integrated system various factors are to be considered.

Figure 0-7: Multi Modal integration

Each intermodal station will consist of three main components:

- An integrated terminal facility with adequate facilities and amenities to cater to the requirements of all user groups
- A mixed-use development with shopping, office spaces and other commercial activity to enable people to fulfil all the needs by using public transport
- Provision of Park-and-Ride facility to encourage the use of public transport.

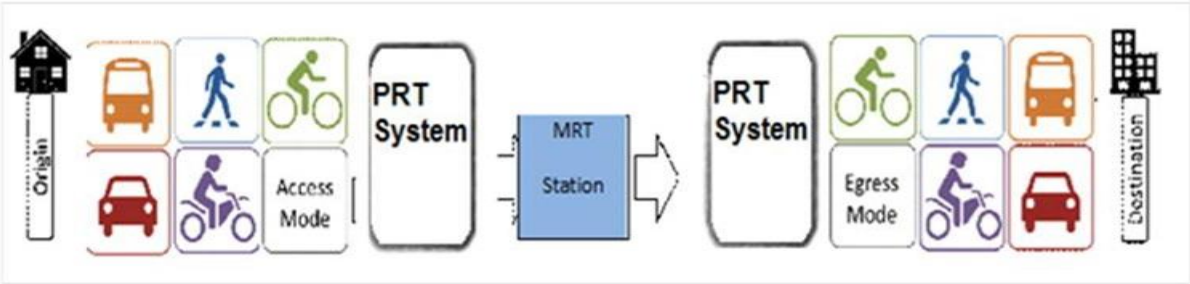

Figure 0-8: Multi Modal Integration of MRT Station

0.13.2Last Mile Connectivity

PRT as a last mile connectivity actually impacts on overall ridership and usage of any mass transit system. It is essential to provide or improve last mile connectivity and link them for ease

of access for users. Even if street infrastructure that comprises of last mile connectivity falls outside mass transit system and control, they remain critical components of an effective public transportation. The easier it is to access the MRT System, the more likely people are to use it. It has been seen that access beyond a distance of 400-500m is not comfortable enough to attract people onto the public transport system. The unavailability of this type of service is one of the main constraints to the use of public transport in urban areas. PRT provide last mile service to close proximity of MRT Station, Railway Station and other Transport hub.

Last Mile Connectivity refers to the provision of travel service from home or workplace to the nearest public transportation mode. A trip is considered as the entire journey between origin and destination. Commuters may utilize and combine different modes of transport for the entire trip. MRT feeder services i.e., PRT may cater to a majority of this kind of trip, but commuters always need to complete the access and egress part on their own.

0.13.3 Physical Integration

Integration of NMT, para transit, feeder services and other public transport modes with MRT stations is possible by planning and designing seamless interchange stations which facilitates physical integration of different access or egress modes.

In order to develop an integrated public transport system, where one mode acts as a complementary mode to another mode rather than its competitor, a trunk and feeder system of transportation network is planned to be developed. Inter-change points are required to be seamless and barrier- free movement of passengers. Thus, for the cities of Haridwar, an effort has been made to thus identify locations and determine various typologies of interchanges that need to be developed for a seamless, barrier- free transportation experience.

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0.13.4 Interchange Stations

Inter-change stations permit riders from particular mode of transport to move and board same or different mode in order to reach their desired destination. Interchanges can be of several types, depending on available modes of transport. Transfer may happen between the same modes or among different available public transport. Interchanges bring public transport together. For example, PRT station can have interchanges with PRT on particular corridor connecting PRT station of different corridor or, PRT stations may have interchange with MRTS/

BRTS, city services and even rail. Interchange helps to integrate various means of transport system under a common node.

Interchanges increases flexibility of movement and gives commuter option to avail multiple public transports at a common station.

0.14 TRANSIT ORIENTED DEVELOPMENT

TOD integrates the land use and transport planning and aim to develop planned sustainable urban group centres. It propagates the mixed land use in the influence area of transit corridors. Normally the inter station distance between the stops of public transit system varies from 0.5 km to 1.5 km. It may be 0.5 km in case of Tramways and go up to 1.5 km in case of underground heavy metro system. TOD can be planned in the influence zone which is defined as the circle of 500-800 m radius or a square of 800 meter from the Transit stop being as centroids. With this influence area it necessitates the public to walk for a maximum distance of 800 meter. TOD policy increases the accessibility of these transit stations by creating pedestrian and non-motorized transport friendly infrastructure.

TOD aims to develop planned sustainable urban growth centres, having walk able and liveable communes with high density mixed land-use. Citizens have access to open green and public spaces and at the same time transit facilities are efficiently utilized.

TOD focuses on creation of high density mixed land use development in the influence zone of transit stations, i.e. within the walking distance of (500-800 m) transit station or along the corridor in case the station spacing is about 1km as shown below:

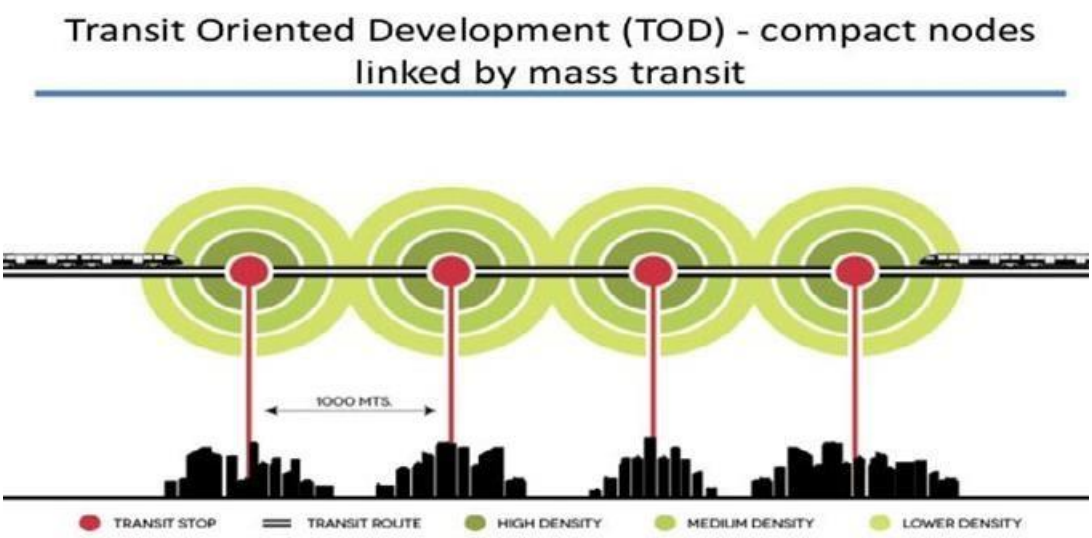


Figure 0-9: TOD along Transit Stations

TOD advocates pedestrian trips to access various facilities such as shopping, entertainment and work. TOD increases the accessibility of the transit stations by creating pedestrian and Non-Motorised Transport (NMT) friendly infrastructure that benefits large number of people, thereby increasing the ridership of the transit facility and improving the economic and financial viability of the system. Since the transit corridor has mixed land-use, where the transit stations are either origin (housing) or destination (work), the corridor experiencing peak hour traffic in both directions would optimize the use of the transit system.

0.15 COST ESTIMATE

Table 0-21 Cost Estimate of PRT System

(June 2021 Price level)

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.0	**Land**				
1.1	Land Cost	Ha.	**20.00**	2.469	49.38
1.2	R and R Cost	Rkm	**1.00**	20.74	20.74
1.3	Utility Shifting	Rkm	**1.00**	20.74	20.74
	Subtotal (1)				**90.86**
2.0	**Civil & Structure Cost**				
	Subtotal (2)	km	19.42	20.740	**402.81**
3.0	**MEP cost**				
	Subtotal (3)	km	5.65	20.740	**117.27**
4.0	**Charging Station Cost**				
	Charging Station	No.	0.16	32.00	4.98
	Subtotal (4)				**4.98**
5.0	**Depot**				
	Subtotal (5)	Each	LS	1	**55.00**
6.0	**Control System**				
	Subtotal (6)	Each	LS	1	**270.97**
7.0	**Total POD cost (Inclusive of Automatic Parking Cost)**				
	Subtotal (7)	no.	0.42	514.000	**213.31**
8.0	**Total of all items except Land**				**1064.34**
9.0	**GC@5%**				**53.22**
10.0	**Contingencies@3%**				**31.93**
11.0	**Total cost of all items including General Charges, and Contingency without land**			**=**	**1149.49**
12.0	**Total cost of all items including General Charges, and Contingency and including Land**			**=**	**1240.36**
13.0	**Taxes**			**=**	**179.10**
14.0	**GROSS TOTAL**			**=**	**1419.45**

Table 0-22 Detail of Taxes and Duties

POST GST Regime

CGST Customs Duty=9.495%	
SGST Customs Duty=	9.495 %
Total Customs Duty=	**24.4900 %**
General IGST=	12 %
General CGST =	6 %
General SGST=	6 %

S. No.	Description	Total cost without Taxes & duties (Cr.)	Foreign Component (%)	Taxes and duties									Total Taxes & Duties (Cr.)
				CUSTOMS DUTY					GST				
				Basic Customs Duty @5.5% (Cr.)	IGST (CGST portion) @9.4635 % (Cr.)	IGST (SGST portion) @9.4635 % (Cr.)	Total Customs Duty (Cr.)	Local Component (%)	GST RATE	CGST (Cr.)	SGST (Cr.)	Total GST (CGST & SGST) (Cr.)	
1	**CIVIL & Structure cost**												
	Total	402.81	20%	4.43	7.65	7.65	19.73	80%	12%	19.33	19.33	38.67	**58.40**
2	**MEP Cost**												
	Total	117.27	20%	1.29	2.23	2.23	5.74	80%	12%	5.63	5.63	11.26	**17.00**
3	**Charging Station**												
	Total	4.98	50%	0.14	0.24	0.24	0.61	50%	12%	0.15	0.15	0.30	**0.91**
4	**Control System**	270.97	80%	11.92	20.58	20.58	53.09	20%	12%	3.25	3.25	6.50	**59.59**
5	**Depot**	55.00	20%	0.61	1.04	1.04	2.69	80%	12%	0.79	0.79	1.58	**4.28**
6	**POD Cost**	213.31	50%	5.87	10.13	10.13	26.12	50%	12%	6.40	6.40	12.80	**38.92**
	Total	**1064.34**		**24.25**	**41.87**	**41.87**	**107.99**			**35.56**	**35.56**	**71.11**	**179.10**
	Total taxes & Duties										**SAY**		**179.10**
Rate of Taxes & Duties on Total cost without taxes & duties													**16.83%**
Total Central GST & Basic Customs duty													101.68
Total State GST													77.42
Total State Taxes & Duties													**179.10**

0.16 FINANCING PLAN

0.16.1 Costs

The Haridwar PRT system from Bharat Mata Temple to Sitapur, Prem Nagar to Daksh Temple & Ganeshpuram to DAV School covering approximately 20.74 km length are proposed to be constructed from April 2021 to March 2024. All the corridors are proposed to be built as Personal Rapid Transit (PRT) System. The financial viability, with estimated cost at September-2020 price level, along with route length of the PRT system (along with construction start date and completion date) is placed in the Table below.

Table 0-23 : Cost Details (at September 2020 Price Level)

Estimated cost without Land and taxes (Rs/Crore)	Estimated cost with land cost (Rs/Crore)	Estimated cost with all taxes & land cost (Rs/Crore)
1149	1240	1419

0.16.2 Investment Cost

It is assumed that the construction work of the line will commence from April 2021 and is expected to be completed by 31.03.2024 with Revenue Opening Date (ROD) as 01.04.2024. The total completion costs duly escalated and shown in the table 0.23 have been taken as the initial investment.

Table 0-24 : Year-wise Investment (Rs./ Crore)

Financial Year	Cost at June 2021 Price Level Including Taxes & Land Cost	Completion Cost Including Taxes & Land Cost
2021-22	163.15	169.79
2022-23	561.73	616.20
2023-24	561.73	645.49
2024-25	132.86	161.49
Total	**1419.47**	**1592.97**

0.16.3 Fare Structure

The fare structure for the FY 2025-26 is shown in the Table below:

Table 0-25: Fare Structure

Distance (Kms)	2024 (Rs.)
0-2	20
2-4	40
4-6	60
6-8	75
8-10	80
10-14	85
>14	90

The fare structure as proposed by UKMRC vide their letter no. 633/U.M.-46/2020-21 dated 21.01.2021 has been escalated @5% p.a. in succeeding years.

0.16.4 Financial Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) with & without additional PD income for 30 years life cycle business model including construction period works is tabulated in Table below:

Table 0-26A: FIRR (with additional PD income)

S. No.	Financial Year			Completion Cost	Additional Cost	Replacement Cost	Running Expense	Total Cost	Fare Box Revenue	Non-Fare Box Including PD	Total Revenue	Net Cash Flow
1	2022	-	2023	170	-	-	-	170	-	-		-170
2	2023		2024	616	-	-	-	616	-	-		-616
3	2024	-	2025	645	-	-	-	645	-	-		-645
4	2025	-	2026	161	-	-	56	217	142	-82	60	-158
5	2026	-	2027	-	-	-	121	121	311	-68	243	121
6	2027	-	2028	-	-	-	131	131	339	-51	288	157
7	2028	-	2029	-	-	-	142	142	369	-33	337	195
8	2029	-	2030	-	-	-	153	153	402	-13	389	236
9	2030	-	2031	-	-	-	165	165	440	-16	424	259
10	2031	-	2032	-	-	-	183	299	486	-9	477	294
11	2032	-	2033	-	122	-	198	320	538	-2	536	217
12	2033	-	2034	-	-	-	214	214	581	4	585	372
13	2034	-	2035	-	-	-	231	231	627	11	638	407
14	2035	-	2036	-	-	12	250	262	678	52	730	469
15	2036	-	2037	-	-	-	270	270	733	55	788	518
16	2037	-	2038	-	-	-	292	292	790	57	848	556
17	2038	-	2039	-	-	-	316	316	855	59	914	598
18	2039	-	2040	-	-	-	342	342	924	63	987	645
19	2040	-	2041	-	-	147	370	517	998	67	1,065	548
20	2041	-	2042	-	-	154	407	788	1,077	70	1,147	587
21	2042	-	2043	-	238	-	440	678	1,153	75	1,228	550
22	2043	-	2044	-	-	-	476	476	1,243	79	1,322	846
23	2044	-	2045	-	-	-	516	516	1,338	83	1,421	905
24	2045	-	2046	-	-	19	559	578	1,442	87	1,529	952
25	2046	-	2047	-	-	-	605	605	1,554	91	1,645	1040
26	2047	-	2048	-	-	-	655	655	1,675	95	1,770	1115
27	2048	-	2049	-	-		710	710	1,805	100	1,905	1194
28	2049	-	2050	-	-	-	770	770	1,944	105	2,049	1279
29	2050	-	2051	-	-	-	834	834	2,093	111	2,204	1370
30	2051	-	2052	-	-	-	916	916	2,255	116	2,370	1454
	Total			**1592**	**360**	**332**	**10322**	**12949**	**26792**	**1109**	**27900**	**15294**
												16.16%

Table 0-27B: FIRR (without PD income)

Sl.	Financial Year			Completion Cost	Additional Cost	Replacement Cost	Running Exp	Total Cost	Fare Box Revenue	Non Fare Box	Total Revenue	Net Cash Flow
1	2022	-	2023	170	-	-	-	170	-	-		-170
2	2023		2024	616	-	-	-	616	-	-		-616
3	2024	-	2025	645	-	-	-	645	-	-		-645
4	2025	-	2026	161	-	-	56	217	142	1	143	-75
5	2026	-	2027	-	-	-	121	121	311	1	312	190
6	2027	-	2028	-	-	-	131	131	339	1	340	209

7	2028	-	2029	-	-	-	142	142	369	1	371	229
8	2029	-	2030	-	-	-	153	153	402	2	404	251
9	2030	-	2031	-	-	-	165	165	440	1	441	276
10	2031	-	2032	-	-	-	183	299	486	2	488	305
11	2032	-	2033	-	122	-	198	320	538	3	541	222
12	2033	-	2034	-	-	-	214	214	581	3	584	371
13	2034	-	2035	-	-	-	231	231	627	4	631	400
14	2035	-	2036	-	-	12	250	262	678	4	682	421
15	2036	-	2037	-	-	-	270	270	733	5	738	468
16	2037	-	2038	-	-	-	292	292	790	5	796	504
17	2038	-	2039	-	-	-	316	316	855	5	860	544
18	2039	-	2040	-	-	-	342	342	924	6	930	588
19	2040	-	2041	-	-	147	370	517	998	6	1,004	487
20	2041	-	2042	-	-	154	407	788	1,077	6	1,083	523
21	2042	-	2043	-	238	-	440	678	1,153	8	1,161	483
22	2043	-	2044	-	-	-	476	476	1,243	8	1,251	775
23	2044	-	2045	-	-	-	516	516	1,338	9	1,347	831
24	2045	-	2046	-	-	19	559	578	1,442	9	1,451	874
25	2046	-	2047	-	-	-	605	605	1,554	10	1,564	959
26	2047	-	2048	-	-	-	655	655	1,675	10	1,685	1,030
27	2048	-	2049	-	-		710	710	1,805	11	1,816	1,105
28	2049	-	2050	-	-	-	770	770	1,944	11	1,955	1,185
29	2050	-	2051	-	-	-	834	834	2,093	12	2,105	1,271
30	2051	-	2052	-	-	-	916	916	2,255	13	2,267	1,351
	Total			**1592**	**360**	**332**	**10322**	**12949**	**26792**	**160**	**26951**	**14345**
												16.85%

0.16.5 Alternative Models of Financing

The financing option shall depend upon selection of the dedicated agency created to implement the project. The prominent models are:

- Special Purpose Vehicle model like Delhi Metro Rail Corporation (DMRC) /Bangalore Metro Rail Corporation (BMRC)/Chennai Metro Rail Corporation (CMRL)/ Mumbai Metro Rail Corporation (MMRC etc.
- Design, Built, Finance, Operate & Transfer (DBFOT) model.

0.16.6 Special Purpose Vehicle (SPV) Model

The corridors are standalone and, therefore, forming a separate SPV may be desirable. The Government of Uttarakhand (GoUK) has already formed a SPV in the name of Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited for planning and implementation of metro rail or other similar mass rapid transport system in the state of Uttarakhand. The funding pattern under this model (SPV) for all the five options are placed in table below:

Table 0-28: Funding pattern under SPV model

Sources of Funds	Amount (Rs/Crore)	Percentage of Contribution
Equity by GoUK	520	40.00%
ODA loan from Multilateral / Bilateral Agency	780	60.00%
Sub-Total (A)	1300	100.00%
Land Cost to be borne by GoUK	91	
Central Taxes to be borne by GoUK	115	

Sources of Funds	Amount (Rs/Crore)	Percentage of Contribution
State Taxes to be borne by GoUK	87	
Sub-Total (B)	293	
Total Cost (A+B)	1593	
IDC (to be borne by the GoUK)	19	
Total Cost including IDC	**1612**	

0.16.7 DFBOT Model

In this model, the private firm will be responsible for financing, designing, building, operating and maintaining of the entire project. The financing model shall depend upon selection of a dedicated agency to implement the project. The proposed corridor is a unique one and first of its kind in the country. The alignment will be fully elevated. Apart from equity contribution from the promoters, it is assumed that the funding for the project shall be achieved through market borrowings. The rate of interest on market borrowings is assumed at 10% p.a. and the repayment of the loan will start immediately after the commercial operations and repaid in 10 (ten) years. Accordingly, the funding pattern proposed is placed in table as under:

Table 0-29 : Funding pattern under DFBOT (without additional PD)

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by Concessionaire	451	30%
Market Borrowings by Concessionaire	1051	70%
Sub-Total (A)	**1502**	**100%**
Land Cost to be borne by GoUk	91	
Sub-Total (B)	**1593**	
IDC on Loan (to be borne by the Concessionaire)	182	
Total Cost including IDC	**1775**	

The total fund to be contributed by GoUK is shown in Table below under SPV and DBFOT model with and without additional PD income.

Table 0-30: Fund contribution by GoUK

(in *Rs. Crore)*

Particulars	SPV Model	DFBOT Model
GoUk	832	91*
Others	780	1684
Total	**1612**	**1775**

*****Additional Land for PD to be arranged & provided by GoUK in case of PD option.

Since the total contribution of GoUK is lesser under DFBOT Model, therefore, the Project is recommended for implementation under DFBOT model.

0.16.8 Recommendations

The FIRR is 16.16% and 16.85% with and without PD. Therefore, **the project is recommended for implementation under DBFOT model without additional PD.**

0.17 ECONOMIC APPRAISAL

0.17.1 Necessity of Economic Appraisal

Normally none of the transport mode is viable financially, but these are justified based on economic benefits to the society. This necessitates monetizing all the benefits indirectly or directly available to society by using the unit rates for the items, namely saving in time, saving in infrastructure maintenance cost, saving in operation and maintenance cost, saving due to environmental benefits to health and also saving in accidents. The unit rates for calculation of these benefits are taken from various sources.

0.17.2 PRT System & Alignment Description

Personal rapid transit (PRT), also referred to as pod cars, is a public transport mode featuring small automated vehicles operating on a network of specially built guideways. PRT provides a taxi-like service for individual or small group of travellers. It provides as demand responsive feeder and shuttle service connecting major facilities such as shopping, tourist attractions, and centres.

The Proposed PRT Alignment in Haridwar City is from Bharat Mata Temple to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge, Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar road and Kankhal area (Ganeshpuram) to Daksh Temple.

0.17.3 Introduction to Economic Appraisal Methodology

Economic benefits are social and environmental benefits which are quantified and then converted into money cost and discounted against the cost of construction and maintenance for deriving Economic Internal Rate of Return (EIRR).
Economic appraisal of a project starts from quantification of measurable socio-economic benefits and then converting these into economic money values, which are basically the savings of resource cost due to introduction of the PRT Corridor. Economic savings are derived from the difference of the cost of the same benefit components under ‘with’ and ‘without’ PRT Corridor.

In highway construction projects, ‘without’ is taken as “base case” and ‘with’ implies ‘alternative case’. In ‘alternative case’ a portion of traffic on the road is diverted to a new road which is estimated first. Then the difference between maintenance & construction cost for ‘base case’ and for ‘alternative case’ which is known as relative road agency cost (RAC) is derived. Difference between road user cost for ‘base case’ and of ‘alternative case’ is also derived which is known as relative road user cost (RUC). Difference between RAC and RUC calculated for each year generates net benefit stream. Economic indicators (EIRR, BC Ratio, NPV) are the obtained.

In PRT project, same principal is followed but procedure is slightly different. Here, diverted traffic is nothing but the passengers shifted from road based modes to PRT. Travel time saving is the difference between time which would be taking on PRT and other mode of transports for same distance. Fuel cost saving is the difference between the cost of the fuel burnt on other modes by the shifted passengers. Thus, benefits are directly obtained by correlating with them with the passenger km (ridership and average trip length is multiplied to get passenger km). As is done in highway projects, net benefit is obtained by subtracting the cost of the project (incurred for construction (capital) and maintenance (recurring) costs for the PRT line) from the benefits derived from pass km savings in each year. The net benefit value which would be

negative during initial years becomes positive as years pass. Internal rate of return and benefit cost ratio are derived from the stream.

0.17.4 Economic Performance Indicators

After generating the cost and benefit stream table, values of economic indicators are derived and are given in Table 17.11. Project period is 2022 to 2052. On the basis of economic cost, EIRR is 11.71%, B/C Ratio is 1.71 and NPV is Rs. 265 Cr. As per the ADB Guidelines, a single option project is considered viable when either the ENPV is positive or the EIRR is greater than the minimum required discount rate. For the present study, ENPV is positive (Rs. 265 Cr.) and EIRR is 11.71% vis-à-vis to the minimum required discount rate of 10%, which shows that the project is economically viable.

Table 0-31: Economic Indicator Values (2051-52)

Economic Indicators	Economic Price
Cumulative Cost (Cr. Rs.)	10,876
Cumulative Benefit (Cr. Rs.)	18,651
Benefit Cost (B/C) Ratio	1.71
NPV (Cr. Rs.)	265
EIRR	**11.71%**

0.18 IMPLEMENTATION PLAN

The total length of PRT Network in Haridwar City is approximately 20.74 km. Haridwar needs more transport services for adequate coverage of the city to provide connectivity to major areas.

Estimated cost of the project at June 2021 price level is Rs. 1419 Crore inclusive of all taxes & duties and land cost. Completion Cost with all the taxes & duties and land cost is Rs. 1593 Crore (excluding IDC) under SPV model. FIRR with and without PD income for 30 years life cycle business model including construction period works out to be 16.16% and 16.85% respectively.

0.18.1 Possible Models for Financing PRT System

The financing option shall depend upon selection of the dedicated agency created to implement the project. The prominent models are:

(i) Special Purpose Vehicle under the State Government Control.
(ii) Design, Built, Finance, Operate & Transfer (DBFOT)

1. Special Purpose Vehicle (SPV) Model

The Government of Uttarakhand (GoUK) has already formed a SPV in the name of Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited for planning and implementation of metro rail or other similar mass rapid transport system in the State of Uttarakhand. This project may also be implemented by M/s UKMRC. The funding pattern under this model (SPV) is placed in the Table below:

Table 0-31: Funding pattern under SPV model

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by GoUk	520	40.00%
ODA loan from Multilateral / Bilateral Agency	780	60.00%
Sub-Total (A)	**1300**	**100.00%**
Land Cost to be borne by GoUk	91	
Central Taxes to be borne by GoUk	115	

Sources of Funds	Amount (Rs/Crore)	% of contribution
State Taxes to be borne by GoUk	87	
Sub-Total (B)	**293**	
Total Cost (A+B)	**1593**	
IDC on Loan (to be borne by the GoUk)	19	
Total Cost including IDC	**1612**	

2. DFBOT Model

In this model, the private firm will be responsible for financing, designing, building, operating and maintaining of the entire project. The financing model shall depend upon selection of a dedicated agency to implement the project. The proposed corridor is a unique one and first of its kind in the country. The alignment will be fully elevated. Apart from equity contribution from the promoters, it is assumed that the funding for the project shall be achieved through market borrowings. The rate of interest on market borrowings is assumed at 10% p.a. and the repayment of the loan will start immediately after the commercial operations and repaid in 10 (ten) years. Accordingly, the funding pattern proposed is placed in table 18.4 as under:

Table 0-32: Funding pattern under DFBOT

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by Concessionaire	451	30%
Market Borrowings by Concessionaire	1051	70%
Sub-Total (A)	**1502**	**100%**
Land Cost to be borne by GoUk	91	
Sub-Total (B)	**1593**	
IDC on Loan (to be borne by the Concessionaire)	182	
Total Cost including IDC	**1775**	

The total fund to be contributed by GoUk is shown in Table 16.13 below under SPV and DBFOT model.

Table 0-33: Fund Contribution

Rs.in crore

Particulars	SPV Model	DFBOT Model
GoUk	832	91*
Others	780	1684
Total	**1612**	**1775**

*****Additional Land for PD to be arranged & provided by GoUK in case of PD option.

Since the total contribution of GoUK is lesser under DFBOT Model, therefore, the Project is recommended for implementation under DFBOT model.

0.18.2 Recommended Financial Model

For DBFOT Model, With the above funding pattern and other assumptions, the FIRR & Equity IRR are as follows:

Particulars	FIRR	Equity IRR
With PD	16.16%	19.80%
Without PD	16.85%	21.57%

The project is recommended for implementation under DBFOT model without additional PD.

0.18.3 Institutional Arrangements

The Government of Uttarakhand (GoUK) has already formed a SPV in the name of Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited for planning and implementation of metro rail or other similar mass rapid transport system in the State of Uttarakhand. The State Govt. of Uttarakhand may approve the implementation of the project through Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited on Government Funding or through Concessionaire on PPP Mode.

0.18.4 Implementation Strategy

When the project is taken up on PPP (DBFOT) mode, Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited (UKMRC) may call international bids for the project and a transaction advisory firm may be appointed for evaluation of bids and selection of the concessionaire. M/s UKMRC will be responsible for overall monitoring of the project. M/S UKMRC will assist the concessionaire to obtain permissions from various department of the State Government. M/s UKMRC will also assist concessionaire in the acquisition of land required for the project.

0.18.5 High Power Committee

During the implementation of the project several problems with regard to acquisition of land, diversion of utilities, shifting of structures falling on the project alignment, rehabilitation of project affected persons, etc. are likely to arise. For expeditious resolution of these problems, an institutional mechanism needs to be set up at the State Government level. Towards this end, it is recommended that a High-Power Committee under the chairmanship of Chief Secretary, Uttarakhand should be set up. Other members of this Committee should be Secretaries of the concerned Departments of the State Government and Heads of civic bodies who will be connected in one way or the other with the implementation of the project. This Committee should meet once a month and sort out all problems brought before it by Concessionaire.

0.18.6 Legal Cover

There is no legislation available for Construction, Operation and Maintenance of PRT System in Uttarakhand. It is learnt that Government of Punjab has enacted legislation in this regard. Government of Uttarakhand may also enact legislation on similar line for Construction, Operation and Maintenance of PRT System in Haridwar (Uttarakhand) in cognisance of international practices.

0.19 CONCLUSION AND RECOMMENDATION

Uttarakhand State is second fastest growing State in India. It is called Devbhoomi (land of Gods) due to the present of too many Hindu Temples and pilgrimage centres throughout the State. Large number of tourists from within country and outside visited Uttarakhand State, mainly the three cities namely Dehradun, Haridwar, Rishikesh and Mussoorie and other important pilgrimage stations namely Kedarnath, Badrinath etc. Haridwar being gateway city Uttarakhand and Yoga Capital of the world thousands of domestic and international tourists visit the city annually. There is no organized, safe, reliable, secure, comfortable and efficient mode of Public Transit available in the city. People are largely depending upon cycle rickshaws, e-rickshaws, auto rickshaws and Vikrams for commuting. Which neither cost effective nor comfortable. Considering the economic growth of the city implementation of PRT System on selected four corridors is strongly recommended.

The proposal of the corridors is technically feasible but involves acquisition of land as well as rehabilitation of some shops. This is a socio-economic problem and has to be tackled for execution of the project.

Estimated Cost of the project at June 2021 price level is ₹1419 Crore with all the taxes & duties and land cost. Whereas, Completion Cost (by October 2025) works out to ₹1593 Crore excluding IDC.

The project has many positive environmental impacts like reduction in traffic congestion, saving in travel time, reduction in noise pollution, lesser fuel consumption, lesser road accidents etc, with a few negative impacts (especially during implementation phase of the project) for which Environmental Management Plan has been suggested.

The project is slated for completion by 31.10.2025. Revenue Opening Date (ROD) has been assumed as 01.11.2025. Project completion date is subject to land required for the project is made available to UKMRC within 6 months' period from date of sanction of project. After examining the various options for execution, it has been recommended that the project should be got executed through a concessionaire on PPP (DFBOT) mode.

The fare structure has been prepared based on prevailing fare structure in different PT/IPT modes as indicated in the Finance Chapter. Subsequently, for the purpose of assessing returns from the project, the fares have been revised each year with an escalation of 5%.

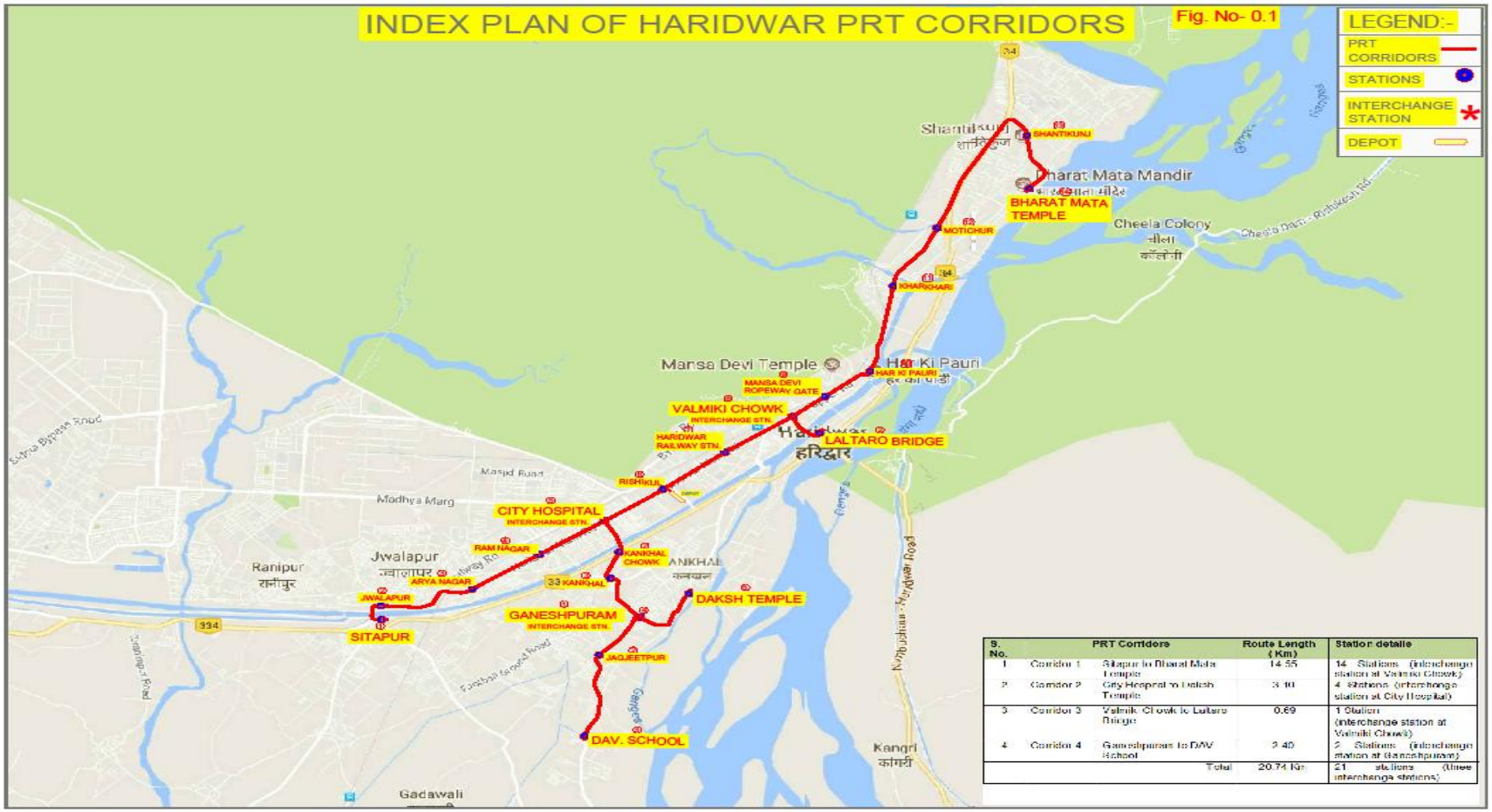
0.19.1 Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR)

The Financial Internal Rate of Return (FIRR) for the project with central taxes has been assessed as **16.16% and 16.85% with and without PD.**

The Economic Internal Rate of Return (EIRR) at present rate works out to 11.71%. It seems to be on lower side, as major portion of modal shift passenger in PRT system is from Cycle Rickshaw & E-rickshaw etc and their contribution in economic benefits is very small.
Meanwhile the State Government should freeze all future developments along the proposed corridors to avoid in-fructuous expenditure.

To avoid delays in processing the clearance for the Project, UKMRC Board should approve project on receipt of the DPR and forward the DPR to Government of Uttarakhand, advising to take up the Project on **DFBOT** Model as recommended in Financial Analysis.

Annexure 0.1



S. No.	PRT Corridors		Route Length (Km)	Station details
1	Corridor 1	Sitapur to Bharat Mata Temple	14.55	14 Stations (interchange station at Valmiki Chowk)
2	Corridor 2	City Hospital to Daksh Temple	3.10	4 stations (interchange station at City Hospital)
3	Corridor 3	Valmiki Chowk to Laltaro Bridge	0.69	1 Station (interchange station at Valmiki Chowk)
4	Corridor 4	Ganeshpuram to DAV School	2.40	2 Stations (interchange station at Ganeshpuram)
		Total	20.74 Km	21 stations (three interchange stations)

Chapter -1
Introduction

1.1 Background

1.2 Haridwar City

1.3 Present Scenario of Transport in Haridwar City

1.4 Review of Earlier Studies

1.5 Personal Rapid Transit System (PRT)

1.6 Present Study for PRT System at Haridwar

1.7 Structure of Detailed Project Report (DPR)

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Uttarakhand formerly known as 'Uttaranchal' became the 27th state of India on November 09, 2000 carved out from Himalayan and north-western parts of Uttar Pradesh. The state of Uttarakhand is broadly divided into two divisions namely (i) Garhwal and (ii) Kumaon and has 13 districts in all with its capital as Dehradun. The official language of the state is Hindi. Uttarakhand has a total area of 53,483 sq. km out of which 86% is mountainous and 65% is covered by forests. Most of the northern parts of the state are covered by high Himalayan peaks and glaciers. Two of most important rivers originate in the region i.e., the Ganga at Gangotri and the Yamuna at Yamunotri.

According to the 2011 Census of India, Uttarakhand has a population of 1,00,86,292 comprising 51,37,773 males and 49,48,519 females, with 69.77% of the population living in rural areas. The state is the 20th most populous state of the country having 0.83% of the population on 1.63% of the land. The population density of the state is 189 people per square kilometer having a 2001–2011 decadal growth rate of 18.81%. The gender ratio is 963 females per 1000 males.

Uttarakhand has 28,508 km of roads, of which 1,328 km are national highways and 1,543 km are state highways. As of 2020, approximately 2164 buses are being plied by the State Transport Corporation on 36 nationalized routes and non-nationalized routes apart from private transport operators. For local travel, the state, like most of the country, has auto rickshaws, cycle rickshaws, etc. Uttarakhand's high rate of visitors has resulted in an ever-increasing demand for transport creating excessive pressure on the existent transport system. With high growth in transport demand over the years, congestion on roads has been increasing due to phenomenal rise in private transport. Absence of an efficient full-fledged public transport system coupled with rapid growth in the use of personalized vehicles has led to high consumption of fossil fuel and increase in the level of environmental pollution.

The inter-city traffic volumes in the state of Uttarakhand necessitated the initiation of full-fledged integrated multi modal mass rapid passenger system. Government of Uttarakhand (GoUK) vide their letter no. 494/UHUDA-142/2016-17 dated 29-11-2016 and 516/UHADA/-142/2016-17, dated. 08-12-2016 (Annexure-A1.1 & A1.2) desired DMRC to prepare the Detailed Project Report (DPR) for Metro Rail Project in the state of Uttarakhand connecting the three cities namely, (i) Dehradun, (ii) Rishikesh and (iii) Haridwar under phase-I of Uttarakhand Metro.

DMRC prepared and submitted Detailed Project Report for Metro Rail project in the state of Uttarakhand connecting the three cities namely, (i) Dehradun, (ii) Haridwar and (iii) Rishikesh under phase-I of Uttarakhand Metro to UKMRC in Oct. 2019 , After analysis of DPR, Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited (UKMRC), has requested DMRC to revise Detailed Project Report for Metrolite Project in Dehradun, Haridwar & Rishikesh (Uttarakhand) which was duly submitted to UKMRC in Feb. 2020.

Subsequently Vide letter No. 398/U.M.-118/2019-20 dated 01.10.2019 (Annexure-A 1.3) UKMRC has requested DMRC to provide Terms of Reference (TOR) for preparation of Personal Rapid Transit (PRT) system in Haridwar City. MoU/Agreement for the Preparation of Detailed Project Report (DPR) for Personalized Rapid Transit System (PRT) in Haridwar signed on 20th October, 2019 between UKMRC and DMRC.

1.2 HARIDWAR CITY

Haridwar also spelled 'Hardwar' is an ancient city and one of the districts of Uttarakhand State. The River Ganga, after flowing for 253 km from its source at Gaumukh at the edge of the Gangotri Glacier, enters the Indo-Gangetic Plains of North India for the first time at Haridwar, which gave the city its ancient name, Gangadwára. It is well connected to Delhi through NH-58. It is important pilgrimage centre and entry/starting point of Char Dham Yatra. Haridwar is also famous for its temples, Ashrams and **Har-Ki-Pauri** (a ghat at the bank of River Ganga). A heaven for nature significant others, Haridwar presents a kaleidoscope of Indian culture and development. In the sacred writings it has been differently specified as Kapilsthan, Gangadwar and Mayapuri. It is additionally a passage indicating the Char Dham (the four principles focus of journey in Uttarakhand viz, Badrinath, Kedarnath, Gangotri, and Yamunotri).

Haridwar district has an area of about 2360 Square km with co-ordinates of 29.945°N 78.163°E and located in the south-western part of Uttarakhand state. Haridwar is situated at height of 314 metres from the sea level, between Shivalik Hills in the North and North-east and the Ganges River in the South. As of 2011 India census, Haridwar Urban Agglomeration has the population of 3, 20,892 comprising 54% Males and 46% Females. Haridwar has an average literacy rate of 70%, which is higher than the national average of 59.5%.

Haridwar has the important pilgrim places namely Mansa Devi Temple, Chandi Devi temple, Bharat Mata Temple, Daksh Temple and Har-Ki-Pauri. In addition to these religious attractions, numbers of Satsang Houses are also located In Haridwar Area. Patanjali Vidyapeeth is has also come up at the distance of about 8 km from Haridwar. Bharat Heavy Electricals limited (BHEL) also has its largest establishment near Haridwar.

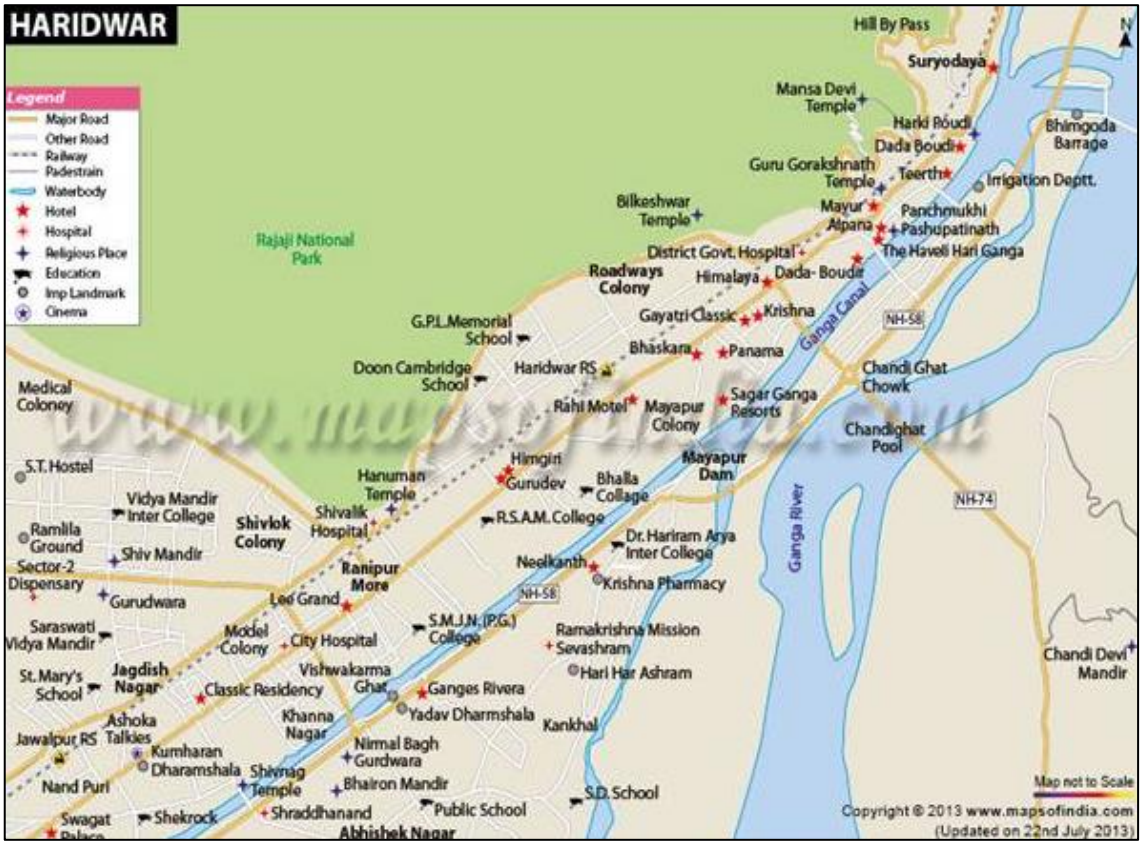


Figure 1-1: Map Showing Study Area (Haridwar)

1.3 PRESENT SCENARIO OF TRANSPORT IN HARIDWAR CITY

Presently, the proposed region does not have adequate public transport system in Haridwar City. Only mode of transport in the city is either through State transport buses or through un-organized private operated buses/ mini buses, auto and tempos. Also, people use their private vehicles to commute their journeys in Haridwar city through private taxi / mini bus. Due to the growth of this region being very rapid and increasing number of tourists there is an urgent need of a proper mass rapid transit system for this area. The dedicated personal rapid transit system will not only make the journey comfortable and time saving, but it will also be eco-friendly and energy efficient. The existing road network is already over loaded and the time taken to travel through this road network is not only on higher side but also prone to accidents and creates more pollution. Provision of efficient and comfortable public transport is likely to give further boost to tourism of State. Being an eco-sensitive zone, it is much more essential that a proper dedicated eco-friendly transit system is developed in this region immediately.

1.4 REVIEW OF EARLIER STUDIES

1.4.1 City Development Plan: Haridwar May 2007

City Development Plan of Haridwar was prepared by GHK, International UK. The objective of the City Development Plan (CDP) was to provide a perspective and a pathway of future

development of a city/town over the next 25 years. In essence, it provides options and choices as exercised by stakeholders, not the city as an urban space by default. Clearly, a CDP was considered a blue-print of an informed exercise, owned by the citizens and the city government, i.e., the ULB.

Important findings of City Development Plan (CDP):

CDP brought out that the lack of developed land for affordable housing. The factors as under causing the traffic congestion were also identified.

- Inadequate width of the roads
- Encroachments
- Street hawkers
- unplanned on-street parking
- Heterogeneity of traffic
- Pedestrian flow
- Improper turning of traffic
- Lack of median on important roads
- More no. of median gaps
- Lack of traffic signals, road markings, guard rails etc
- Lack of enforcement of traffic rules

Existing Traffic/ Transport Situation:

The total road network length is 246 km, of which 214.1 km are under Municipal Corporation and 31.9 km are maintained by PWD. The main local transports of Haridwar include private taxis, local buses, auto rickshaws e-rickshaws and cycles. However, it is not sufficient enough to cover ever increasing need for mobility.

The number of registered vehicles in Haridwar increased from about 1.37 lakhs in 2006 to approximately 4.28 lakhs in 2019, indicating an increase of 212% during the period, out of which majority is two wheelers followed by cars and other vehicles.

Apart from these thousands of vehicles that come from outside the city on any given day which accentuated the already existing parking and traffic problems being faced by the city. Non regulation of auto and e-rickshaw movements is among the major reasons behind the traffic

problems of the city.

CDP mentioned 8 million religious tourists every year. For this city also, population growth was expected to stabilize at 2.5% per annum. City Development Plan mentions that the accommodation available at Haridwar is too short than the requirement on the mela days. As regards, Public Transport System, CDP mentions as under-

There is a need to gradually eliminate the IPT mode and replace them with the better public transport systems; better quality buses, which are affordable and also sufficient to meet the city's travel, demand. Minimum infrastructure such as bus bays, bus stands, terminals etc. needs to be provided.

Dedicated bus corridors and construction of new terminals at major hubs will also ease the traffic flow, significantly increasing the share of public transport and will also improve the comfort of the passengers. MRTS corridors of about 15 km length are suggested as a long-term improvement to cater for increasing demand. A detailed study would be needed to work out this plan. However, either light rail or monorail systems are very expensive, but may be the only alternatives to cater to the long-term intra-city travel demand.

City Development Plan had proposed the fund outlay of Rs.1800 Crore for monorail for Haridwar city by the year of 2025.

1.4.2 Master Plan 2025 of Haridwar.

This Master Plan was prepared and approved on 18th September, 2009. The population of Haridwar Town for the decades starting from 1901 to 2001 as given in the Master Plan is reproduced in the Table below:

Table 1-1 Decadal Population of Haridwar

S. No.	Year	Decade Population	Increase in Decadal Population	Percentage Increase
1	1901	25,597	-	-
2	1911	28,682	3,085	12.05
3	1921	30,764	2,082	7.26
4	1931	33,287	2,523	8.20
5	1941	40,823	7,536	22.64
6	1951	57,338	16,515	40.46
7	1961	59,960	2,622	4.57
8	1971	79,277	19,317	32.22
9	1981	1,15,513	36,236	45.71
10	1991	1,87,392	71,879	62.22
11	2001	2,20,767	33,375	17.81

Source: Haridwar Mahayojna 2025. Table no.- 2.2 (Annexure A 1.4)

Master Plan 2025 projected the population of this city as 4.73 lakh in 2025. As per the Census of 2011, the population of Haridwar city was reported as 3.10 Lakhs (UA). Master Plan 2025 finalized in 2009 also projected the population of Haridwar city as 3 lakhs in 2011 and 4.03 lakh in 2021. The population of Master Plan area was projected as 4.65 lakh, 6.26 lakh and 7.35 lakh in the years 2011, 2021 and 2025 respectively.

Master Plan also gave the information on the Tourism of Haridwar. There is always a flow of pilgrims and tourists to Haridwar during the entire year. The important occasions are Makar Sakranti, Basant Panchmi, Magh Purnima, Mahashivratri, Chaitra Amavasya, Navsamvatsar, Ramnawmi, Baisakhi, Akshay Tritiya, Ganga Dussehra, Somvati Amavasya and Kartik Purnima. In addition to these occasions, every year there are large fares at the interval of every six years namely, Ardh Kumbh and Maha Kumbh. These special occasions bring the big crowd to Haridwar not only from country, but also from other parts of the world. Master Plan 2025 of Haridwar reported the number of publics taking Holy Dip in Ganga on the main Baisakhi Snan Parv as 26 lakhs in 1992 (Ardh Kumbh), 100 lakhs in 1998 (Maha kumbh) and 35.15 lakh in 2004 (Ardh Kumbh). Important places reported for pilgrims in Haridwar area are Brahm Kund, Saptarishi Kshetra, Daksh Mandir, Bikleswar Mahadev, Chandi Devi Mandir and Mansa Devi Mandir. Tourists having visited and projected to visit Haridwar as per Master plan are given in the table below:

Table 1-2 Actual Tourists and Their Projections for Haridwar

Year	Indian	Foreign	Total	Annual Percentage Increase
1997	40,70,182	3,569	40,73,751	-
1998	58,11,200	6,187	58,17,387	(+)42.88 *
1999	44,21,974	4,922	44,26,896	(+)4.33
2000	53,16,980	7,659	53,24,639	(+)20.28
2001	55,02,273	6,276	55,08,549	(+)3.45
2002	55,18,270	6,029	55,24,299	(+)0.28
2003	55,24,432	7,532	55,31,964	(+)0.14
2004	62,83,726	11,012	62,94,738	(+)13.79 *
2011	70,52,000	13,000	70,65,000	(+)1.52
2021	79,82,000	18,000	80,00,000	(+)1.20
2025	84,80,000	20,000	85,00,000	(+)1.25

* Higher number of tourist influx due to Kaha Kumbh and Ardh Kumbh

Source: Haridwar Mahayojna 2025. Table no.- 6.3 (Annexure A 1.5)

From the above table it is seen that 85 lakh tourists are expected to visit Haridwar in 2025.

Master Plan 2025 of Haridwar brings out that there is lot of scope to develop guest houses and hotels for accommodating tourists on different occasions namely, Aardh Kumbh, Kumbh and other important Hindu festivals.

Master Plan reports the peak hour passenger car unit traffic on various roads arrived based on the surveys conducted in January, 2003. The same are reiterated below:

Table 1-3 Traffic on Different Roads in Haridwar

S. No.	Name of Road	PCU (in 2003) at Selected Locations
1	Rishikeksh Marg	Chandighat Chowk – 2,197
2	Roorkee Marg	Chandracharya Chowk – 1,662
3	Najibabad Marg	Changhat Chowk – 774
4	Roorkee Bye pass Marg	Chandighat Chowk – 1,897
5	BHEL Marg	Chandracharya Chowk – 1,920
6	Station Marg	Shankracharya Chowk – 2,132
7	Har-ki-Pauri Marg	Laltarao Chowk – 2,506
8	Kankhal Marg	Shankracharya Chowk – 1,395
9	Laltarao Marg	Chandighat Chowk – 1,023
10	Saptrishi Marg	Pawan Dham Chowk - 562

Source: Haridwar Mahayojna 2025. Table no.- 7.6 (Annexure A 1.6)

Master Plan proposed that Highway between Haridwar and connecting cities having today the ROW of 45-60 meter should be widened to 60-meter ROW throughout its length.

1.4.3 Public Transport Study, GoUK

A study was carried out by UDEC, IDFC and M/s Aakar Abhinav Consultants Pvt. Ltd. The main objective of the study was to assess the transport scenario for preparation of public transportation plan. The Transport Department, Government of Uttarakhand envisaged the purchase of buses for Dehradun, Haridwar and Nainital towns so as to improve the public transport. Thus, the total cost of Rs.124.72 Crores will be required for the horizon period of 2036 for the operation of buses. The cost includes bus stops along the route, bus depots for Dehradun, interchange and multi modal facility, ITS, Central Control Station, GPS Vehicle Mounted for 1000 buses, Display System, Communication Cost and GIS Software.

1.4.4 Comprehensive Mobility Plan for Dehradun City, MDDA, 2013

In 2019, Urban Mass Transit Company Limited (UMTC) carried out a comprehensive traffic study for Dehradun-Haridwar- Rishikesh & Roorkee city. In this study the existing traffic and travel characteristics are observed and the future model is developed to evaluate various policies, strategies and plans for Dehradun Haridwar- Rishikesh & Roorkee city. The study objective was to come out with short, medium and long-term measures. While planning for improvements in the Urban Mobility sector, efforts were made to project the base year and future traffic scenario of the cities covering Dehradun-Haridwar-Rishikesh and Roorkee city. Following which, a Comprehensive Mobility Plan (CMP) is needed to address the mobility needs of the people focusing on non-motorized and public transport, rather than catering to the needs of private automobiles. A CMP optimizes the “mobility pattern of people and goods” and

act as an effective platform for integrating land use and transport planning. Apart from the study corridor details the overall road improvement plan, various bus routes, terminal, transport nagar are proposed for the horizon year.

1.4.5 Other Relevant Traffic Studies in Uttarakhand

M/s Uttarakhand Infrastructure Projects Company Pvt. Ltd. (UIPC) prepared a report in 2015-16 for the metro corridors for Uttarakhand. Some of the important findings of this report are reiterated as under:

- The major growth is observed for the vehicles such as Cars, Two-wheelers as the personalized modes. The cars have grown by more than 23% per annum on an average. At the same time the Two-wheelers have grown more than 12% per annum, the growth of Vikram Tempos is about 1.64% per annum and it is said to be prominent mode of transport for the movement of people.
- There are various modes of transport Haridwar City which are listed as under:
  - (i) **Bus:** State Road Transport of various States.
  - (ii) **Railway:** There is direct connectivity between Haridwar and other Cities in India.
  - (iii) **IPT:** There are various IPT services running parallel to Bus and Railways. Usual route followed by IPT.
- Passengers dealt at Haridwar Railway Station year-wise is given in the report submitted by UIPC and the same is reproduced in the table below:

Table 1-4 Monthly Passenger at Haridwar Railway Station

Month	2011-2012	2012-2013	2013-2014	2014-2015
April	3,63,430	3,89,223	3,59,147	3,62,492
May	4,17,822	4,84,077	3,89,232	4,06,521
June	5,16,128	5,35,173	3,89,407	5,04,166
July	5,32,893	6,03,091	3,10,386	4,83,630
Aug	4,80,902	4,18,234	4,09,854	4,11,204
Sept.	3,75,178	3,99,399	3,34,168	3,24,675
Oct.	3,43,513	4,03,986	3,32,050	3,23,885
Nov	3,83,992	3,33,326	3,61,215	3,07,048
Dec	2,23,861	2,65,748	2,97,137	2,24,110
Jan	2,28,666	2,37,222	2,32,174	2,08,813
Feb	3,02,234	2,50,889	3,52,124	2,43,164
March	3,37,611	3,64,136	3,22,384	-
Total	**45,06,230**	**46,84,504**	**40,89,278**	**37,99,708**

- The total passengers dealt at Haridwar Railway Station in 2014-15 are 37,99,708, which on an average comes to 10,554 daily.
- **Bus Services:** UIPC report indicates that about 735 buses from various State Transport Authorities operate daily from Haridwar ISBT.

1.4.6 Comprehensive Mobility Plan (May, 2019)

This study was carried out by Urban Mass Transit Company Ltd. with focus on, Haridwar and nearby cities. The main objective of the study is to provide a long-term strategy for the desirable mobility pattern of the Metropolitan area covering Dehradun, Rishikesh, Haridwar and Roorkee.

The 1.4.6Comprehensive Mobility Plan (CMP) report broadly groups the proposals for improving urban transport under three categories:

- **Short Term Improvements:** These are short term proposals that need to be reviewed and revised within 5 years as per the requirement.
- **Medium Term Improvements:** The usefulness of these improvements will last for about 5-10 years.
- **Long Term Improvements:** The usefulness of these improvements will last for more than 10-15 years.

The measures suggested in CMP are listed in the table below:

Table 1-5 Required Implementation Measures for Uttarakhand as per CMP, 2019

Short Term Improvements (Phase-I)	Medium Term Improvements (Phase-II)	Long Term Improvements (Phase-III)
Traffic and Pedestrian Management measures	Off, On Street Parking Development	Development of Multi Modal Hubs
Junction Improvements and Management Measures	Freight Terminal	
Restriction on Street Parking Uncertain locations	Intelligent Transport System	
Construction of Footpaths	Construction of Footpaths	Construction of Footpaths
Bus Augmentation & Depot	Bus Augmentation & Depot	Bus Augmentation & Depot
PT Route rationalization	Redevelopment of Bus Terminal	
Off street Parking	Off street Parking	
Road widening & improvement	Road widening & improvement	Road widening & improvement
Mass Rapid Transit System	Mass Rapid Transit System	Mass Rapid Transit System

The Mobility Corridors identified are categorized under three categories:

- **First Order Transit System** includes high capacity mass transit system. A number of transit options are available for mass transit and the same may be selected based on the need and detailed Feasibility Study and Alternatives Analysis. Example: - Heavy metro, Medium Metro, BRT etc.

- **Second Order Mass Transit system** includes bus based system, PRT (Personal Rapid Transit) as well as cable propelled transit, which are medium capacity and are of low speed. Example, Light metro, city bus service PRT, Cable car etc.
- **Third Order Mass Transit System** includes Aggregator Cabs, e-rickshaws and other IPT modes (vikram, chakras and auto rickshaws etc.) as well as individual cabs. Third order systems are meant to be the last mile connector, offering low capacity but maximum coverage. Example: feeder-bus, vikrams, auto, e-rickshaws etc.

CMP, 2019 proposes 18 km corridor for first order transit system as LRT or light metro in Haridwar city. Total cost of this corridor is estimated as Rs. 4,500 Crore @ Rs. 250 Crore per km. Implementation of this corridor is proposed in three phases.

1.4.7 Alternative Analysis Study Report (January, 2019)

This study was carried out by Urban Mass Transit Company Ltd for first and second order transit corridors in Haridwar City. The main objective of the study is to provide a long-term strategy for the desirable mobility pattern of the Metropolitan area covering Haridwar City area. The report recommends as under:

- **First order corridor analysis:** The Corridor's catchment area includes Haripur Kalan – Motichor – Har-Ki-Pauri – Railway Station – Uttarakhand Sanskrit Academy.
- **Second order corridor analysis:** For second order transit corridors in Haridwar city, which required Alternative corridor assessment, Alternative A1, B1 (refer Table 1.12) were found preferable. These corridors were preferred as it has least ROW constraints with high potential for intermodal connectivity. These corridors connect all the important centers too. The most suitable transit systems for second order in Haridwar City are given below:
  - (i) Haridwar Railway/Sitapur station to SIDCUL and Sarai: City Bus service received the highest ranking due to easy implementation and least environmental impact.
  - (ii) Haridwar Railway Station to Har-Ki-Pauri to Sitapur: Cable Car/ PRT system received highest ranking due to suitability in mobility effects.

The following systems are proposed for the corridors based on the Alternative analysis conducted as given in Table below:

Table 1-6 Systems proposed for the Alternative Corridor

Proposed Corridors	Suitable Alignment	Transit System Order	Proposed Transit System
Haridwar – SIDCUL and Sarai	Alternative A1: Haridwar: Sitapur to SIDCUL Haridwar: Sitapur to Sarai	Second	City Bus Service
Haridwar- Har-Ki-Pauri	Alternative B1: Haridwar: Sitapur to Har-Ki-Pauri	Second	PRT/ Cable Car System

Source: The Alternatives Analysis Study Report, Dehradun, Haridwar and Rishikesh as per Comprehensive

Mobility Plan for the Metropolitan Area, Final Report, January, 2019 prepared by M/s UMTC. (page no.-156, table 9-1)

Since City bus services also face traffic congestion issue as well increase pollution to the environment, also during festival and Mela days in Haridwar city. Numbers of private vehicle are coming from various cities make jam issue in the city. Hence, PRT system which provides fast and convenient services is consider as most suitable option for transpiration in Haridwar City.

1.5 PERSONAL RAPID TRANSIT SYSTEM (PRT)

The Personal Rapid Transit (PRT) system is a new and innovative on-demand system for urban environments. The system uses small, driverless electric vehicles that run on a dedicated network of guide ways. The lightweight and flexible nature of the system enables it to be retrofitted into a broad range of environment and provide transportation that is environmentally friendly and operationally efficient. In contrast, PRT offers personal transport with negligible waiting time. Passengers travel non-stop from origin to destination assisted by the fact that all stations are off-line. Vehicles are normally be available on public demand. Waiting times are very short unlike other modes of mass transit where one has to wait for the transport to arrive based on a pre-determined schedule, PRT is an on-demand mass transport system.

The PRT system uses small electric vehicles automatically controlled on a dedicated guide way. While the design speed is typically 100 kmph, the operating speed (maximum) is 90 kmph & the average speed is between 40-60 kmph. The PRT vehicle is based on conventional automotive technologies and is battery powered, and can negotiate inclined surfaces for ascent and descent. The innovative design of the PRT system provides many operational, economic, and environmental benefits, including:

- Low capital and operational costs
- Flexible routing
- 24-hour availability if required
- On-demand service, with no transfers
- Greater privacy
- Zero on-site emissions
- Extremely low overall energy use
- Minimal visual intrusion and acoustic impact.

PRT is an automatic on-demand transport system that has been designed to be both cost-effective and environmentally friendly. It is in essence a personal automatic taxi. All stations are off-line; the PRT vehicle maintains average journey speeds well above that of road traffic in

an urban environment resulting in short travel time.

1.6 PRESENT STUDY FOR PRT SYSTEM AT HARIDWAR

The project site is located in Haridwar city, Uttarakhand. Following four corridors have been proposed for the PRT system.

Table 1-7 Proposed PRT Corridors in Haridwar City

S. No.	Proposed PRT Corridor	Length (km)
1	Bharat Mata Temple – Sitapur	14.55
2	City Hospital – Daksha Temple	3.10
3	Valmiki Chowk – Laltaro Bridge	0.69
4	Ganeshpuram – DAV School	2.40
	Total	**20.74**

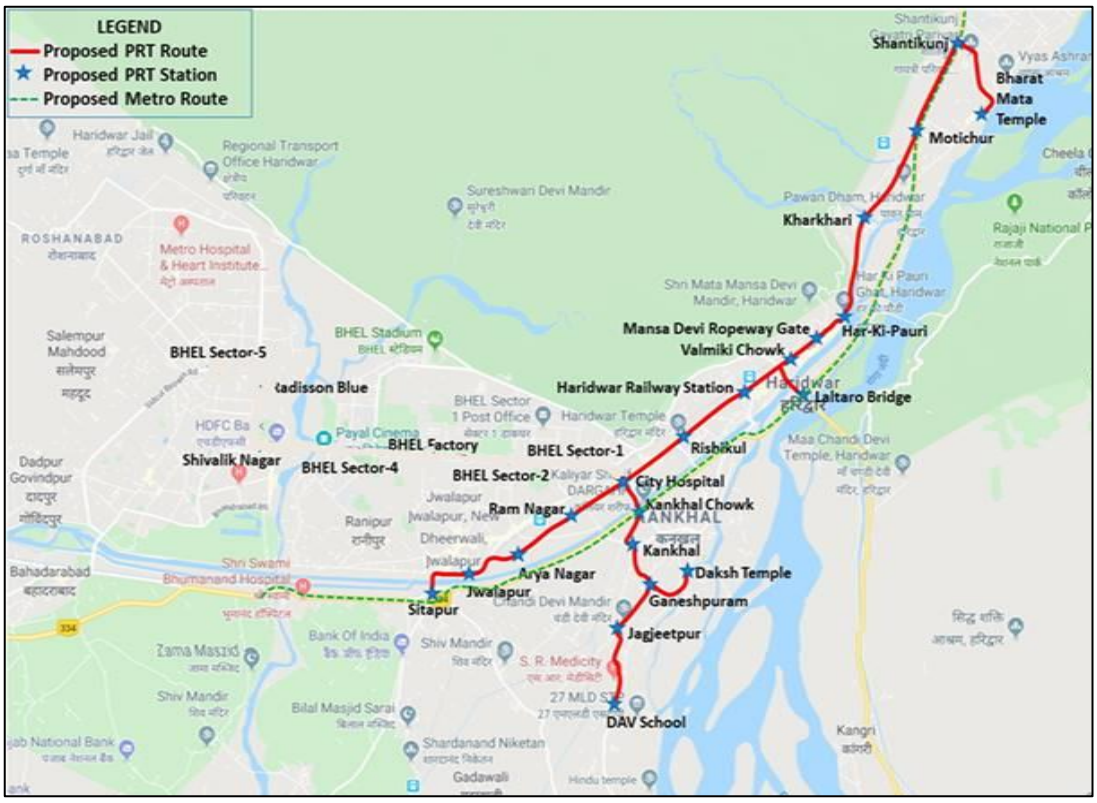


Figure 1-2: Map Showing Proposed PRT Corridors in Haridwar City

1.7 STRUCTURE OF DETAILED PROJECT REPORT (DPR)

This report includes the chapters as under:

Executive Summary

Chapter-1: Introduction

Chapter-2: Traffic Study and Demand Forecast

Chapter-3: Mode Selection (Alternative Analysis)

Chapter-4: Geometric Design Parameters and Civil Engineering

Chapter-5: Station Planning

Chapter-6: Operation Plan, Depot and Maintenance Facilities

Chapter-7: Power Supply Arrangements

Chapter-8: Signalling and Telecommunication

Chapter-9: Disabled Friendly Features

Chapter-10: Environment & Social Impact Assessment

Chapter-11: Security Measures PRT System

Chapter-12: Disaster Management Measures

Chapter-13: Multi Modal Traffic Integration at PRT Station

Chapter-14: TOD and Value Capture Financing

Chapter-15: Cost Estimates

Chapter-16: Financing Options, Fare Structure and Financial Viability

Chapter-17: Economic Appraisal

Chapter-18: Implementation Plan

Chapter-19: Conclusions and Recommendations

Annexure – A 1.1

Appendix-I

दूरभाष : 0135-2719000

उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण

राजीव गाँधी बहुउद्देशीय कॉम्पलैक्स, डिस्पेन्सरी रोड, देहरादून, उत्तराखण्ड

e-mail- shudauk@gmail.com फैक्स : 0135-2719500

पत्रांक:-494 /उडा-142/2016-17 दिनांक:-29.11.2016

प्रेषक,

मुख्य प्रशासक,
उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण,
देहरादून।

सेवा में,

प्रबन्ध निदेशक,
दिल्ली मेट्रो रेल कॉरपरेशन लि0,
मेट्रो भवन, फायर ब्रिगेड लेन,
12-खण्डा रोड, नई दिल्ली।

विषय : उत्तराखण्ड में मेट्रो रेल हेतु डी0पी0आर0 बनवाने के सम्बन्ध में।

महोदय,

उत्तराखण्ड राज्य में मेट्रो रेल/मोनो रेल एवं भवन निर्माण निर्माण आदि के नियोजन, निर्माण सुधार, विकास, प्रबन्धन, नियंत्रण तथा रखरखाव हेतु उत्तराखण्ड मेट्रो रेल, शहरी अवस्थापना एवं भवन निर्माण निगम लिमिटेड का गठन किया जा चुका है और कम्पनी एक्ट में पंजीकृत करने की कार्यवाही उत्तराखण्ड आवास एवं नगर विकास द्वारा की जा रही है। वर्तमान में राज्य सरकार द्वारा देहरादून, ऋषिकेश एवं हरिद्वार के मध्य मेट्रो रेल की सुविधा विकसित किये जाने का निर्णय लिया गया है, जिसके लिए एक विस्तृत कार्ययोजना बनायी जानी है। इस खण्ड के डी0पी0आर0 बनवाने का कार्य दिल्ली मेट्रो रेल कॉरपरेशन लि0 के माध्यम से कराया जाना प्रस्तावित है। उक्त कार्य हेतु श्री बंशीधर तिवारी, संयुक्त मुख्य प्रशासक, उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण को नोडल अधिकारी नामित किया गया है।

अतः अनुरोध है कि उपरोक्त प्रस्ताव पर सहमति प्रदान करते हुए देहरादून, ऋषिकेश एवं हरिद्वार क्षेत्र में मेट्रो रेल सुविधा विकसित करने हेतु डी0पी0आर0 तैयार किये जाने हेतु आवश्यक कार्यवाही किये जाने का कष्ट करेंगे।

भवदीय,

(डॉ0 आर0मीनाक्षी सुन्दरम्)
मुख्य प्रशासक।

प्रतिलिपि : सचिव, आवास, उत्तराखण्ड शासन को आदेश संख्या: 1753/V/आ0-2016-06(प्रा0)/2016 दिनांक: 28 नवम्बर,2016 के क्रम में सूचनार्थ प्रेषित।

(डॉ0 आर0मीनाक्षी सुन्दरम्)
मुख्य प्रशासक।

Page 16 of 23

Annexure – A 1.2

दूरभाष / फैक्स : 0135-2719900

उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण

राजीव गाँधी बहुउद्देश्यीय कॉम्पलैक्स, किसैन्सरी रोड, देहरादून, उत्तराखण्ड

Website- uhuda.org.in E-mail – uhudauk@gmail.com

Letter No. 516 /UHUDA-142/2016-17 Dated 8.12.2016

To,

Mr. Pamod Kumar,
Advisor/CS
Delhi Metro Corporation Ltd.
Metro Bhawan, Fire Brigade Lane,
Barakhamba Road, New Delhi

Sub: Preparation of Detailed Project Report for Metro Rail in Uttarakhand.

Sir,

Please refer your letter no. DMRC/ Adv (CS)/Uttarakhand/2016 dated 08th Dec, 2016. In this context, we would like to bring to your kind notice that the proposed Metro rail project has been planned between Dehradun, Rishikesh and Haridwar cities as per our letter no. 494/UHUDA-142/2016-7 dated 29th Nov 2016.

It is to communicate you that the Metro which is mentioned in your proposal from Dehradun ISBT to Jhakhan should be corrected as Dehradun to Rishikesh hence the approximate distance between the cities would be changed as below:-

1- Dehradun to Rishikesh- 45 Km.
2- Rishikesh to Haridwar- 28 Km.

Therefore, it is requested you to apply scan the revised financial proposal for the above subjected project so the appropriate decision can be taken up as earliest.

Thanking you.

(Dr. R.Meenakshi Sundaram)
Chief Administrator

Copy: Secretary Housing, Uttarakhand for information.

(Dr. R.Meenakshi Sundaram)

Delhi Metro Rail Corporation Ltd.
Advisor/CS
Dy. No. 985
Dated 09/12/2016

Annexure – A 1.3

Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited (1)

(A Government of Uttarakhand Undertaking)

(CIN: 45309UR 2017 SGC007687) (GSTIN: 05AACCU1650R1ZT)

Website: - www.ukmrc.org, Email: -info@ukmrc.org

Letter No. - 370/U.M.-118 /2019 -20 Date:- -10-2019

To,

Director/Business Development,
Delhi Metro Rail Corporation,
25 , Ashoka Road,
New Delhi 110001.

Subject: - Preparation of the DPR of Ropeway/PRT (POD) in Dehradun & Haridwar.

Sir,

Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited intends to get the DPR prepared for a Ropeway/Cable Car system as MRTS for the city of Dehradun and Personalised Rapid Transit (PRT) system for Haridwar by Delhi Metro Rail corporation Ltd. Tentative lengths of the two systems are as under:-

S.No.	Brief Description of Work	Length in Kms (Approximate)
1.	Preparation of DPR of Ropeway system in Dehradun	25 Kms
2.	Preparation of DPR of PRT system in Haridwar	8 Kms

The above given length of corridors are mentioned on the basis of Comprehensive Mobility Plan. Actual length may be decided after detailed study. The above issue was discussed with MD/DMRC and you during my last visit to DMRC

It is therefore requested to please provide a draft MOU/Agreement and cost of both DPRs separately.

01.10.19

(Jitendra Tyagi)
Managing Director

Copy to:- Mananging Director, Metro Bhawan, Fire Brigade Lane, Barakhamba Road, New Delhi-110001

(Jitendra Tyagi)
Managing Director

5th Floor, Rajeev Gandhi Multi Purpose Complex, Dispensary Road, Dehradun - Uttarakhand - 248001

Phone: 0135-2719442, Fax 0135-2719444

Chapter -2
Traffic Study & Demand Forecast

2.1 Study Area

2.2 Demographic Detail

2.3 Socio – Economic Outline

2.4 Tourism

2.5 Existing Traffic and Transport Characteristics

2.6 PRT System and Selected Corridors

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2.12 Impact of Shifting of Car Parking

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CHAPTER 2
TRAFFIC STUDY AND DEMAND FORECAST

2.1 STUDY AREA

The study area comprising of Haridwar is located in the Garhwal region of Uttarakhand. Haridwar is the most prominent religious and spiritual centre of the state of Uttarakhand. Haridwar is the headquarters and the largest city of the district. The total geographical area of the Haridwar Township is about 42.01sq.km and is situated at the height of 249 m above mean sea level.

Haridwar is the gateway to the four pilgrimages of Uttarakhand. History depicts that it is the starting point of the two holy rivers Ganga and the Yamuna. Haridwar's chief object of pilgrimage is Har-ki-pauri—the bathing ghat, or steps, along the river. Haridwar is also one of the four places where Kumbh Mela occurs after rotation of every twelve Years and Ardh Kumbh Mela is organised after six years of every Kumbh. Large numbers of pilgrims gather there annually at the beginning of the Hindu solar year in April.

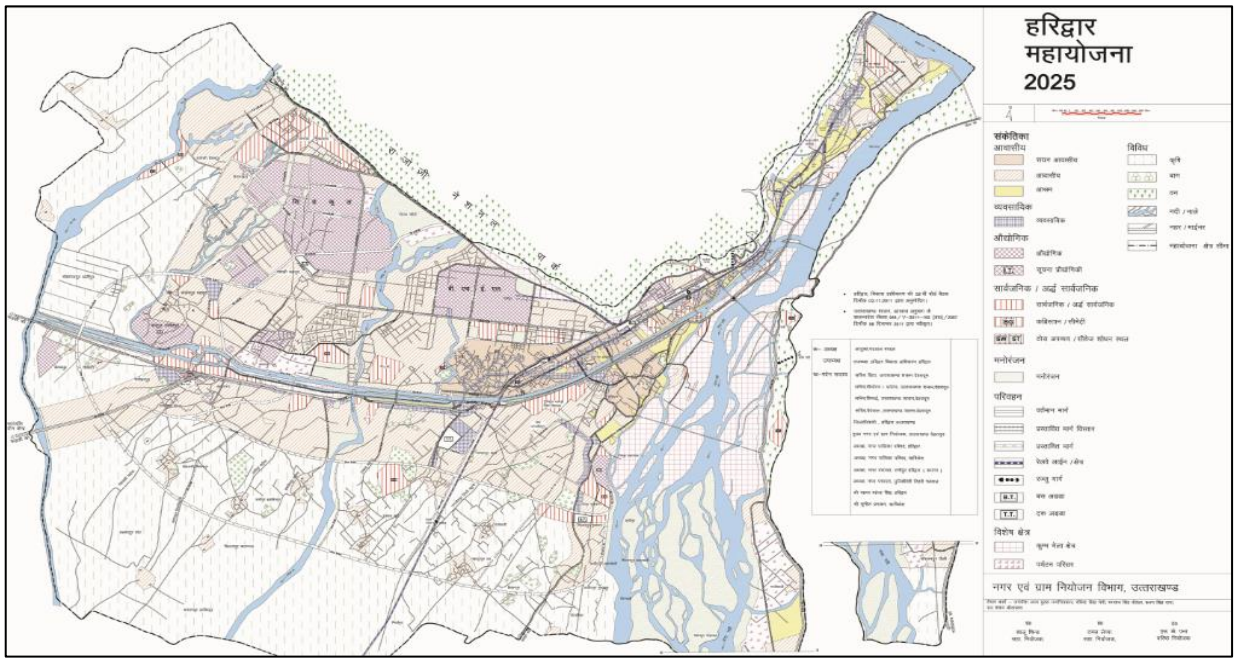


Figure 2-1: Key Parameters to be Considered for Multimodal Integration

Today, the city is developing beyond its religious importance, with the fast-developing industrial estate of State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIIDCUL), and the close by township of Bharat Heavy Electricals Limited (BHEL) as well as its

affiliated ancillaries. Being one of the seven holiest cities in India, Haridwar often bustles with devotees. Its propitious location near the holy River Ganga has made it to gain more popularity.

2.2 DEMOGRAPHIC DETAIL

As of 2011 India census, Haridwar district had population of 18,90,422 (2011) & Haridwar city has 3,20,892 population in 2011. As per Census 2001, average household size is about 5.4 persons. Haridwar has an average literacy rate of 70%, higher than the national average of 59.5%.

Table 2-1 Demographic Data of Haridwar as per Census 2011

Region	Population (Census 2011)	Density (in PPSQKM)	No of Household	Household Size	Male Population	Female	Sex Ratio	Literacy Rate	Decadal Growth Rate
Rawali Mahdood (CT)	17,467	3,130	3,464	5.04	9,438	8,029	851	68.73	140.70
Bahadarabad (CT)	10,096	3,913	1,903	5.31	5,366	4,730	881	70.39	33.63
Jagjeetpur (CT)	15,043	3,270	3,090	4.87	7,917	7,126	900	74.32	110.50
Hardwar (NPP+OG)	2,31,338	9,819	47,251	4.9	1,23,455	1,07,883	874	73.69	30.32
Bharat Heavy Electricals Limited Ranipur (ITS)	46,948	1,743	10,381	4.52	24,893	22,055	886	80.16	8.53

Haridwar hosts about 8 million religious tourists every year. The giant public sector unit BHEL a large unit of Hindustan Lever and three engineering units have their impact on the tertiary sector of the economy of the town. In private sector also, some large industrial units are functioning in the fringes of Haridwar, which have impact on the economy of the town; and many more units which are in the offing, will also indirectly strengthen the economy of this town. As the economy grows, the rate of in-migration of workers will grow concomitantly, which will reflect on the growth of population. Besides the tourist population, a large number of daily religious visitors and visitors who come on different business in this head quarter town (Haridwar town is the Head Quarter of District Haridwar) constitute the floating population.

2.3 SOCIO – ECONOMIC OUTLINE

Haridwar is the hub of religious tourism in the State of Uttarakhand. Among several religious tourist destinations in this State, Haridwar attracts largest number of visitors, the impact of which on the service sector is quite significant, particularly in the small trade, hotel business, transport and such other activities. Haridwar is also growing as the industrial hub of the State.

SIIDCUL is a massive industrial area, spread over 2,034 acres, developed by State Industrial Development Corporation of Uttarakhand (SIIDCUL), a state government body. With the arrival of big enterprises like ITC, Hindustan Unilever Limited, Dabur, Mahindra & Mahindra, Havells and Kirby, SIIDCUL is set to develop into another industrial township within the city 3 km away from the Delhi-Hardwar National Highway.

The giant public sector unit BHEL (population 47,000 in its colony - as per census 2011), a large unit of Hindustan Lever (employment 559 - as per CDP Haridwar 2007), and three engineering units (together employing 11,040 workers - as per CDP Haridwar 2007) have their impact on the tertiary sector of the economy of the town. In private sector also, some large industrial units are functioning in the fringes of Haridwar, which have impact on the economy of the town; and many more units which are in the offing, will also indirectly strengthen the economy of this town. As the economy grows, the rate of in-migration of workers will grow concomitantly, which will reflect on the growth of population.

As per CDP Haridwar 2007 and IMaCS primary survey 2017, majority of the households in Haridwar are in below poverty line and poor income groups, at present more than 15% population is below the national (GoI) poverty line. Mean per capita income of the families is around Rs. 5,000 and mean household income is around Rs. 15,000. There is a considerable proportion of population in the lower expenditure group and it is evident that they spend most of their income. Families in the middle-income groups have maximum savings in Haridwar.

2.4 TOURISM

Haridwar is considered as the point of entry to Char Dham, the four main centres of pilgrimage in Uttarakhand region viz. Badrinath, Kedarnath, Gangotri and Yamunotri. Haridwar, with its rich heritage attracts millions of tourists on religious occasions every year and especially during Kumbh Mela and Ardh Kumbh Mela. Haridwar has neighbouring tourist attractions which makes it a tourist hub in the region.

Tourists come in millions to Haridwar from all over India and the world throughout the year. Almost 1.25 lakh pilgrims and tourists visit Haridwar every day. Over the years, there has been a continuous increase in the number of tourists visiting Haridwar.

2.5 EXISTING TRAFFIC AND TRANSPORT CHARACTERISTICS

Haridwar is well connected by rail and road from Delhi, Kolkata, Mumbai, Dehradun and Yamunotri in the Himalayas. Haridwar is located at a distance of 225 kms Northeast from Delhi, 52 kms from Dehradun and 494 kms from Lucknow. The city is connected by road to other parts of the state with Delhi – Niti pass road, Rishikesh road, Nazibabad road and NH- 58

forming the major travel corridors. This city is also connected by rail with other parts of the country.

2.5.1 Road Network

Haridwar city comprises of 246 km of roads of which 214.10 km are maintained by HNPP and 31.90 km (including 13 km of National Highway) are maintained by PWD. The traffic carrying capacities of city roads are low due to limited widths, intense land use and encroachments.

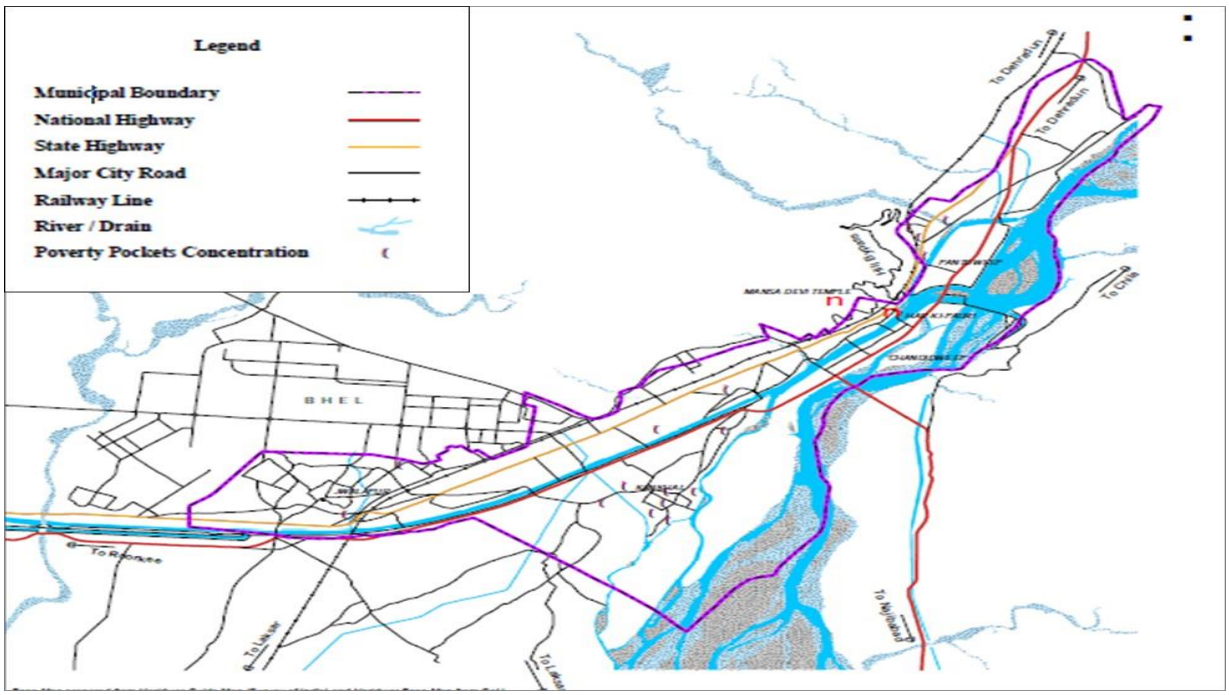


Figure 2-2: Road Network Map of Haridwar

The city has a network of extremely narrow roads within the core city area. There is a lack of general road hierarchy and inadequate traffic management. There is a total of 214 km of roads maintained by HNPP and about 45 km roads maintained by PWD.

Linear growth has resulted in ribbon development along the main corridor of town, the Delhi-Niti Pass highway, known as DN Road/ Upper Road within the municipal boundary. DN road has high density commercial development creating traffic congestion during religious fairs and festivals. Increasing number of tourists every year has further accentuated the need for additional flyovers, dedicated pedestrian ways, widening of existing roads, development of parking places etc.

2.5.2 Public Transport

There is an absence of organized public transport system for Haridwar. However, IPT as auto, vikram and e-rickshaw constitute of most of the public transport trips. The main local transports

of Haridwar include private taxis, local buses, auto rickshaws, e-rickshaws and cycles. Locals and tourists make use of these local transports for traveling within the city. Tempos or vikrams are operated on a fixed route and fixed fare basis (by RTO) for short distance intra-city trips within the city, while auto rickshaws are operated on free route pattern without any fixed rate.

2.5.3 Vehicular Growth

According to the data by RTO, total registered vehicles in Haridwar city in 2017 was around 1.6 lakhs. The vehicle registration is witnessed an increase of 18% from 2016 to 2017. Total newly registered vehicles in 2016 was 21,856 which is increased to 25,841 in 2017; out of which majority is two wheelers followed by cars and other vehicles.

2.6 PRT SYSTEM AND SELECTED CORRIDORS

Personal rapid transit (PRT), also referred to as pod cars, is a public transport mode featuring small automated vehicles operating on a network of specially built guideways. PRT provides a taxi-like service for individual or small group of travellers. It provides as demand responsive feeder and shuttle service connecting major facilities such as shopping, tourist attractions, and centres. The system uses automated electric driven pod cars with capacity of 4 to 6 peoples on a network of narrow segregated guide ways in order to ensure unhindered direct trips between origin and destination. With high vehicle speeds and very small headways, PRT provides fast, individual, on-demand and point-to-point PT with very short waiting times.

This system is proposed in the Haridwar city. The system will provide on-demand operations, direct origin to destination stop service, and congestion free transport due to operating on segregated guideways. The selected corridors for traffic study are given in the following table.

Table 2-2 Selected PRT Corridors in Haridwar for Traffic Study

Corridor	Corridor Name
Corridor I	Har-Ki-Pauri to Sitapur along Haridwar Main Road
Corridor II	Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar Road
Corridor III	Har-Ki-Pauri to Shantikunj area connecting Haridwar-Rishikesh Main Road
Corridor IV	Haridwar Main Road (Prem Nagar) to Shivalik Nagar along Madhya Marg
Corridor V	Valimiki Chowk to Parking area near Laltaro Bridge
Corridor VI	Extensions connecting Bhart Mata Temple from Shantikunj area and Daksh Temple from Kankhal/ Ganeshpuram

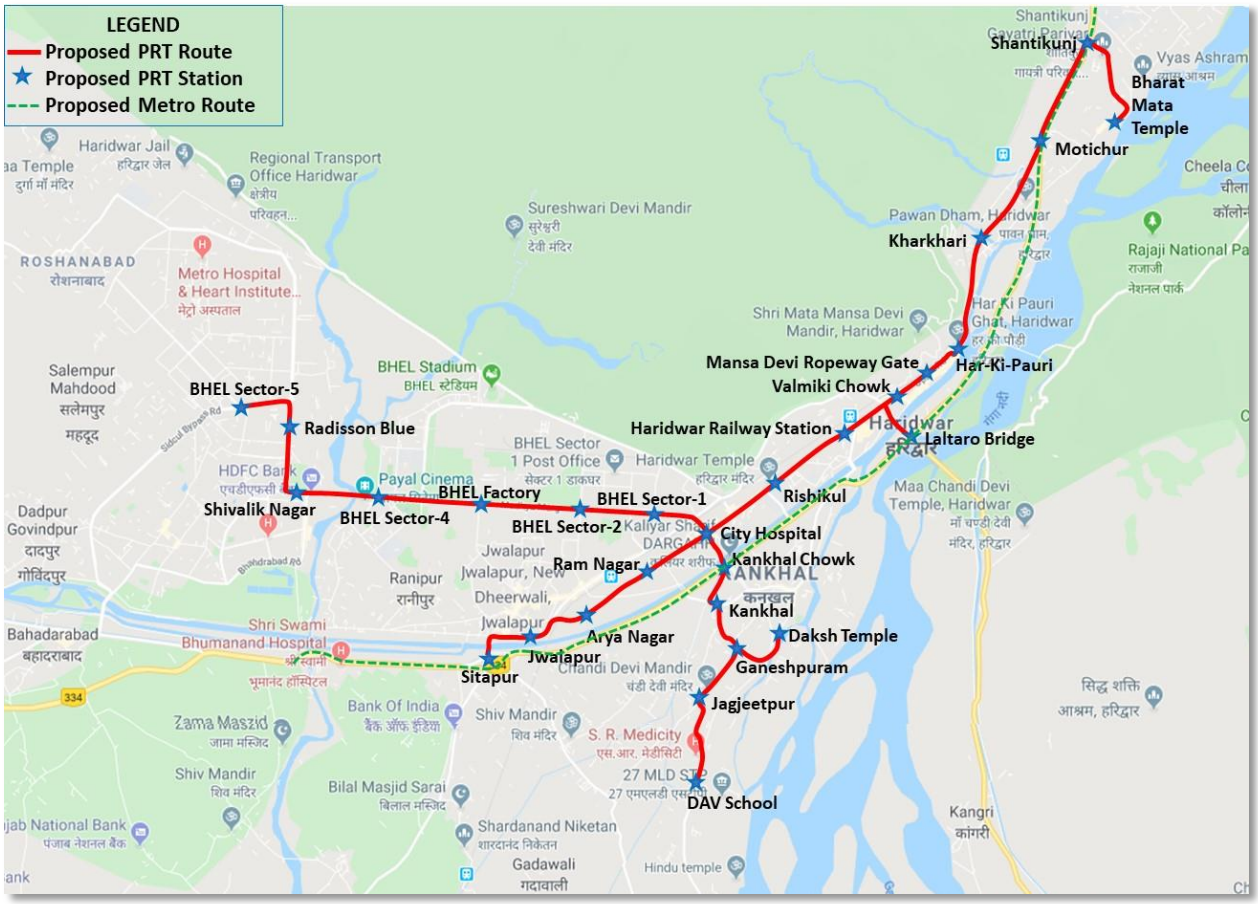


Figure 2-3: Selected PRT Corridors in Haridwar City for Traffic Study

2.7 PRIMARY SURVEY

DMRC engaged M/s ICRA for carrying out the Traffic study & Demand forecast. Various primary traffic surveys for the study area are executed in order to assess the baseline traffic condition and to achieve desired results for future proposals. The primary surveys are conducted at the selected locations with respect to the proposed PRT corridor in the study area. The required surveys undertaken are described in the chapter.

Table 2-3 List of Primary Surveys

Survey	Duration/ Samples
Traffic Volume Count including Occupancy Survey	24 hours for 3 days
Traffic Volume Count -Videography	24 hours for 3 days
Road side OD Survey including Willingness to Pay Survey	16 hours for 1 day
Speed and Delay by Moving Car Observer Method	Morning and Evening Peak

2.7.1 Traffic Volume Count including Occupancy Survey

Traffic Volume Count (TVC) surveys (including occupancy surveys) provide information regarding traffic characteristics and the average Occupancy on the study corridor. Manual Classified Traffic Volume Count Surveys was undertaken at 6 identified locations across the study corridor, while videographic TVC Survey was also carried out across 2 locations. TVC survey details are listed in the following table.

Table 2-4 Traffic Volume Count (TVC) Survey Locations

Survey	Location ID	Location	Duration	Date
Manual TVC	MB1	Sanjay Colony	24 hours for 3 days	15/12/2019
	MB3	Rishikul	24 hours for 3 days	12/12/2019
	MB5	Har-ki-Pauri	24 hours for 3 days	12/12/2019
	MB6	Vaidik Mohan Ashram	24 hours for 3 days	12/12/2019
	MB7	Gandhi Park	24 hours for 3 days	15/12/2019
	MB8	Laksar Road	24 hours for 3 days	15/12/2019
Videographic TVC	MB2	Aurobindo Ashram	24 hours for 3 days	15/12/2019
	MB4	Railway Station	24 hours for 3 days	15/12/2019

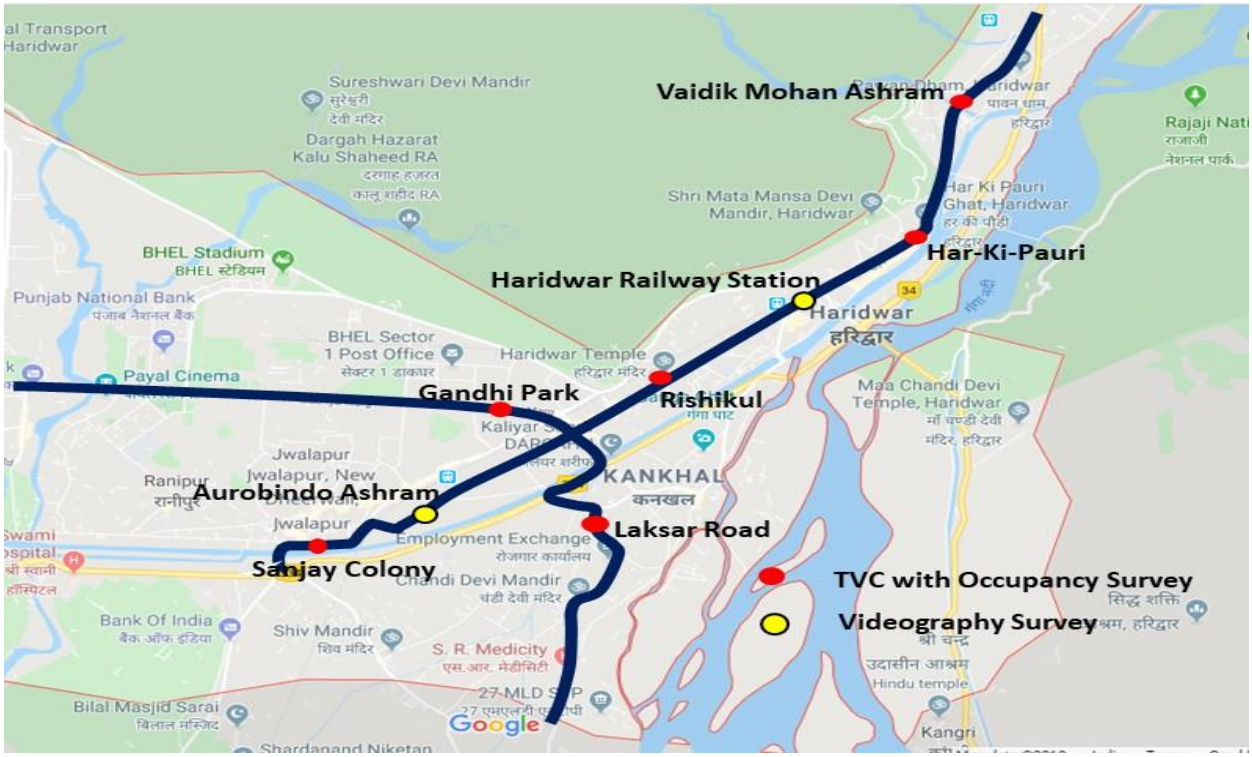


Figure 2-4: Traffic Survey Location Map

Directional classified traffic volume counts are analysed to obtain:

1.Average Daily Traffic (ADT) - ADT provides an insight to the amount of traffic moving on various stretches of the corridors and is further appropriately used for assessment.

2.Peak Hour Flows - From observing the peak hour values, the observed peak hour time, its associated traffic and also the peak hour factor the location are obtained.

3.Directional Distribution by hour of the day - Directional distribution presents the directional split in traffic at each survey location.

4.Traffic Composition - Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area.

In addition, Occupancy survey was carried out along with the TVC Survey wherein the mode wise occupancy values were also recorded. These in conjunction with one another are further used for the traffic assessment.

Traffic Volume counts conducted at various locations along the project corridor provided an insight to the amount of traffic moving on various stretches of the corridor. Table below shows the average traffic volume observed at all individual locations.

Table 2-5 Traffic Volume Count (TVC) at Midblock Location (24 Hours)

Location ID	Mid-Block	Direction	Vehicles	PCUs	Total Vehicles	Total PCUs
MB1	Sanjay Colony	Towards Rishikesh	13,050	8,962	26,483	18,277
		Towards Sitapur	13,434	9,315		
MB2	Aurobindo Ashram	Towards Rishikesh	14,613	9,733	29,168	19,588
		Towards Sitapur	14,555	9,855		
MB3	Rishikul	Towards Rishikesh	14,891	11,453	30,206	23,186
		Towards Sitapur	15,314	11,734		
MB4	Railway Station	Towards Rishikesh	15,698	13,430	28,570	23,768
		Towards Sitapur	12,872	10,339		
MB5	Har-ki-Pauri	Towards Rishikesh	5,394	3,764	10,750	7,487
		Towards Sitapur	5,357	3,723		
MB6	Vaidik Mohan Ashram	Towards Rishikesh	7,151	5,064	13,779	9,781
		Towards Sitapur	6,628	4,717		
MB7	Gandhi Park	Towards Rishikul	14,611	10,135	28,871	20,054
		Towards BHEL	14,260	9,919		
MB 8	Laksar Road	Towards Haridwar Main Road	16,167	11,442	31,286	22,019
		Towards Laksar	15,119	10,577		

The above Table represents average daily passenger traffic volume observed at individual locations for 24 hours. It can be noted that highest vehicular flow on Haridwar Old Road as 30,206 (23,186 PCUs) is observed at Midblock location MB3 i.e., Rishikul. However, vehicular traffic volume on Laksar Road is highest among all traffic volume count locations. Average daily vehicular traffic at Laksar Road is observed as 31,286 (22,019 PCUs). Due to narrow ROW and congestion of pedestrian pilgrimages, vehicular traffic volume on Haridwar Old Road after Valmiki Chowk towards Har-Ki-Pauri reduces to 10,750 vehicles (7,487 PCUs) per day.

Analysing the observed daily passenger traffic after the Haridwar Railway Station (MB4) and after Valmiki Chowk (MB5), it is clear that significant amount of traffic is getting diverted from railway station towards NH334A (Haridwar Main Road) via Mayapur Road and Valmiki Chowk (Laltaro Bridge). As per the available ROW and local connectivity of three different roads (Mayapur Road, Laltaro Bridge Road and Bypass Road towards Bilkeshwar Colony) between Haridwar Railway Station and Har-Ki-Pauri, it is estimated at around 45% of total diverted traffic from Haridwar Railway Station is on the Laltaro Bridge, 35% is on Mayapur Road and 20% is on the Bypass Road towards Bilkeshwar Colony. Further there is straight movement traffic between Laltaro Bridge and Bypass Road towards Bilkeshwar Colony. This component is estimated as additional 20% of total diverted traffic on Laltaro Bridge. After this detailed analysis of traffic diversion mentioned above, traffic estimates on Laltaro Bridge shows average daily vehicular flow of around 9,622 (8,790 PCU) and on Mayapur Road shows average daily vehicular flow of around 6,235 (5,695 PCU). In terms of passenger volume Laltaro Bridge carries around 36,000 passengers and Mayapur Road carries around 24,000 passengers per day.

Table 2-6 Traffic Volume Count (TVC) at Laltaro Bridge and Mayapur Road (24 Hours)

Location	Direction	Vehicles	PCUs	Total Vehicles	Total PCUs
Laltaro Bridge	Towards NH334A	5,564	5,219	9,622	8,790
	Towards Haridwar Old Road	4,058	3,571		
Mayapur Road	Towards NH334A	3,605	3,381	6,235	5,695
	Towards Haridwar Old Road	2,630	2,315		

Daily variations of traffic volume at each primary survey location shows that weekend traffic for Rishikul to Vaidic Mohan Ashram is around 8% higher than weekday traffic. Whereas, other locations in the city (locations at the residential areas) are observed with lower weekend traffic than weekday or almost similar traffic for both the weekend and weekday. This implies the additional impact of tourist traffic at the Rishikul – Vaidik Mohan Ashram section due to concentration of religious places and temples at this area. Whereas, other locations in the city have more weekday traffic with due impact of day-to-day work, business or educational traffic.

The Passenger Car Unit (PCU) values adopted for the study are provided in the following table.

Table 2-7 PCU Values Adopted for the Study

Vehicle Type	Two Wheeler	Auto Rickshaw	Tempo	Car / Taxi	E-Rickshaw	Mini Bus	Public Bus	Chartered Bus
PCU	0.5	1.00	1.00	1.00	1.00	1.5	3.00	3.00

2.7.2 Vehicle Occupancy

The occupancy survey for vehicles was undertaken as part of the traffic studies. The purpose of this study is to determine the existing sectional ridership on the particular route during the study period. This would act as a major input towards model development and validation. The occupancy survey was also carried out along with TVC Survey. The location wise occupancy details are provided in the following table, wherein mode wise observed average occupancy values are listed.

Table 2-8 Mode-wise Occupancy Survey Summary

Location ID	Mid-Block	Two Wheeler	Car / Jeep / Van	Tempo / Share Auto	E-Rickshaw	Govt. Bus	Chartered Bus	Mini Bus	Cycle Rickshaw
MB1	Sanjay Colony	1.59	3.77	4.36	4.06	46.18	-	12.99	1.50
MB3	Rishikul	1.51	4.39	4.68	4.06	44.35	41.00	13.19	1.58
MB5	Har-ki-Pauri	1.55	5.46	5.00	4.35	-	-	13.24	1.39
MB6	Vaidik Mohan Ashram	1.58	3.61	4.67	4.12	44.83	44.50	13.54	1.33
MB7	Gandhi Park	1.53	3.49	4.86	4.87	43.44	39.64	13.36	2.00
MB8	Laksar Road	1.58	3.55	4.60	3.99	38.76	47.78	13.24	1.00

The observed average occupancy values for all passenger modes were collated to obtain an accurate estimation of passenger movement. Occupancy values were used in conjunction with the traffic volumes to estimate the prevalent passenger movement at individual survey locations. The following table presents the location wise summary of the above-mentioned survey locations.

Table 2-9 Location-wise Traffic Summary (24 Hours)

Location ID	Location	ADT		Total Passengers	Excluding Bus Passengers	E-Rickshaw, Auto Rickshaw and NMT Passengers
		Vehicle	PCU			
MB1	Sanjay Colony	26,483	18,277	67,987	66,542	28,182

Location ID	Location	ADT		Total Passengers	Excluding Bus Passengers	E-Rickshaw, Auto Rickshaw and NMT Passengers
		Vehicle	PCU			
MB2	Aurobindo Ashram	29,168	19,588	68,381	68,298	22,478
MB3	Rishikul	30,206	23,186	102,642	86,378	42,289
MB4	Railway Station	28,570	23,768	87,408	80,616	49,846
MB5	Har-ki-Pauri	10,750	7,487	19,132	18,815	5,673
MB6	Vaidik Mohan Ashram	13,779	9,781	37,472	36,462	16,122
MB7	Gandhi Park	28,871	20,054	68,979	66,520	3,311
MB8	Laksar Road	31,286	22,019	82,423	79,148	20,124

2.7.3 Vehicular Composition

Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area. The overall composition is expressed in the following chart.

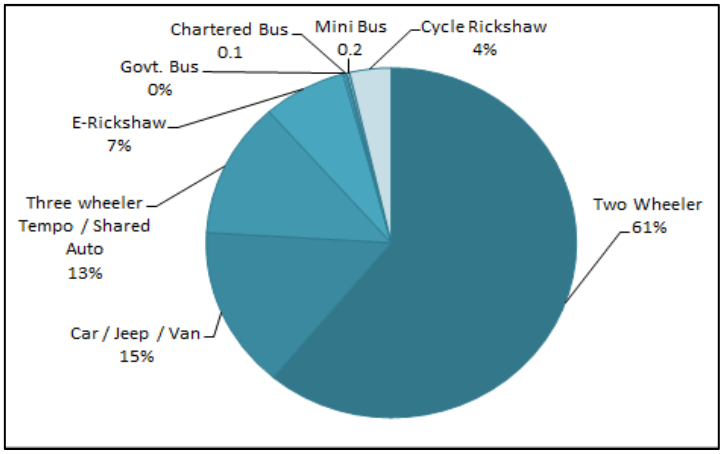


Figure 2-5: Vehicular Composition of Study Area

Average vehicular composition recorded during the traffic volume study shows that majority of the traffic comprises of two-wheelers (61%) and IPT (20%). IPT vehicles include Temp/Shared Auto/E-rickshaw. Car recorded the share of 15% and buses recorded a negligible share of less than 1%. The following table presents the vehicle composition of the surveyed locations.

Table 2-10 Vehicle Composition at Surveyed Locations

Location ID	Location	Vehicles	Two Wheeler	Car / Jeep / Van	Three wheeler/ Tempo/ Shared Auto	E-Rickshaw	Govt. Bus	Chartered Bus	Mini Bus	Cycle Rickshaw	Total Vehicles
MB 1	Sanjay Colony	Vehicle	16,576	3,187	4,093	2,532	23	0	31	42	26,483
		%	63	12	15	10	0.08	0.0	0.12	0.16	100

Location ID	Location	Vehicles	Two Wheeler	Car / Jeep / Van	Three wheeler/ Tempo/ Shared Auto	E-Rickshaw	Govt. Bus	Chartered Bus	Mini Bus	Cycle Rickshaw	Total Vehicles
MB 2	Aurobindo Ashram	Vehicle	19,694	3,852	3,106	2,028	1	14	3	472	29,168
		%	68	13	11	7	0.00	0.05	0.01	2	100
MB 3	Rishikul	Vehicle	15,681	4,641	7,496	1,705	275	45	169	194	30,206
		%	52	15	25	6	1	0.1	1	1	100
MB 4	Railway Station	Vehicle	13,464	1,748	6,577	3,536	138	67	50	2,991	28,570
		%	47	6	23	12	0.5	0.2	0.2	10	100
MB 5	Har-ki-Pauri	Vehicle	8,217	79	65	699	0	0	24	1,667	10,750
		%	76	1	1	7	0.0	0.0	0.2	16	100
MB 6	Vaidik Mohan Ashram	Vehicle	8,178	1,904	2,400	1,181	10	12	42	53	13,779
		%	59	14	17	9	0.1	0.1	0.3	0	100
MB 7	Gandhi Park	Vehicle	17,890	10,183	450	226	37	9	65	10	28,871
		%	62	35	2	1	0.13	0.03	0.23	0.04	100
MB 8	Laksar Road	Vehicle	19,196	7,126	2,192	2,503	58	73	78	61	31,286
		%	61	23	7	8	0.2	0.2	0	0.2	100
Average (%)			61.0	14.9	12.6	7.3	0.2	0.1	0.2	3.6	100

Figure 2-6: Observed Traffic Volumes (Number of Passenger Vehicles) on the Proposed Corridors

2.7.4 Peak Hour Flows

Peak Hour and peak hour characteristics (Peak Hour PCU, Peak Period Factor) obtained during the 16 hours TVC survey are listed in the following table.

Table 2-11 Peak Hour, Peak Hour PCU and Peak Hour Factor Summary

Location ID	Location	Peak Hour	Peak Hour PCU	Peak Hour Factor w.r.t. 16 Hour PCU
MB1	Sanjay Colony	17:30-18:30	1,639	8.97%
MB2	Aurobindo Ashram	17:00-18:00	1,580	8.06%
MB3	Rishikul	11:00-12:00	1,885	8.13%
MB4	Railway Station	18:00-19:00	1,716	7.22%
MB5	Har-ki-Pauri	11:15-12:15	684	9.14%
MB6	Vaidik Mohan Ashram	10:30-11:30	772	7.90%
MB7	Gandhi Park	16:30-17:30	1,797	8.96%
MB8	Laksar Road	17:45-18:45	2,000	9.08%

The average peak hour share across the survey locations is 8.4%.

2.7.5 Pedestrian Count

Haridwar is visited by millions of tourists every year. It is the place where fairs are being organized with full enthusiasm round the year, such as Somwati Amavasya, Kartik Poornima, Shravan Poornima, Ganga Dussehra and other important bathing dates of Hindu calendar. To understand the impact of Poornima and Mela days, pedestrian count was conducted between Valmiki Chowk and Har-Ki-Pauri on Kartik Purnima day (11th November evening to 12th November evening) in 2019. Kartik Purnima was on 12th November in 2019. Har-Ki-Pauri is the most sacred ghat in Haridwar, where every pilgrim comes to take their holly bath, to sing their praises, to float earthen diyas, to see the Ganga Aarti and to enjoy the mela. It has been observed that the total pedestrian movement including both directions at that particular location was around 1.5 lakh in 24 hours. Occasional day (Poornima/ mela day) traffic for Haridwar Railway Station to Har-Ki-Pauri section is observed as 4.3 times of normal day average. Peak movement of 14,158 pedestrians is observed between 11:00 am to 12:00pm. The peak hour factor is 9.3%. The pedestrian movement is high during the daytime between 10 am to 4 pm.

The hourly variation of pedestrian traffic is illustrated in Figure below.

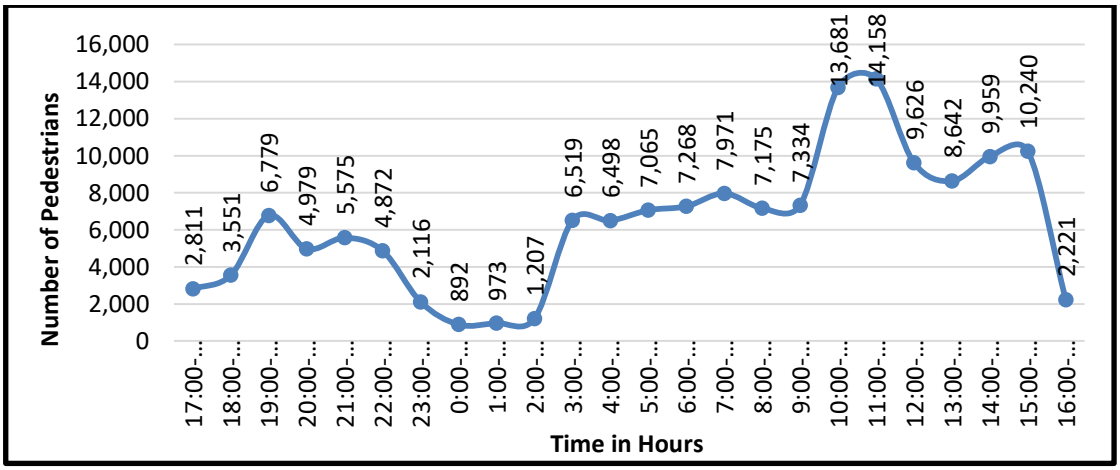


Figure 2-7: Hourly Variation of Pedestrians near Har-Ki-Pauri on Kartik Poornima Day, 2019

2.7.6 Origin- Destination Survey

For analysing the travel pattern within the catchment area of proposed PRT corridors, origin destination surveys were conducted in front of Haridwar Railway station and near DAV School, Shivedale School, ITI College and other institutional areas on Laksar Road.

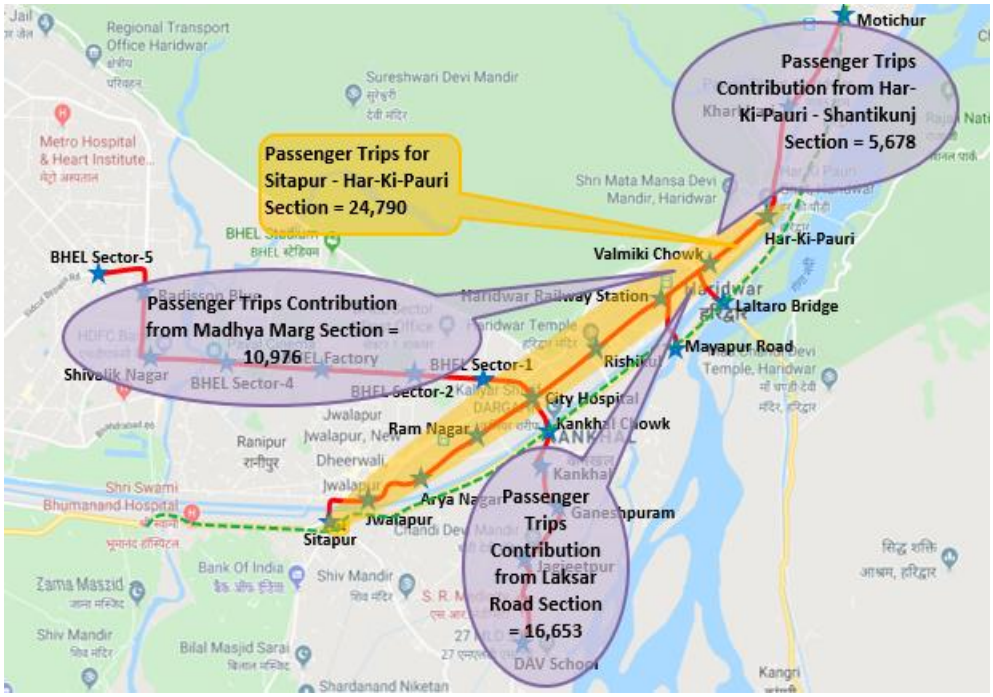


Figure 2-8: Daily Travel Pattern on Haridwar Old Road near Haridwar Railway Station

Travel pattern near Haridwar Railway Station on Haridwar Old Road shows around 25,000 daily passengers (including car and two-wheeler passengers) travelling between Sitapur to Har-Ki-Pauri section on a normal day. Har-Ki-Pauri – Motichur section is adding additional 6,000 passengers on a normal day, whereas Madhya Marg (BHEL Township) and Laksar Road

sections are contributing 11,000 and 17,000 daily passengers respectively. Passengers travelling between Haridwar Railway Station and Har-Ki-Pauri are around 12,000 on a normal day

Similarly travel pattern on Laksar Road shows around 24,000 daily passengers (including car and two-wheeler passengers) travelling between Haridwar Old Road – Laksar Road (up to DAV School) section on a normal day whereas, Madhya Marg is contributing only 1,000 passengers per day to Laksar Road.

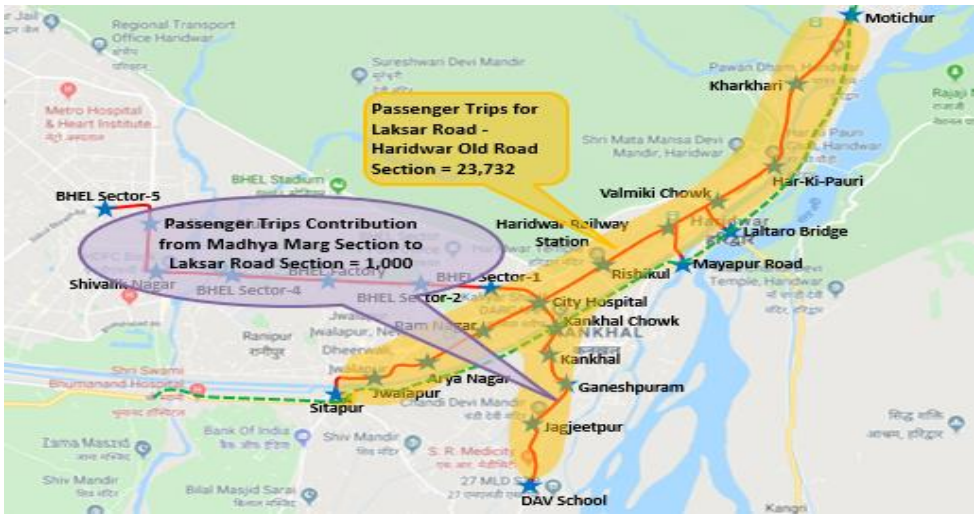


Figure 2-9: Daily Travel Pattern on Laksar Road

Response for willingness to pay for proposed PRT shows that passengers are ready to pay at least Rs. 9 for 2 km distance. Data shows that time is the most important aspect for willingness to shift to proposed PRT system. Whereas only 11% passengers feel that proposed PRT is cost saving mode compare to existing auto rickshaw or e-rickshaw. This indicates that expected high fare of proposed PRT is a real concern which can affect the willingness to shift to PRT. As per the willingness to shift survey result, around 28% passengers are willing to shift to proposed PRT.

Table 2-12 Willingness to Pay Summary for Proposed PRT System

Distance Slab (km)	Willingness to Pay (Rs.)
0 to 2	9
2 to 6	17
More than 6	More than 18

Table 2-13 Willingness to Pay Summary for Proposed PRT System

Reason to Shift	Willingness to Shift (%)
Time	61%

Cost	11%
Both Time and Cost	28%

Responses from the passengers willing to pay for their unit km of travel by proposed PRT have been plotted as scatter diagram to understand the fare sensitivity of the proposed PRT system. A best fitted exponential curve of equation y = 250.99 exp(-0.313x) explains the fare sensitivity of the passengers in terms of percentage share of passengers interested to pay different amount for per km of travel by proposed PRT system.

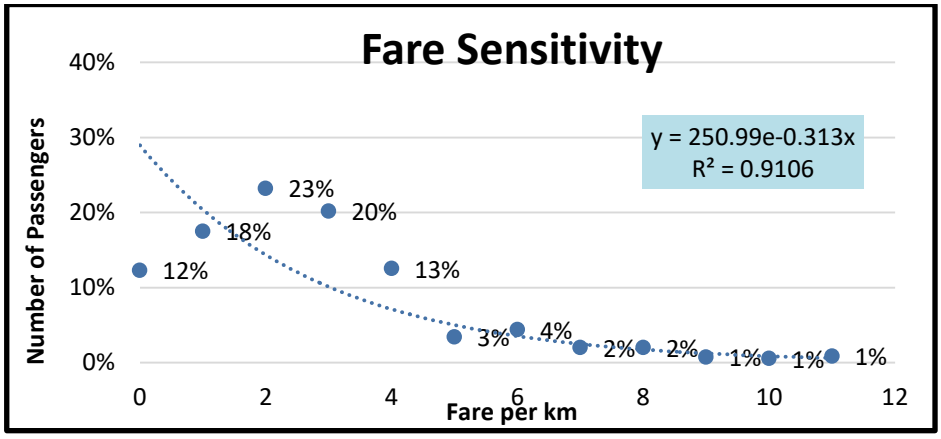


Figure 2-10: Fare Sensitivity Diagram for Proposed PRT System

2.7.7 Speed Delay Survey

Speed and Delay Survey was carried out to assess the network characteristics of the study corridor. Moving car observer method was adopted wherein the observed speed and delay was recorded while travelling through the network in a car. Both the morning and evening peak speed data has been collected and overall average speed has been estimated. The findings of the same are provided in the following table.

Table 2-14 Observed Average Speed on Haridwar Old Road

Link (Both Direction)	Distance	Journey Time	Delay	Running Time	Journey Speed	Running Speed
	(km)	(hr:min:sec)	(hr:min:sec)	(hr:min:sec)	(kmph)	(kmph)
Roorkee-Haridwar Road, Sitapur - Arya Nagar Chowk	2.50	00:07:40	00:00:34	00:07:06	19.63	21.21
Arya Nagar Chowk - Chandra Charya Chowk	1.60	00:05:08	00:00:46	00:04:21	18.77	22.10
Chandra Charya Chowk - Valmiki Chowk	3.00	00:10:20	00:01:02	00:09:18	17.45	19.42
Valmiki Chowk - Har-Ki-Pauri	1.30	00:04:58	00:01:11	00:03:46	15.74	20.72
Har-Ki-Pauri - Motichur	3.20	00:08:41	00:01:01	00:07:40	22.12	25.07

Roorkee-Haridwar Road, Sitapur - Motichur	11.60	00:36:46	00:04:35	00:32:11	18.93	21.62

Table 2-15 Observed Average Speed on Madhya Marg and Laksar Road

Link (Both Direction)	Distance	Journey Time	Delay	Running Time	Journey Speed	Running Speed
	(km)	(hr:min:sec)	(hr:min:sec)	(hr:min:sec)	(kmph)	(kmph)
SIIDCUL Bypass Road Junction - Chandra Charya Chowk	7.30	00:16:00	00:02:00	00:14:00	27.40	31.33
Chandra Charya Chowk - Kankhal Chowk	0.55	00:01:32	00:00:02	00:01:30	22.04	22.45
Kankhal Chowk - DAV School, Laksar Road	4.00	00:10:43	00:02:13	00:08:30	22.42	28.33
SIIDCUL Bypass Road Junction - DAV School, Laksar Road	11.85	00:28:15	00:04:15	00:24:00	25.17	29.63

The average network speed during peak hour on Haridwar Old Road (Upper Road) was observed to be 18.93 kmph whereas on Madhya Marg and Laksar Road was observed better speed as 25.17 kmph. The average link wise speeds obtained from the multiple runs are also provided in the above table. This assessment would be further used as an input for assessing the network characteristics.

2.8 RIDERSHIP ESTIMATION

The base year of the study is considered as 2019. Demand forecasting on the network was undertaken till 2031. In order to estimate the demand on the PRT corridor, all relevant data has been collated for the base year 2019 and secondary sources available. The horizon years are considered as 2021 and 2031.The figure below discusses the analytical framework towards the model built up. This assignment technique involved:

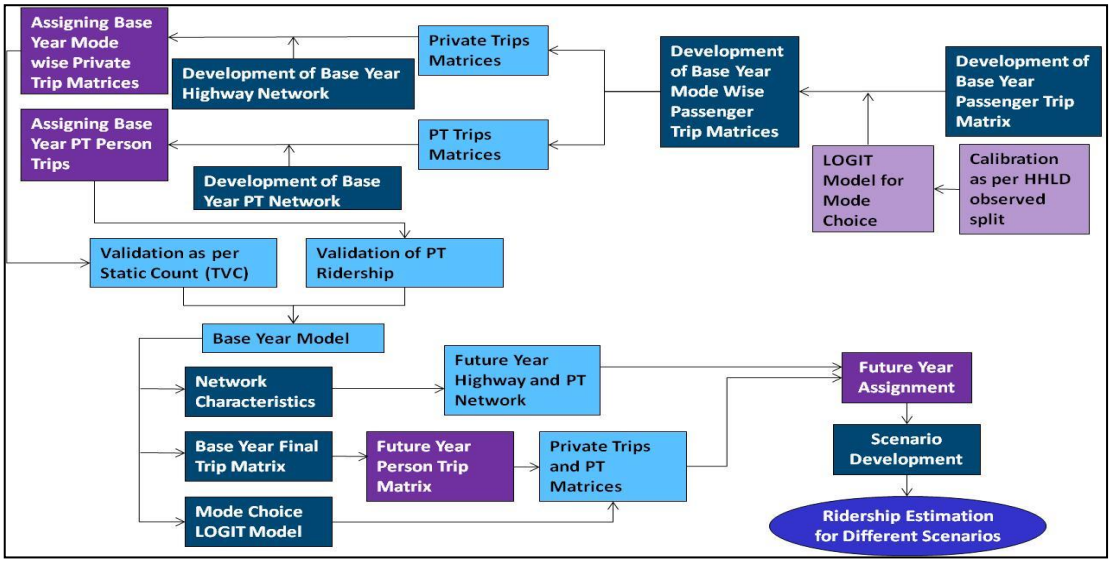


Figure 2-11: Analytical Framework for Ridership Estimation Model

Worldwide accepted CUBE Voyager software has been utilized to develop the ridership estimation model. A complete three-fold analytical approach was adopted. The assignment technique adopted helped to ascertain the ridership at the proposed PRT corridors.

- **Network Development:** The network development stage involves both the highway and transit network throughout the entire study area. Base year network is the existing road network. Once the base year mode-wise matrices are developed and assigned to the base year network, the network characteristics have been calibrated and validated with respect to the ground conditions. Further future year network has been developed for both the highway and public transport (PT) incorporating the additional future proposed road networks and future phases PT routes including proposed PRT routes with the base year validated network.

- **Matrix Development:** Base year passenger trip matrix has been developed from the zone-wise population-employment database and calibrated. This calibrated passenger trip matrix was utilised to develop base year mode-wise passenger trip matrices as per the existing modal share. Once these base year passenger trip matrices have been assigned to the base year highway as well as transit network, the assigned passenger trips have been validated comparing to the existing database. These base year mode-wise passenger trips matrices further forecasted for future year with estimated future PCTR and modal shift from other modes to proposed PRT as per the Logit Model.

- **Trip Assignment:** Trip assignment has been conducted for both the highway assignment and PT assignment. Base year assigned trips has been validated in comparison with existing database to validate the model. Further future year assignment was undertaken to estimate the ridership for horizon years.

2.8.1 Model Input Parameter

For estimation of projected population of Haridwar, recent past trend of both the residing population for Haridwar town as well as tourist population of the city have been analysed. Past population growth figures of Haridwar town as per available census data shows an average CAGR of around 2.3% from 1981 to 2011. Following this average CAGR of past 3 decades in Haridwar town, growth rate for projected population in 2021 is considered as 2.5%. Further, considering stabilisation of population as reflecting in recent past decades all over the country, projected population growth rates for 2031, 2041 and 2051 in Haridwar town are assumed as 2.0%, 1.6% and 1.3% respectively.

Table 2-16 Past Population Growth of Haridwar Town

Census Year	Population	CAGR
1981	1,16,000	-
1991	1,47,000	2.4%
2001	1,75,340	1.8%
2011	2,28,832	2.7%

Source: District Census Handbook of Haridwar

Table 2-17 Past 10 Years Trend of Tourist Population in Haridwar

Year	Yearly Tourist Numbers	Daily Tourist Numbers	CAGR
2010	1,88,66,680	51,690	
2011	1,34,81,372	36,935	-28.5%
2012	1,52,58,750	41,805	13.2%
2013	1,27,86,261	35,031	-16.2%
2014	1,54,77,542	42,404	21.0%
2015	1,93,50,640	53,015	25.0%
2016	2,05,08,097	56,187	6.0%
2017	2,10,09,098	57,559	2.4%
2018	2,15,77,583	59,117	2.7%
2019	2,18,25,499	59,796	1.1%

Source: https://uttarakhandtourism.gov.in/sites/default/files/document/type/Tourist-Statistics-from-2000-to-2002-of-Major-Tourist-Destinations.pdf

Last 10 years tourist population of Haridwar from Uttarakhand Tourism data has been reviewed and analysed to understand the past trend of tourist population in Haridwar. Average of year-on-year growth for last 10 years tourist population of Haridwar is considered their growth rate (CAGR) for recent future till 2021. This estimated growth rate (CAGR) till 2021 is 3.0. Further, last 10 years trend in above table shows the tourist numbers are getting stabilised in recent 3 years and the average year-on-year growth rate for last years is as low as 2.1%. Therefore,

with stabilisation of tourist population in Haridwar, the CAGR of tourists has been moderated from3.0% in 2021 to 2.5%, 2.0% and 1.6% in 2031, 2041 and 2051 respectively. Applying the above mentioned future growth rates for residential as well tourist population, the projected population for Haridwar is presented below:

Table 2-18 Projected Population and Total Trips for Haridwar

Population and Trips	2021	2031	2041	2051
Residing Population	2,92,924	3,57,073	4,18,499	4,76,199
Tourist Population	63,408	81,168	98,943	1,15,964
Total Trips	4,59,715	5,79,153	6,94,403	8,05,043

2.8.2 Modal Split

Mode share of person trips was considered from OD survey conducted by the consultant. According to the observed modal split, it was found that only 6% daily trips are by bus and majority of trips consists of IPT (32%), two wheeler (39%) and car/ four wheeler (21%).

Table 2-19 Mode Share (%) of Motorised Trips

Mode	Percentage Share
Two-Wheeler	38.5%
Car	21.3%
Tempo/Shared Auto	20.3%
E-Rickshaw	11.6%
Bus	5.9%
Cycle Rickshaw	2.4%
Total	**100%**

2.8.3 Assessment of Willingness to Shift

To assess the probability of shift from different existing motorized modes to new introduced PRT, mode-wise Binary Logit Model has been developed. According to this model, probability equation of mode used is as follows:

$$\text{Pr (Existing Mode)} = \frac{1}{1 + e^{-\gamma(U(PRT) - U(EM))}}$$

Where, U (PRT) = Deterministic component of utility of PRT and U (EM) = Deterministic component of utility of Existing Mode.

γ= Constant factor estimated from regression analysis of willing to shift to PRT and Cost Difference from existing mode

These utility functions are:

$U(EM) = \alpha WT(EM) + \beta TT(EM) + \gamma TC(EM) + \varphi TR(EM) + \eta DC(EM)$

and $U(PRT) = \alpha WT(PRT) + \beta TT(PRT) + \gamma TC(PRT) + \varphi TR(PRT) + \eta DC(PRT)$

where, WT = Waiting Time

TT = Travel Time

TC = Travel Cost

TR = Transfer Cost

DC = Discomfort Cost

The traffic within Haridwar consists of multi directional traffic which differences w.r.t trip purposes. There is huge influx of tourism in Haridwar and it thus becomes essential to address the characteristics difference of tourist flow. Thus, the traffic pattern has been distributed and shift is applied to respective distribution to achieve a rational percentage of passengers that would shift from existing mode of transport to proposed PRT system.

2.8.4 Induced Traffic

When a new transport facility or service becomes available the users of the transport system can alter their behaviour in a number of manners like change their route, change mode, change destination to one easily reachable using the new system, change their trip making frequency, change the time of travel etc. Induced traffic is therefore defined as the additional traffic (in person or vehicle kilometres) that has been induced by the project through mode changes, destination changes, trip re-timing, trip frequency changes or new trips associated with different land uses. Estimation of induced traffic depends on the user benefits caused by the transportation changes. In the majority of situations, the calculation of the user benefit associated with induced traffic is relatively straight forward and utilises the Rule of Half (RoH) methodology. According to RoH, user benefits due to introduce of new mode as PRT is estimated as 12.4%. Therefore, 12% additional passengers have already been attributed as induced traffic for the operation of PRT system.Estimated Riderships for both normal day and Poornima (Mela) day for all different options as presented in this report are including the induced traffic.

2.8.5 Option Building

To evaluate the best possible network and to estimate the optimum demand for that selected network for proposed PRT system, a set of 7 different possible network combinations have been conceptualised. The combinations tested out as a part of evaluation process are discussed below. Ridership estimates has been carried out for the following proposed combinations for the horizon years – 2021 and 2031. There are 75 festival days in a year in Haridwar, when a large number of tourist or pilgrims visit the city including all important ghats and temples. Therefore, ridership models for a normal day and Poornima (Mela) day separately have been developed for all different options and horizon years.

1. **Option-I:** Har-Ki-Pauri to Sitapur on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge.

   In Option-I, proposed PRT corridor was conceptualised from Sitapur to Har-Ki-Pauri including connection with proposed metro via Laltaro Bridge. It has been observed that ridership estimates for normal day in Option-I are low for both the horizon years and this may not be a viable option due to its shorter length and lower catchment area. Therefore, it is suggested to further extend the corridor and estimate the ridership for the horizon years.

2. **Option-II:** Motichur to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge.

   In case of Option-II, ridership estimation was carried out for additional 3km corridor; extending Option-I till Shantikunj (Motichur) area along Haridwar-Rishikesh Main Road. Option-II from Sitapur to Motichur has been worked out to add the Shantikunj Gayatri Parivar passengers.

3. **Option-III:** Motichur to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge and Haridwar Main Road (Prem Nagar) to Shivalik Nagar (BHEL Township) along Madhya Marg.

   In case of Option-III, ridership estimation was carried out for additional two corridors (in addition to Option-I); Haridwar Main Road (Prem Nagar) to Shivalik Nagar (BHEL Township) along Madhya Marg and Har-Ki-Pauri to Motichur connecting Haridwar-Rishikesh Main Road.

4. **Option-IV:** Motichur to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge and Haridwar Main Road

(Prem Nagar) to Kankhal area (near DAV school) along Laksar road.

In case of Option-IV, ridership estimation was carried out for additional two corridors (in addition to Option-I); Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar road and Har-Ki-Pauri to Motichur connecting Haridwar-Rishikesh Main Road.

5. **Option-V:** Motichur to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge, Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar road and Haridwar Main Road (Prem Nagar) to Shivalik Nagar (BHEL Township) along Madhya Marg.

   In case of Option-V, ridership estimation was carried out for additional three corridors (in addition to Option-I); Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar road, Haridwar Main Road (Prem Nagar) to Shivalik Nagar (BHEL Township) along Madhya Marg and Har-Ki-Pauri to Motichur connecting Haridwar-Rishikesh Main Road.

6. **Option-VI:** Bharat Mata Temple to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge and Haridwar Main Road (Prem Nagar) to Daksh Temple via Kankhal area.

   In case of Option-VI, ridership estimation was carried out for additional two corridors (in addition to Option-I); Haridwar Main Road (Prem Nagar) to Daksh Temple via Kankhal area and Har-Ki-Pauri to Bharat Mata Temple via Motichur and Shantikunj area.

7. **Option-VII:** Bharat Mata Temple to Sitapur via Har-Ki-Pauri on Haridwar-Rishikesh Main Road including connection with proposed metro via Laltaro Bridge, Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar Road and Kankhal area (Ganeshpuram) to Daksh Temple.

   In case of Option-VII, ridership estimation was carried out for additional three corridors (in addition to Option-I); Haridwar Main Road (Prem Nagar) to Kankhal area (near DAV school) along Laksar road, Har-Ki-Pauri to Bharat Mata Temple via Motichur and Shantikunj area and Kankhal area (Ganeshpuram) to Daksh Temple.

2.9 ESTIMATED RIDERSHIP ON PROPOSED PRT SYSTEM FOR 2021 AND 2031

2.9.1 Ridership Details for Various Options

Tables below presents the proposed daily and peak hour ridership estimates in option-I for the horizon years 2021 and 2031. Both the normal day and Poornima (Mela) Day estimates have been presented separately.

Table 2-20 Proposed Haridwar PRT Ridership Summary for Option-I

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Har-Ki-Pauri	8.24	20,174	629	74,376	3.69
2021	Valmiki Chowk - Laltaro Bridge	0.69	2,646	135	1,720	0.65
2031	Sitapur - Har-Ki-Pauri	8.24	32,675	970	1,29,127	3.95
2031	Valmiki Chowk - Laltaro Bridge	0.69	4,145	210	2,694	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Har-Ki-Pauri	8.24	73,535	2,502	2,42,206	3.29
2021	Valmiki Chowk - Laltaro Bridge	0.69	11,189	573	7,273	0.65
2031	Sitapur - Har-Ki-Pauri	8.24	94,485	3,103	3,80,021	4.02
2031	Valmiki Chowk - Laltaro Bridge	0.69	13,520	688	8,788	0.65

Table 2-21 Proposed Haridwar PRT Ridership Summary for Option-II

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Motichur	11.03	34,544	1,165	1,58,005	4.57
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,044	156	1,979	0.65
2031	Sitapur - Motichur	11.03	52,634	1,727	2,46,782	4.69
2031	Valmiki Chowk - Laltaro Bridge	0.69	4,620	233	3,003	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Motichur	11.03	87,905	3,038	3,26,159	3.71
2021	Valmiki Chowk - Laltaro Bridge	0.69	11,587	594	7,531	0.65
2031	Sitapur - Motichur	11.03	1,14,444	3,830	4,98,170	4.35
2031	Valmiki Chowk - Laltaro Bridge	0.69	13,995	711	9,097	0.65

Table 2-22 Proposed Haridwar PRT Ridership Summary for Option-III

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Motichur	11.03	49,748	1,521	2,12,589	4.27
2021	BHEL Sector-5 - City Hospital	6.50	17,240	856	78,964	4.58
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,935	206	2,558	0.65
2031	Sitapur - Motichur	11.03	68,110	2,016	2,97,984	4.38
2031	BHEL Sector-5 - City Hospital	6.50	17,364	847	70,841	4.08
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,361	269	3,485	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Motichur	11.03	1,03,109	3,394	3,80,743	3.69
2021	BHEL Sector-5 - City Hospital	6.50	17,240	856	1,03,234	5.99
2021	Valmiki Chowk - Laltaro Bridge	0.69	12,478	644	8,111	0.65
2031	Sitapur - Motichur	11.03	1,29,920	4,115	5,49,373	4.23
2031	BHEL Sector-5 - City Hospital	6.50	17,364	847	93,677	5.39
2031	Valmiki Chowk - Laltaro Bridge	0.69	14,736	745	9,578	0.65

Table 2-23 Proposed Haridwar PRT Ridership Summary for Option-IV

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Motichur	11.03	46,540	1,522	2,04,915	4.40
2021	City Hospital - DAV School	4.36	13,307	675	35,401	2.66
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,524	181	2,291	0.65
2031	Sitapur - Motichur	11.03	72,100	2,260	3,18,770	4.42
2031	City Hospital - DAV School	4.36	21,548	1,116	56,479	2.62
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,319	268	3,457	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Motichur	11.03	1,16,991	4,097	4,41,140	3.77
2021	City Hospital - DAV School	4.36	31,021	1,629	87,852	2.83
2021	Valmiki Chowk - Laltaro Bridge	0.69	13,213	681	8,588	0.65
2031	Sitapur - Motichur	11.03	1,59,181	5,410	6,71,228	4.22
2031	City Hospital - DAV School	4.36	47,558	2,532	1,33,774	2.81
2031	Valmiki Chowk - Laltaro Bridge	0.69	16,363	821	10,636	0.65

Table 2-24 Proposed Haridwar PRT Ridership Summary for Option-V

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Motichur	11.03	61,744	1,879	2,59,498	4.20
2021	BHEL Sector-5 - DAV School	12.00	33,287	993	1,38,921	4.17
2021	Valmiki Chowk - Laltaro Bridge	0.69	4,415	232	2,870	0.65
2031	Sitapur - Motichur	11.03	87,576	2,550	3,69,973	4.22
2031	BHEL Sector-5 - DAV School	12.00	42,368	1,297	1,55,345	3.67
2031	Valmiki Chowk - Laltaro Bridge	0.69	6,060	308	3,939	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Motichur	11.03	1,32,195	4,453	4,95,723	3.75
2021	BHEL Sector-5 - DAV School	12.00	51,001	1,766	1,93,016	3.78
2021	Valmiki Chowk - Laltaro Bridge	0.69	14,104	731	9,168	0.65
2031	Sitapur - Motichur	11.03	1,74,657	5,845	7,22,430	4.14
2031	BHEL Sector-5 - DAV School	12.00	68,378	2,713	2,35,090	3.44
2031	Valmiki Chowk - Laltaro Bridge	0.69	17,104	861	11,118	0.65

Table 2-25 Proposed Haridwar PRT Ridership Summary for Option-VI

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Bharat Mata Temple	14.55	48,570	1,604	2,47,961	5.11
2021	City Hospital - Daksh Temple	3.11	9,668	523	14,013	1.45
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,550	182	2,307	0.65
2031	Sitapur - Bharat Mata Temple	14.55	74,768	2,409	3,88,000	5.19
2031	City Hospital - Daksh Temple	3.11	15,910	856	23,008	1.45
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,334	268	3,467	0.65
Summary for Poornima (Mela) Day						
2021	Sitapur - Bharat Mata Temple	14.55	1,09,672	3,760	4,47,325	4.08
2021	City Hospital - Daksh Temple	3.11	17,576	955	24,473	1.39
2021	Valmiki Chowk - Laltaro Bridge	0.69	12,825	661	8,336	0.65
2031	Sitapur - Bharat Mata Temple	14.55	1,47,705	4,917	6,84,644	4.64

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
2031	City Hospital - Daksh Temple	3.11	27,278	1,467	37,467	1.37
2031	Valmiki Chowk - Laltaro Bridge	0.69	15,713	787	10,213	0.65

Table 2-26 Proposed Haridwar PRT Ridership Summary for Option-VII

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
Summary for Normal Day						
2021	Sitapur - Bharat Mata Temple	14.55	54,608	1,819	2,74,572	5.03
2021	City Hospital - Daksh Temple	3.11	16,295	858	26,877	1.65
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,723	191	2,420	0.65
2021	Ganeshpuram - DAV School	2.38	7,015	366	13,336	1.90
2031	Sitapur - Bharat Mata Temple	14.55	84,449	2,739	4,29,241	5.08
2031	City Hospital - Daksh Temple	3.11	26,671	1,412	43,809	1.64
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,612	283	3,648	0.65
2031	Ganeshpuram - DAV School	2.38	11,185	603	21,422	1.92
Summary for Poornima (Mela) Day						
2021	Sitapur - Bharat Mata Temple	14.55	1,25,059	4,393	5,12,459	4.10
2021	City Hospital - Daksh Temple	3.11	33,766	1,812	56,012	1.66
2021	Valmiki Chowk - Laltaro Bridge	0.69	13,412	690	8,718	0.65
2021	Ganeshpuram - DAV School	2.38	16,821	905	33,227	1.98
2031	Sitapur - Bharat Mata Temple	14.55	1,71,530	5,888	7,84,212	4.57
2031	City Hospital - Daksh Temple	3.11	52,457	2,828	86,334	1.65
2031	Valmiki Chowk - Laltaro Bridge	0.69	16,656	836	10,826	0.65
2031	Ganeshpuram - DAV School	2.38	25,827	1,427	51,140	1.98

2.10 OPTION EVALUATION

Initially the proposed PRT corridor in Haridwar city was conceptualised from Sitapur to Har-Ki-Pauri. However, estimated ridership for this independent Sitapur to Har-Ki-Pauri section found very low. Therefore, this corridor is proposed to extend till Motichur area from Har-Ki-Pauri and

another corridor from Shivalik Nagar (BHEL Township) to DAV School on Laksar Road has also been proposed. Shivalik Nagar (BHEL Township) to DAV School corridor intersects the Sitapur to Motichur corridor at Chandra Arya Chowk near City Hospital. One more option is also conceptualised connecting Bharat Mata Temple and Daksh Temple to capture the additional potential pilgrims or tourists. With these different combinations of proposed PRT networks, a set of 7 possible alternative options have been conceptualised. These 7 options have been defined in previous sections of this chapter along with their ridership details for horizon year 2021 and 2031. However, for easy evaluation of the best possible network option, a comprehensive ridership summary of all the options is presented on next page.

Table 2-27 Comprehensive Ridership Summary of Different Options Conceptualised for Proposed PRT System in Haridwar

Horizon Year	Scenario	Ridership Details	Option-I: Har-Ki-Pauri to Sitapur – 8 km	Option-II: Motichur to Sitapur – 11 km	Option-III: Motichur to Sitapur and Prem Nagar to Shivalik Nagar (BHEL Township) – 19 km	Option-IV: Motichur to Sitapur and Prem Nagar to DAV School – 15 km	Option-V: Motichur to Sitapur, Prem Nagar to DAV school and Prem Nagar to Shivalik Nagar (BHEL Township) – 23 km	Option-VI: Bharat Mata Temple to Sitapur and Prem Nagar to Daksh Temple – 18 km	Option-VII: Bharat Mata Temple to Sitapur, Prem Nagar to Daksh Temple and Ganeshapuram to DAV School – 20 km
2021	Normal Day	Daily Ridership	22,820	37,588	70,923	63,371	99,446	61,788	81,641
		PHPDT	629	1,165	1,521	1,522	1,879	1,604	1,819
		Daily Passenger-km	76,096	1,59,984	2,94,111	2,42,607	4,01,289	2,64,282	3,17,205
		Average Trip Length	3.33	4.26	4.15	3.83	4.04	4.28	3.89
	Poornima (Mela) Day	Daily Ridership	84,724	99,492	1,32,827	1,61,224	1,97,299	1,40,073	1,89,057
		PHPDT	2,502	3,038	3,394	4,097	4,453	3,760	4,393
		Daily Passenger-km	2,49,479	3,33,691	4,92,088	5,37,580	6,97,907	4,80,134	6,10,416
		Average Trip Length	2.94	3.35	3.70	3.33	3.54	3.43	3.23
	Annual Average	Daily Ridership	35,540	50,308	83,643	83,478	1,19,553	77,874	1,03,712
		PHPDT	1,014	1,550	1,906	2,051	2,408	2,047	2,348
		Daily Passenger-km	1,11,723	1,95,677	3,34,791	3,03,218	4,62,238	3,08,635	3,77,454
		Average Trip Length	3.25	4.07	4.06	3.73	3.93	4.10	3.75
2031	Normal Day	Daily Ridership	36,820	57,254	90,834	98,967	1,36,004	96,012	1,27,917
		PHPDT	970	1,727	2,016	2,260	2,550	2,409	2,739
		Daily Passenger-km	1,31,821	2,49,785	3,72,310	3,78,706	5,29,256	4,14,475	4,98,120
		Average Trip Length	3.58	4.36	4.10	3.83	3.89	4.32	3.89
	Poornima (Mela) Day	Daily Ridership	1,08,005	1,28,439	1,62,020	2,23,102	2,60,139	1,90,695	2,66,470
		PHPDT	3,103	3,830	4,115	5,410	5,845	4,917	5,888
		Daily Passenger-km	3,88,809	5,07,267	6,52,628	8,15,637	9,68,638	7,32,324	9,32,513
		Average Trip Length	3.60	3.95	4.03	3.66	3.72	3.84	3.50
	Annual Average	Daily Ridership	51,447	71,881	1,05,462	1,24,474	1,61,511	1,15,468	1,56,387
		PHPDT	1,408	2,159	2,447	2,907	3,227	2,924	3,386
		Daily Passenger-km	1,84,627	3,02,692	4,29,909	4,68,487	6,19,540	4,79,787	5,87,379
		Average Trip Length	3.58	4.28	4.08	3.79	3.86	4.22	3.81

Estimated ridership for Sitapur to Har-Ki-Pauri corridor (option-I) and Sitapur to Motichur corridor (option-II) for both the normal day as well as annual average daily are very low compare to other 5 options. Therefore, these two options (option-I and option-II) are not viable to develop. Estimated ridership of option-V is highest among all the options for all the situations or scenarios. This is due to connectivity of Haridwar Railway Station, Haridwar Bus Terminal and Har-Ki-Pauri with enhanced catchment area of BHEL Township and institutional areas as well as religious places along the Laksar Road. However, the network length of option-V is much higher than all other options. This indicates that despite the maximum demand, option-V may not be the best viable option. Further, option-IV with lowest network length (15 km) from rest 4 options (option III, IV, VI and VII) shows higher demand than option-VI for all the situations (scenarios). This indicates that option-VI is not also the best viable network.

Therefore, individual ridership parameter is not enough to evaluate the best viable option or configuration for the proposed PRT network in Haridwar city. Therefore, a next stage evaluation with estimated ridership per unit network length for each option is necessary to find out the best possible configuration. To evaluate finally the best one among all the options, passenger-km per km of network length for each option in 2031 (as the proposed PRT in Haridwar might be operational from 2026 or thereafter) is compared and presented below:

Table 2-28 Passenger-km per Network-km of Different Options Conceptualised for Proposed PRT System in Haridwar

Scenarios (2031)	Option-I: Har-Ki-Pauri to Sitapur – 8 km	Option-II: Motichur to Sitapur – 11 km	Option-III: Motichur to Sitapur and Prem Nagar to Shivalik Nagar (BHEL Township) – 19 km	Option-IV: Motichur to Sitapur and Prem Nagar to DAV School – 15 km	Option-V: Motichur to Sitapur, Prem Nagar to DAV school and Prem Nagar to Shivalik Nagar (BHEL Township) – 23 km	Option-VI: Bharat Mata Temple to Sitapur and Prem Nagar to Daksh Temple – 18 km	Option-VII: Bharat Mata Temple to Sitapur, Prem Nagar to Daksh Temple and Ganeshapuram to DAV School – 20 km
Normal Day	16,478	22,708	20,684	25,247	23,011	24,381	26,217
Poornima/ Mela Day	48,601	46,115	36,257	54,376	42,115	43,078	49,080
Annual Average Daily	23,078	27,517	23,884	31,232	26,937	28,223	30,915

Final stage evaluation based on passenger-km per unit of network-km for each option mentioned above shows that the annual average daily number with due impact of Poornima (Mela) day in terms of passenger-km per network-km for option-IV is the highest followed by option-VII. Despite being second highest in terms of passenger-km per network-km, option-VII connects additional two major temples (tourist spots and religious placaes) compare to option-

IV. These two temples are Bharat Mata Temple and Daksh Temple. Therefore, **based on the combined benefit of passenger-km per network-km and connectivity of all important places including the maximum possible numbers of religious places, option-VII is selected as the most viable option for implementation.**

This option evaluation process has been discussed in detail with the concerned authorities of Uttarakhand Metro Rail, Urban Infrastructure and Building Construction Corporation Ltd. Later on, Uttarakhand Metro Rail, Urban Infrastructure and Building Construction Corporation Ltd. vide their letter no. 849/U.M.-46/2019-20 dated 12-02-2020 also recommended that option-VII connecting all major temples and religious places for preparation of DPR of PRT System in Haridwar City.

Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited
(A Government of Uttarakhand Undertaking)
(CIN: 45309UR 2017 SGC007687) (GSTIN:-05AACCU1650R1Z1)
Website: - www.ukmrc.org, Email: -info@ukmrc.org

Letter No. 849/U.M.-46/2019 -20 Date:- 12/02/2020

To,
Director/Business Development,
Delhi Metro Rail Corporation,
25, Ashoka Road
New Delhi 110001.

Subject:- Preparation of DPR of PRT System in Haridwar City.

Ref:- DMRC/ED(CS) /Hardiwar/Dehradun/2019-20 Dated 02.02.2020.

Sir,

In reference to above it is noted that passenger km./per km. for option-7 Bharat Mata temple to Sitapur, Premnagar to Daksha temple & Ganesh puram to DAV School for 19 km. is satisfactory. Hence the variation for the contract agreement clause No-4 of TOR (appendix-2) 8 km. is enhance to 19 km. approximately.

Your Sincerely

(Brajesh Kumar Mishra)
Director(Project & Planning)

Copy to:- Mr. P.K Garg, ED/Consultancy, Delhi Metro Rail Corporation Ltd., New Delhi.

(Brajesh Kumar Mishra)
Director(Project & Planning)

4th Floor, SCI Tower, NH-72, Opposite Mahindra Showroom, Haridwar Bypass Road, Ajabpur, Dehradun, Uttarakhand – 248121
Phone: 0135-2719442, Fax:-0135-2719500

2.11 FUTURE FORECAST FOR 2041 AND 2051 FOR SELECTED OPTION

As option-VII has been selected for implementation, future forecasted ridership details for 2021 to 2051 have been assessed for this option. Tables below present the proposed daily and peak hour ridership estimates in option-VII for the horizon years from 2021to 2051. Both the normal day and Poornima (Mela) Day estimates have been presented separately.

Table 2-29 Proposed Haridwar PRT Ridership Summary for Normal Day – Option-VII

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length/ Passenger Lead (km)
2021	Sitapur - Bharat Mata Temple	14.55	54,608	1,819	2,74,572	5.03
2021	City Hospital - Daksh Temple	3.11	16,295	858	26,877	1.65
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,723	191	2,420	0.65
2021	Ganeshpuram - DAV School	2.38	7,015	366	13,336	1.90
2031	Sitapur - Bharat Mata Temple	14.55	84,449	2,739	4,29,241	5.08
2031	City Hospital - Daksh Temple	3.11	26,671	1,412	43,809	1.64
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,612	283	3,648	0.65
2031	Ganeshpuram - DAV School	2.38	11,185	603	21,422	1.92
2041	Sitapur - Bharat Mata Temple	14.55	1,12,558	3,681	6,46,088	5.74
2041	City Hospital - Daksh Temple	3.11	35,642	1,892	73,400	2.06
2041	Valmiki Chowk - Laltaro Bridge	0.69	7,256	364	4,716	0.65
2041	Ganeshpuram - DAV School	2.38	14,372	776	32,148	2.24
2051	Sitapur - Bharat Mata Temple	14.55	1,45,939	4,849	8,43,098	5.78
2051	City Hospital - Daksh Temple	3.11	45,574	2,446	92,222	2.02
2051	Valmiki Chowk - Laltaro Bridge	0.69	9,393	471	6,105	0.65
2051	Ganeshpuram - DAV School	2.38	17,412	953	39,677	2.28

Table 2-30 Proposed Haridwar PRT Ridership Summary for Poornima (Mela) Day – Option-VII

Target Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
2021	Sitapur - Bharat Mata Temple	14.55	1,25,059	4,393	5,12,459	4.10
2021	City Hospital - Daksh Temple	3.11	33,766	1,812	56,012	1.66
2021	Valmiki Chowk - Laltaro Bridge	0.69	13,412	690	8,718	0.65
2021	Ganeshpuram - DAV School	2.38	16,821	905	33,227	1.98
2031	Sitapur - Bharat Mata Temple	14.55	1,71,530	5,888	7,84,212	4.57
2031	City Hospital - Daksh Temple	3.11	52,457	2,828	86,334	1.65
2031	Valmiki Chowk - Laltaro Bridge	0.69	16,656	836	10,826	0.65
2031	Ganeshpuram - DAV School	2.38	25,827	1,427	51,140	1.98
2041	Sitapur - Bharat Mata Temple	14.55	2,28,185	7,894	11,73,564	5.14
2041	City Hospital - Daksh Temple	3.11	69,355	3,741	1,43,913	2.08
2041	Valmiki Chowk - Laltaro Bridge	0.69	21,752	1,090	14,139	0.65
2041	Ganeshpuram - DAV School	2.38	33,547	1,857	77,786	2.32
2051	Sitapur - Bharat Mata Temple	14.55	2,97,100	10,462	15,40,236	5.18
2051	City Hospital - Daksh Temple	3.11	89,220	4,862	1,83,503	2.06
2051	Valmiki Chowk - Laltaro Bridge	0.69	28,337	1,423	18,419	0.65
2051	Ganeshpuram - DAV School	2.38	42,092	2,360	99,411	2.36

Table 2-31 Daily PRT Ridership for Normal Day – Option-VII

Sitapur-Bharat Mata Temple Corridor Daily Ridership for Normal Day - Horizon Year 2021										
Sitapur to Bharat Mata Temple Direction						Bharat Mata Temple to Sitapur Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Sitapur	1,162	0	0		14	Bharat Mata Temple	610	0	0
2	Jwalapur	2,898	90	1,162		13	Shantikunj	2,821	57	610
3	Arya Nagar	1,693	143	3,970		12	Motichur	6,941	375	3,374
4	Ram Nagar	1,149	136	5,520		11	Kharkhari	1,025	213	9,940
5	City Hospital	7,599	1,388	6,533		10	Har-Ki-Pauri	4,081	1,214	10,752
6	Rishikul	2,931	1,339	12,744		9	Mansadevi Ropeway Gate	2,641	981	13,619

7	Haridwar Railway Station	6,921	3,069	14,336		8	Valmiki Chowk	2,286	1,087	15,279
8	Valmiki Chowk	1,010	2,384	18,188		7	Haridwar Railway Station	2,929	6,756	16,478
9	Mansadevi Ropeway Gate	869	2,812	16,814		6	Rishikul	1,310	2,731	12,651
10	Har-Ki-Pauri	1,096	4,730	14,871		5	City Hospital	1,536	6,227	11,230
11	Kharkhari	267	912	11,237		4	Ram Nagar	142	1,134	6,539
12	Motichur	400	6,941	10,592		3	Arya Nagar	141	1,967	5,547
13	Shantikunj	50	3,491	4,051		2	Jwalapur	100	2,496	3,721
14	Bharat Mata Temple	0	610	610		1	Sitapur	0	1,325	1,325
	Total	**28,045**	**28,045**				**Total**	**26,563**	**26,563**	
City Hospital-Daksh Temple Corridor Daily Ridership for Normal Day - Horizon Year 2021										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	6,939	0	0		5	Daksh Temple	393	0	0
2	Kankhal Chowk	226	1,047	6,939		4	Ganeshpuram	4,902	48	393
3	Kankhal	104	1,809	6,118		3	Kankhal	2,516	93	5,247
4	Ganeshpuram	54	4,077	4,413		2	Kankhal Chowk	1,161	255	7,670
5	Daksh Temple	0	390	390		1	City Hospital	0	8,576	8,576
	Total	**7,323**	**7,323**				**Total**	**8,972**	**8,972**	
Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Normal Day - Horizon Year 2021										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	1,909	0	0		2	Laltaro Bridge	1,814	0	0
2	Laltaro Bridge	0	1,909	1,909		1	Valmiki Chowk	0	1,814	1,814
	Total	**1,909**	**1,909**				**Total**	**1,814**	**1,814**	
Ganeshpuram-DAV School Corridor Daily Ridership for Normal Day - Horizon Year 2021										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	3,183	0	0		3	DAV School	2,673	0	0
2	Jagjeetpur	88	1,057	3,183		2	Jagjeetpur	1,071	87	2,673
3	DAV School	0	2,214	2,214		1	Ganeshpuram	0	3,657	3,657
	Total	**3,271**	**3,271**				**Total**	**3,744**	**3,744**	
Sitapur-Bharat Mata Temple Corridor Daily Ridership for Normal Day - Horizon Year 2031										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	2,099	0	0		14	Bharat Mata Temple	896	0	0
2	Jwalapur	4,802	193	2,099		13	Shantikunj	4,174	85	896
3	Arya Nagar	4,038	414	6,708		12	Motichur	9,187	414	4,985
4	Ram Nagar	2,297	404	10,332		11	Kharkhari	1,884	320	13,758
5	City Hospital	12,534	2,554	12,225		10	Har-Ki-Pauri	6,171	1,647	15,322

6	Rishikul	4,326	3,095	22,205		9	Mansadevi Ropeway Gate	3,866	1,282	19,846
7	Haridwar Railway Station	8,414	4,465	23,436		8	Valmiki Chowk	3,819	1,326	22,430
8	Valmiki Chowk	1,238	3,823	27,385		7	Haridwar Railway Station	4,305	8,261	24,923
9	Mansadevi Ropeway Gate	1,126	4,120	24,800		6	Rishikul	3,030	4,050	20,967
10	Har-Ki-Pauri	1,461	7,076	21,806		5	City Hospital	2,921	10,339	19,947
11	Kharkhari	355	1,787	16,191		4	Ram Nagar	373	2,381	12,529
12	Motichur	439	9,182	14,759		3	Arya Nagar	394	4,666	10,521
13	Shantikunj	78	5,172	6,016		2	Jwalapur	222	4,106	6,249
14	Bharat Mata Temple	0	923	922		1	Sitapur	0	2,366	2,365
	Total	**43,207**	**43,208**				**Total**	**41,242**	**41,243**	
City Hospital-Daksh Temple Corridor Daily Ridership for Normal Day - Horizon Year 2031										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	11,256	0	0		5	Daksh Temple	883	0	0
2	Kankhal Chowk	317	2,036	11,256		4	Ganeshpuram	7,776	122	883
3	Kankhal	183	2,771	9,537		3	Kankhal	3,871	173	8,537
4	Ganeshpuram	119	6,256	6,949		2	Kankhal Chowk	2,265	382	12,235
5	Daksh Temple	0	813	812		1	City Hospital	0	14,119	14,118
	Total	**11,875**	**11,875**				**Total**	**14,795**	**14,795**	
Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Normal Day - Horizon Year 2031										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	2,831	0	0		2	Laltaro Bridge	2,781	0	0
2	Laltaro Bridge	0	2,831	2,831		1	Valmiki Chowk	0	2,781	2,781
	Total	**2,831**	**2,831**				**Total**	**2,781**	**2,781**	
Ganeshpuram-DAV School Corridor Daily Ridership for Normal Day - Horizon Year 2031										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	4,978	0	0		3	DAV School	4,408	0	0
2	Jagjeetpur	86	1,578	4,978		2	Jagjeetpur	1,713	91	4,408
3	DAV School	0	3,486	3,486		1	Ganeshpuram	0	6,030	6,030
	Total	**5,064**	**5,064**				**Total**	**6,121**	**6,121**	
Sitapur-Bharat Mata Temple Corridor Daily Ridership for Normal Day - Horizon Year 2041										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	2,816	0	0		14	Bharat Mata Temple	930	0	0
2	Jwalapur	6,421	257	2,816		13	Shantikunj	5,564	90	930
3	Arya Nagar	5,626	562	8,980		12	Motichur	12,299	485	6,404

4	Ram Nagar	3,099	543	14,044		11	Kharkhari	2,521	389	18,218
5	City Hospital	16,684	3,455	16,600		10	Har-Ki-Pauri	5,747	901	20,350
6	Rishikul	5,849	4,321	29,829		9	Mansadevi Ropeway Gate	7,935	3,046	25,196
7	Haridwar Railway Station	11,064	5,615	31,357		8	Valmiki Chowk	5,092	1,597	30,085
8	Valmiki Chowk	1,477	5,029	36,806		7	Haridwar Railway Station	5,474	10,944	33,580
9	Mansadevi Ropeway Gate	2,362	9,603	33,254		6	Rishikul	4,252	5,485	28,110
10	Har-Ki-Pauri	1,046	5,506	26,013		5	City Hospital	3,940	13,749	26,877
11	Kharkhari	424	2,385	21,553		4	Ram Nagar	497	3,232	17,068
12	Motichur	520	12,224	19,592		3	Arya Nagar	539	6,534	14,333
13	Shantikunj	84	7,007	7,888		2	Jwalapur	298	5,413	8,338
14	Bharat Mata Temple	0	963	965		1	Sitapur	0	3,221	3,223
	Total	**57,472**	**57,470**				**Total**	**55,088**	**55,086**	
City Hospital-Daksh Temple Corridor Daily Ridership for Normal Day - Horizon Year 2041										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	15,048	0	0		5	Daksh Temple	1,175	0	0
2	Kankhal Chowk	443	2,777	15,048		4	Ganeshpuram	10,079	123	1,175
3	Kankhal	236	3,891	12,714		3	Kankhal	5,454	212	11,131
4	Ganeshpuram	128	8,086	9,059		2	Kankhal Chowk	3,079	537	16,373
5	Daksh Temple	0	1,101	1,101		1	City Hospital	0	18,915	18,915
	Total	**15,855**	**15,855**				**Total**	**19,787**	**19,787**	
Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Normal Day - Horizon Year 2041										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	3,644	0	0		2	Laltaro Bridge	3,612	0	0
2	Laltaro Bridge	0	3,644	3,644		1	Valmiki Chowk	0	3,612	3,612
	Total	**3,644**	**3,644**				**Total**	**3,612**	**3,612**	
Ganeshpuram-DAV School Corridor Daily Ridership for Normal Day - Horizon Year 2041										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	6,375	0	0		3	DAV School	5,792	0	0
2	Jagjeetpur	117	1,916	6,375		2	Jagjeetpur	2,087	120	5,792
3	DAV School	0	4,577	4,576		1	Ganeshpuram	0	7,760	7,759
	Total	**6,492**	**6,492**				**Total**	**7,879**	**7,879**	
Sitapur-Bharat Mata Temple Corridor Daily Ridership for Normal Day - Horizon Year 2051										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	3,443	0	0		14	Bharat Mata Temple	956	0	0

2	Jwalapur	8,396	308	3,443		13	Shantikunj	7,459	93	956
3	Arya Nagar	7,542	726	11,531		12	Motichur	15,882	583	8,322
4	Ram Nagar	3,887	651	18,347		11	Kharkhari	3,197	450	23,621
5	City Hospital	21,762	4,099	21,583		10	Har-Ki-Pauri	7,683	1,124	26,368
6	Rishikul	7,890	5,819	39,246		9	Mansadevi Ropeway Gate	10,585	4,145	32,927
7	Haridwar Railway Station	14,106	6,938	41,317		8	Valmiki Chowk	6,684	2,007	39,367
8	Valmiki Chowk	1,838	6,553	48,485		7	Haridwar Railway Station	6,799	13,962	44,044
9	Mansadevi Ropeway Gate	3,170	12,914	43,770		6	Rishikul	5,730	7,385	36,881
10	Har-Ki-Pauri	1,318	7,353	34,026		5	City Hospital	4,745	17,726	35,226
11	Kharkhari	501	2,998	27,991		4	Ram Nagar	583	4,088	22,245
12	Motichur	630	15,745	25,494		3	Arya Nagar	701	8,808	18,740
13	Shantikunj	86	9,478	10,379		2	Jwalapur	367	6,948	10,633
14	Bharat Mata Temple	0	987	987		1	Sitapur	0	4,052	4,052
	Total	**74,569**	**74,569**				**Total**	**71,371**	**71,371**	
City Hospital-Daksh Temple Corridor Daily Ridership for Normal Day - Horizon Year 2051										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	19,139	0	0		5	Daksh Temple	1,348	0	0
2	Kankhal Chowk	546	3,698	19,139		4	Ganeshpuram	12,580	119	1,348
3	Kankhal	265	5,253	15,987		3	Kankhal	7,445	236	13,809
4	Ganeshpuram	129	9,878	10,999		2	Kankhal Chowk	4,121	677	21,018
5	Daksh Temple	0	1,250	1,250		1	City Hospital	0	24,462	24,462
	Total	**20,079**	**20,079**				**Total**	**25,494**	**25,494**	
Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Normal Day - Horizon Year 2051										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	4,707	0	0		2	Laltaro Bridge	4,686	0	0
2	Laltaro Bridge	0	4,707	4,707		1	Valmiki Chowk	0	4,686	4,686
	Total	**4,707**	**4,707**				**Total**	**4,686**	**4,686**	
Ganeshpuram-DAV School Corridor Daily Ridership for Normal Day - Horizon Year 2051										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	7,653	0	0		3	DAV School	7,353	0	0
2	Jagjeetpur	114	2,089	7,653		2	Jagjeetpur	2,292	118	7,353
3	DAV School	0	5,678	5,678		1	Ganeshpuram	0	9,527	9,527
	Total	**7,767**	**7,767**				**Total**	**9,645**	**9,645**	

Table 2-32 Daily PRT Ridership for Poornima (Mela) Day – Option-VII

Sitapur-Bharat Mata Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2021

Sitapur to Bharat Mata Temple Direction						Bharat Mata Temple to Sitapur Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Sitapur	2,254	0	0		14	Bharat Mata Temple	610	0	0
2	Jwalapur	5,919	120	2,254		13	Shantikunj	2,821	57	610
3	Arya Nagar	4,047	211	8,053		12	Motichur	6,941	375	3,374
4	Ram Nagar	2,337	203	11,889		11	Kharkhari	1,292	213	9,940
5	City Hospital	18,004	1,475	14,023		10	Har-Ki-Pauri	15,829	1,214	11,019
6	Rishikul	7,141	1,699	30,552		9	Mansadevi Ropeway Gate	10,949	1,895	25,634
7	Haridwar Railway Station	18,026	10,088	35,994		8	Valmiki Chowk	8,708	3,349	34,688
8	Valmiki Chowk	3,124	9,201	43,932		7	Haridwar Railway Station	9,687	17,473	40,047
9	Mansadevi Ropeway Gate	1,664	11,281	37,855		6	Rishikul	1,719	6,565	32,261
10	Har-Ki-Pauri	1,096	17,920	28,238		5	City Hospital	1,617	14,743	27,415
11	Kharkhari	267	1,089	11,414		4	Ram Nagar	211	2,348	14,289
12	Motichur	400	6,941	10,592		3	Arya Nagar	210	5,023	12,152
13	Shantikunj	50	3,491	4,051		2	Jwalapur	136	4,964	7,339
14	Bharat Mata Temple	0	610	610		1	Sitapur	0	2,512	2,511
	Total	**64,329**	**64,329**				**Total**	**60,730**	**60,731**	

City Hospital-Daksh Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2021

City Hospital to Daksh Temple Direction						Daksh Temple to City Hospital Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	City Hospital	14,487	0	0		5	Daksh Temple	393	0	0
2	Kankhal Chowk	354	2,170	14,487		4	Ganeshpuram	12,003	48	393
3	Kankhal	159	2,886	12,671		3	Kankhal	3,993	144	12,348
4	Ganeshpuram	54	9,607	9,944		2	Kankhal Chowk	2,324	402	16,197
5	Daksh Temple	0	390	391		1	City Hospital	0	18,118	18,119
	Total	**15,054**	**15,054**				**Total**	**18,713**	**18,713**	

Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Poornima Day - Horizon Year 2021

Valmiki Chowk to Laltaro Bridge Direction						Laltaro Bridge to Valmiki Chowk Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Valmiki Chowk	6,904	0	0		2	Laltaro Bridge	6,508	0	0
2	Laltaro Bridge	0	6,904	6,904		1	Valmiki Chowk	0	6,508	6,508
	Total	**6,904**	**6,904**				**Total**	**6,508**	**6,508**	

Ganeshpuram-DAV School Corridor Daily Ridership for Poornima Day - Horizon Year 2021

Ganeshpuram to DAV School Direction						DAV School to Ganeshpuram Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ganeshpuram	7,489	0	0		3	DAV School	7,129	0	0
2	Jagjeetpur	144	2,037	7,489		2	Jagjeetpur	2,059	143	7,129
3	DAV School	0	5,596	5,596		1	Ganeshpuram	0	9,045	9,045
	Total	**7,633**	**7,633**				**Total**	**9,188**	**9,188**	

Sitapur-Bharat Mata Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2031										
Sitapur to Bharat Mata Temple Direction						Bharat Mata Temple to Sitapur Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Sitapur	4,246	0	0		14	Bharat Mata Temple	896	0	0
2	Jwalapur	9,186	254	4,246		13	Shantikunj	4,174	85	896
3	Arya Nagar	9,627	580	13,178		12	Motichur	9,187	414	4,985
4	Ram Nagar	4,390	577	22,225		11	Kharkhari	2,269	320	13,758
5	City Hospital	28,585	2,749	26,038		10	Har-Ki-Pauri	19,711	1,647	15,707
6	Rishikul	10,408	3,850	51,874		9	Mansadevi Ropeway Gate	12,489	1,822	33,771
7	Haridwar Railway Station	14,948	14,497	58,432		8	Valmiki Chowk	12,491	2,790	44,438
8	Valmiki Chowk	2,594	12,407	58,883		7	Haridwar Railway Station	14,026	14,639	54,139
9	Mansadevi Ropeway Gate	1,622	13,289	49,070		6	Rishikul	3,858	9,575	53,526
10	Har-Ki-Pauri	1,461	22,414	37,403		5	City Hospital	3,105	23,528	47,809
11	Kharkhari	355	2,043	16,450		4	Ram Nagar	541	4,652	27,386
12	Motichur	439	9,182	14,762		3	Arya Nagar	562	11,880	23,275
13	Shantikunj	78	5,172	6,019		2	Jwalapur	285	7,682	11,957
14	Bharat Mata Temple	0	923	925		1	Sitapur	0	4,558	4,560
	Total	**87,939**	**87,937**				**Total**	**83,594**	**83,592**	

City Hospital-Daksh Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2031										
City Hospital to Daksh Temple Direction						Daksh Temple to City Hospital Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	City Hospital	22,368	0	0		5	Daksh Temple	883	0	0
2	Kankhal Chowk	476	3,829	22,368		4	Ganeshpuram	18,177	122	883
3	Kankhal	267	4,408	19,015		3	Kankhal	6,030	251	18,938
4	Ganeshpuram	119	14,179	14,874		2	Kankhal Chowk	4,138	576	24,717
5	Daksh Temple	0	813	814		1	City Hospital	0	28,278	28,279
	Total	**23,230**	**23,230**				**Total**	**29,228**	**29,228**	

Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Poornima Day - Horizon Year 2031										
Valmiki Chowk to Laltaro Bridge Direction						Laltaro Bridge to Valmiki Chowk Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Valmiki Chowk	8,359	0	0		2	Laltaro Bridge	8,297	0	0
2	Laltaro Bridge	0	8,359	8,359		1	Valmiki Chowk	0	8,297	8,297
	Total	**8,359**	**8,359**				**Total**	**8,297**	**8,297**	

Ganeshpuram-DAV School Corridor Daily Ridership for Poornima Day - Horizon Year 2031										
Ganeshpuram to DAV School Direction						DAV School to Ganeshpuram Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ganeshpuram	11,286	0	0		3	DAV School	11,166	0	0
2	Jagjeetpur	132	2,972	11,286		2	Jagjeetpur	3,242	140	11,166
3	DAV School	0	8,447	8,446		1	Ganeshpuram	0	14,269	14,268

	Total	**11,418**	**11,419**				**Total**	**14,408**	**14,409**	

Sitapur-Bharat Mata Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2041										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	5,628	0	0		14	Bharat Mata Temple	930	0	0
2	Jwalapur	12,378	336	5,628		13	Shantikunj	5,564	90	930
3	Arya Nagar	13,392	787	17,670		12	Motichur	12,299	485	6,404
4	Ram Nagar	5,799	775	30,275		11	Kharkhari	3,062	389	18,218
5	City Hospital	37,567	3,712	35,299		10	Har-Ki-Pauri	18,261	901	20,891
6	Rishikul	13,962	5,369	69,154		9	Mansadevi Ropeway Gate	25,578	4,194	38,251
7	Haridwar Railway Station	19,354	18,165	77,747		8	Valmiki Chowk	16,711	3,374	59,635
8	Valmiki Chowk	3,100	16,364	78,936		7	Haridwar Railway Station	17,769	19,096	72,972
9	Mansadevi Ropeway Gate	3,294	30,915	65,672		6	Rishikul	5,411	12,832	71,645
10	Har-Ki-Pauri	1,046	17,187	38,051		5	City Hospital	4,180	30,951	64,224
11	Kharkhari	424	2,745	21,910		4	Ram Nagar	720	6,229	37,453
12	Motichur	520	12,224	19,589		3	Arya Nagar	769	16,727	31,944
13	Shantikunj	84	7,007	7,885		2	Jwalapur	380	10,204	15,986
14	Bharat Mata Temple	0	963	962		1	Sitapur	0	6,164	6,162
	Total	**1,16,548**	**1,16,549**				**Total**	**1,11,634**	**1,11,636**	

City Hospital-Daksh Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2041										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	29,573	0	0		5	Daksh Temple	1,175	0	0
2	Kankhal Chowk	662	5,107	29,573		4	Ganeshpuram	23,704	123	1,175
3	Kankhal	345	6,063	25,128		3	Kankhal	8,307	310	24,756
4	Ganeshpuram	128	18,437	19,410		2	Kankhal Chowk	5,461	805	32,753
5	Daksh Temple	0	1,101	1,101		1	City Hospital	0	37,409	37,409
	Total	**30,708**	**30,708**				**Total**	**38,647**	**38,647**	

Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Poornima Day - Horizon Year 2041										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	10,856	0	0		2	Laltaro Bridge	10,896	0	0
2	Laltaro Bridge	0	10,856	10,856		1	Valmiki Chowk	0	10,896	10,896
	Total	**10,856**	**10,856**				**Total**	**10,896**	**10,896**	

Ganeshpuram-DAV School Corridor Daily Ridership for Poornima Day - Horizon Year 2041										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	14,614	0	0		3	DAV School	14,807	0	0
2	Jagjeetpur	180	3,615	14,614		2	Jagjeetpur	3,947	183	14,807

3	DAV School	0	11,178	11,179		1	Ganeshpuram	0	18,570	18,571
	Total	**14,794**	**14,793**				**Total**	**18,754**	**18,753**	

Sitapur-Bharat Mata Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2051

Sitapur to Bharat Mata Temple Direction						Bharat Mata Temple to Sitapur Direction				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	6,907	0	0		14	Bharat Mata Temple	956	0	0
2	Jwalapur	16,485	400	6,907		13	Shantikunj	7,459	93	956
3	Arya Nagar	18,109	1,013	22,992		12	Motichur	15,882	583	8,322
4	Ram Nagar	7,173	923	40,088		11	Kharkhari	3,775	450	23,621
5	City Hospital	48,714	4,387	46,338		10	Har-Ki-Pauri	24,409	1,124	26,946
6	Rishikul	18,958	7,213	90,665		9	Mansadevi Ropeway Gate	34,151	5,677	50,231
7	Haridwar Railway Station	24,626	22,414	1,02,410		8	Valmiki Chowk	21,971	4,292	78,705
8	Valmiki Chowk	3,905	21,350	1,04,622		7	Haridwar Railway Station	22,082	24,293	96,384
9	Mansadevi Ropeway Gate	4,398	41,599	87,177		6	Rishikul	7,291	17,388	94,173
10	Har-Ki-Pauri	1,318	22,920	49,976		5	City Hospital	5,009	39,596	84,076
11	Kharkhari	501	3,382	28,374		4	Ram Nagar	841	7,841	49,489
12	Motichur	630	15,745	25,493		3	Arya Nagar	1,001	22,820	42,489
13	Shantikunj	86	9,478	10,378		2	Jwalapur	465	13,343	20,670
14	Bharat Mata Temple	0	987	986		1	Sitapur	0	7,790	7,792
	Total	**1,51,810**	**1,51,811**				**Total**	**1,45,292**	**1,45,290**	

City Hospital-Daksh Temple Corridor Daily Ridership for Poornima Day - Horizon Year 2051

City Hospital to Daksh Temple Direction						Daksh Temple to City Hospital Direction				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	37,783	0	0		5	Daksh Temple	1,348	0	0
2	Kankhal Chowk	817	6,729	37,783		4	Ganeshpuram	30,349	119	1,348
3	Kankhal	387	8,051	31,871		3	Kankhal	11,194	346	31,578
4	Ganeshpuram	129	23,086	24,207		2	Kankhal Chowk	7,214	1,018	42,426
5	Daksh Temple	0	1,250	1,250		1	City Hospital	0	48,621	48,622
	Total	**39,116**	**39,116**				**Total**	**50,105**	**50,105**	

Valmiki Chowk-Laltaro Bridge Corridor Daily Ridership for Poornima Day - Horizon Year 2051

Valmiki Chowk to Laltaro Bridge Direction						Laltaro Bridge to Valmiki Chowk Direction				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	14,104	0	0		2	Laltaro Bridge	14,232	0	0
2	Laltaro Bridge	0	14,104	14,104		1	Valmiki Chowk	0	14,232	14,232
	Total	**14,104**	**14,104**				**Total**	**14,232**	**14,232**	

Ganeshpuram-DAV School Corridor Daily Ridership for Poornima Day - Horizon Year 2051

Ganeshpuram to DAV School Direction						DAV School to Ganeshpuram Direction				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	18,140	0	0		3	DAV School	19,430	0	0
2	Jagjeetpur	174	3,945	18,140		2	Jagjeetpur	4,348	180	19,430
3	DAV School	0	14,368	14,369		1	Ganeshpuram	0	23,598	23,598

Total	**18,314**	**18,313**			**Total**	**23,778**	**23,778**	

Table 2-33 Peak Hr PRT Ridership for Normal Day – Option-VII

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2021										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	116	0	0		14	Bharat Mata Temple	61	0	0
2	Jwalapur	290	9	116		13	Shantikunj	282	6	61
3	Arya Nagar	169	14	397		12	Motichur	694	38	337
4	Ram Nagar	115	14	552		11	Kharkhari	103	21	994
5	City Hospital	760	139	653		10	Har-Ki-Pauri	408	121	1,075
6	Rishikul	293	134	1,274		9	Mansadevi Ropeway Gate	264	98	1,362
7	Haridwar Railway Station	692	307	1,434		8	Valmiki Chowk	229	109	1,528
8	Valmiki Chowk	101	238	1,819		7	Haridwar Railway Station	293	676	1,648
9	Mansadevi Ropeway Gate	87	281	1,681		6	Rishikul	131	273	1,265
10	Har-Ki-Pauri	110	473	1,487		5	City Hospital	154	623	1,123
11	Kharkhari	27	91	1,124		4	Ram Nagar	14	113	654
12	Motichur	40	694	1,059		3	Arya Nagar	14	197	555
13	Shantikunj	5	349	405		2	Jwalapur	10	250	372
14	Bharat Mata Temple	0	61	61		1	Sitapur	0	133	133
	Total	**2,805**	**2,804**				**Total**	**2,657**	**2,658**	
City Hospital-Daksh Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2021										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	694	0	0		5	Daksh Temple	39	0	0
2	Kankhal Chowk	23	105	694		4	Ganeshpuram	490	5	39
3	Kankhal	10	181	612		3	Kankhal	252	9	525
4	Ganeshpuram	5	408	441		2	Kankhal Chowk	116	26	767
5	Daksh Temple	0	39	39		1	City Hospital	0	858	858
	Total	**732**	**732**				**Total**	**897**	**897**	
Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Normal Day - Horizon Year 2021										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	191	0	0		2	Laltaro Bridge	181	0	0
2	Laltaro Bridge	0	191	191		1	Valmiki Chowk	0	181	181
	Total	**191**	**191**				**Total**	**181**	**181**	
Ganeshpuram-DAV School Corridor Peak Hour Ridership for Normal Day - Horizon Year 2021										

Ganeshpuram to DAV School Direction					DAV School to Ganeshpuram Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ganeshpuram	318	0	0	3	DAV School	267	0	0
2	Jagjeetpur	9	106	318	2	Jagjeetpur	107	9	267
3	DAV School	0	221	221	1	Ganeshpuram	0	366	366
	Total	**327**	**327**			**Total**	**374**	**375**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2031

Sitapur to Bharat Mata Temple Direction					Bharat Mata Temple to Sitapur Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Sitapur	210	0	0	14	Bharat Mata Temple	90	0	0
2	Jwalapur	480	19	210	13	Shantikunj	417	9	90
3	Arya Nagar	404	41	671	12	Motichur	919	41	499
4	Ram Nagar	230	40	1,033	11	Kharkhari	188	32	1,376
5	City Hospital	1,253	255	1,223	10	Har-Ki-Pauri	617	165	1,532
6	Rishikul	433	310	2,221	9	Mansadevi Ropeway Gate	387	128	1,985
7	Haridwar Railway Station	841	447	2,344	8	Valmiki Chowk	382	133	2,243
8	Valmiki Chowk	124	382	2,739	7	Haridwar Railway Station	431	826	2,492
9	Mansadevi Ropeway Gate	113	412	2,480	6	Rishikul	303	405	2,097
10	Har-Ki-Pauri	146	708	2,181	5	City Hospital	292	1,034	1,995
11	Kharkhari	36	179	1,619	4	Ram Nagar	37	238	1,253
12	Motichur	44	918	1,476	3	Arya Nagar	39	467	1,052
13	Shantikunj	8	517	602	2	Jwalapur	22	411	625
14	Bharat Mata Temple	0	92	92	1	Sitapur	0	237	237
	Total	**4,322**	**4,322**			**Total**	**4,124**	**4,124**	

City Hospital-Daksh Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2031

City Hospital to Daksh Temple Direction					Daksh Temple to City Hospital Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	City Hospital	1,126	0	0	5	Daksh Temple	88	0	0
2	Kankhal Chowk	32	204	1,126	4	Ganeshpuram	778	12	88
3	Kankhal	18	277	954	3	Kankhal	387	17	854
4	Ganeshpuram	12	626	695	2	Kankhal Chowk	227	38	1,224
5	Daksh Temple	0	81	81	1	City Hospital	0	1,412	1,412
	Total	**1,188**	**1,188**			**Total**	**1,480**	**1,480**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Normal Day - Horizon Year 2031

Valmiki Chowk to Laltaro Bridge Direction					Laltaro Bridge to Valmiki Chowk Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Valmiki Chowk	283	0	0	2	Laltaro Bridge	278	0	0

2	Laltaro Bridge	0	283	283		1	Valmiki Chowk	0	278	278
	Total	**283**	**283**				**Total**	**278**	**278**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Normal Day - Horizon Year 2031										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	498	0	0		3	DAV School	441	0	0
2	Jagjeetpur	9	158	498		2	Jagjeetpur	171	9	441
3	DAV School	0	349	349		1	Ganeshpuram	0	603	603
	Total	**507**	**507**				**Total**	**612**	**612**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2041										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	282	0	0		14	Bharat Mata Temple	93	0	0
2	Jwalapur	642	26	282		13	Shantikunj	556	9	93
3	Arya Nagar	563	56	898		12	Motichur	1,230	49	640
4	Ram Nagar	310	54	1,404		11	Kharkhari	252	39	1,822
5	City Hospital	1,668	346	1,660		10	Har-Ki-Pauri	575	90	2,035
6	Rishikul	585	432	2,983		9	Mansadevi Ropeway Gate	794	305	2,520
7	Haridwar Railway Station	1,106	562	3,136		8	Valmiki Chowk	509	160	3,009
8	Valmiki Chowk	148	503	3,681		7	Haridwar Railway Station	547	1,094	3,358
9	Mansadevi Ropeway Gate	236	960	3,325		6	Rishikul	425	549	2,811
10	Har-Ki-Pauri	105	551	2,601		5	City Hospital	394	1,375	2,688
11	Kharkhari	42	239	2,155		4	Ram Nagar	50	323	1,707
12	Motichur	52	1,222	1,959		3	Arya Nagar	54	653	1,433
13	Shantikunj	8	701	789		2	Jwalapur	30	541	834
14	Bharat Mata Temple	0	96	97		1	Sitapur	0	322	322
	Total	**5,747**	**5,747**				**Total**	**5,509**	**5,509**	

City Hospital-Daksh Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2041										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	1,505	0	0		5	Daksh Temple	118	0	0
2	Kankhal Chowk	44	278	1,505		4	Ganeshpuram	1,008	12	118
3	Kankhal	24	389	1,271		3	Kankhal	545	21	1,113
4	Ganeshpuram	13	809	906		2	Kankhal Chowk	308	54	1,637
5	Daksh Temple	0	110	110		1	City Hospital	0	1,892	1,892
	Total	**1,586**	**1,586**				**Total**	**1,979**	**1,979**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Normal Day - Horizon Year 2041		
Valmiki Chowk to Laltaro Bridge Direction		**Laltaro Bridge to Valmiki Chowk Direction**

Station No.	Station Name	Boarding	Alighting	Sectional Load		Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Valmiki Chowk	364	0	0		2	Laltaro Bridge	361	0	0
2	Laltaro Bridge	0	364	364		1	Valmiki Chowk	0	361	361
	Total	**364**	**364**				**Total**	**361**	**361**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Normal Day - Horizon Year 2041										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	638	0	0		3	DAV School	579	0	0
2	Jagjeetpur	12	192	638		2	Jagjeetpur	209	12	579
3	DAV School	0	458	458		1	Ganeshpuram	0	776	776
	Total	**650**	**650**				**Total**	**788**	**788**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2051										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	344	0	0		14	Bharat Mata Temple	96	0	0
2	Jwalapur	840	31	344		13	Shantikunj	746	9	96
3	Arya Nagar	754	73	1,153		12	Motichur	1,588	58	832
4	Ram Nagar	389	65	1,835		11	Kharkhari	320	45	2,362
5	City Hospital	2,176	410	2,158		10	Har-Ki-Pauri	768	112	2,637
6	Rishikul	789	582	3,925		9	Mansadevi Ropeway Gate	1,059	415	3,293
7	Haridwar Railway Station	1,411	694	4,132		8	Valmiki Chowk	668	201	3,937
8	Valmiki Chowk	184	655	4,849		7	Haridwar Railway Station	680	1,396	4,404
9	Mansadevi Ropeway Gate	317	1,291	4,377		6	Rishikul	573	739	3,688
10	Har-Ki-Pauri	132	735	3,403		5	City Hospital	475	1,773	3,523
11	Kharkhari	50	300	2,799		4	Ram Nagar	58	409	2,225
12	Motichur	63	1,575	2,549		3	Arya Nagar	70	881	1,874
13	Shantikunj	9	948	1,038		2	Jwalapur	37	695	1,063
14	Bharat Mata Temple	0	99	99		1	Sitapur	0	405	405
	Total	**7,458**	**7,458**				**Total**	**7,138**	**7,138**	

City Hospital-Daksh Temple Corridor Peak Hour Ridership for Normal Day - Horizon Year 2051										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	1,914	0	0		5	Daksh Temple	135	0	0
2	Kankhal Chowk	55	370	1,914		4	Ganeshpuram	1,258	12	135
3	Kankhal	27	525	1,599		3	Kankhal	745	24	1,381
4	Ganeshpuram	13	988	1,100		2	Kankhal	412	68	2,102

							Chowk			
5	Daksh Temple	0	125	125		1	City Hospital	0	2,446	2,446
	Total	**2,009**	**2,009**				**Total**	**2,550**	**2,550**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Normal Day - Horizon Year 2051										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	471	0	0		2	Laltaro Bridge	469	0	0
2	Laltaro Bridge	0	471	471		1	Valmiki Chowk	0	469	469
	Total	**471**	**471**				**Total**	**469**	**469**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Normal Day - Horizon Year 2051										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	765	0	0		3	DAV School	735	0	0
2	Jagjeetpur	11	209	765		2	Jagjeetpur	229	12	735
3	DAV School	0	568	568		1	Ganeshpuram	0	953	953
	Total	**776**	**777**				**Total**	**964**	**965**	

Table 2-34 Peak Hr PRT Ridership for Poornima (Mela) Day – Option-VII

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2021										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	225	0	0		14	Bharat Mata Temple	61	0	0
2	Jwalapur	592	12	225		13	Shantikunj	282	6	61
3	Arya Nagar	405	21	805		12	Motichur	694	38	337
4	Ram Nagar	234	20	1,189		11	Kharkhari	129	21	994
5	City Hospital	1,800	148	1,402		10	Har-Ki-Pauri	1,583	121	1,102
6	Rishikul	714	170	3,055		9	Mansadevi Ropeway Gate	1,095	190	2,563
7	Haridwar Railway Station	1,803	1,009	3,599		8	Valmiki Chowk	871	335	3,469
8	Valmiki Chowk	312	920	4,393		7	Haridwar Railway Station	969	1,747	4,005
9	Mansadevi Ropeway Gate	166	1,128	3,786		6	Rishikul	172	657	3,226
10	Har-Ki-Pauri	110	1,792	2,824		5	City Hospital	162	1,474	2,742
11	Kharkhari	27	109	1,141		4	Ram Nagar	21	235	1,429
12	Motichur	40	694	1,059		3	Arya Nagar	21	502	1,215
13	Shantikunj	5	349	405		2	Jwalapur	14	496	734
14	Bharat Mata Temple	0	61	61		1	Sitapur	0	251	251
	Total	**6,433**	**6,433**				**Total**	**6,074**	**6,073**	
City Hospital-Daksh Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2021										

City Hospital to Daksh Temple Direction					Daksh Temple to City Hospital Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	City Hospital	1,449	0	0	5	Daksh Temple	39	0	0
2	Kankhal Chowk	35	217	1,449	4	Ganeshpuram	1,200	5	39
3	Kankhal	16	289	1,267	3	Kankhal	399	14	1,235
4	Ganeshpuram	5	961	994	2	Kankhal Chowk	232	40	1,620
5	Daksh Temple	0	39	39	1	City Hospital	0	1,812	1,812
	Total	**1,505**	**1,505**			**Total**	**1,870**	**1,870**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2021

Valmiki Chowk to Laltaro Bridge Direction					Laltaro Bridge to Valmiki Chowk Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Valmiki Chowk	690	0	0	2	Laltaro Bridge	651	0	0
2	Laltaro Bridge	0	690	690	1	Valmiki Chowk	0	651	651
	Total	**690**	**690**			**Total**	**651**	**651**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2021

Ganeshpuram to DAV School Direction					DAV School to Ganeshpuram Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Ganeshpuram	749	0	0	3	DAV School	713	0	0
2	Jagjeetpur	14	204	749	2	Jagjeetpur	206	14	713
3	DAV School	0	560	560	1	Ganeshpuram	0	905	905
	Total	**763**	**764**			**Total**	**919**	**919**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2031

Sitapur to Bharat Mata Temple Direction					Bharat Mata Temple to Sitapur Direction				
Station No.	Station Name	Boarding	Alighting	Sectional Load	Station No.	Station Name	Boarding	Alighting	Sectional Load
1	Sitapur	425	0	0	14	Bharat Mata Temple	90	0	0
2	Jwalapur	919	25	425	13	Shantikunj	417	9	90
3	Arya Nagar	963	58	1,318	12	Motichur	919	41	499
4	Ram Nagar	439	58	2,223	11	Kharkhari	227	32	1,376
5	City Hospital	2,859	275	2,604	10	Har-Ki-Pauri	1,971	165	1,571
6	Rishikul	1,041	385	5,187	9	Mansadevi Ropeway Gate	1,249	182	3,377
7	Haridwar Railway Station	1,495	1,450	5,843	8	Valmiki Chowk	1,249	279	4,444
8	Valmiki Chowk	259	1,241	5,888	7	Haridwar Railway Station	1,403	1,464	5,414
9	Mansadevi Ropeway Gate	162	1,329	4,907	6	Rishikul	386	958	5,353
10	Har-Ki-Pauri	146	2,241	3,740	5	City Hospital	311	2,353	4,781
11	Kharkhari	36	204	1,645	4	Ram Nagar	54	465	2,739
12	Motichur	44	918	1,476	3	Arya Nagar	56	1,188	2,328
13	Shantikunj	8	517	602	2	Jwalapur	29	768	1,196
14	Bharat Mata	0	92	93	1	Sitapur	0	456	456

	Temple									
	Total	**8,796**	**8,796**				**Total**	**8,361**	**8,361**	

City Hospital-Daksh Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2031										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	2,237	0	0		5	Daksh Temple	88	0	0
2	Kankhal Chowk	48	383	2,237		4	Ganeshpuram	1,818	12	88
3	Kankhal	27	441	1,902		3	Kankhal	603	25	1,894
4	Ganeshpuram	12	1,418	1,487		2	Kankhal Chowk	414	58	2,472
5	Daksh Temple	0	81	81		1	City Hospital	0	2,828	2,828
	Total	**2,324**	**2,324**				**Total**	**2,923**	**2,923**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2031										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	836	0	0		2	Laltaro Bridge	830	0	0
2	Laltaro Bridge	0	836	836		1	Valmiki Chowk	0	830	830
	Total	**836**	**836**				**Total**	**830**	**830**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2031										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	1,129	0	0		3	DAV School	1,117	0	0
2	Jagjeetpur	13	297	1,129		2	Jagjeetpur	324	14	1,117
3	DAV School	0	845	845		1	Ganeshpuram	0	1,427	1,427
	Total	**1,142**	**1,142**				**Total**	**1,441**	**1,441**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2041										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	563	0	0		14	Bharat Mata Temple	93	0	0
2	Jwalapur	1,238	34	563		13	Shantikunj	556	9	93
3	Arya Nagar	1,339	79	1,767		12	Motichur	1,230	49	640
4	Ram Nagar	580	78	3,028		11	Kharkhari	306	39	1,822
5	City Hospital	3,757	371	3,530		10	Har-Ki-Pauri	1,826	90	2,089
6	Rishikul	1,396	537	6,915		9	Mansadevi Ropeway Gate	2,558	419	3,825
7	Haridwar Railway Station	1,935	1,817	7,775		8	Valmiki Chowk	1,671	337	5,964
8	Valmiki Chowk	310	1,636	7,894		7	Haridwar Railway Station	1,777	1,910	7,297
9	Mansadevi Ropeway Gate	329	3,092	6,567		6	Rishikul	541	1,283	7,165

10	Har-Ki-Pauri	105	1,719	3,805		5	City Hospital	418	3,095	6,422
11	Kharkhari	42	275	2,191		4	Ram Nagar	72	623	3,745
12	Motichur	52	1,222	1,959		3	Arya Nagar	77	1,673	3,194
13	Shantikunj	8	701	789		2	Jwalapur	38	1,020	1,599
14	Bharat Mata Temple	0	96	96		1	Sitapur	0	616	616
	Total	**11,654**	**11,654**				**Total**	**11,163**	**11,163**	

City Hospital-Daksh Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2041										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	2,957	0	0		5	Daksh Temple	118	0	0
2	Kankhal Chowk	66	511	2,957		4	Ganeshpuram	2,370	12	118
3	Kankhal	35	606	2,513		3	Kankhal	831	31	2,476
4	Ganeshpuram	13	1,844	1,941		2	Kankhal Chowk	546	81	3,275
5	Daksh Temple	0	110	110		1	City Hospital	0	3,741	3,741
	Total	**3,071**	**3,071**				**Total**	**3,865**	**3,865**	

Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2041										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	1,086	0	0		2	Laltaro Bridge	1,090	0	0
2	Laltaro Bridge	0	1,086	1,086		1	Valmiki Chowk	0	1,090	1,090
	Total	**1,086**	**1,086**				**Total**	**1,090**	**1,090**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2041										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	1,461	0	0		3	DAV School	1,481	0	0
2	Jagjeetpur	18	362	1,461		2	Jagjeetpur	395	18	1,481
3	DAV School	0	1,118	1,118		1	Ganeshpuram	0	1,857	1,857
	Total	**1,479**	**1,480**				**Total**	**1,876**	**1,875**	

Sitapur-Bharat Mata Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2051										
Sitapur to Bharat Mata Temple Direction						**Bharat Mata Temple to Sitapur Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Sitapur	691	0	0		14	Bharat Mata Temple	96	0	0
2	Jwalapur	1,649	40	691		13	Shantikunj	746	9	96
3	Arya Nagar	1,811	101	2,299		12	Motichur	1,588	58	832
4	Ram Nagar	717	92	4,009		11	Kharkhari	378	45	2,362
5	City Hospital	4,871	439	4,634		10	Har-Ki-Pauri	2,441	112	2,695
6	Rishikul	1,896	721	9,067		9	Mansadevi Ropeway Gate	3,415	568	5,023
7	Haridwar Railway	2,463	2,241	10,241		8	Valmiki Chowk	2,197	429	7,871

	Station									
8	Valmiki Chowk	391	2,135	10,462		7	Haridwar Railway Station	2,208	2,429	9,638
9	Mansadevi Ropeway Gate	440	4,160	8,718		6	Rishikul	729	1,739	9,417
10	Har-Ki-Pauri	132	2,292	4,998		5	City Hospital	501	3,960	8,408
11	Kharkhari	50	338	2,837		4	Ram Nagar	84	784	4,949
12	Motichur	63	1,575	2,549		3	Arya Nagar	100	2,282	4,249
13	Shantikunj	9	948	1,038		2	Jwalapur	47	1,334	2,067
14	Bharat Mata Temple	0	99	99		1	Sitapur	0	779	779
	Total	**15,183**	**15,183**				**Total**	**14,530**	**14,530**	
City Hospital-Daksh Temple Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2051										
City Hospital to Daksh Temple Direction						**Daksh Temple to City Hospital Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	City Hospital	3,778	0	0		5	Daksh Temple	135	0	0
2	Kankhal Chowk	82	673	3,778		4	Ganeshpuram	3,035	12	135
3	Kankhal	39	805	3,187		3	Kankhal	1,119	35	3,158
4	Ganeshpuram	13	2,309	2,421		2	Kankhal Chowk	721	102	4,243
5	Daksh Temple	0	125	125		1	City Hospital	0	4,862	4,862
	Total	**3,912**	**3,912**				**Total**	**5,010**	**5,010**	
Valmiki Chowk-Laltaro Bridge Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2051										
Valmiki Chowk to Laltaro Bridge Direction						**Laltaro Bridge to Valmiki Chowk Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Valmiki Chowk	1,410	0	0		2	Laltaro Bridge	1,423	0	0
2	Laltaro Bridge	0	1,410	1,410		1	Valmiki Chowk	0	1,423	1,423
	Total	**1,410**	**1,410**				**Total**	**1,423**	**1,423**	

Ganeshpuram-DAV School Corridor Peak Hour Ridership for Poornima Day - Horizon Year 2051										
Ganeshpuram to DAV School Direction						**DAV School to Ganeshpuram Direction**				
Station No.	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**		**Station No.**	**Station Name**	**Boarding**	**Alighting**	**Sectional Load**
1	Ganeshpuram	1,814	0	0		3	DAV School	1,943	0	0
2	Jagjeetpur	17	395	1,814		2	Jagjeetpur	435	18	1,943
3	DAV School	0	1,437	1,437		1	Ganeshpuram	0	2,360	2,360
	Total	**1,831**	**1,832**				**Total**	**2,378**	**2,378**	

2.12 IMPACT OF SHIFTING OF CAR PARKING

Haridwar is a religious city. Therefore, environmental quality of the city has an important role. To maintain a better environmental quality and to reduce the pollution level, an additional option of shifting all the car parking from the city core to the two ends of the city has been considered. Only through traffic crossing the city will be allowed for cars. This will improve the air quality as well as city scape. However, this needs a lot of policy decision and enforcement. With this

concept all car parking including Deen Dayal Parking, Pant Deep Parking, and Ram Ghat Parking etc. would be shifted at the two ends – Sitapur end and Motichur end of the city. All tourists coming by car or taxi from outside of Haridwar would have to park their vehicle at these two ends and travel by public transport or IPT to visit different religious places in Haridwar. On a normal day, average daily car parking at Deen Dayal Parking is around 350 and total car parking in Haridwar city is around 650. Therefore, around 2,600 daily tourists (as average occupancy of car is 4.05) will be shifted at the two ends of the city and will travel by proposed PRT to reach Har-Ki-Pauri. Again, they will ride the same mode to return to the parking lots at the two ends. This shows around 5,200 additional daily trips for the Sitapur – Har-Ki-Pauri or Motichur – Har-Ki-Pauri section with an increased PHPDT of around 250 passengers.

2.13 TRAFFIC SUMMARY OF OPTION-VII

Table 2-35 Proposed Haridwar PRT Ridership Summary for Normal Day – Option-VII

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger-km (km)	Average Trip Length (km)
2021	Sitapur - Bharat Mata Temple	14.55	54,608	1819	2,74,572	5.03
2021	City Hospital - Daksh Temple	3.11	16,295	858	26,877	1.65
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,723	191	2,420	0.65
2021	Ganeshpuram - DAV School	2.38	7,015	366	13,336	1.90
2031	Sitapur - Bharat Mata Temple	14.55	84,449	2739	4,29,241	5.08
2031	City Hospital - Daksh Temple	3.11	26,671	1412	43,809	1.64
2031	Valmiki Chowk - Laltaro Bridge	0.69	5,612	283	3,648	0.65
2031	Ganeshpuram - DAV School	2.38	11,185	603	21,422	1.92
2041	Sitapur - Bharat Mata Temple	14.55	1,12,558	3681	6,46,088	5.74
2041	City Hospital - Daksh Temple	3.11	35,642	1892	73,400	2.06
2041	Valmiki Chowk - Laltaro Bridge	0.69	7,256	364	4,716	0.65
2041	Ganeshpuram - DAV School	2.38	14,372	776	32,148	2.24
2051	Sitapur - Bharat Mata Temple	14.55	1,45,939	4849	8,43,098	5.78
2051	City Hospital - Daksh Temple	3.11	45,574	2446	92,222	2.02
2051	Valmiki Chowk - Laltaro Bridge	0.69	9,393	471	6,105	0.65
2051	Ganeshpuram - DAV School	2.38	17,412	953	39,677	2.28

Table 2-36 Proposed Haridwar PRT Ridership Summary for Poornima (Mela) Day – Option-VII

Horizon Year	Corridor	Route Length (km)	Daily Ridership (Passengers)	PHPDT (Passengers)	Daily Passenger -km (km)	Average Trip Length (km)
2021	Sitapur - Bharat Mata Temple	14.55	1,25,059	4393	5,12,459	4.10
2021	City Hospital - Daksh Temple	3.11	33,766	1812	56,012	1.66
2021	Valmiki Chowk - Laltaro Bridge	0.69	13,412	690	8,718	0.65
2021	Ganeshpuram - DAV School	2.38	16,821	905	33,227	1.98
2031	Sitapur - Bharat Mata Temple	14.55	1,71,530	5888	7,84,212	4.57
2031	City Hospital - Daksh Temple	3.11	52,457	2828	86,334	1.65
2031	Valmiki Chowk - Laltaro Bridge	0.69	16,656	836	10,826	0.65
2031	Ganeshpuram - DAV School	2.38	25,827	1427	51,140	1.98
2041	Sitapur - Bharat Mata Temple	14.55	2,28,185	7894	11,73,564	5.14
2041	City Hospital - Daksh Temple	3.11	69,355	3741	1,43,913	2.08
2041	Valmiki Chowk - Laltaro Bridge	0.69	21,752	1090	14,139	0.65
2041	Ganeshpuram - DAV School	2.38	33,547	1857	77,786	2.32
2051	Sitapur - Bharat Mata Temple	14.55	2,97,100	10462	15,40,236	5.18
2051	City Hospital - Daksh Temple	3.11	89,220	4862	1,83,503	2.06
2051	Valmiki Chowk - Laltaro Bridge	0.69	28,337	1423	18,419	0.65
2051	Ganeshpuram - DAV School	2.38	42,092	2360	99,411	2.36

Table 2-37 Traffic Summary for PRT System in Haridwar City (Option-VII)

Parameters	2021	2031	2041	2051
Section Length (in km)	20.74	20.74	20.74	20.74
Daily Ridership including Induced Traffic on Normal Day	81,641	1,27,917	1,69,828	2,18,317
Average Trip Length including Induced Traffic on Normal Day (in km)	3.89	3.89	4.45	4.49
Daily Ridership on Mela (Poornima) Day	1,89,057	2,66,470	3,52,839	4,56,749
Average Trip Length for Mela (Poornima) Day (in km)	3.23	3.50	3.99	4.03
Weighted Average Daily Ridership with Induced Traffic	**1,03,712**	**1,56,387**	**2,07,433**	**2,67,310**
Weighted Average Trip Length with Induced Traffic (in km)	**3.75**	**3.81**	**4.36**	**4.40**

Note - *Weighted Average Daily Ridership of PRT system in Haridwar has been calculated by considering 75 Mela Days and 290 Normal Days in a Year.*

Chapter -3
Mode Selection

3.1 General

3.2 Benefits of PRT System

3.3 PRT System World Wide

3.4 Options for Public Transport System

3.5 Characteristics of Urban Transit System

3.6 Alternative Selection Norms in India

3.7 Selection of Mode

3.8 Conclusions

CHAPTER 3
MODE SELECTION

3.1 GENERAL

Personal Rapid Transit (PRT) is a contemporary form of public transport. It provides taxi-like demand responsive services for individuals or small groups of travellers. PRT is an efficient rapid transit system which provides the last mile connectivity to the users with a high level of reliability and comfort. It has small automated electric 'Pod cars' which are usually two, four or six passenger vehicles that run on a segregated guide way.

The following corridors are proposed for PRT system in Haridwar City.

Table 3-1 Proposed PRT Corridors in Haridwar City

S. No.	PRT Corridors		Route Length (km)	Station Detail
1	Corridor 1	Sitapur to Bharat Mata Temple	14.55	14 Stations including two interchanges
2	Corridor 2	City Hospital to Daksh Temple	3.10	4 Stations including Two interchanges
3	Corridor 3	Valmiki Chowk to Laltaro Bridge.	0.69	1 Station including one interchange
4	Corridor 4	Ganeshpuram to DAV School	2.40	2 Stations including one interchange
Total			**20.74**	21 Stations including all interchanges

3.2 BENEFITS OF PRT SYSTEM

PRT is gaining popularity around the world for its uninterrupted, efficient and sustainable journey between origin and destination. It is a lightweight system and it incurs lesser capital cost as compared to other public transport systems. PRT stations are off line stations that ensure non-stop point to point service.

PRT can be introduced in a city or an area in various forms. It works most efficiently in a system of small loops. These loops may be around a mass transit line and PRT may act as a feeder to the mass transit. A feeder system not only provides easy access to the transit users but also induces latent demand to the transit.

PRT can be integrated with the transit directly at the platform level which is not possible with any other mode. PRT can also work as a standalone network to serve the demand in a

particular area. The stations of a PRT system are usually closely spaced to provide high level of accessibility. It is commonly marketed as a comfortable mode which provides the last mile connectivity to the user with negligible waiting time.

3.3 PRT SYSTEM WORLD WIDE

The concept of PRT was introduced in 1953 by Don Fichter who conducted a research on alternative transportation methods. An operational PRT system was first introduced in 1975 in West Virginia University in Morgantown, USA. It connects three campuses of West Virginia University. It is also known as Automated Group Rapid Transit system. There is some disagreement whether Morgantown system is a true PRT system or not. This is because it has a capacity to hold 21 person (8 seated & rest standing), which is large in comparison to most PRT concepts. It is also known as Morgantown People mover (MPM). The total length of this system is 13.2 km.

PRT got real momentum only after 2011 when PRT operations began at Heathrow Airport Terminal 5. Since then, the world has realized the potentials of PRT system and it is now being considered for public transport planning studies in various cities around the world. As of 2014, only two modern PRT systems were operational worldwide. Since 2010 a 13-vehicle 2getthere system at Masdar City, UAE, and since 2011 a 21-vehicle Ultra PRT system at London Heathrow Airport has been operational. The route length of the first phase of Masdar PRT and Heathrow PRT is 1.5 km and 3.8 km long respectively.

3.3.1 MRT System in India

India is experiencing a rapid growth in both population and rate of urbanisation. Travel demand is increasing by 5% annually on average, leading to sharp increase in personal vehicles and overwhelming the limited transport infrastructure. A need was therefore felt to develop mass rapid transit systems in metro cities of India to reduce the burden on normal railways as well as road transport service providers. Major cities were facing a situation of rising population and increasing vehicles which had led to problems like congestion and pollution. To overcome these problems, Indian Cities took the initiative towards development of urban mass transit system by starting metro rail. Metro rail systems are operational in Delhi, Kolkata, Bangalore Jaipur, Chennai, Mumbai, Kochi, Lucknow, Hyderabad, Noida-Greater Noida, Nagpurand Metro projects are now being executed in many other cities of India. Some of the images of metro rails are given below.

Delhi Metro

Kolkata Metro

Chennai Metro

Jaipur Metro

Figure 3-1: Some of the Metro Systems in India

3.4 OPTIONS FOR PUBLIC TRANSPORT SYSTEM

The following systems are mainly available for Urban Transit System:

(i) **Metro System:** Metro system is a grade separated dedicated system for high peak hour traffic densities. It is characterized by short inter-station distance of about 1 km, high acceleration and declaration and average speed of 30-35 kmph.

(ii) **Light Rail Transit:** These are the Modern trams - street cars running on rails at grade or elevated with sharp curves up to 24m radius. These are extremely popular and operating in large number of European countries. Generally, the stations are spaced at 500m to 1 km and have high acceleration and deceleration characteristics. In most of the countries, they are operating at-grade with prioritized signalling at road inter-section.

(iii) Other **Rail Based Systems:** A number of options are available but have not been introduced in India. Some of these are very briefly mentioned below:

- **Maglev:** This is an advanced Rail based transit system in which Magnetic Levitation is used to raise the vehicles above the rail surface. Rail wheel interaction is thus avoided and very

high speeds are attainable. Maglev Levitation can either be due to attractive force or due to repulsive forces.

- **Linear Induction Motor (LIM) Train:** This is also an advanced Rail based transit system in which propulsion is through a Linear Induction Motor whose stator is spread along the track. The rotor is a magnetic material provided in the under frame of train. In the technology the tractive force is not transmitted through rail-wheel interaction, and so there is no limitation on account of adhesion. This technology is most appropriate for tunnels, as the height of the tunnel can be reduced to lower height of cars.

(iv) Monorail**:** Monorail trains operate on grade separated dedicated corridors with sharp curves of up to 50m radius. This is a rubber tyred based rolling stock, electrically propelled on concrete beams known as guide-ways. The system is extremely suitable in narrow corridors as it requires minimum right of way on existing roads and permits light and air and is more environment friendly. This is prevalent only in few countries. Experience of Mono Rail in India has not been satisfactory.

(v) **Bus** Rapid **Transit System:** This system involves operation of buses on a dedicated corridor (except road intersections) at a high frequency to achieve PHPDT.

For providing a very high transport capacity say 20,000 PHPDT, about 200 bus trips will be required per hour i.e., at headway of 20 seconds. Such a high PHPDT can be achieved by providing two lanes of traffic in each direction and elimination of traffic intersection on the route. Other way may be to go for grade separated elevated bus service. Some of the photos of electric bus are given as under.

(vi) **Automated Guide way Transit System:** The term is used for systems other than conventional rail based system on grade separated guide ways. The system can be rail based or rubber tyre based but fully automated guided systems with driver less operation.

(vii) **Personal Rapid Transit (PRT) System:** Personal Rapid Transit or PRT is on demand, advance, non-stop, environmentally viable origin to destination service, which consist of small and automatic vehicles running over small and exclusive use guideways. It is a state of art amalgamation of automotive, computer, network and transit technologies. PRT system comprises the attributes of a personal car and has a very low environmental impact. This system constitutes of small, lightweight, fully automatic, individually controlled and electrically driven vehicles (known as “pods”) which run along the dedicated guideways situated on, above or beneath street levels. PRT network consists of interconnected loops and offline stations, making non-stop travel possible between any two stations and provide last mile connectivity to users. PRT guideways are light weighted and don’t acquire much space for construction. Stations can be customized to fit in specific area and can also be integrated into new buildings.

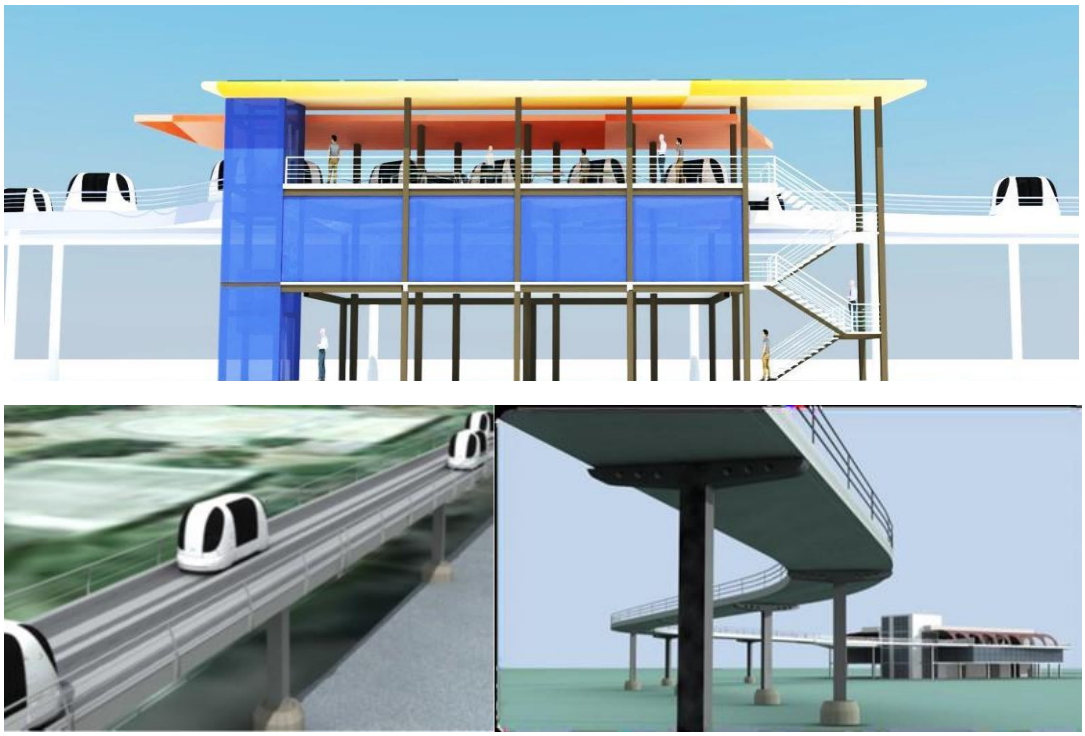


Figure 3-2: PRT System

3.5 CHARACTERISTICS OF URBAN TRANSIT SYSTEM

3.5.1 Transport Capacity

It is product of passenger carrying capacity of a train and maximum permissible frequency of operation. The passenger carrying capacity is determined by number of cars (units/ coaches), which can be clubbed to form a train and dimensions of each car. To compare different systems uniform packing density is considered although for different systems different crush loading may be permissible. The passenger carrying capacity is dependent on the following:

- **Dimensions of vehicle:** Length and breadth- useful area. The car length varies from about 9m to 24m for most of the systems. The width varies from 2.5m to 3.6m.
- **Passengers per sq. m:** The normal to crush loading of most systems varies from 4 to 7 passengers per m^2.
- **No of Cars per train:** The cars can be from 1 to 15 for most of the systems and the train length can be up to 315m.

Table 3-2 Comparison of Different Types of Mass Rapid Systems

Parameter	Heavy Metro	Medium Metro	Light Metro	LRT/ Metrolite	Electric Bus	PRT
Axle Load	17 T	16T	11T to 12T	12 T	10 T	1.5T
PHPDT range	More than 45000	More than 25000 and up to 45000	Up to 30000	More than 2000 and up to 15000	Up to 8000	Up to 10000

Parameter	Heavy Metro	Medium Metro	Light Metro	LRT/ Metrolite	Electric Bus	PRT
Number of cars	6 cars or more	4 to 6 cars	3 to 4 cars	3 to 9 units /cars train	Electric Bus	Pods
Car dimensions	2.9 m - 3.2 m wide, 22 m long	2.9 m - 3.2 m wide, 22 m long	2.65 m - 2.9 m wide, 22-23 m long	2.5 m to 2.65 m wide, length 11-12 m and unit length 33 m	Length 24 m, width 2.5 m	Length 3.7 m, width 1.47 m, height 1.8 m
Car capacity	300 persons per car	300 persons per car	300 persons per car	300 per train	150 per bus	6 persons/ pod
Viaduct particulars	Box Girder/ U-Girder/ double U-Girder/ I-Girder	Box Girder/ U-Girder/ double U-Girder /I-Girder	Box Girder/ U-Girder/ double U Girder /I-Girder	Box Girder/ U-Girder/ I- Girder	Box Girder/ U-Girder/ I-Girder	Steel Structure
Length of platform required	185 m to 210 m	140 m	80 m	50- 80 m	50 m	21m (4 Berth Station & 2 Sleeping Pod Bay)
CAPEX/km (Approx. ₹)	250 Crore	225 Crore	175 Crore	120 Crore	80 Crore	70 Crore
O&M/km	Depends on No. of passengers carried/ day and number of train trips.					
Deck width of viaduct	9 m to 10 m	8.5 m to 9.0 m	7.0 m to 8.5 m	7.0 m to 8.5 m	7.0 m to 8.5 m	4.2 m
Distance between pillars	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	25 m to 37 m span	18 m span
Speed (Maximum)	85 kmph	85 kmph	85 kmph	60 kmph	50 kmph	100 kmph

3.5.2 Need for a Grade Separated Transit System

Grade separation in transit system is required at following situations:

- A large number of intersection points
- High vehicular density
- Excessive congestion and delays on the corridors, especially during peak hours
- As the corridors are normally following busy areas of the city, it is not easy to find the required areas for depots, workshops.

Additional capacity needs to be created on the corridors to accommodate more traffic on the roads. Mere re-allocation of road space to provide for dedicated bus lanes for public transport may not serve the purpose due to presence of large number of private vehicles, which will continue to operate, and whose numbers will continue to rise.

Further presence of large number of intersection points will severely restrict speed of operation of public transit system employing dedicated lanes. Considering projections of travel demand on these corridors it is essential to provide grade separated transit system for these corridors.

In view of levels of services that will be required to meet the travel demand on the corridors, a fixed guide way, grade separated system may be preferable.

3.6 ALTERNATIVE SELECTION NORMS IN INDIA

Metro Rail Policy (2017) and the Appraisal Guidelines for Metro Rail Project Proposals (September, 2017) issued by Government of India Ministry of Housing and Urban Affairs (MOHUA) mandates compulsory incorporation of Alternatives Analysis in the Detailed Project Report of metro rail for submitting the same to the central government while seeking central assistance.

Guidelines for adoption of various modes – During 12th Five Year Plan, a Group were formed to study various types of modes and lay down the criteria for their adoption. This Group has recommended the PHPDT and other parameters for various modes as given below:

Table 3-3 Mode Selection Criteria Recommended by Working Group on Urban Transport for 12th Five Year Plan

Mode Choice	PHPDT in 2021	Population as per 2011 Census (in million)	Average Trip Length (km)
Metro	More than 15000 in 5 Km. stretch	More than, equal to 2	More than 7-8
LRT at grade	Less than, equal to 10000	More than 1	More than 7-8
Mono Rail	Less than, equal to 10000	More than 2	About 5-6
BRT	4000-20000	More than 1	More than 5
Org. City Bus		>1 Lac, 50000 in case of hilly towns	>2 to 3

However, the above recommendations are only for guidance and the decision has to be taken case to case based on techno-economic factors.

3.7 SELECTION OF MODE

Based on the Alternatives Analysis Study Report for two Corridors in Dehradun city and Corridors connecting Dehradun, Haridwar and Rishikesh as per Comprehensive Mobility Plan for the Metropolitan Area, Final Report, January, 2019 prepared by M/s UMTC, the screening was done for the selection of Alternative corridor and transit system based on the parameters selected in accordance with the principles of Metro Rail Policy 2017. The screening parameters are described in the table below.

3.7.1 Evaluation Parameters of Alternative Transit Systems

The evaluation parameters for the second level screening are based on

- Mobility Effects
- Engineering Effects
- Social and Environmental
- Costing and Financial

Table 3-4 Screening Parameters for Selection of Corridor and Transit System

Screening Level	Criteria
Screening for Corridor	Right of way (RoW)
	Coverage
	Number of Bridges
	Impact on Intermodal Connectivity
Screening for Transit System	**Mobility/ Travel Demand**
	Max Capacity of System (PHPDT)
	RoW required for the system
	Area occupied by stations
	Average operating speed
	Opportunity of Intermodal integration
	Headway (min)
	Influenced by Topography
	Engineering and design characteristics
	Utility Shifting Required
	Ease of construction
	Time for Implementation
	Safety
	Comfort
	LA required (Stations and Pillar)
	Environmental and Social Impacts
	Level of Persons Affected
	Reduction in road accidents
	Construction Phase
	Cost Estimate Financial Analysis
	Project Cost Estimate
	Operation and Maintenance Cost

Source: The Alternatives Analysis Study Report, Dehradun, Haridwar and Rishikesh as per Comprehensive Mobility Plan for the Metropolitan Area, Final Report, January, 2019 prepared by M/s UMTC

3.8 CONCLUSIONS

The screening has been done and concluded that PRT is the most suitable mode of transport for the second order transit system in Haridwar.

Chapter -4
Geometric Designing & Civil Engineering (PRT)

4.1 General

4.2 Planning and Design

4.3 Station design

4.4 Track Alignment and Guideway

4.5 Description of Route Alignment of PRT Corridors

4.6 Road Width Required during Construction

4.7 Geo-Technical Investigations

4.8 Land

4.9 Utility Diversions

4.10 Issues Related to Interface with External Agencies

4.11 Traffic Diversion

CHAPTER 4
GEOMETRIC DESIGN & CIVIL ENGINEERING

4.1 GENERAL

This chapter deals with planning, design, civil elevated structure, station design, Geotechnical investigation, construction methods, land requirements, Utility services and Traffic diversion during construction etc.

4.2 PLANNING AND DESIGN

4.2.1 Planning

Mobility and accessibility in particular, is an important element for people in the selection of their housing or place of work. Hence PRT system will be an integral part of the urban planning. The PRT network needs to be planned to provide the required capacity, while also minimizing its footprint to ensure space can be used for other activities. To be able to ensure the throughput of PRT system, avoiding the congestion on 'normal' roads and avoiding using the space at grade, leaving it for other activities such as walking, for other modes of traffic, parks etc. should be considered. PRT system requires a dedicated, grade-separated infrastructure (guideway). For PRT the popular choice is an elevated infrastructure, a result of the costs of underground installation and working within existing spatial planning in build-up areas. The elevated infrastructure ensures that many locations are easily reached. The design of the infrastructure is a vital element to ensure the width and visual intrusion are minimized. One clear aspect needing to be addressed is the accessibility of the stations. Where cars (and bikes) provide door-to-door transit (if parking is available at both origin and destination), the best effort for PRT requires a network with a high station density. Walking distances should be kept relatively small to improve the accessibility and the network will become more attractive to use for people in the catchment area of a station. This could impact the costs of the network, as stations are not located at grade.

4.2.2 Design

The transit system is one of many elements within a city, with each element influencing and being influenced by all of the other elements. The PRT network needs to take into account that:

- Stations need to be featured near main attractors of traffic,
- Stations need to be spaced such that the walking distance is minimized,
- The exact location for a station is based on the space available at each location,
- The routes may be restricted by the current spatial planning,

- PRT tracks should preferably be one way,
- The junctions of the PRT network should preferably allow only merge/diverge maneuvers,
- On- and off ramps are required near stations and at turns

The complexity in the design is matching the architectural needs of the city with the attraction of traffic to the characteristics of the PRT system. In parallel with the design of the route network, the locations of the PRT stations have to be determined, based on the requirement to ensure the maximum accessibility.

The construction of the guide way and the stations is a vital phase. Any problems for the public and the existing services taking place in the implementation environment should be minimized. This means flexibility is required: the ability to fit within the demanding space constraints and the ability for reconfiguration after installation.

Flexibility is an important issue in many developments. Cities are constantly changing and are subject to extensive and extended growth – especially in developing countries. Thus, the flexibility to easily reconfigure a transport system to meet new needs is vital. The basic design approach and small scale of PRT systems provide considerable flexibility. The disturbance to operations caused by major rebuilding programs is a fact of life for most applications, but nevertheless remains a major issue and is a significant negative factor for larger scale systems. By comparison disruption caused by PRT is minimal. This is due to the far smaller scale of the infrastructure which can be largely prefabricated as modules off-site. Although some small-scale ground works are inevitable the infrastructure as a whole can be installed in months. PRT offers the opportunity to alter column spacing with the same superstructure to overcome local ground features such as services, footways and roadways, and can operate on smaller radius curves so that fitting into existing built environments is more readily achieved.

The **modular construction** also allows elements to be removed and replaced within a short time (such as overnight) as part of route modification or extension. Stations are perhaps the more complex elements relative to the guide way. A station needs to accommodate the throughput expected, but can also be limited in its footprint and/or shape by the spatial planning in the area of realization. A ‘standard design’ for a PRT station (one-size-fits-all) is very unlikely and the stations most of the time will be designed to the surroundings. Although the need for multiple station designs can impact the design and construction costs, this is (partly) offset by being able to integrate the system in the most favorable location. Within stations there are different types of configurations, also dependent on the technology of the PRT system that also influences shape and size. Berths to allow arrival and departure of PRT PODs independently from each berth.

An important aspect to take into account is station access. With the guideway typically constructed on an elevated level, there is a requirement for either the track to come down or the stations to be constructed elevated as well. Because of the space constraints the spatial

planning in existing cities pose, bringing the track to grade level is typically not an option – the length of the guideway to reach ground level becomes restrictive of achieving this. Hence stations are constructed elevated, which means stairs, escalators and elevators need to be integrated – increasing the costs of the system. There are however opportunities to integrate the stations directly into buildings & pedestrian bridges. With the small cross section of the vehicles combined with low weight, the structural load can be easily accommodated on first or second floors in most buildings. Which means the existing stairs, escalators and elevators can also be used. For commercial buildings, this can generate similar store- front value to these upper floors as is often attributed today to the ground floor.

4.2.3 Structural Design Basis

The plans and longitudinal sections of the entire track alignment have been shown in the General Arrangement Drawings (GAD). Depending upon the availability of road width, median or side green, track alignment will run. Accordingly, the guideway supporting columns to be designed for tracks in the form of central column or of portal frame design.

- Easy Constructability: All the Components will have to be fabricated off-site and transported to site just for erection on the top of in-situ pre-constructed foundations, so that disturbance to the normal traffic is minimum.

Structural System: An overview of the typical structural system and the structural concept plan is given in Fig 4.1.

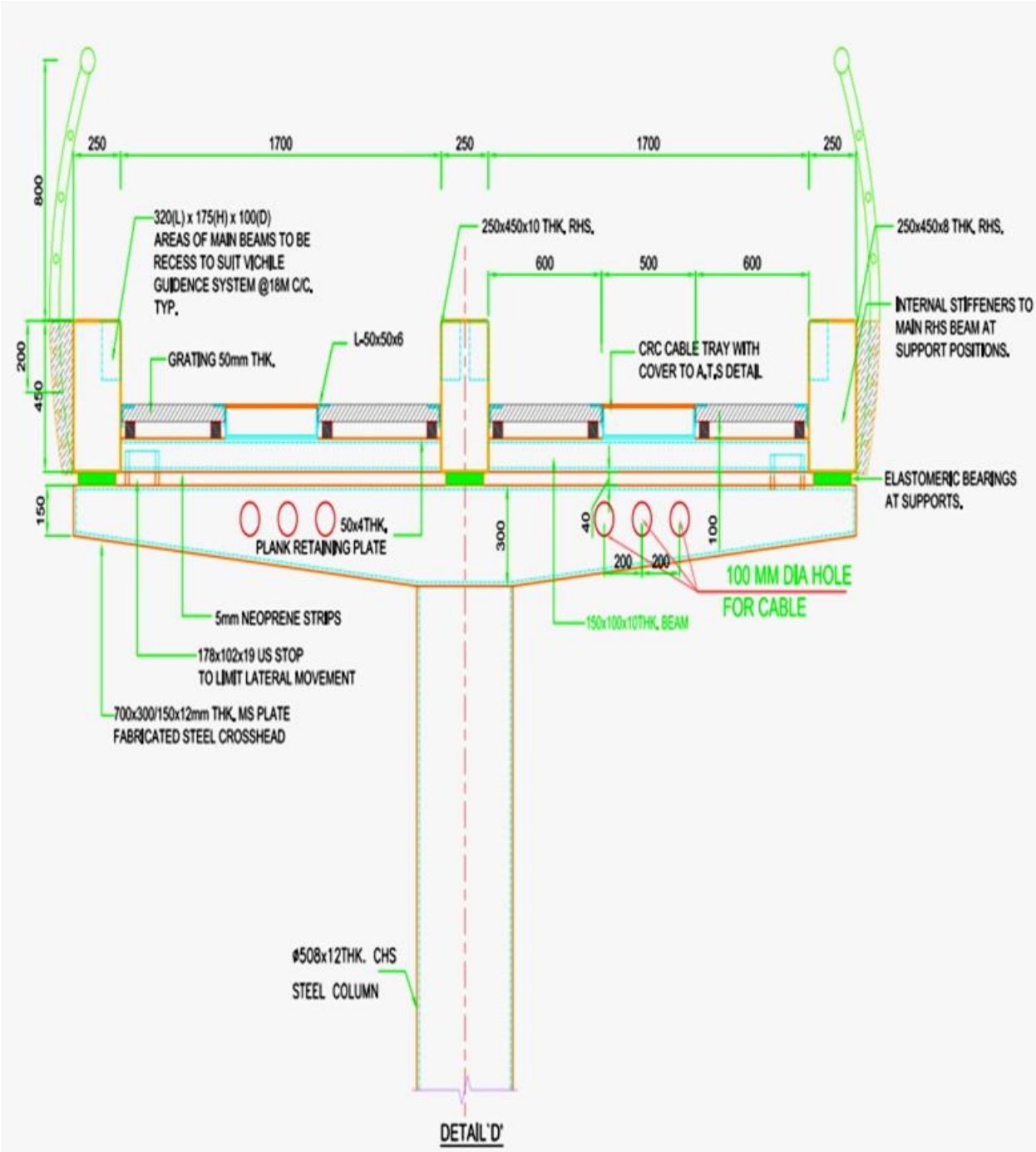


Figure 4-1: Typical Structural Details

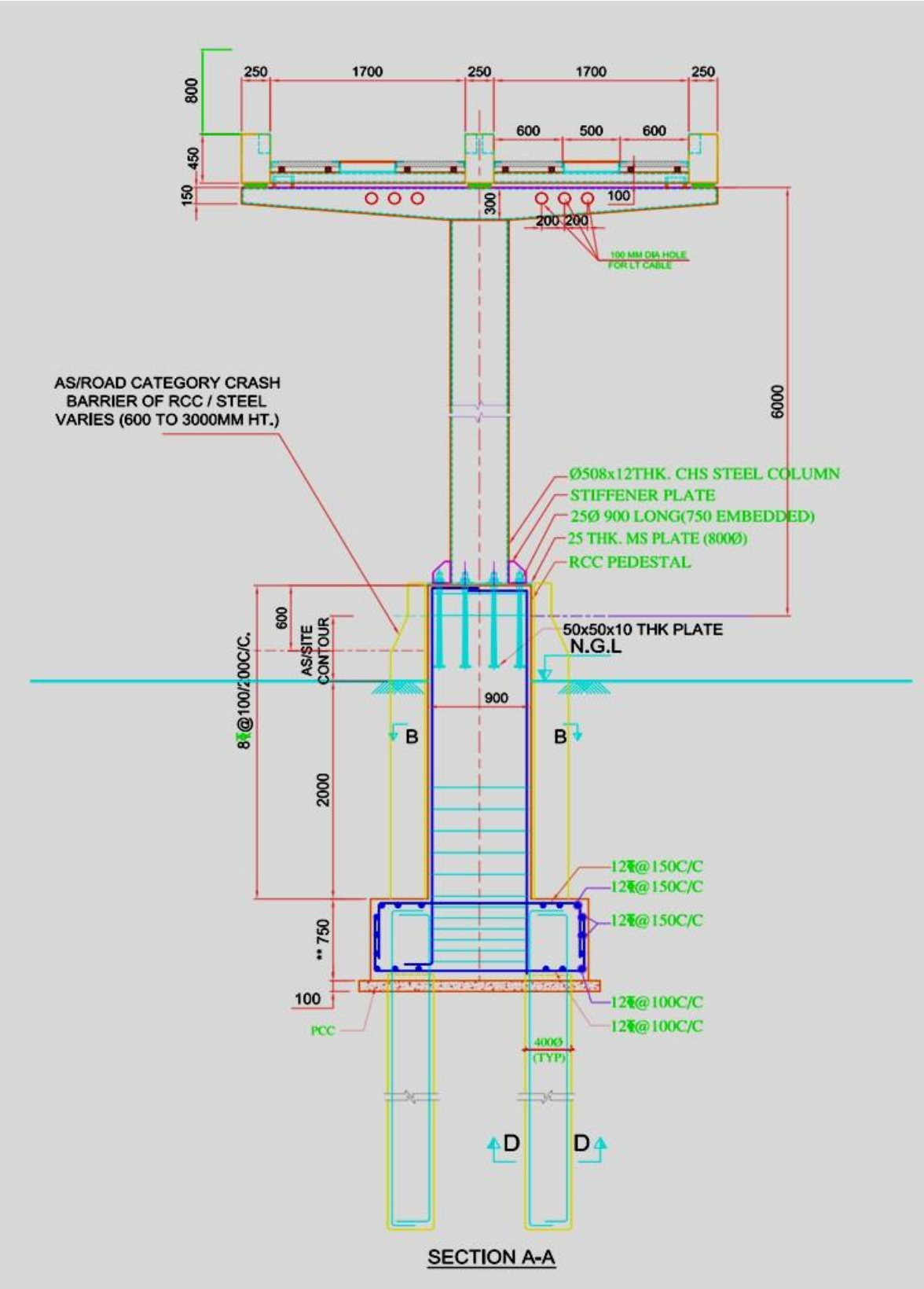


Figure 4-2: Typical Structural Details

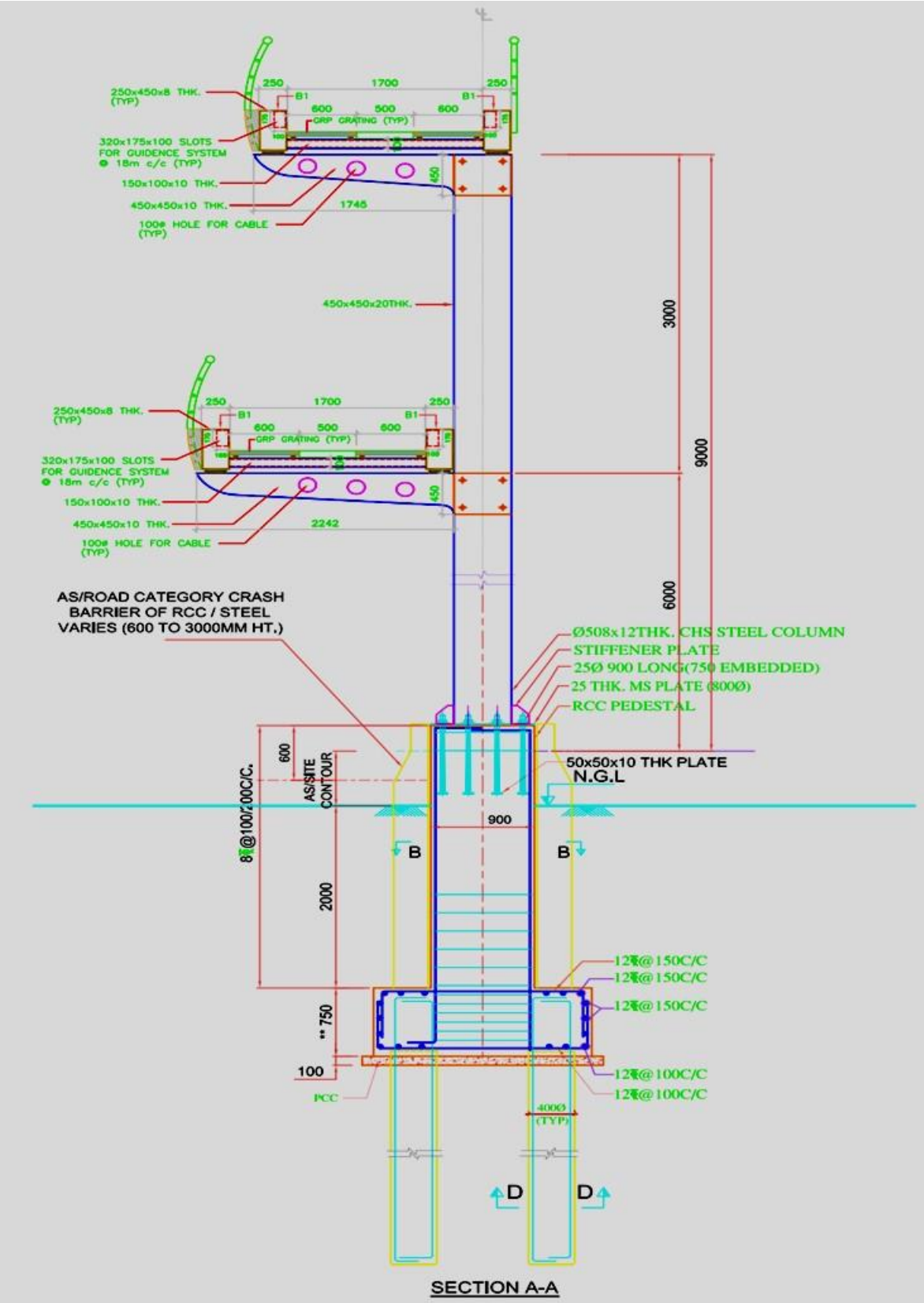


Figure 4-3: Typical Structural Details

4.3 STATION DESIGN

PRT Stations are critical elements in PRT systems and ensuring that station capacity matches demand with limited passenger waiting time is an essential part of the system design process and each station should be designed for its specific location and passenger throughput characteristics.

An essential feature of PRT stations is that these are located “off line”, vehicles destined for the station, leave the online track and utilize track dedicated to the station function. This design of station must deal with track and structures used for:

- deceleration from the Online track line speed,
- vehicle queuing,
- vehicle berth(s) aligned to provide access to the passenger boarding area,
- the passenger waiting/ boarding area,
- ticketing area
- staircases, escalators, elevators
- public amenities such as toilet & shops
- vehicle manoeuvring space to re-join station track,
- Acceleration to re-join the online track at line speed.

4.3.1 Station Track Configuration

The components of station track should include:

- turnout from Online track,
- deceleration track leading up to queue point and low speed vehicle maneuvering area,
- acceleration track, and
- merge track to re-join the online track

PRT systems use offline stations so that all vehicles can have very short headway. An Offline Station is a station which allows a vehicle to stop while other vehicles pass without stopping at PRT Stations

PRT stations are typically created off-line because of the number of vehicles and the short headways. For both off-line and on-line stations there are several standard designs that can be readily implemented.

All stations should be designed individually to ensure optimal integration within the local spatial

planning (space available) for that particular station.

The size (length and width), platform and track layout for each station will always be based on the capacity required, the traffic intensity expected and the desired image of the location. When capacity requires, a station can feature multiple (independent) berths – allowing for multiple vehicles being boarded at the same time, ensuring a higher throughput, eliminating single-point-of-failure vulnerability and thus increasing system availability.

Each station might have multiple berths, with perhaps one-third of the vehicles in a system being stored at stations waiting for passengers. Elevators and escalators have been provided for accessibility to the concourse level.

The nearest PRT station will be approximately 600-800 m away, so that the commuters can easily walk or bike there. To reach the platform level, passengers have to take stairs or elevator from the footpath level. They can buy the ticket or can use the smart card / Mobile apps. Further they need to feed the information for their destination and based on it the system programs the vehicle with your trip information.

Moving to the boarding turnstile, a vehicle is either waiting (empty pods would be lined up at stations until needed) or will arrive shortly, as the pod requirement button is pressed and the destination is fed in the system. As the passenger board the vehicle, the door closes, and the push button is pressed to signal that the passenger is ready to go. PRT offers a non-stop trip, which is faster and takes lesser time in reaching the desired destination. After finishing the first journey, the pod immediately becomes available for the next rider.

Stations may be located above, at, or below ground, or, due to the system's virtually silent nature, inside the buildings. Stations can be enclosed or open-air, will always provide at least a minimal covering above the berth area and are designed to be suitable for 24-hour operation.

4.3.2 Station Elements

The PRT Station design comprises the following elements:

- **Berth** - (vehicle docking point, interfaces, buffer + charging equipment). Berths are the docking point where the vehicles wait for the passengers and from where passenger can board the vehicle.
- **Passenger Interface** (at each berth): Destination selection console,
- **Plinth** (where required, raised floor for passenger level access to vehicles)
- **Envelope** (passenger weather protection + vehicle movement area segregation screen)
- **Canopy** passenger area roof + vehicle solar shading)

4.3.3 Station Details

The proposed Haridwar PRT system will comprise of 21 stations. The main purpose is to provide seamless connectivity across the city, commercial zones, Railway Station, Bus Stand, tourist places like Harki Pauri Mansa Devi Temple, Bharat Mata Temple, Daksh Temple etc. Total route lengths of 20.74km. PRT stations are located at major transit area with high footfall and are planned for to connect important tourist attractions at Haridwar. Stations are planned within the walkable distances for the passengers from their origin/destinations. Maintenance yard and a control room for the operation and maintenance of the full system are planned near Rishikul.

4.4 TRACK ALIGNMENT AND GUIDEWAY

PRT system uses a dedicated guide way, which can be constructed elevated, underground, embedded in buildings. The dedicated guide way ensures the congestion of normal city streets is avoided and supports system safety. PRT system uses a simple, completely flat guide way – comparable to normal roads. Optionally the track only consists of two asphalt rails (instead of paving the entire track width).

Standard elevated Guideway to be fabricated in steel would be 6 m to 9 m high with ramping up and ramping down depending on locations as and wherever required as non-standard ones. Online tracks bypass the stations without any turning by just moving to 10 mtr. Over the stations and station entry / exits happens at 6m. level.

Guideway will be of various designs, such as, single guideway, double guideway on single stack, single guideway with double stack, double guideway with double stack, triple guideway, triple guideway with double stack, etc. depending on site context. Broadly, both track at same level or tack above other track (F type) will commonly use along the entire route. F-type track will majorly be implemented on the single road (without a median) and will be placed on the side pathway. Apart from this all the track will be laid on the road median. The exact locations of placement of columns with various combinations would be worked out only after detailed engineering is finalized. However, in general the columns would be designed for standardized span length of 18 m to 20 m and non-standard spans would be used in the curved stretch and to clear any site-specific conflict.

Guideway supports will be of different types, namely, single column, double columns as portal frame, columns with cantilever support, etc. depending upon the road widths available, underground existing storm water and sewerage lines alignment and building projections etc.

To enable automated operations, passive reference points (magnets) are embedded in the road surface every 4 meters. There is no requirement for any physical guidance (rail) or other guiding infrastructure elements (kerbs and/or walls), making the system less vulnerable (more reliable) and ensuring reduced capital and maintenance costs.

Where spatial planning allows the track can be constructed at grade, realizing significant cost advantages and avoiding visual intrusion. Although the PRT system is equipped with obstacle detection systems to prevent collisions, people should be discouraged from entering the track as this will disturb operations.

PRT system allows for customization of (each section of) the guide way to achieve a natural fit with the environment. Typically, a PRT system will be build-up of multiple (intersecting) single lane loops. Depending on the area of operation, a section of a loop could be constructed elevated or at grade. Even though systems are engineered to maximize safety and reliability performance, the eventuality of evacuation should be taken into account.

The details of Horizontal and vertical curves if the PRT alignment are given at **Annexure - 4.1**

4.5 DESCRIPTION OF ROUTE ALIGNMENT OF PRT CORRIDORS

4.5.1 Corridor–1: Sitapur to Bharat Mata Temple

This Corridor is planned as fully elevated corridor starts from Sitapur runs along Jwalapur Road, Haridwar Main Road, Upper Road, Haridwar-Motichur Road, Haridwar – Rishikesh Road (NH 334) and Sapt Rishi Road and terminates at Bharat Mata Temple. The total length of the Corridor is 14.553 km with 14 stations.

The Corridor starts from Sitapur at Chainage (-) 29.900 where Sitapur station is planned off the road by the side of Roorkee - Haridwar Road (NH-334). The alignment takes right turn and crosses Ganga canal and align along the Jwalapur main road by taking right turn again and reaches Jwalapur where a second PRT station is planned at Chainage 398.6m. The alignment continues on Jwalapur main road for about 1 km and takes left turn and aligns along Haridwar main road runs by the side of railway line for about 200 m and take right turn and crosses the railway tracks at Chainage 1340 m and reaches Arya Nagar where a PRT station is planned at Chainage 1704.1m. The alignment continues to run along the median of Haridwar main road for about 5 km length and five PRT stations are planned in this stretch viz. Ram Nagar (Ch. 2762.6m), City Hospital (Ch. 3760.2m), Rishikul (Ch.4709.5m), Haridwar Railway Station (Ch.6119.5m) and Valmiki Chowk(Ch. 6781.2m). After Valmiki station, the alignment runs along upper road towards Har ki Pauri for about 1 km stretch and a station viz. Mansa Devi Ropeway gate is planned at Ch.7638.2m. Further, the alignment take a left turn and align along Haridwar-Motichur Road for about 3 km stretch where three PRT stations namely Har ki Pauri (Ch.8130.0m), Kharkhari (Ch. 9519.6m) and Motichur (Ch.10925.2m) are planned on this stretch. Thereafter the alignment reaches Haridwar – Rishikesh Road (NH 334) at Chainage 11200m and runs along the road for about 1.6 km (upto Ch.12 875 m) and take right turn and align along Sapt Rishi Road and run on this road for about 1.5 km. On this stretch two PRT stations are planned namely Shantikunj (Ch. 13278.4m) and Bharat mata Temple (Ch. 14382.4m). The Corridor terminates at Ch 14448.1m (dead end.)

4.5.2 Corridor–2: City Hospital to Daksh Temple

This Corridor is planned as fully elevated corridor starts at City Hospital and have interchange connectivity with Sitapur – Bharat Mata Temple PRT Corridor at this location runs along Bye pass road crosses Ganga canal and Roorkee - Haridwar Road (NH-334) and further runs along Bhairav Mandir Road, take left turn and runs along Jwalapur Road, take right turn and runs along Laksar Road, take further left turn and run along Gurubaksh Vihar Road and thereafter take right turn, runs along Daksh Mandir Road, and terminates near Daksh temple. The total length of the Corridor is 3.109 km with 4 stations.

The Corridor starts from City Hospital at Chainage 0.0 which is interchange Station. The alignment runs along Bye pass road crosses Ganga canal and Roorkee - Haridwar Road (NH-334) and further runs along Bhairav Mandir Road where a PRT station Viz Kankhal Chowk is planned at Chainage 598.4m. The alignment continues on this road upto Chainage 1030m and takes left turn to align along Jwalapur Road. A PRT station namely Kankhal is planned at Chainage 1127.8m. Thereafter alignment continues on Jwalapur Road upto Chainage 1215m and takes right turn towards Laksar Road. The alignment runs along this road for about 725 m i.e. upto Chainage 1940 m and thereafter further runs along Gurubaksh Vihar Road for about 930 m i.e. upto Chainage 2870m and take right turn and align along Daksh Mandir Road and terminates near Daksh Temple where a PRT terminal station namely Daksh temple is planned at Chainage3018.2m.The Corridor terminates at Ch. 3109.9m (dead end.)

4.5.3 Corridor–3: Valmiki Chowk to Laltaro Bridge

This Corridor is planned as fully elevated corridor starts at Valmiki Chowk and have interchange connectivity with Sitapur – Bharat Mata Temple PRT Corridor at this location The alignment starts at Valmiki Chowk runs towards Laltaro Bridge crosses Ganga canal and take left turn runs alongside of Roorkee - Haridwar Road (NH-334) and a off –road PRT station viz bridge is planned near parking area. This station is planned to be integrated with proposed Haridwar – Rishikesh Metrolite Corridor at this location. The total length of the Corridor /spur is 0.693 km with 1 PRT station.

4.5.4 Corridor–4: Ganeshpuram to DAV School

This Corridor is planned as fully elevated corridor starts at Ganeshpuram and has interchange connectivity with City Hospital –Daksh Temple PRT Corridor at this location. The alignment starts at Ganeshpuram runs along Laksar Road for about 2.3 km upto DAV school. On this stretch 2 PRT stations are planned namely Jagjeetpur and ‘DAV School ‘at Chainages 860.1m and 2275m respectively. The corridor terminates at Chainage 2379.3m. The total length of the Corridor /spur is 2.40 km with 2 PRT station.

Index plan showing the route alignment and station locations of above PRT corridors is given in Annexure 4.3.

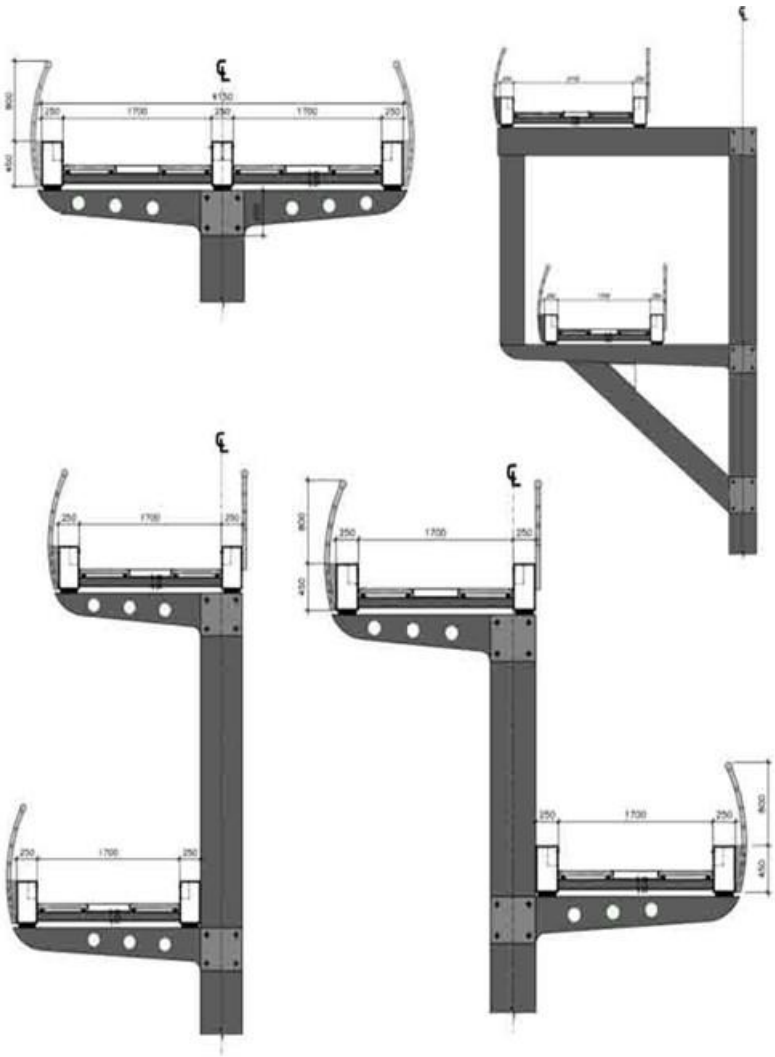


Figure 4-4 : Typical Guideway System – Sections

4.5.5 Some of the Typical Station views are given below

Figure 4-5 : PRT Station Elevation 1

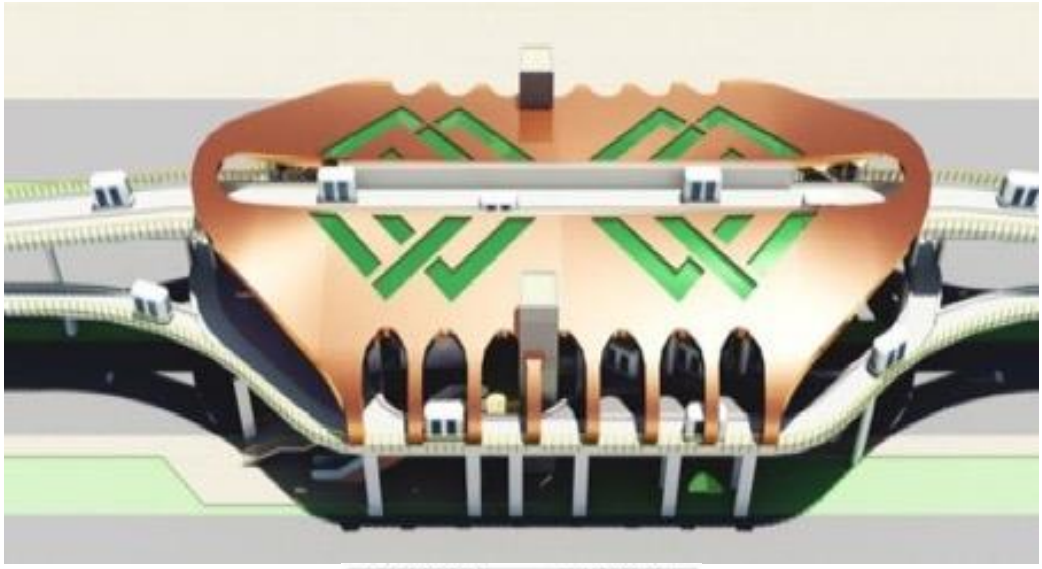
Figure 4-6: PRT Station Elevation 2

Figure 4-7: PRT Station Side Elevation

Figure 4-8 : Station Perspective

Figure 4-9: Station Perspective

Figure 4-10: Station Perspective



STATION AREA	= 390.94 SQM
POD PARKING	= 272.59 SQM
TRACK AREA	= 482.04 SQM
TOTAL AREA	= 1,145.57 SQM
ROOF AREA	= 1,315.69 SQM

Figure 4-11: Station Perspective

4.6 ROAD WIDTH REQUIRED DURING CONSTRUCTION

As most of the construction is to be carried out on the middle of the road, a width of about 5 to 7 m will be required for construction activities, during piling and open foundation work and the same will be barricaded. It is proposed that necessary traffic management plan during construction by diversion/rerouting of traffic, if necessary. In certain cases, one-way traffic may be resorted to.

The implementing agency has to take up the following preliminary works on priority to ensure no delay in implementing the project:

1. Preliminary action for diversion of utility and preparation of estimates thereof.
2. Reservation of land along the corridor, identification and survey for acquisition.

4.7 GEO-TECHNICAL INVESTIGATIONS

4.7.1 Methodology of Investigation

The investigation has been planned to obtain the subsurface stratification in the proposed project area and collect soil samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum to arrive at the foundation design parameters.

For Geotechnical investigation work, boring / drilling rig has been installed at the specified borehole locations. Stability of rig was ensured by making the ground level. Boring has been advanced by shell and auger method in soil and sampling carried out at regular interval in the bore hole.

The rig deployed was suitable for and had arrangement for boring, conducting Standard Penetration Test (SPT), collection of Undisturbed Soil Sample (UDS) and Disturbed Soil Samples (DS).

4.7.2 Standard Penetration Tests (SPT)

Standard Penetration Tests (SPT) are planned to be conducted at different depths in these bore holes. SPT split spoon sampler of standard dimensions has been driven into the soil from the borehole bottom using 63.5 kg hammer falling from 75 cm height. The SPT weight was mechanically lifted to the specified height and allowed to fall freely on the anvil with the use of cathead winch with one to one and half turn of the drum. The efficiency of the SPT blows is expected to be 65 to 75% in this system, and can be directly used in most of analyses involving “N” values.

Blow counts for the penetration of every 15 cm were recorded and the N is reported as the blow

counts for 30 cm penetration of the sampler leaving the first 15 cm penetration as seating driver.

When the number of blows exceeded 50 to penetrate the first or second 15 cm length of the sampler, the SPT N is regarded as more than 100 as described in IS 2131 – 1981. The test is terminated in such case and a record of penetration of the sampler under 50 blows is made. SPT refusal is recorded when there is no penetration of the sampler at any stage and also when a rebound of the sounding system is recorded. These tests were conducted at close intervals of 1.5m at shallow depths so that a continuous SPT N profile is available.

Geology

Geologically the area may be divided into three zones viz. Swales, Bhabar and Gangetic Alluvial Plains from North to South.

Siwalik Range: This forms the outermost part of Himalaya and comprises Tertiary Group of rocks. In Bhagwanpur block only Upper and Middle Siwaliks are exposed. The Upper Siwaliks is constituted of boulders, pebbles, sand and clay. The boulders and pebbles are mostly of quartzite's. Middle Siwaliks comprises mainly grey micaceous sandstone and siltstone. Older Alluvium (Piedmont Plains or Bhabar): The Piedmont Plains are formed along the foothills of Siwaliks. It is formed by flooding hill torrents and nallahs (locally termed as 'Rao'). Alluvial fans in the piedmont zones are wider and longer when formed along mature streams. The Older Alluvium consists of polycyclic sequence of brown to grey silt, clay with boulders and pebbles.

Soil Type

The northern part, paleochannels and active flood plain rivers have soils of sandy loam whereas remaining part of the block is covered by silty loam soils. Important soil is ultimo, which is the brown hill soil, occurring all through the northern part of the block. These are the soils with a horizon of clay accumulation and low base supply. Entisols are the soils (also called the Bhabar soil) occurring all along the foothills of Siwaliks and extends upto Tarai. These soils are without pedogenic horizons. Though these soils consist of boulders, pebble sand, silt and clay. Moll soils, also called the Tara soil, occur in the southern part of the block. They consist mainly offline- grained and, silt and clay.

4.7.3 Seismicity

The seismic hazard map of India was updated in 2002 by the Bureau of Indian Standards (BIS) as per IS:1893 (Part-1)-2002. The area under study and its surroundings are seismically active falls in Seismic Zone-IV. The Seismic map & recent earthquake map is as follows.

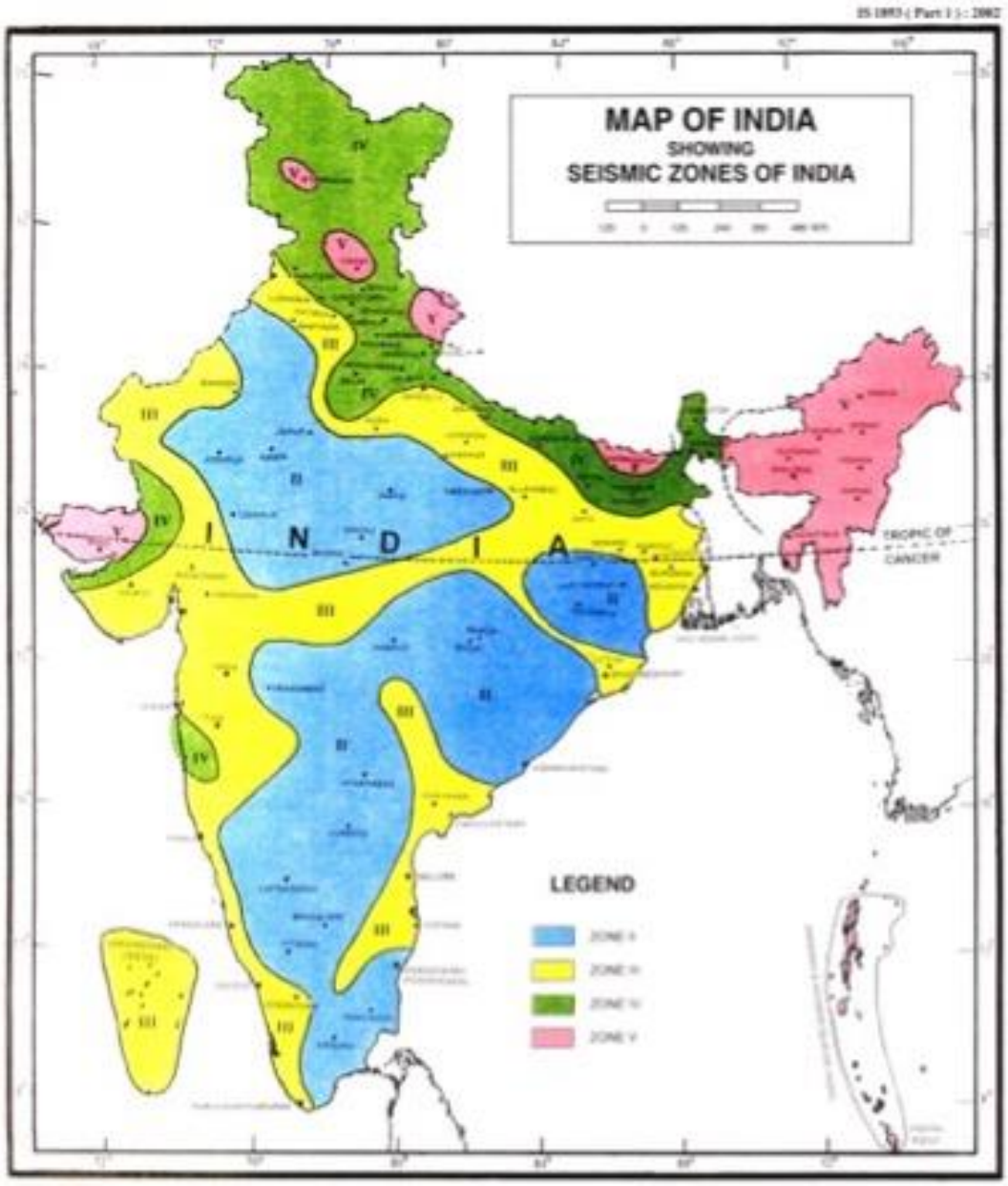


Figure 4-12: Seismic Zone of India (IS: 1893 (Part-I) -2002)

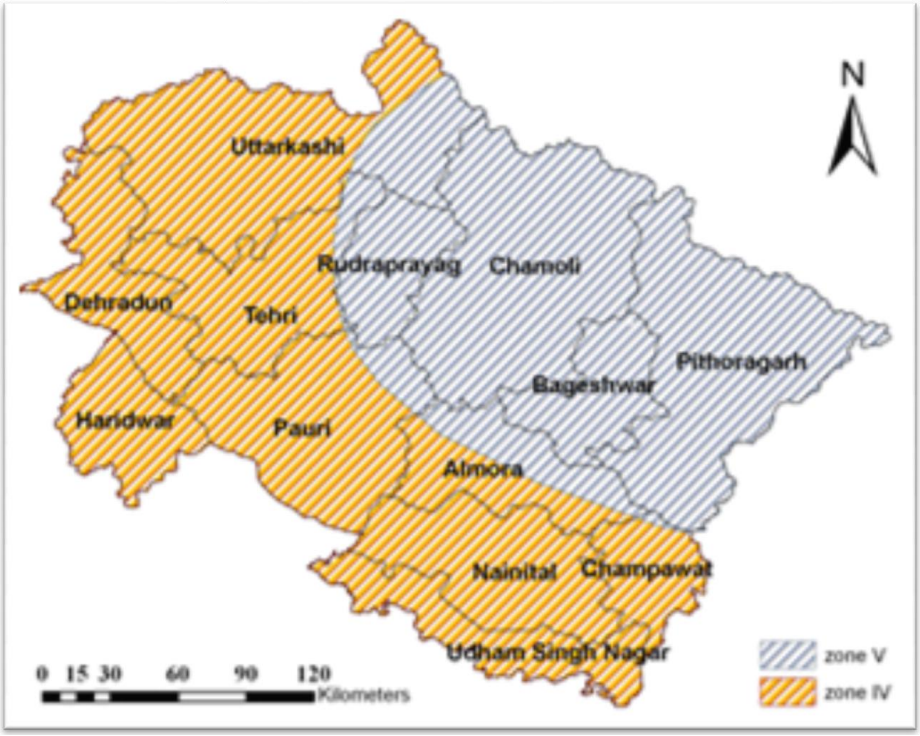


Figure 4-13: Seismic Map of Uttarakhand

4.7.4 Foundations

Type of Foundation: Details are given in Geotechnical Investigation Report.

4.7.5 Brief Detail of Geo-Technical Investigations

Twelve numbers of boreholes of diameter 150 mm were made within the proposed route alignment of the PRT project from (i) Sitapur to Bharat Mata Temple (ii) Perm Nagar to Daksh Temple & (iii) Ganeshpuram to DAV School. The boreholes were progressed using power driven rotary drilling machines. Where caving of the borehole occurred, casing was used to keep the borehole stable. The depth of borehole has been given in Geo-tech Report. The bore holes were started in 150 mm diameter in top soil stratum and then 75mm (NX size) in the rock mass or the refusal strata fully disintegrated rock mass. After getting the refusal in Standard penetration test and where the borehole could not be progressed even after using the chisels for displacing or breaking the gravels, bore holes were further progressed by using the diamond bits. The locations of boreholes have been reported in “TEST LOCATION PLAN”.

Standard Penetration Tests were conducted at every interval of1.50m or any change of strata as per the procedure in IS 2131-1981 in all the boreholes. For conducting the test, the bottom of the borehole was properly cleaned and split spoon sampler was properly seated in position in the borehole. The split spoon sampler resting on the bottom of borehole was allowed to sink under its own weight; then the sampler was allowed to penetrate 15 cm with the blows of the hammer 63.50 kg weight falling free through 75cm, thereafter the split spoon sampler was further driven by another 15 cm. For the 3rd and final drive, the sampler was further allowed to penetrate 15 cm. The number of blows required to affect each 15 cm of penetration was

recorded. The first 15 cm of drive is considered to be seating drive.

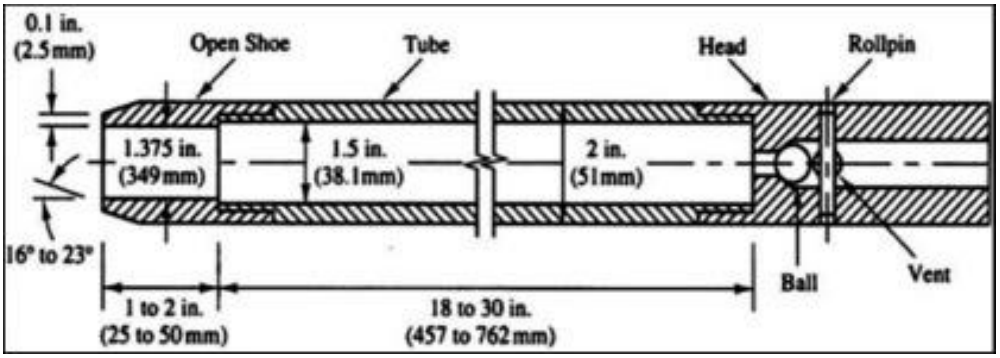


Figure 4-14: Structure of SPT Sampler

The total blows of penetration for the second and third 15 cm of penetration is termed the penetration resistance N. The N' values are indicative of the compactness/ relative density of cohesion less soils and consistency of cohesive soils.

In case the blows count of SPT in soil (including the number of blows of seating) exceeds 100, the corresponding penetration was recorded and this particular test at that depth stopped. If the total penetration is more than the seating penetration of 15 cm, then breakup of blows count for 15 cm seating penetration and for remaining portion of penetration is also given.

SPT 'N' values are correlated with relative of non-cohesive stratum as per BS: 5930 (1999) - for sandy strata and with consistency of cohesive stratum.

Table 4-1: Correlation for clay/Plastic silt

Correlation for Clay/ Plastic Silt		Correlation for Sand/ Non-Plastic Silt	
Consistency of clays	**Penetration Value**	**Relative Density of sand**	**Penetration Value**
Very Soft	0 to 2 Blows	Very loose	0 to 4 Blows
Soft	3 to 4 Blows	Loose	5 to 10 Blows
Medium Stiff	5 to 8 Blows	Medium	11 to 30 Blows
Stiff	9 to 16 Blows	Dense	31 to 50 Blows
Very Stiff	17 to 32 Blows	Very Dense	Above 50
Hard	Above 32		

In this method, the sampler acts as a probe and the driving energy is supplied by the fall of the drop weight. The values of 'N' depend on the compactness or relative density of the materiel. In hard formations, the testing is discontinued if 'N' value is found to be more than 100. It is termed as refusal.

'N' value depends upon degree of saturation and over burden pressure of the formation. Silty fine sand and fine sand below the water table develop pore water pressure depending on the in-situ void ratio, which in turn affects the effective stress. This change in effective stress influences the 'N' value considerably.

Terzaghi and peck have recommended a correction for 'N' values in case of saturated Silty and fine sand when the 'N' observed in the field is higher than 15.

Modified value 'N'= 15+ (N-15)/2.

Soil sample obtained from standard spoon sampler for all above standard penetration tests were collected in the polythene bags of suitable size. These samples were property seal, labelled, record and carefully transported to the laboratory for testing.

Disturbed soil samples were tried to be collected at every 1.5-meter interval and at significant change of stratum. Soils from cutting edge of SPT samplers and retained in split spoon sampler, used for Standard Penetration Tests was taken as disturbed samples. These samples were placed in polythene bags without delay and sealed adequately, where the disturbed soil samples could not be collected from SPT.

Undisturbed soil samples were tried to be collected in accordance with IS: 2132-1986. Undisturbed soil samples (UDS) were obtained at every 2.50 m and 5.00 meter in most of the boreholes, however the exact depth of UDS collection is given in Bore Log chart. Undisturbed samples were collected using 100 mm dia and 450 mm long MS tubes provided with sampler head with ball check arrangement. Collection of Undisturbed samples in very hard cohesive soils/ dense granular soils/gravels/ cobbles/ pebbles/ boulders, refusal strata are practically not possible and such collected samples will not truly represent the undisturbed conditions. Immediately after taking and undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the samples shall each be trimmed off any wet disturbed soil. The ends will then be coated alternately with four layers of just molten wax. More molten wax will then be added to give a total thickness of not less than 25mm.

Field permeability test have been conducted at specified location as per IS 5529 Part-1.

The depth of ground water table was carefully noted in the completed borehole. The ground water table in the borehole was allowed to stabilize and measured after 8, 16, 24 and 48 hours. It was ensured that last two reading were identical. The records of water table have been given in Geo-tech report.

Rock core recovered during the NX size (75mm dia.) rock drilling have been measured, numbered and packed in wooden core boxes. The Core Recovery (CR) and Rock Quality Designation (RQD) information have been reported in bore log charts.

Laboratory Tests

The following laboratory tests were conducted to determine the engineering characteristics of

sub-soils:

Natural moisture contents were determined by oven drying method as per IS 2720 (part II)-2010.

Dry and Bulk density of soil strata were obtained using Shelby tubes in accordance with IS 2720 (part XXIX)-1975.

Mechanical sieve analysis test was performed in accordance with IS 2720 (Part IV) 2010, for the purpose of identification by grain size analysis, on coarse part of the soil samples.

Particle size analysis test by hydrometer method were performed in accordance with IS 2720 (Part IV) - 1965 on the part of soil samples obtained after the sieve analysis.

Atterberg's limits tests were performed in accordance with IS 2720 (part V)-2010.

Specific gravity tests were performed in accordance with IS 2720 (part III-sec. 1) -2011.

Tri-axial Compression Test under Unconsolidated Un-drained (UU) as per IS: 2720 (Part-XI)-2011 were performed on the undisturbed soil samples obtained during the field investigation. Some of the tests have been conducted on the remoulded soil samples, where undisturbed soil samples could not be collected during the investigation.

Direct shear tests were performed as per IS 2720 (part XIII)-2016, on the undisturbed soil samples obtained during the field investigation only when the specimen soil sample could not be extracted. Some of the tests have been conducted on the remoulded soil samples, where undisturbed soil samples could not be collected during the investigation.

Density test for rock sample were performed in accordance with IS 13030-2016.

Hardness test of rock were performed in accordance with IS: 12608-1989.

Water absorption and Porosity test on rock samples were performed in accordance with IS: 1124-1974.

Chemical analysis on soil and water samples were performed in accordance with relevant standard.

4.7.6 Field Investigations

Field work for Geotechnical investigation for the proposed PRT corridors at Haridwar have been carried out during the period from 8thSeptember 2020 to13thOctober 2020. Preparation of Geo-technical report is completed. Based on these recommendations for foundation design are given in Geotechnical Investigation report.

Coordinates and Ground water

The water table at this site was encountered during the boring operation. Depth of water table was recorded as per IS 6935-1973. Recorded depths of water table in different boreholes are as under:

Table 4-2: Coordinates and Ground water table

Borehole No.	Locations	Coordinates		Depth of borehole (m)	Water Table (m)
		N	E		
BH-1	Har Ki Paudi (Near Sulabh Complex)	3274932.14	219194.13	30.00	13.50
BH-2	Bhim Goda, Khad Khadi	3275155.11	219257.21	30.00	9.50
BH-3	Dudha Dhari Chowk Bhupat Wala	3276294.40	219603.16	30.00	7.00
BH-4	Sapt Rishi Chungi Marg (Shanti Kunj, Haridwar)	3276294.40	219603.16	12.00	4.00
BH-5	Bharat Mata Mandir	3276891.10	220380.10	27.00	10.00
BH-7	Chandra Charya Chowk (Near Over Head Tank)	3273105.87	217141.48	27.00	8.50
BH-8	Y.M.P.B. Hospital Laksar Road	3272793.50	217174.56	27.00	12.00
BH-9	Bharat Vihar Laksar Road (NTPC Colony Road)	3272502.20	217208.27	24.00	10.00
BH-10	Shivedale School (Jagjeet Pur, Laksar Road)	3271757.42	217045.19	27.00	12.00
BH-11	D.A.V. School (Jag Jeet Pur, Laksar Road) Near Police Chowki	3271498.94	216630.16	30.00	7.50
BH-12	Sita Pur(Near Pink Bridge)	3272624.40	215275.88	30.00	7.50
BH-13	Durga Chowk Jwala Pur	3272707.38	215530.48	27.00	7.50

4.7.7 Details of Soil & Rock Strata

The classification of soil strata has been done with the help of soil characteristics obtained in laboratory tests as per IS 1498-1978. The description of rock masses has been made as per IS: 13665 (part-1)-1998.

4.7.8 Classification Criteria of Rock Masses

Rock classification in terms of weathering and state of fractures and strength is carried out in the following manner. Tabulations given in below explain it briefly.

Table 4-3: Classification Criteria of Rock Masses

Terms	Description	Grade	Geologist Interpretation
Fresh	No visible sign of rock material weathering; perhaps slight coloration on major discontinuity surfaces	I	CR > 90 %
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discoloured by weathering.	II	CR between 70 % to 90 %
Moderately Weathered	Less than half of the rock material is decomposed or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as core-stones.	III	CR between 51 % to 70 %
Highly Weathered	More than half of the rock material is decomposed or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as core-stones.	IV	CR between 11 % to 50 %
Completely weathered	All rock material is decomposed and / or disintegrated to soil. The original mass structure is still largely intact.	V	CR between zero to 10 %
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI	CR = Zero % But N > 50

CR indicates Core Recovery

As per IS 4464, It should be understood that all grades of weathering may not be seen in a given rock mass and that in some cases a particular grade may be present to a very small extent. Distribution of the various weathering grades of rock material in the rock mass may be related to the porosity of the rock material and the presence of open discontinuities of all types in the rock mass.

Relation between RQD and In-situ Rock quality is further measured by frequency of natural joints in rock mass. Rock Quality Designation (RQD) is used to define state of fractures or massiveness of rock. Following table defines the quality of rock mass.

Table 4-4: Classification of RQD

RQD classification	RQD %
Excellent	91 to 100
Good	76 to 90
Fair	51-75
Poor	25-50
Very Poor	0-25

Table 4-5: Classification of Rock by Compressive Strength

Rock type	Unconfined compressive strength in MPa
Extremely strong	>200
Very Strong	100 to 200
Strong	50 to 100
Moderately Strong	12.5 to 50
Moderately Weak	5 to 12.5
Weak	1.25 to 5
Very weak	<1.25

4.7.9 Calculations and Results

A suitable foundation for any structure should have an adequate factor of safety against exceeding the bearing capacity of the supporting soils. Also, the vertical movements due to compression of the soils should be within tolerable limits for the structure. We consider that foundation designed in accordance with the recommendations given herein will satisfy these criteria.

RCC bored cast-in-situ piles may be used to support the structural loads of proposed viaduct / stations in the elevated section. The details are provided in geotechnical investigation Reports.

Table 4-6: Recommended Foundation Type

Alignment	Section	Boreholes	Recommended Foundation Type
Corridor 1- Sitapur to Bharat mata Temple Corridor 2 – City hospital to Daksh Temple Corridor 3 – Valmiki Chowk to Laltaro Bridge Corridor 4 – Ganeshpuram to DAV School	Elevated	BH-1 to BH-12	Pile Foundations may be provided for the proposed PRT track & Stations. (Details are provided in Geotechnical Investigation report)

4.7.10 Safe Pile Capacity

Pile foundation shall be provided for the proposed structure. The depth and corresponding safe bearing capacity shall be given in table below:

Table 4-7: Safe Pile Capacities

Borehole	Pile Diameter(mm)	Length of Pile (m)	Safe Vertical Load Carrying capacity in (Tonne)	Recommended Vertical Safe Load Carrying capacity in (Tonne)	Safe Horizontal Load Carrying capacity in (Tonne)	Recommended Vertical Safe Load Carrying capacity in (Tonne)
BH-1	1200	15.0	160	160	44	40
BH-2	1200	15.0	160	160	44	40
BH-3	1200	12.0	150	150	44	40
		15.0	200	200	44	40
BH-4	1200	12.0	150	150	44	40
		15.0	210	200	44	40
BH-5	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-7	1200	12.0	153	150	44	40

Borehole	Pile Diameter(mm)	Length of Pile (m)	Safe Vertical Load Carrying capacity in (Tonne)	Recommended Vertical Safe Load Carrying capacity in (Tonne)	Safe Horizontal Load Carrying capacity in (Tonne)	Recommended Vertical Safe Load Carrying capacity in (Tonne)
		15.0	210	200	44	40
BH-8	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-9	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-10	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-11	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-12	1200	12.0	153	150	44	40
		15.0	210	200	44	40
BH-13	1200	12.0	153	150	44	40
		15.0	210	200	44	40

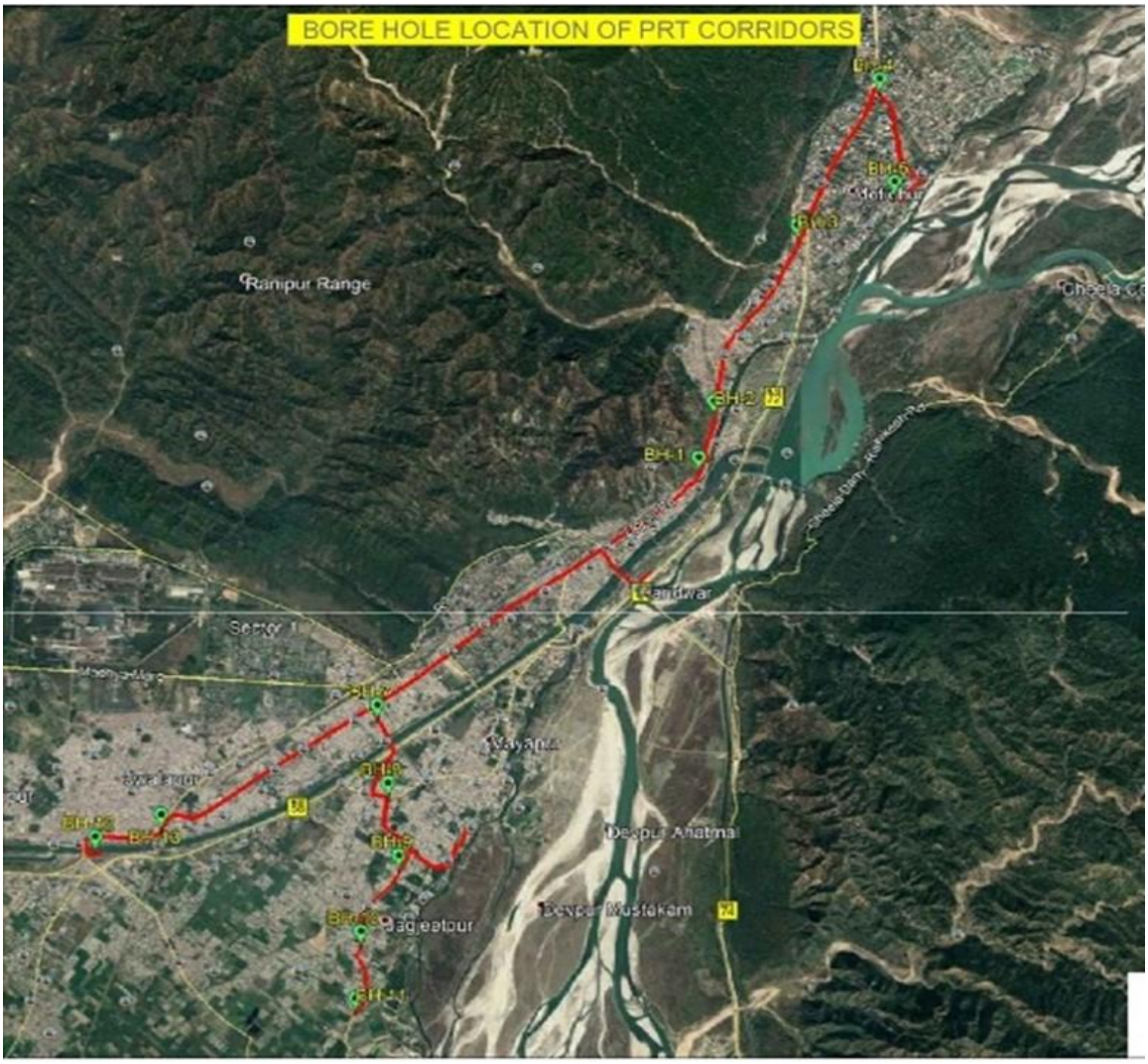


Figure 4-15: Borehole's Location Plan for PRT Corridors

4.8 LAND

In order to minimise land acquisitions and to provide good accessibility form either directions, the PRT alignment is located mostly along the centre of the roads, which lie on the corridor. But, at some locations the geometrics of the roads especially at road turnings may not match with geometric parameters required for PRT systems. In such cases, either the alignment will be off the road or some properties abutting the road would get affected. Further, some land is required for various purposes as detailed below:

4.8.1 Land Requirement for following Major Components

- PRT Structure (including Route Alignment), Station Building, Platforms, Entry/Exit Structures, Traffic Integration Facilities, Depots, etc.
- Temporary Construction Depots and work sites.
- Maintenance Depot and operation control center (OCC)

4.8.2 Land required for elevated stretches

For elevated section, single steel column supporting the steel girders will be located on the middle of road so that the existing roads remain in use as usual. Accordingly, necessary permission for using such right-of-way will have to be obtained from the concerned authorities. Land is required mainly for locating the entry/exit structures Maintenance Depot. Traffic integration facilities are provided wherever the same are required.

The normal viaduct structure of PRT is about 4.2 m (edge to edge) wide. However, for reasons of safety a clean marginal distance / setback of about 3m is necessary from either edge of the viaduct (or 5.0 m on both sides of the centre line) wherein no structures are to be located. Also, it ensures road access and working space all along the viaduct for working of emergency equipment and fire brigade. In stretches, where the elevated alignment has to be located away from road, acquisition is proposed only for pier locations.

4.8.3 Land for Traffic Integration

Certain land is required for traffic integration at PRT stations integrating with other transport systems or having major crowd due to tourists/visitors like Har-Ki-Pauri etc. Hence land for traffic integration has been proposed based on the availability.

4.8.4 Land Requirement for Stations & Running Section

As indicated earlier, the ROW of the roads along which the alignment is planned is sufficiently wide and hence no land is required for acquisition as long as the alignment is in the centre of the road. However, at curved portions, the alignment could not be kept in the centre of the road and land acquisition at such locations is inevitable.

To the extent possible the Entry and Exit points of stations were planned on the footpaths.

The details of land permanently required for depot, running sections, stations, ramp, parking, property development etc. are indicated in the Tables below.

Table 4-8: Details of land required for stations

S. No.	Stations	Code	Land Area (sq. m)	Ownership	Remarks
Sitapur to Bharat Mata Temple					
1	Sitapur	S-1	1351.9	Govt.	Open
2	Jwalapur	J-1	6.7	Pvt.	Adil Steel
		J-2	6.7	Pvt.	Bharat Enterprises
5	City Hospital	CH-1	50.6	Govt.	LIC Office
		CH-2	70.2	Govt.	Open
7	Haridwar Railway Station	HRS-1	6.8	Govt.	parking
9	Mansadevi Ropeway Gate	MRG-1	137.3	Pvt.	Building
10	Har-Ki-Pauri	HP-1	12.5	Govt.	open
		HP-2	35.7	Govt.	open
11	Kharkhari	K-1	6.7	Pvt.	Vijay Tetram Niwash
12	Motichur	M-1	182.1	Pvt.	Open Land
		Total	**1867.2**		
City Hospital to Daksh Temple					
1	Kankhal Chowk	KC-1	2.0	Pvt.	Nirmal Ashram
2	Ganeshpuram	G-1	324.8	Pvt.	Open Plot
		Total	**326.8**		
Ganeshpuram to DAV School					
S. No.	**Stations**	**Code**	**Land Area (sq. m)**	**Ownership**	**Remarks**
1	DAV School	DS-1	4.8	Pvt.	Agriculture Land
		DS-2	148.4	Pvt.	Open Plot
		Total	**398.0**		
Valmiki Chowk to Laltaro Bridge					
S. No.	**Stations**	**Code**	**Land Area (sq. m)**	**Ownership**	**Remarks**
1	Laltaro Bridge	LB-1	2288.10	Govt.	Open
		Total	**2288.1**		

Table 4-9: Details of Land Required for Depot Area

S No	Stations	Land Area (sq. m)	Ownership	Remarks
1	DEPOT-1	17730.0	Govt.	Open
	Total =	**17370.0**		

Table 4-10: Details of land required for Running Section

S. No.	Plot	Area (sq.m)	Ownership	Remarks
1	RS-1	440.9	Govt.	Land b/w Road
2	RS-2	896	Govt.	Land b/w Road
3	RS-3	141.1	Govt.	
4	RS-4	93.7	Govt.	pump house
5	RS-5	46.3	Pvt.	shop + trust
6	RS-6	97.2	Pvt.	hotel Ganga
7	RS-7	33.8	Pvt.	Building
8	RS-8	12.9	Pvt.	Dharamsala
9	RS-9	34.6	Pvt.	house
10	RS-10	12.9	Pvt.	house
11	RS-11	213.7	Pvt.	house
12	RS-12	26.4	Govt.	
13	RS-13	34.4	Govt.	sub-station
14	RS-14	358.2	Pvt.	Bharat Marble (open)
	Total	**2442.1**		

4.8.5 Temporary office accommodation

During construction period, huge quantities of construction materials like reinforcing bars, cement, steel sections, shutters, pre-cast segments etc. are to be stored and sufficient land is required for storage of these materials. The areas may be identified based on availability as vacant on date nearer to the corridors. At the time of construction, depending up on the need the location and size can be reassessed and temporary land acquisitions can be made accordingly.

Since the area of land being acquired permanently at most of the stations is bare minimum, the land required for construction depots purpose has been considered throughout the corridor @ 2000sqm at every 5 km. These sites will be obtained on lease temporarily for the construction period. After completion of construction, these will be handed over back to the land-owning agency.

4.8.6 Land for property Development

Government land pocket of about 10 ha. area near DAV School at Haridwar is identified for Property Development. Financial analysis has also been done considering additional income from PD.

4.8.7 Segment Casting Yard

Large numbers of steel columns, girders etc. are required for construction of elevated structures for which a large open area is required for setting up of casting yards. As far as possible, this area should be close to the site, easily accessible and away from habitation. Casting yard will need minimum 2 ha. of land.

4.8.8 Summary of Land Requirements

Abstract of land requirements for different components of this corridor is given in the Table below. However, the land requirement is summarized below:

Table 4-11: Summary of Permanent Land Requirement *

S.No.	PRT Corridor	Stations (sq. m)	Depot (sq. m)	Running Section (sq. m)	Property Development (in ha.)
1.	Sitapur to Bharat Mata Temple	1867.2	17370.0	2442.1	10 (Govt land near DAV school to be provided by Uttarakhand Govt. free of Cost)
2.	City Hospital to Daksh Temple	326.8			
3.	Valmiki Chowk to Laltaro Bridge.	2288.1			
4.	Ganeshpuram to DAV School	398.0			
	Total	**4880.1**	**17370.0**	**2442.1**	**10.0**
Grand total		**24692.2**			**10.0**

S.No.	Description	Govt. Land (sq. m)	Private land (sq. m)	Total (sq. m)
1	Stations	3815.8	1064.3	4880.1
2	Running Section	1632.5	809.6	2442.1
3	Depot	17370.0	0.0	17370.0
		Gross Total Land		**24692.2**

*Apart from land required as mentioned in above table, in case Entry/Exit structure of stations constructed outside Master plan ROW, then 1-1.5 Hectare additional land will be required.

4.9 UTILITY DIVERSIONS

4.9.1 Introduction

Besides the details of various aspects e.g., transport demand analysis, route alignment, station locations, system design, steel structure, geo-technical investigations etc. as brought out in previous paras, there are a number of other engineering issues, which are required to be considered in sufficient details before really deciding on taking up any infrastructure project of such magnitude. Accordingly, following engineering items have been studied and described in

this Para. Existing underground and at surface utilities and planning for their diversion during construction, if necessary.

4.9.2 Utility and Services

The proposed PRT alignments under Uttarakhand PRT System network are passing along major arterial roads of the city road network, which are serving Institutional, Commercial and residential areas. Large number of sub-surfaces, surface and overhead utility services, viz. Sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. are existing along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule /costs, for which necessary planning / action needs to be initiated in advance.

Affected Utilities as indicated hereunder are notional, actual investigation is required before commencement of the fieldwork.

Organizations/ Departments responsible for concerned utility services are provided in subsequent table.

Table 4-12: Organization responsible for utilities and services

S. No.	Organization/Department	Utility Services
1	Uttarakhand Jal Sansthan	Water mains, their service lines, including hydrants, water treatment plants, pumping station Sewerage and drainage lines. etc.
2	Nagar Nigam	Roads, Surface water drains, Nallah etc.
3	Uttarakhand Power Corporation LTD.(UPCL)	Power cables and their appurtenances, pole mounted transformers, power cables etc.
4	Power Transmission Corporation of Uttarakhand Ltd. (PTCUL)	H.T. Lines, their pylons, sub-station, etc.
5	BSNL	Telecommunication cables, junction boxes, telephone posts, O.H. Lines etc.
6	Uttarakhand Traffic Police	Traffic signal posts, junction boxes and cable connection etc.
7	Reliance Mobile India Ltd.,	Telecommunication cables, junction boxes etc.,
8	Idea, Airtel& Tata Tele services India Ltd.	Telecommunication cables, junction boxes etc.,
9	N.A.	Gas Pipeline.

Prior to the actual execution of work at site, detailed investigation of all utilities at foundation location will be undertaken well in advance by making trench pit to avoid damage to any utility.

4.9.3 Diversion of Underground Utilities

While planning for diversion of underground utility services viz. sewer lines, water pipelines, cables, etc., during construction of PRT alignment, following guidelines have been adopted:

- Utility services have to be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.
- Sewer lines and water supply lines are mainly affected in underground cut and cover construction. These services are proposed to be maintained by temporarily replacing them with CI/Steel pipelines and supporting them during construction, these will be encased in reinforced cement concrete after completion of construction and retained as permanent lines
- Where permanent diversion of the affected utility is not found feasible, temporary diversion with CI/Steel pipes without manholes is proposed during construction. After completion of construction, these will be replaced with conventional pipes and manholes.
- The elevated steel structure does not pose much of a difficulty in negotiating the underground utility services, especially those running across the alignment. The utilities infringing at pier location can be easily diverted away from the pile cap location.
- In case a major utility is running along/across the alignment which cannot be diverted or the diversion of which is difficult, time consuming and uneconomical, the spanning arrangement of the viaduct and layout of piles in the foundation may be suitably adjusted to ensure that no foundation needs be constructed at the location, where utility is crossing the proposed alignment. The utility service can also be encased within the foundation piles.

4.9.4 Elevated Stretch

Entire length in each corridor is elevated. Elevated length of corridor has been planned in the centre of the road except at few locations as detailed in the Alignment description.

4.9.5 Sewer Lines, Storm Water Drains and Water Lines

The sewer/drainage lines generally exist in the service lanes i.e. away from main carriageway. However, in certain stretches, these have come near the central verge or under main carriageway, as a result of subsequent road widening.

The major sewer/drainage lines and water mains running across the alignment and likely to be affected due to location of column foundations are proposed to be taken care of by relocating on column supports of viaduct by change in span or by suitably adjusting the layout of pile foundations. Where, this is not feasible, lines will be suitably diverted. Provision has been made in the project cost estimate towards diversion of utility service lines.

4.9.6 Above-Ground Utilities

Above ground utilities namely street light poles, traffic signal posts, telecommunication posts, junction boxes, etc. are also required to be shifted and relocated suitably during construction of elevated viaduct. Since these will be interfering with the proposed alignment. Approximate numbers of affected lamp/ telecom/elect posts & boxes are given in **Annexure–4.2**.

4.10 ISSUES RELATED TO INTERFACE WITH EXTERNAL AGENCIES

In order to complete the work timely and successfully, for all the corridors under Uttarakhand PRT Project network, interface with external agencies on different issues shall have to be conducted as per details given in the Table below:

Table 4-13: Interface with External Agencies

S. No.	Name of Agency	Issue
1	Nagar Nigam	Clearance of ROW for PRT wherever encroached/occupied.
2	Railways	Crossing of Railway lines at Jwalapur Haridwar
3	Uttarakhand Traffic Police	Alignment of various corridors under Uttarakhand PRT Project network shall pass on/along the roads.

In addition to above, some more external agencies may have to be coordinated during the course of actual construction.

4.11 TRAFFIC DIVERSION

4.11.1 Need

Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during PRT construction of various corridors. Any reduction of road space during PRT construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow up to the construction time; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. They are:

- For elevated section wherever it is passing along the road, the requirement would be mainly along the central verge.
- As regards to the alignment cutting across a major traffic corridor, all efforts will be made to prevent traffic hold-ups or diversions of any kind.

4.11.2 Traffic Diversion Plans

Only temporary diversion plans will be required during construction of the PRT corridors. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary

from 'on-street' parking to informal activities. Total blockage of traffic along the section will be done wherever reasonably good alternate road is available.

Keeping in view of future traffic growth and reduction of carriageway due to PRT construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement.

Annexure - 4.1

Table 4-14: Details of Horizontal Curve

Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle	Tangent (m)	Straight Length (m)
Sitapur - Bharat Mata Temple								
				L1	L2	D M S		154.668
1	Right	25	26.061	15	15	59 43 38.325	14.355	119.299
2	Right	50	51.726	30	30	59 16 24.061	28.446	483.089
3	Left	250	47.321	30	30	10 50 42.575	23.731	24.87
4	Left	210	163.895	35	25	44 42 59.920	86.377	0
5	Right	190	106.687	25	25.453	32 10 19.729	54.791	0
6	Right	66	25.752	25.453	25	22 21 20.594	13.042	46.849
7	Left	210	140.748	40	40	38 24 04.442	73.132	233.753
8	Left	3010	210.063	25	25	03 59 54.859	105.074	178.214
9	Right	710	29.11	40	40	02 20 56.951	14.557	91.773
10	Left	4010	38.134	25	25	00 32 41.505	19.067	111.232
11	Left	1210	27.809	25	25	01 19 00.427	13.905	155.443
12	Right	1310	25.493	25	25	01 06 53.971	12.747	399.369
13	Right	5010	25.077	10	10	00 17 12.418	12.538	324.591
14	Left	1310	25.221	20	20	01 06 11.219	12.611	24.261
15	Right	2510	54.478	20	20	01 14 36.891	27.24	176.757
16	Left	1510	120.994	25	25	04 35 27.714	60.529	439.866
17	Left	2210	26.013	10	10	00 40 27.892	13.007	22.954
18	Right	2710	26	10	10	00 32 58.900	13	574.378
19	Right	1010	74.44	25	25	04 13 22.350	37.237	76.698
20	Left	2110	26.8	25	25	00 43 39.875	13.4	338.25
21	Right	3010	27.406	25	25	00 31 18.017	13.703	362.89
22	Left	1110	29.098	25	25	01 30 07.058	14.55	164.89
23	Right	510	27.948	25	25	03 08 23.211	13.977	0
24	Left	380	26.472	30	30	03 59 29.270	13.242	76.731
25	Right	1110	26.762	25	25	01 22 53.011	13.382	178.973
26	Right	130	30.883	25	25	13 36 40.499	15.515	0
27	Left	90	28.259	40	40	17 59 24.294	14.247	0
28	Right	310	66.382	35	35	12 16 08.788	33.319	93.66
29	Left	1110	25.835	10	10	01 20 00.843	12.918	63.707

Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle	Tangent (m)	Straight Length (m)
30	Left	260	91.454	30	30	20 09 12.906	46.204	14.521
31	Right	28	36.998	10	10	75 42 29.930	21.761	0
32	Left	22	26.94	10	10	70 09 40.339	15.451	125.666
33	Left	150	25.796	10	10	09 51 12.019	12.93	0
34	Right	90	47.369	15	15	30 09 22.673	24.247	0
35	Left	45	32.509	20	20	41 23 28.237	17	0
36	Right	240	139.451	30	30	33 17 29.163	71.756	51.314
37	Left	120	24.144	10	10	11 31 40.295	12.113	56.375
38	Right	190	26.499	10	10	07 59 27.360	13.271	0.765
39	Left	260	64.944	10	10	14 18 41.979	32.642	41.783
40	Right	260	26.909	15	15	05 55 47.365	13.466	48.468
41	Left	510	30.339	15	15	03 24 30.244	15.174	205.37
42	Left	510	26.376	10	10	02 57 47.559	13.191	46.17
43	Right	610	93.891	15	15	08 49 08.378	47.039	48.067
44	Right	450	187.445	15	15	23 51 58.473	95.102	59.846
45	Right	660	26.334	15	15	02 17 09.932	13.169	77.15
46	Left	3510	27.353	10	10	00 26 47.409	13.677	222.17
47	Left	610	125.154	15	15	11 45 19.584	62.798	44.149
48	Left	1010	27.339	15	15	01 33 03.325	13.671	254.259
49	Left	1610	25.189	10	10	00 53 47.083	12.595	45.194
50	Right	1610	25.189	10	10	00 53 47.073	12.595	239.758
51	Left	360	33.727	15	15	05 22 03.921	16.876	336.025
52	Right	510	26.369	15	15	02 57 44.758	13.188	327.547
53	Right	1010	47.302	25	25	02 41 00.086	23.655	155.929
54	Right	510	46.488	15	15	05 13 21.681	23.26	256.811
55	Left	910	343.495	15	15	21 37 38.054	173.816	49.832
56	Right	20	34.972	10	10	100 11 18.153	23.915	120.037
57	Left	3010	26.434	15	15	00 30 11.408	13.217	69.364
58	Right	67	25.547	10	10	21 50 47.803	12.93	225.365
59	Left	5010	31.831	10	10	00 21 50.519	15.916	269.111
60	Left	60	26.056	10	10	24 52 53.314	13.237	96.522
61	Right	2010	27.848	25	25	00 47 37.699	13.924	81.738
62	Right	22	25.173	10	10	65 33 36.715	14.167	0
63	Left	510	65.4	20	20	07 20 50.388	32.745	202.334
City Hospital to Daksh Temple at Haridwar								
				L1	L2	D M S		159.694
1	Left	4010	27.058	10	10	00 23 11.823	13.529	78.636
2	Right	190	25.69	15	15	07 44 48.819	12.864	161.296
3	Right	50	26.675	15	15	30 34 03.671	13.663	256.348

Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle	Tangent (m)	Straight Length (m)
4	Right	16010	25.767	10	10	00 05 31.965	12.883	171.753
5	Left	20	26.867	10	10	76 58 07.715	15.9	130.235
6	Right	22	24.385	10	10	63 30 30.059	13.616	86.287
7	Left	370	76.576	10	10	11 51 28.918	38.425	72.479
8	Left	150	157.639	15	15	60 12 49.303	86.976	38.129
9	Right	185	103.384	15	15	32 01 07.123	53.08	27.81
10	Left	190	26.056	10	10	07 51 26.470	13.048	68.165
11	Left	210	31.529	10	10	08 36 07.995	15.794	163.065
12	Left	35	29.098	10	10	47 38 00.576	15.449	0
13	Right	78	37.099	10	10	27 15 06.434	18.908	30.271
14	Left	80	52.924	10	21	37 54 13.255	27.471	0
15	Left	45	12.285	21	10	15 38 29.465	6.181	151.098
16	Right	25	28.059	5	5	64 18 20.119	15.715	0
17	Left	30	26.741	5	5	51 04 16.820	14.332	28.788
18	Left	250	48.425	15	15	11 05 53.730	24.289	63.34
19	Right	110	32.039	10	10	16 41 17.598	16.134	131.513
20	Left	52	23.374	10	10	25 45 15.882	11.888	18.3
Valmiki Chowk to Laltaro Bridge								
				L1	L2	D M S		31.452
1	Right	170	60.157	10	10	20 16 29.767	30.396	58.786
2	Left	140	52.465	10	10	21 28 17.471	26.544	253.514
3	Left	23	25.352	10	10	63 09 21.750	14.138	154.273
Ganeshpuram to DAV School								
				L1	L2	D M S		25.235
1	Left	46	25.619	10	10	31 54 36.922	13.151	34.994
2	Right	165	25.377	10	10	08 48 42.917	12.713	52.669
3	Right	1010	50.79	10	10	02 52 52.420	25.4	154.866
4	Right	240	60.615	10	10	14 28 14.700	30.47	47.27
5	Left	1005	167.854	25	25	09 34 10.029	84.122	143.853
6	Left	35	40.166	10	10	65 45 10.475	22.622	78.343
7	Right	35	30.967	10	10	50 41 39.013	16.58	27.239
8	Left	310	28.169	10	10	05 12 23.030	14.094	122.512
9	Right	350	26.613	15	15	04 21 23.631	13.313	0
10	Left	60	39.164	15	15	37 23 56.145	20.308	97.082
11	Right	160	55.252	10	10	19 47 08.822	27.904	106.589
12	Right	260	55.51	10	10	12 13 57.179	27.861	28.581
13	Right	810	28.198	10	10	01 59 40.604	14.101	99.81
14	Right	140	56.176	10	10	22 59 24.502	28.471	92.783
15	Left	210	76.958	10	10	20 59 49.298	38.916	150.016

Table 4-15: Details of Vertical Curve

S. No.	Chainage		Length	Rail Level		Gradient	Remarks
	From	To		From	To		
Sitapur - Bharat Mata Temple							
1	-105.0	77.7	182.7	296.9	296.9	0.000%	Level
2	77.7	180.0	102.3	296.9	292.7	-4.155%	Fall
3	180.0	360.0	180.0	292.7	295.5	1.583%	Rise
4	360.0	440.0	80.0	295.5	295.5	0.000%	Level
5	440.0	640.0	200.0	295.5	291.8	-1.857%	Fall
6	640.0	1060.0	420.0	291.8	292.7	0.218%	Rise
7	1060.0	1346.0	286.0	292.7	302.1	3.287%	Rise
8	1346.0	1580.0	234.0	302.1	297.0	-2.179%	Fall
9	1580.0	1750.0	170.0	297.0	297.0	0.000%	Level
10	1750.0	2080.0	330.0	297.0	295.1	-0.584%	Fall
11	2080.0	2460.0	380.0	295.1	295.3	0.060%	Rise
12	2460.0	2700.0	240.0	295.3	298.0	1.125%	Rise
13	2700.0	2820.0	120.0	298.0	298.0	0.000%	Level
14	2820.0	3200.0	380.0	298.0	291.9	-1.605%	Fall
15	3200.0	3710.0	510.0	291.9	295.1	0.627%	Rise
16	3710.0	3834.1	124.1	295.1	295.1	0.000%	Level
17	3834.1	4100.0	265.9	295.1	291.6	-1.309%	Fall
18	4100.0	4360.0	260.0	291.6	294.5	1.092%	Rise
19	4360.0	4650.0	290.0	294.5	300.9	2.221%	Rise
20	4650.0	4750.0	100.0	300.9	300.9	0.000%	Level
21	4750.0	4940.0	190.0	300.9	297.0	-2.059%	Fall
22	4940.0	5260.0	320.0	297.0	297.6	0.199%	Rise
23	5260.0	5530.0	270.0	297.6	299.8	0.812%	Rise
24	5530.0	5800.0	270.0	299.8	298.7	-0.415%	Fall
25	5800.0	6050.0	250.0	298.7	301.4	1.082%	Rise
26	6050.0	6180.0	130.0	301.4	301.4	0.000%	Level
27	6180.0	6360.0	180.0	301.4	297.1	-2.365%	Fall
28	6360.0	6558.4	198.4	297.1	296.6	-0.276%	Fall
29	6558.4	6730.0	171.6	296.6	301.0	2.568%	Rise
30	6730.0	6884.1	154.1	301.0	301.0	0.000%	Level
31	6884.1	7140.0	255.9	301.0	297.2	-1.485%	Fall
32	7140.0	7530.0	390.0	297.2	303.6	1.641%	Rise
33	7530.0	7740.0	210.0	303.6	303.6	0.000%	Level
34	7740.0	7840.0	100.0	303.6	302.1	-1.482%	Fall
35	7840.0	8080.0	240.0	302.1	310.4	3.451%	Rise
36	8080.0	8207.0	127.0	310.4	310.4	0.000%	Level

37	8207.0	8520.0	313.0	310.4	304.7	-1.821%	Fall
38	8520.0	8705.0	185.0	304.7	301.0	-2.000%	Fall
39	8705.0	8990.0	285.0	301.0	297.0	-1.404%	Fall
40	8990.0	9200.0	210.0	297.0	297.5	0.238%	Rise
41	9200.0	9450.0	250.0	297.5	303.3	2.320%	Rise
42	9450.0	9580.0	130.0	303.3	303.3	0.000%	Level
43	9580.0	9790.0	210.0	303.3	301.5	-0.857%	Fall
44	9790.0	10080.0	290.0	301.5	300.5	-0.358%	Fall
45	10080.0	10400.0	320.0	300.5	301.9	0.438%	Rise
46	10400.0	10580.0	180.0	301.9	303.3	0.798%	Rise
47	10580.0	10844.8	264.8	303.3	307.7	1.662%	Rise
48	10844.8	10970.0	125.2	307.7	307.7	0.000%	Level
49	10970.0	11400.0	430.0	307.7	308.6	0.216%	Rise
50	11400.0	11730.0	330.0	308.6	309.5	0.264%	Rise
51	11730.0	12040.0	310.0	309.5	309.3	-0.065%	Fall
52	12040.0	12320.0	280.0	309.3	309.9	0.214%	Rise
53	12320.0	12930.0	610.0	309.9	321.1	1.830%	Rise
54	12930.0	13224.2	294.2	321.1	321.5	0.149%	Rise
55	13224.2	13325.0	100.8	321.5	321.5	0.000%	Level
56	13325.0	13498.3	173.3	321.5	315.0	-3.751%	Fall
57	13498.3	13816.4	318.1	315.0	305.9	-2.870%	Fall
58	13816.4	14190.0	373.6	305.9	314.3	2.256%	Rise
59	14190.0	14448.4	258.4	314.3	314.3	0.000%	Level
City Hospital to Daksh Temple at Haridwar							
1	0.0	100.0	100.0	295.1	295.1	0.000%	Level
2	100.0	260.0	160.0	295.1	291.9	-1.988%	Fall
3	260.0	480.0	220.0	291.9	309.6	8.055%	Rise
4	480.0	650.0	170.0	309.6	309.6	0.000%	Level
5	650.0	880.0	230.0	309.6	291.0	-8.104%	Fall
6	880.0	1056.4	176.4	291.0	293.2	1.248%	Rise
7	1056.4	1180.0	123.6	293.2	293.2	0.000%	Level
8	1180.0	1380.0	200.0	293.2	285.7	-3.750%	Fall
9	1380.0	1600.0	220.0	285.7	285.8	0.045%	Rise
10	1600.0	1920.0	320.0	285.8	288.3	0.781%	Rise
11	1920.0	2037.0	117.0	288.3	288.3	0.000%	Level
12	2037.0	2200.0	163.0	288.3	284.4	-2.393%	Fall
13	2200.0	2540.0	340.0	284.4	287.6	0.941%	Rise
14	2540.0	2700.0	160.0	287.6	287.0	-0.375%	Fall
15	2700.0	2940.0	240.0	287.0	292.1	2.125%	Rise
16	2940.0	3109.9	169.9	292.1	292.1	0.000%	Level

Valmiki Chowk to Laltaro Bridge							
1	0.0	80.0	80.0	301.0	301.0	0.000%	Level
2	80.0	340.0	260.0	301.0	295.9	-1.962%	Fall
3	340.0	518.5	178.5	295.9	296.3	0.224%	Rise
4	518.5	696.0	177.5	296.3	296.3	0.000%	Level
Ganeshpuram to DAV School							
1	0.0	180.0	180.0	288.3	288.3	0.000%	Level
2	180.0	533.8	353.8	288.3	283.8	-1.272%	Fall
3	533.8	810.0	276.2	283.8	291.1	2.643%	Rise
4	810.0	900.0	90.0	291.1	291.1	0.000%	Level
5	900.0	1260.0	360.0	291.1	284.4	-1.875%	Fall
6	1260.0	1500.0	240.0	284.4	284.2	-0.079%	Fall
7	1500.0	1801.0	301.0	284.2	283.3	-0.299%	Fall
8	1801.0	2000.0	199.0	283.3	282.2	-0.525%	Fall
9	2000.0	2180.0	180.0	282.2	286.4	2.324%	Rise
10	2180.0	2379.3	199.3	286.4	286.4	0.000%	Level

Annexure - 4.2

Table 4-16: Haridwar PRT Corridors Utilities

S. No.	Description	Sitapur to Bharat Mata Temple	City Hospital to Daksh Temple	Ganeshpuram to DAV School	Valmiki Chowk to Laltaro Bridge
		Nos.	Nos.	Nos.	Nos.
1	Electric Pole	296	148	47	18
2	Lamp Post	176	50	40	5
3	Signal pole	5	1	0	0
4	Telephone pole	52	2	0	0
5	MH	285	46	14	6
6	JB	11	30	1	1
7	DH	92	24	1	2
8	BW	2	0	0	0
9	SB	27	3	2	0
10	CH	32	4	1	2
11	OFC	10	0	1	2
12	Electric Mask	3	0	0	0
13	TR	106	105	0	
14	CBL	7	4	4	4
15	WP	1	4	1	6
16	Chimney	2	3	0	0
17	Hand Pump	6	1	0	0
18	IGL	2	7	1	0
19	TF	6	0	0	0
20	LB	1	0	0	0
21	GP	1	0	0	0
22	KM	0	1	1	1
23	CCTV	0	1	2	2
	Total=	**1017**	**329**	**116**	**49**

S. No.	Description	Chainage
1	HT Electrical Lines	75
2		1028.5
3		1142.7- 1250.1
4		1437.4-1622.3
5		2102-2126.1
6		2169
7		2200
8		4645.2
9		4689
10	HT Electrical Lines	4693.4
11		6365.8
12		6553.5
13		6586.5
14		6750.2
15		7078
16		7282.3-8055
17	HT Electrical Lines	41.6-137.9
18		239.1
19		392.6
20		562.3-680

Chapter -5
Station Planning

5.1 Stations on the Line

5.2 Types of Elevated Station

5.3 Details of Proposed Stations

CHAPTER 5
STATION PLANNING

5.1 STATIONS ON THE LINE

The proposed for Personal Rapid Transit (PRT) System in Haridwar consists of the following corridors:

S. No.	PRT Corridors		Route Length (km)	Station details
1	Corridor 1	Sitapur to Bharat Mata Temple	14.55	14 Stations with two interchange
2	Corridor 2	City Hospital to Daksh Temple	3.10	4 Stations with two interchange
3	Corridor 3	Valmiki Chowk to Laltaro Bridge	0.69	1 Station with one interchange
4	Corridor 4	Ganeshpuram to DAV School	2.40	2 Stations with one interchange

There are three interchange stations in the proposal at Valmiki Chowk, City Hospital and Ganeshpuram. The Corridor 1 from Sitapur to Bharat Mata temple serves the city along the main road and the other 3 corridors serve as feeders to the main line.

Majority of the stations as well as the trackway viaduct is constructed over the road and care has been take in the design and planning to have minimum adverse impact on the urban fabric of the city.

A total of 21 stations including three interchange stations have been planned along the proposed Corridor. All stations are planned as elevated with only staircases and lifts being constructed on the footpath in addition to the support columns. This ensures that the traffic and pedestrian movement on the road is not affected and the system moulds itself to the working of the city spaces and traffic lifelines.

Table 5-1: Proposed Personal Rapid Transit (PRT) corridors at Haridwar.

S. No.	Station Name	Chainage	Inter Station Distance (m)	Track Level from Ground (m)*	Platform Type	Alignment
Corridor 1: Sitapur to Bharat Mata Temple (14 Stations including Two interchange)						
1	Sitapur	-29.90	75.1	10.309	Type-1	Elevated
2	Jwalapur	398.6	428.5	10.052	Type-2	Elevated
3	Arya Nagar	1704.1	1305.5	9.979	Type-2	Elevated
4	Ram Nagar	2762.6	1058.5	10.178	Type-2	Elevated

S. No.	Station Name	Chainage	Inter Station Distance (m)	Track Level from Ground (m)*	Platform Type	Alignment
5	City Hospital	3760.2	997.6	10.927	Type-1A, Interchange	Elevated
6	Rishikul	4709.5	949.3	10.278	Type-1	Elevated
7	Haridwar Railway Station	6119.5	1410.0	10.030	Type-2	Elevated
8	Valmiki Chowk	6781.2	661.7	10.626	Type-1A, Interchange	Elevated
9	Mansadevi Ropeway Gate	7638.2	857.0	12.601	Type-4	Elevated
10	Har-Ki-Pauri	8130.0	491.8	12.645	Type-4	Elevated
11	Kharkhari	9519.6	1389.6	10.054	Type-2	Elevated
12	Motichur	10925.2	1405.6	10.374	Type-1	Elevated
13	Shantikunj	13278.4	2353.2	12.052	Type-3	Elevated
14	Bharat Mata Temple	14382.4	1104.0	13.559	Type-1B	Elevated
Corridor 2: City Hospital to Ganeshpuram (Terminal) (4 Stations including one Interchange)						
15	Kankhal Chowk	598.4	598.4	28.751	Type-3	Elevated
16	Kankhal	1127.8	529.4	12.225	Type-3	Elevated
17	Ganeshpuram	1976.8	849.0	10.952	Type-1A, Interchange	Elevated
18	Daksh Temple	3018.2	1041.4	8.047	Type-3	Elevated
Corridor 3: Valmiki Chowk to Laltaro Bridge (2 Stations including one interchange)						
19	Lal Taro Bridge	620.6	620.6	10.472	Type-1	Elevated
Corridor 4: Ganeshpuram to DAV School (3 Stations including one interchange)						
20	Jagjeetpur	860.1	860.1	12.025	Type-3	Elevated
21	DAV school	2275.0	1414.9	12.049	Type-2	Elevated

*Level Difference i.e., road level from ground (m) as per through road level.

*Entries to be located outside the Master Plan Right of Way

5.2 TYPES OF ELEVATED STATION

There are generally four different types of elevated PRT stations as detailed below:

1. **Type 1**: This station is designed as an island type station with a loop running around the platform. The trackway goes above the station and passes through. The loop, accessed by turnouts results in maximum flexibility with the POD units being able to traverse in any direction without provision of additional U turn loops on the viaduct. In addition, there is a space for parking and charging of an additional 9 PODs built into the station to ensure minimum wait time for the passengers.

- The passengers reach the concourse/platform by means of staircase and lift from the footpath.
- The ticket vending machines are located below the staircases leading up to the concourse/platform thereby restricting the waiting/queuing to the footpath level.
- The station shall be designed on 3 piers with portals. The side piers shall be located on either side of the road and the central pier shall be on the median. The viaduct beyond the station shall continue on the median. This shall ensure adequate ROW as well as a minimal footprint on the road to ensure that the ground level traffic is not adversely impacted in any way by addition of the POD infrastructure.
- The through trackway above ensures that there is minimum impact on the normal operation speed and the passenger interface of boarding/alighting is done on the lower level.

2. **Type 1A**: This is a variation of Type-1 station; the station has been planned with placing platform on one side of the turnaround loop to mitigate the effect of restricted ROW as well as to allow bidirectional movement in all three directions with boarding – deboarding on one platform.

   This reduces confusion and the requirement of guiding the passengers. As the POD is an intelligent system, the destination and direction of travel is decided automatically by the system. The passenger just has to swipe the card/token and board the pod at the designated bay number. As in Type 1, the trackway continues on ramp above the station resulting in minimum impact on the operational speed with the platform below being accessed by the pods through turnouts.

3. **Type 1B**: This is a variation of Type-1 station, without the provision of charging station and additional parking bay to reduce the size of the station. This is planned at Bharat Mata station due to its uniquely placed topography, restricted ROW and level difference under the station. Being a terminal station, the U turn of the loop facilitates easy reversal of the pods.

4. **Type 2**: This is a side platform type station with platforms being located over the footpath on either side of the road. The trackway passes above the station by means of ramps. The boarding bays and platform are located below the through track adjacent to the trackway on the platform. The passengers obtain e-tickets from Ticket Vending Machines located below the staircases and adjacent to the lift and reach the first floor directly to board at the platform.

   The platform is at present proposed with 6 bays but the design is modular and additional bays can be added as per requirement.

   The structure is designed as a 3 pier structure with side piers on the footpath on either side of the road and the central pier on the median. The viaduct beyond the station shall continue on the median. For traversing in either direction separate U turn loops shall have to be provided along the viaduct alignment.

5. **Type 3**: This is a staggered side platform type station. The platforms have been staggered

along either side of the alignment to mitigate the effect of restricted ROW and still allow boarding from both sides of the road. The trackway rises above the platforms and continues above. The platform and boarding – alighting bays below are accessed by the PODs by means of turnouts. This arrangement has been proposed in locations where the available ROW is restricted.

6. **Type 4**: Due to extreme constraint in the available ROW and availability of land, Mansa Devi Ropeway station and Har-ki-Pauri station has been planned as double level stations. The Ticket Vending machines are located in the ground level lobby. From there, the first platform (UP Direction) is accessed by means of the stairs and lift. For the second platform (DN Direction) the platform is located above the first platform and is accessed through stairs leading up from the first platform. This is proposed to reduce unnecessary movement of the pod for taking U turns thereby saving energy as well as time. Beyond and before the station, the trackway shall continue as double decker till such location where adequate ROW is available to transition by means of ramp into the standard sire-by-side trackway/viaduct.

5.3 DETAILS OF PROPOSED STATIONS

5.3.1 Sitapur Station

Chainage	:	-29.900 m
Inter Station Distance	:	75.1m
Track Level	:	10.309 m
Station type	:	Elevated, Type-1 Terminal
Station Details	:	The station is located adjacent to Shri Ravidas Ghat. Main source of passengers to this station is the daily commuters from dense and mixed development around Shri Ravidas Ghat.

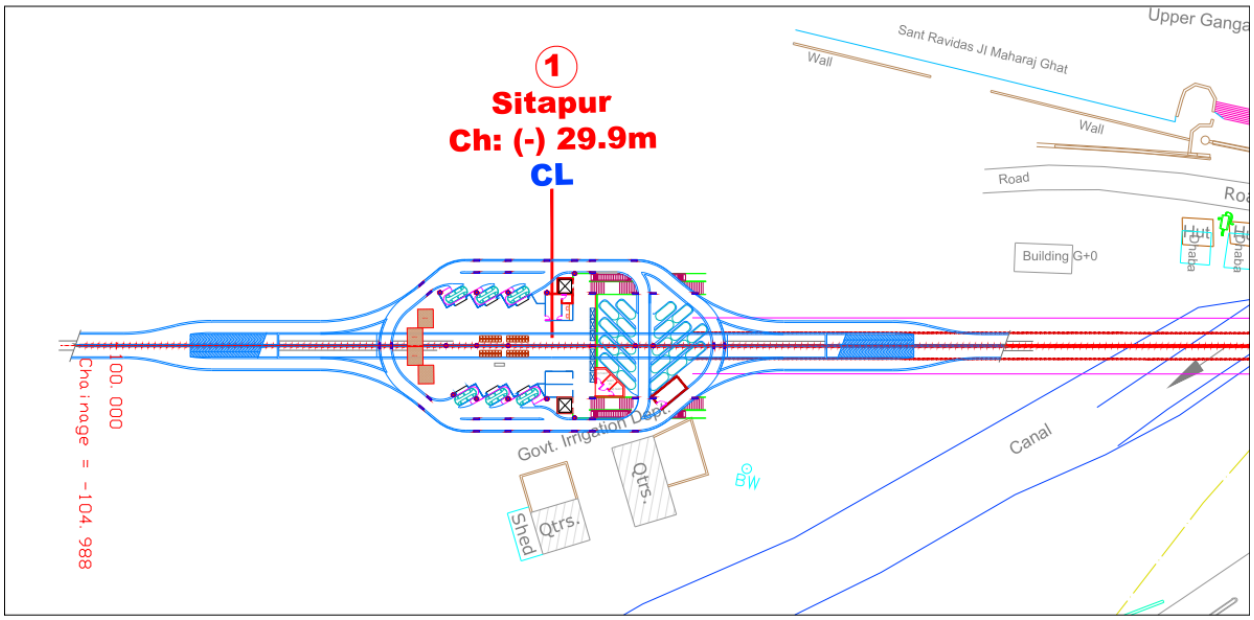


Figure 5-1: Sitapur Station

5.3.2 Jwalapur Station

Chainage	:	398.6m
Inter Station Distance	:	428.5m
Track Level	:	10.052
Station type	:	Elevated, Type-2
Station Details	:	Located on the Jwalapur Main road. Main source of passengers to this station includes Jwalapur Kotwali, BSNL office and staff quarters and adjacent mixed land use of residential & commercial areas. Two entries are proposed - one on either side of the road.

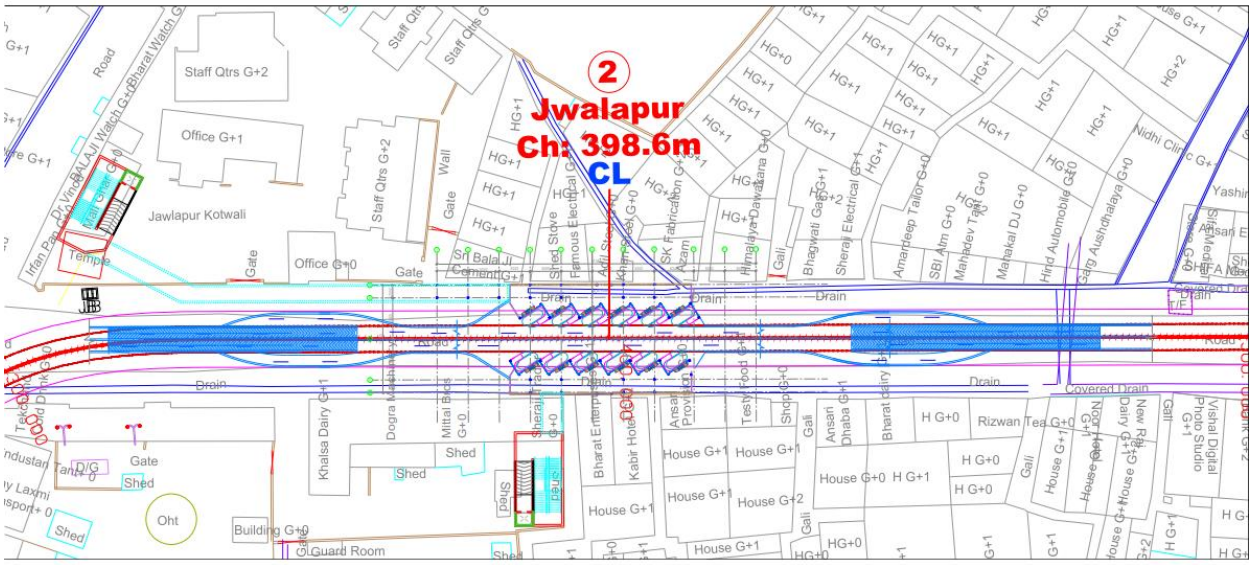


Figure 5-2: Jwalapur Station

5.3.3 Arya Nagar Station

Chainage	:	1704.1
Inter Station Distance	:	1305.5m
Track Level	:	9.979m
Station type	:	Elevated, Type-2
Station Details	:	The station is located on Haridwar Main Marg. Main source of passengers to this station is dense mixed land use on both sides along with Maharishi Dayanand Saraswati Smarak Ashram and the Raj Bhawan (Town Hall) located within walking distance. Two entries are proposed - one on either side of the road.

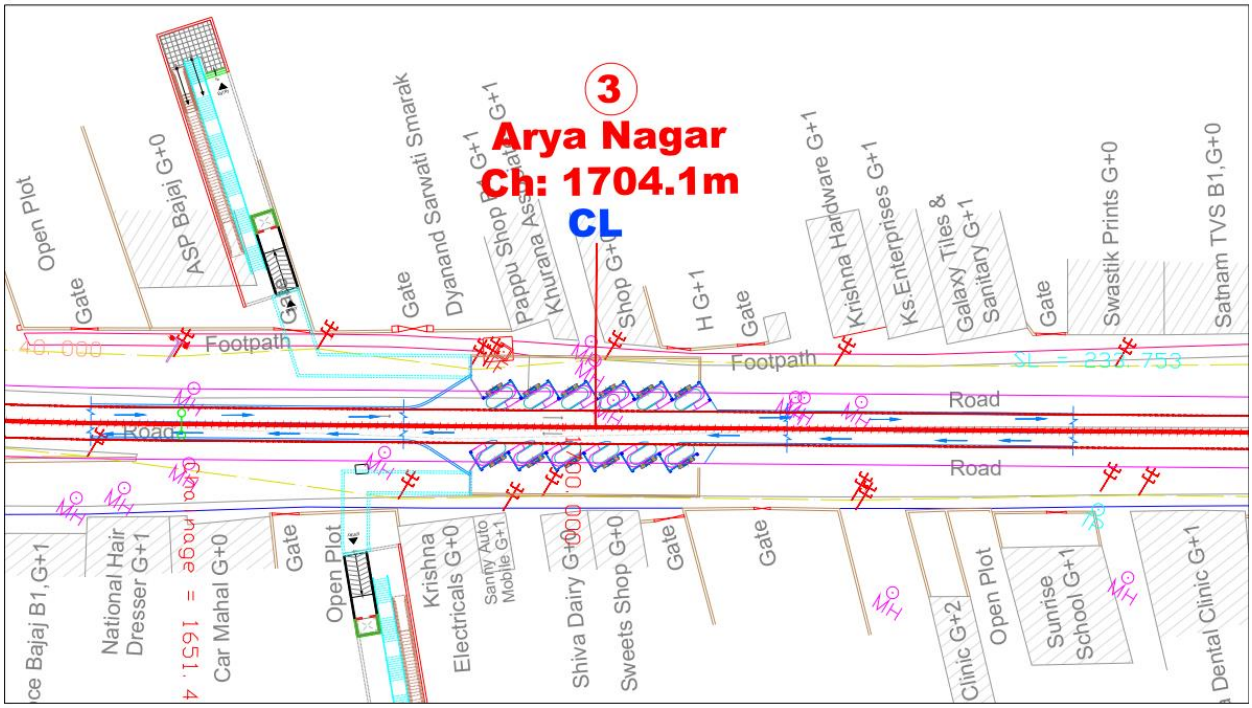


Figure 5-3: Arya Nagar Station

5.3.4 Ram Nagar Station

Chainage	:	2762.6m
Inter Station Distance	:	1058.5m
Track Level	:	10.178m
Station type	:	Elevated, Type-2
Station Details	:	The station is located on Haridwar Main Road. Main source of passengers to this station is the dense development in vicinity of Registrar office and Tehsil. Two entries are proposed, one on either side of the station.

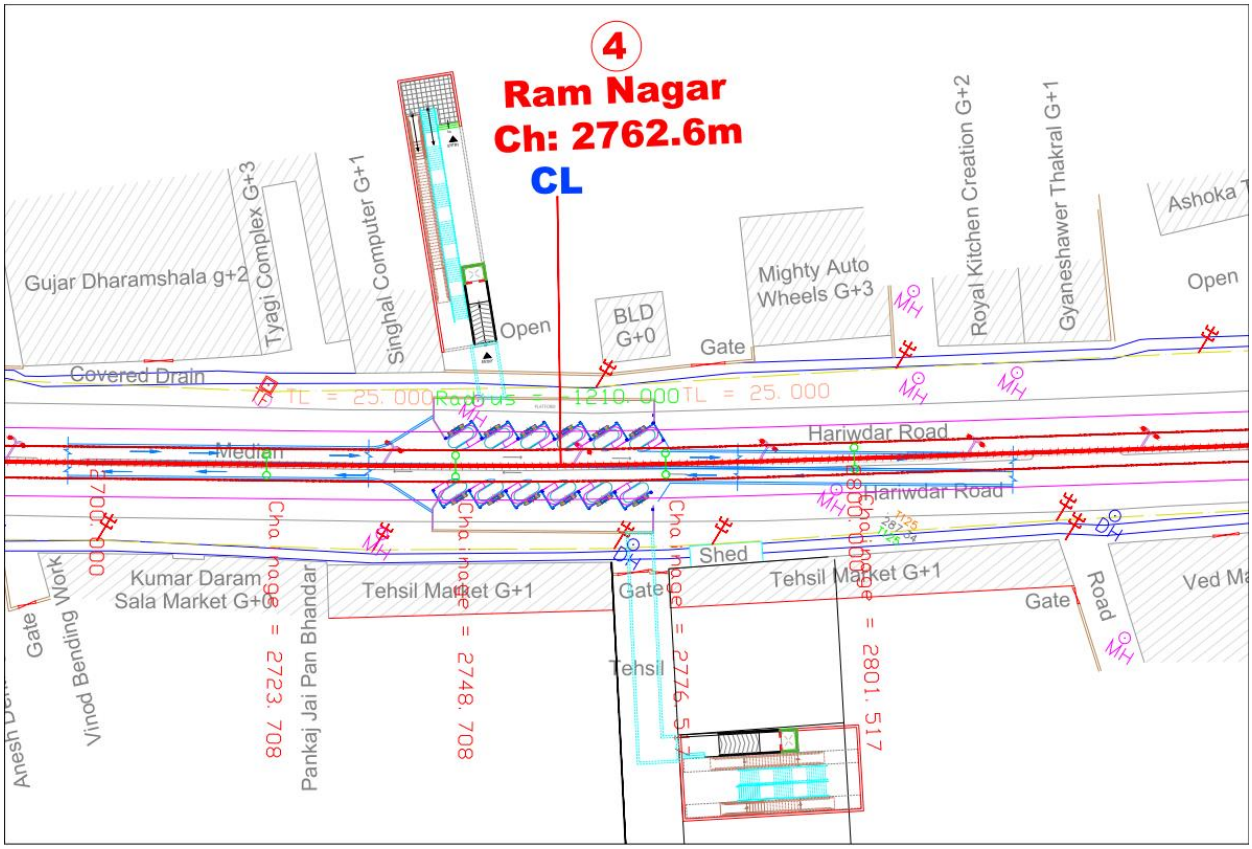


Figure 5-4: Ram Nagar Station

5.3.5 City Hospital Station

Chainage	:	3760.2m
Inter Station Distance	:	997.6m
Track Level	:	10.927m
Station type	:	Elevated, Type-1A, Interchange (corridor 1&2)
Station Details	:	The station is located on intersection of Haridwar Main Road and Bypass Road. Main source of passengers to this station is the daily commuters travelling to City Hospital and commercial development in vicinity. Two entries are proposed, one on either side of station

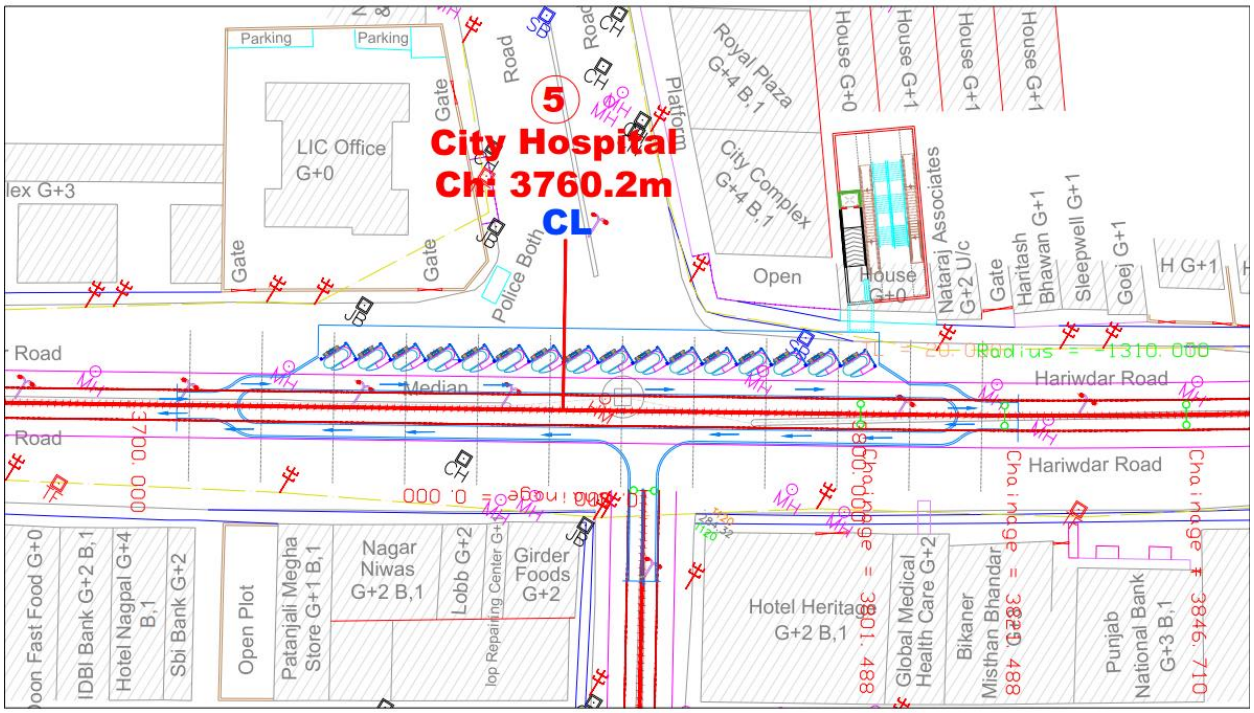


Figure 5-5: City Hospital Station

5.3.6 Rishikul Station

Chainage	:	4709.5m
Inter Station Distance	:	949.3m
Track Level	:	10.278m
Station type	:	Elevated, Type-1
Station Details	:	The station is located on Haridwar Main Road near Saraswati Vidya Mandir Inter college. Part of the college ground has been earmarked for the depot. Main source of passengers to this station is the daily commuters travelling to college and residential and commercial development around it. Two entries are proposed, one on either side of station.

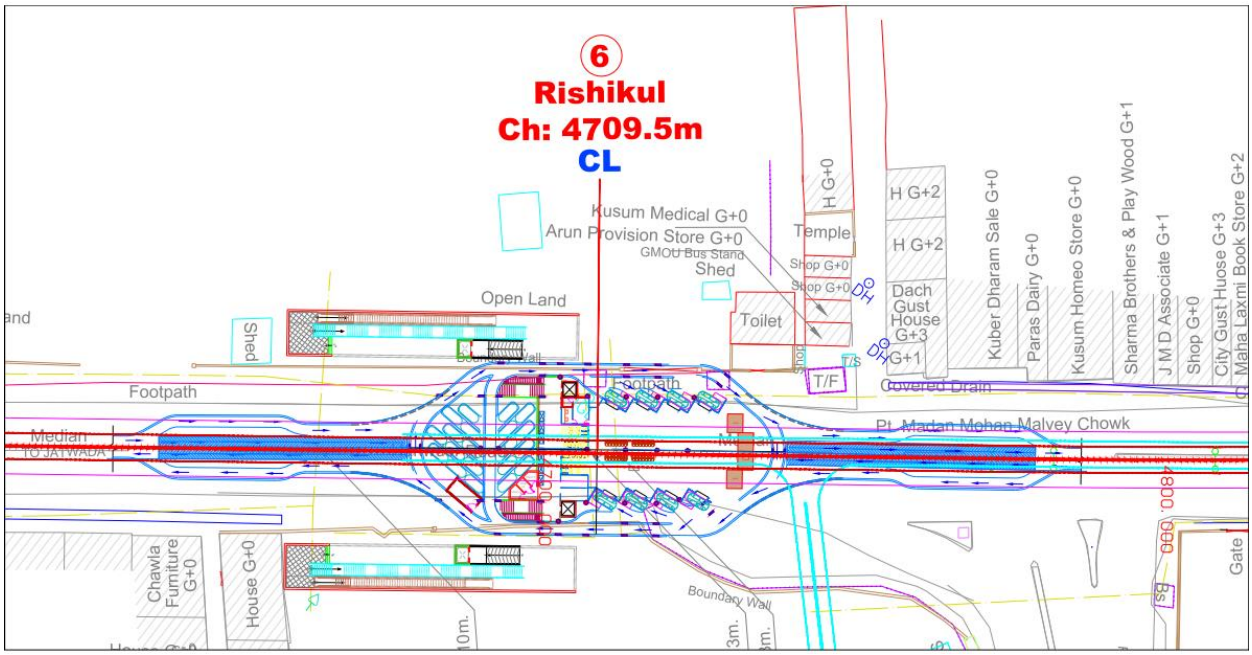


Figure 5-6: Rishikul Station

5.3.7 Haridwar Railway Station

Chainage	:	6119.5m
Inter Station Distance	:	1410.0m
Track Level	:	10.030m
Station type	:	Elevated, Type-2
Station Details	:	The station is located on Haridwar Main Road. Main source of passengers to this station are the Railway passengers and pilgrims staying in numerous hotels and dharmashalas located around the area. Two entries are proposed, one on either side of the station

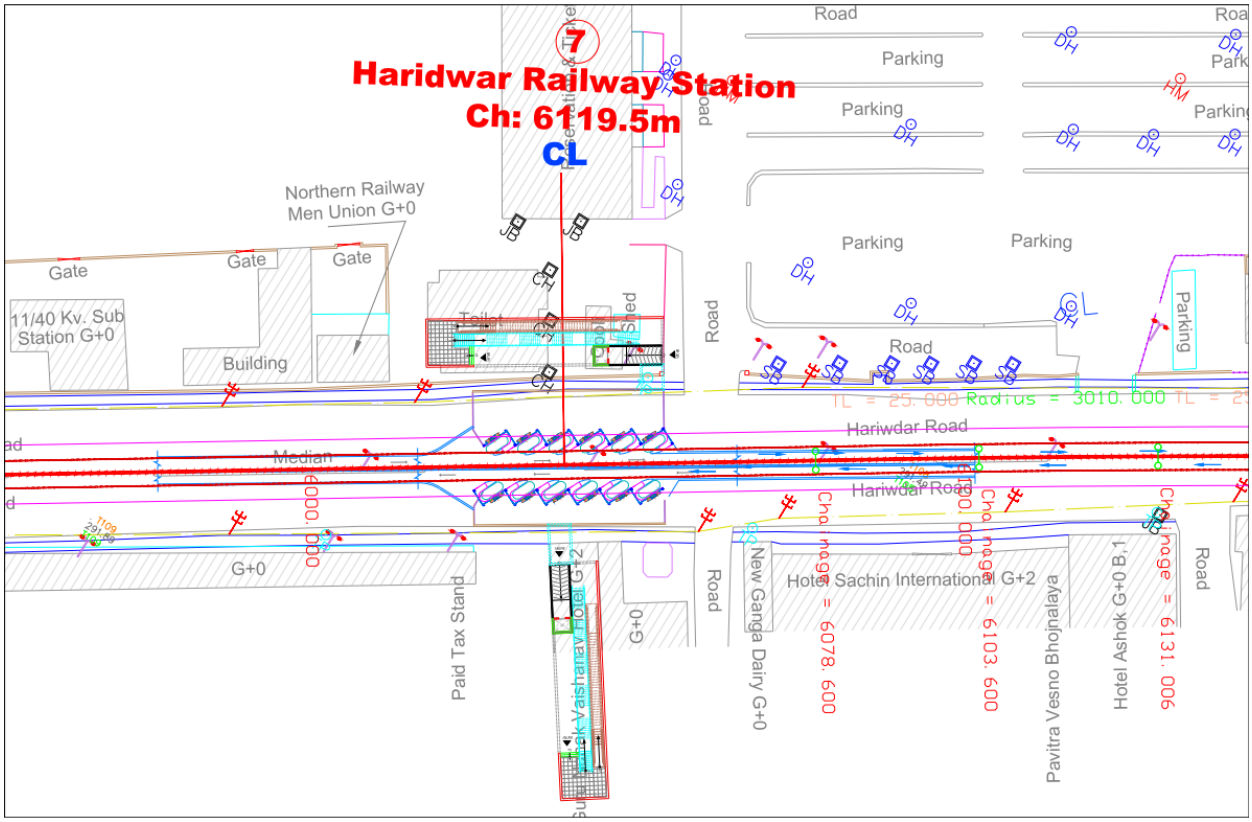


Figure 5-7: Haridwar Railway Station

5.3.8 Valmiki Chowk Station

Chainage	:	6781.2m
Inter Station Distance	:	661.7m
Track Level	:	10.626m
Station type	:	Elevated , Type-1A, Interchange (corridor 1&3)
Station Details	:	The station is located Bhagwan Valmiki Chowk on Haridwar Main Road. Main source of passengers to this station are pilgrims staying in dharmshala and dense development around the locality. Two entries are proposed, one on either side of the station.

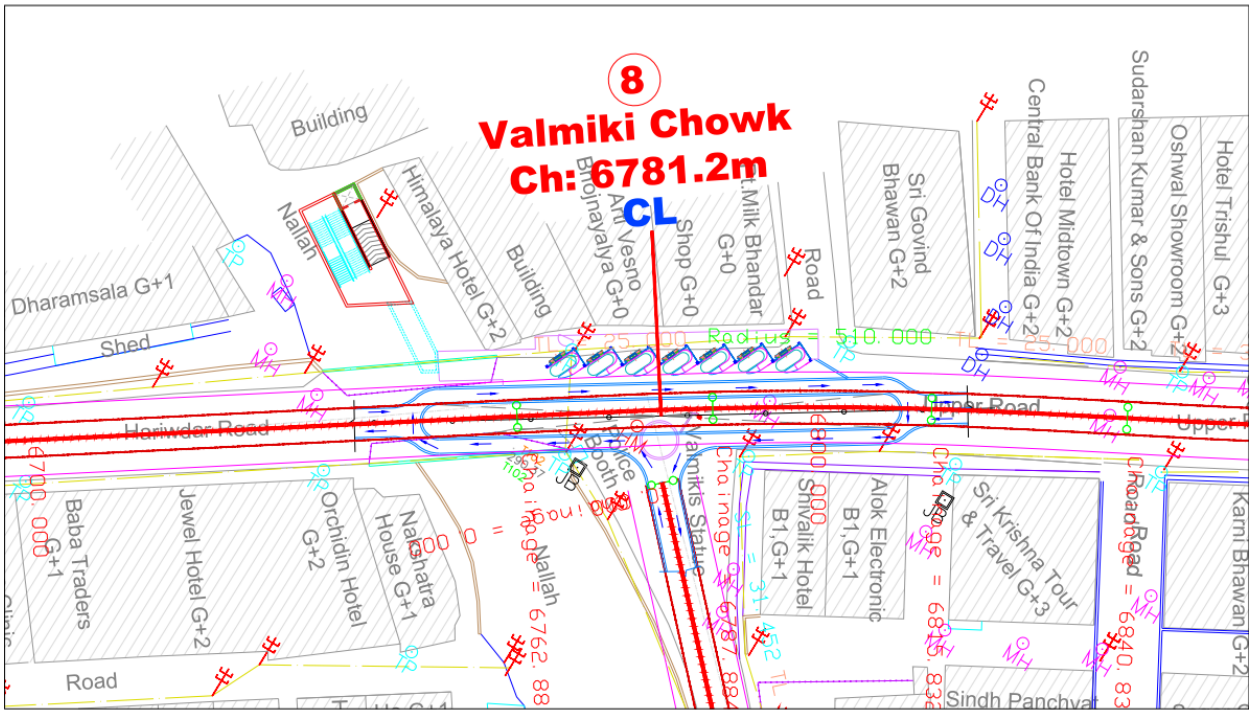


Figure 5-8: Valmiki Chowk Station

5.3.9 Mansa Devi Ropeway Gate Station

Chainage	:	7638.2m
Inter Station Distance	:	857.0m
Track Level	:	12.601m
Station type	:	Elevated, Type-4
Station Details	:	The station is located near Mansa Devi Ropeway gate. Main source of passengers to this station are pilgrims to Mansa Devi Temple and old and congested city and shall serve to reduce traffic on the narrow road below. Two entries are proposed, one on either side of the station.

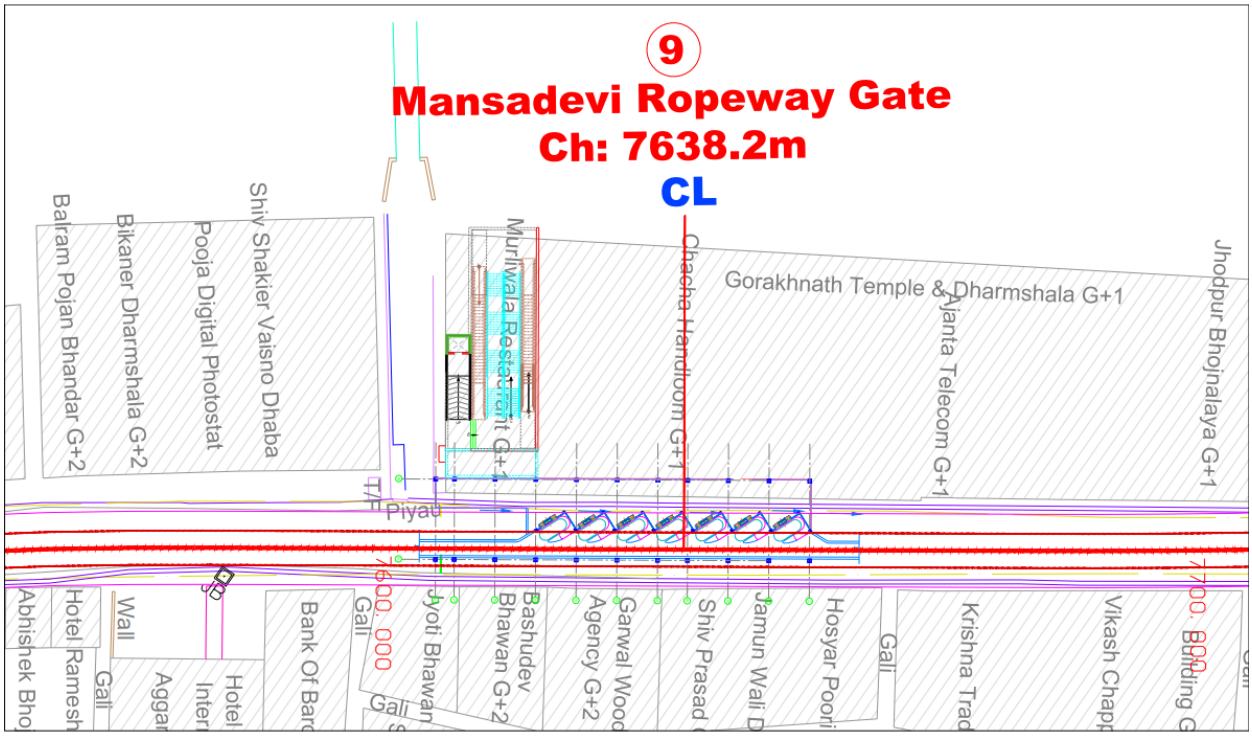


Figure 5-9: Mansa Devi Ropeway Gate Station

5.3.10 Har-Ki-Pauri Station

Chainage	:	8130.0m
Inter Station Distance	:	491.8m
Track Level	:	12.645m
Station type	:	Elevated, Type-4
Station Details	:	The station is located Haridwar Motipur Road Station shall serve the iconic and culturally vibrant Har ki Pauri. The proposed corridor shall also serve to provide unfettered access from the Railway station to the old town as well as the Har Ki Pauri. Two entries are proposed, one on either side of the station.

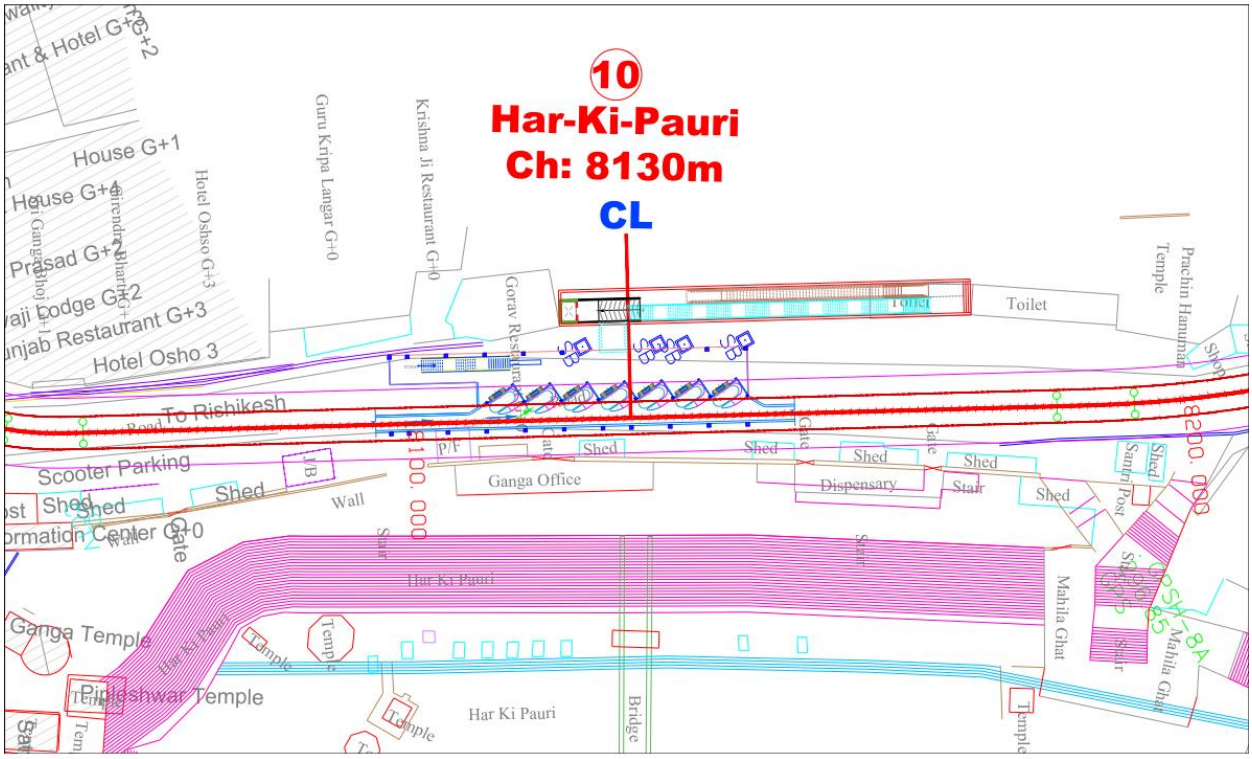


Figure 5-10: Har-Ki-Pauri Station

5.3.11 Kharkhari Station

Chainage	:	9519.6m
Inter Station Distance	:	1389.6m
Track Level	:	10.054m
Station type	:	Elevated, Type-2
Station details	:	The station is located on Hilly bypass road and the Haridwar Motichur Road. Main source of passengers to this station are pilgrims staying in dharmshala and Ashrams in vicinity. Two entries are proposed, one on either side of the station.

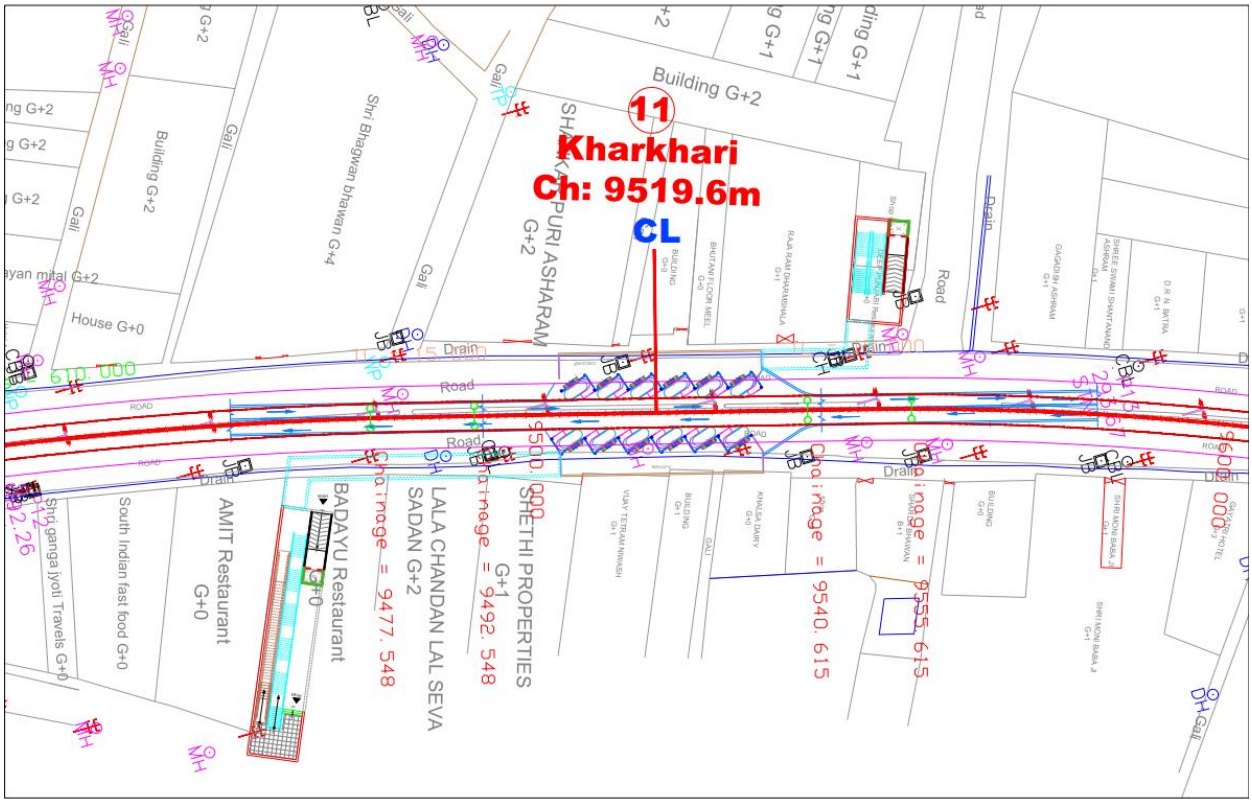


Figure 5-11: Kharkari Station

5.3.12 Motichur Station

Chainage	:	10925.2m
Inter Station Distance	:	1405.6m
Track Level	:	10.374m
Station type	:	Elevated, Type-1
Station Details	:	The station is located near Motichur Railway station on Haridwar Motichur Road. Main source of passengers to these station Railway passengers. Two entries are proposed, one on either side of the station.

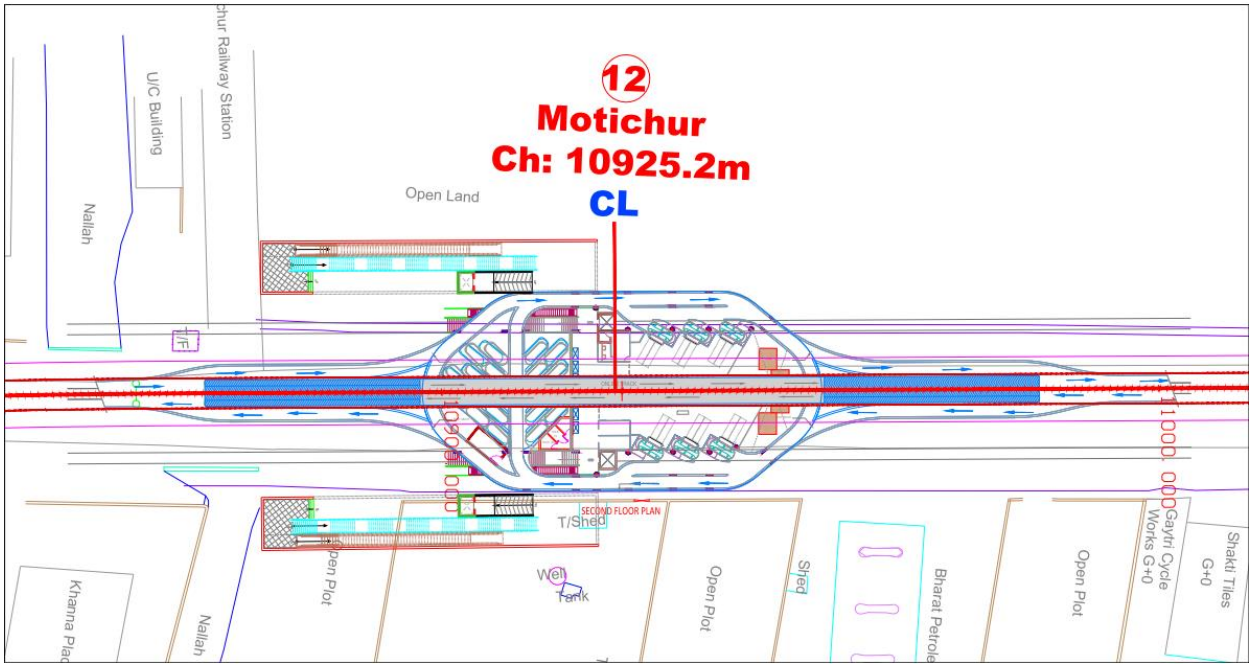


Figure 5-12: Motichur Station

5.3.13 Shantikunj Station

Chainage	:	13278.4m
Inter Station Distance	:	2353.2m
Track Level	:	12.052m
Station type	:	Elevated, Type- 3
Station Details	:	The station is located in Shantikunj on Saptrishi Road (Haridwar).Main source of passengers to this station are pilgrims staying in dharmshala and dense development around the locality. Two entries are proposed, one on either side of the station.

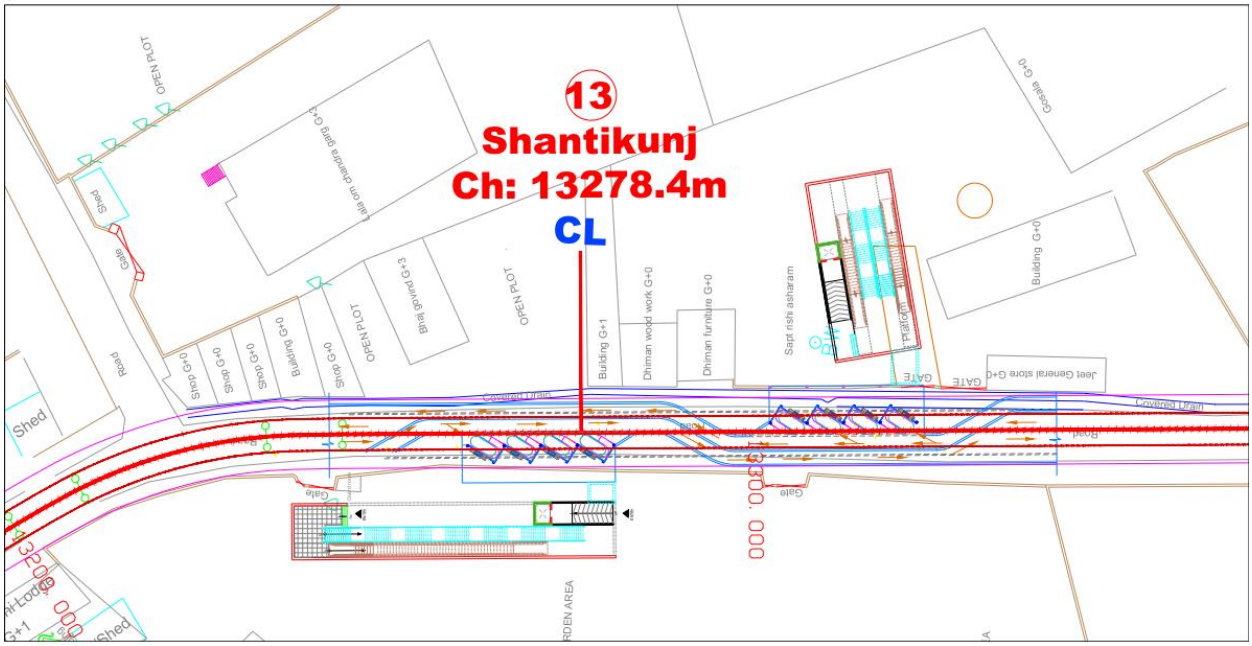


Figure 5-13: Shantikunj Station

5.3.14 Bharat Mata Temple Station

Chainage	:	14382.4m
Inter Station Distance	:	1104.0m
Track Level	:	13.559m
Station type	:	Elevated, Type-1B
Station Details	:	The station is located near Bharat Mata Temple. Main source of passengers to this station are pilgrims staying in dharmshala and development around the locality.

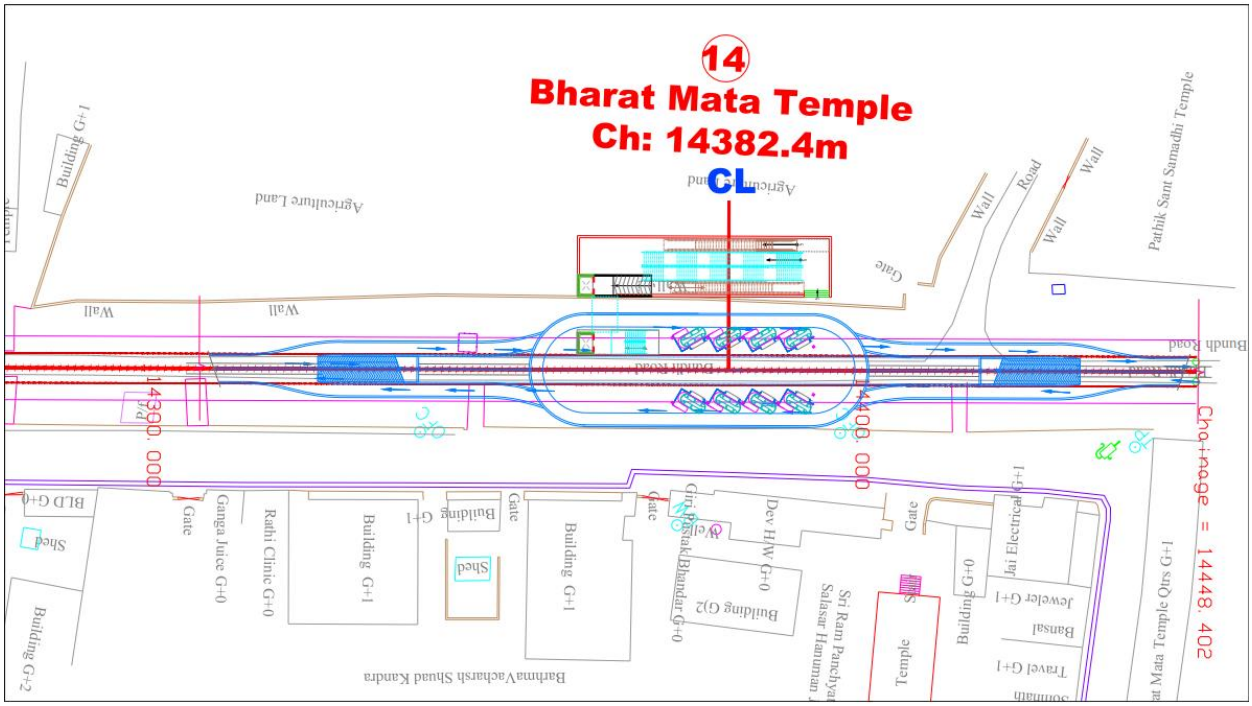


Figure 5-14: Bharat Mata Temple Station

5.3.15 Kankhal Chowk Station

Chainage	:	594.4m
Inter Station Distance	:	598.4m
Track Level	:	28.751m
Station type	:	Elevated, Type-3
Station Details	:	The station is located adjacent to the intersection of Haridwar Roorkee Marg, Bypass road and Bhairav Mandir Marg. Main source of passengers to this station are commuters from mixed development in nearby area. Two entries are proposed, one on either side of the station.

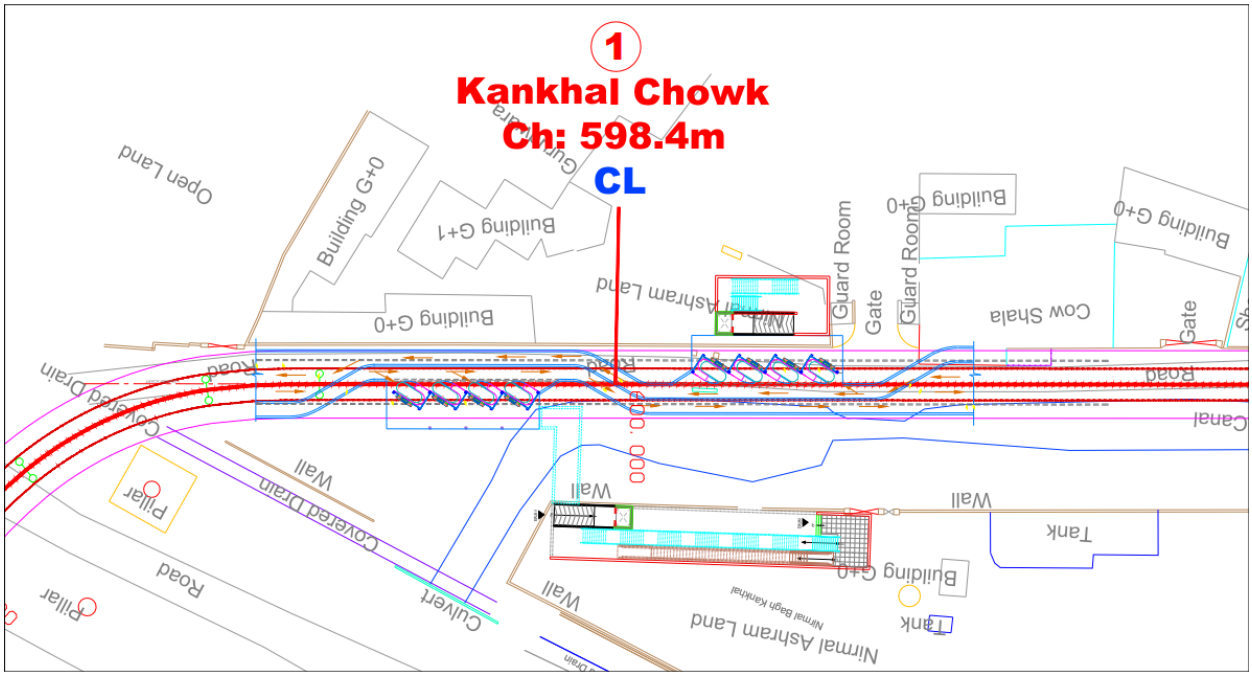
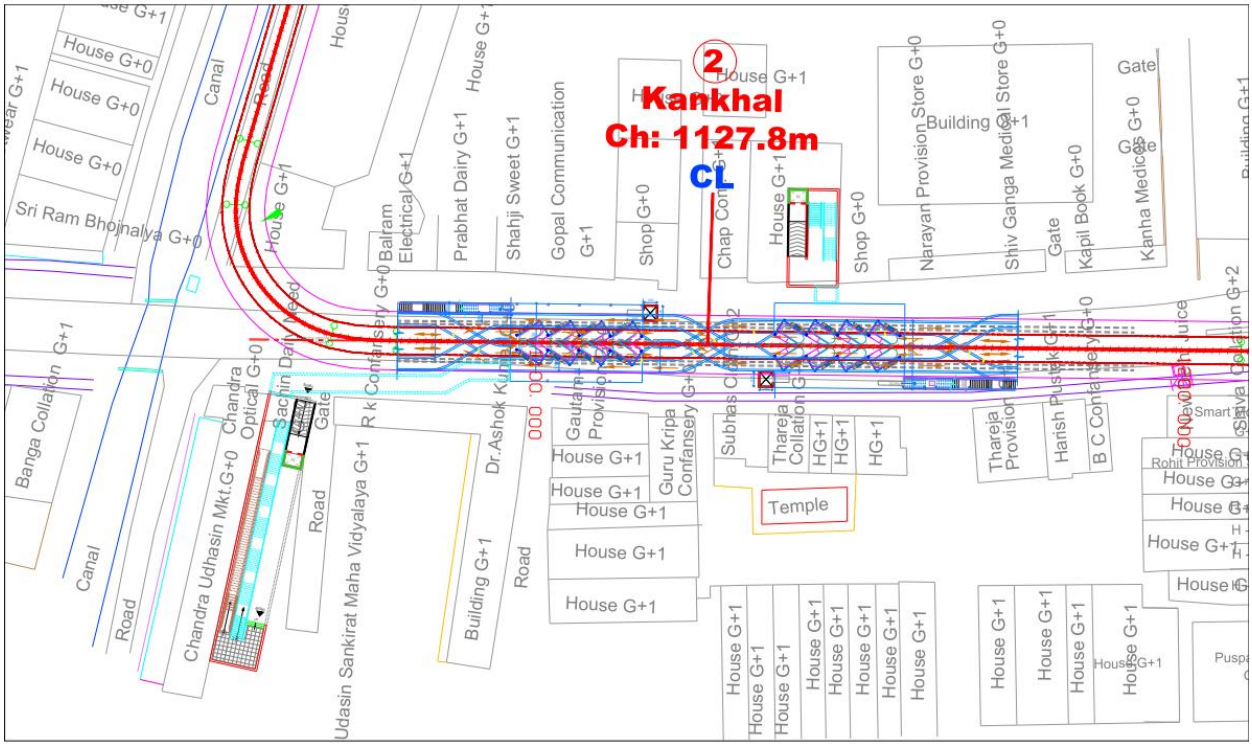


Figure 5-15: Kankhal Chowk Station

5.3.16 Kankhal Station

Chainage	:	1127.8m
Inter Station Distance	:	529.4m
Track Level	:	12.225m
Station type	:	Elevated, Type-3
Station Details	:	The station is located Bhairav Mandi Marg and Kankhal Jwalapur Marg. Main source of passengers to this station are commuters from Residential area and Ashrams. Two entries are proposed, one on either side of the station.


2
Kankhal
Ch: 1127.8m
CL
House G+1
Shop G+0
Shop G+0
Gopal Communication G+1
Shahji Sweet G+1
Prabhat Dairy G+1
Balram Electrical G+1
Narayan Provision Store G+0
Building G+1
Shiv Ganga Medical Store G+0
Kapil Book G+0
Kanha Medicos G+0
Gate
Gate
Gate
Sri Ram Bhojnalya G+0
House G+0
House G+0
House G+0
Canal
Road
Banga Collation G+1
Chandra Optical G+0
Chandra Udhasin Mkt.G+0
Sachin Dairy G+0
Gate
Road
Udasin Sankirat Maha Vidyalaya G+1
R k Confansery G+0
Dr.Ashok Kumar
Building G+1
Road
Gautam Provision
Guru Kripa Confansery G+0
Subhas Confansery G+0
Thareja Collation G+0
HG+1
HG+1
HG+1
Thareja Provision
Harish Pushpak G+1
B C Confansery G+0
Temple
Rohit Provision
House G+1
House G+1
House G+1

5.3.17 Ganeshpuram Station

Chainage	:	1976.8m
Inter Station Distance	:	849.0m
Track Level	:	10.952m
Station type	:	Elevated, Type-1A, Interchange station (Corridor 2&4)
Station Details	:	The station is located on Laksar Road and Gurubaksh Vihar. The station caters to dense development in nearby areas. Two entries are proposed, one on either side of the station.

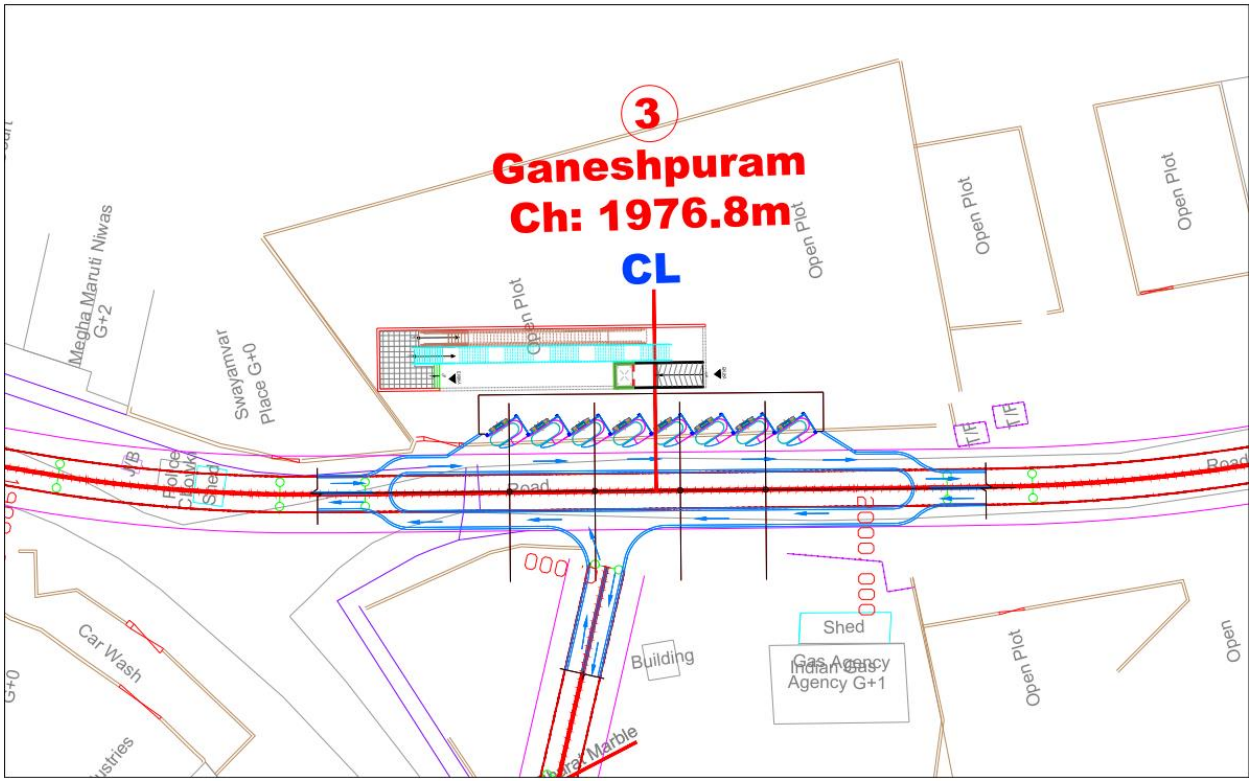


Figure 5-17: Ganeshpuram Station

5.3.18 Daksh Temple Station

Chainage	:	3018.2m
Inter Station Distance	:	1041.4m
Track Level	:	12.154m
Station type	:	Elevated, Type-3
Station Details	:	The station is located on the Bank of river Ganges. The station will cater to nearby residential area, Ashrams and Dharmashalas. Two entries are proposed, one on either side of the station.

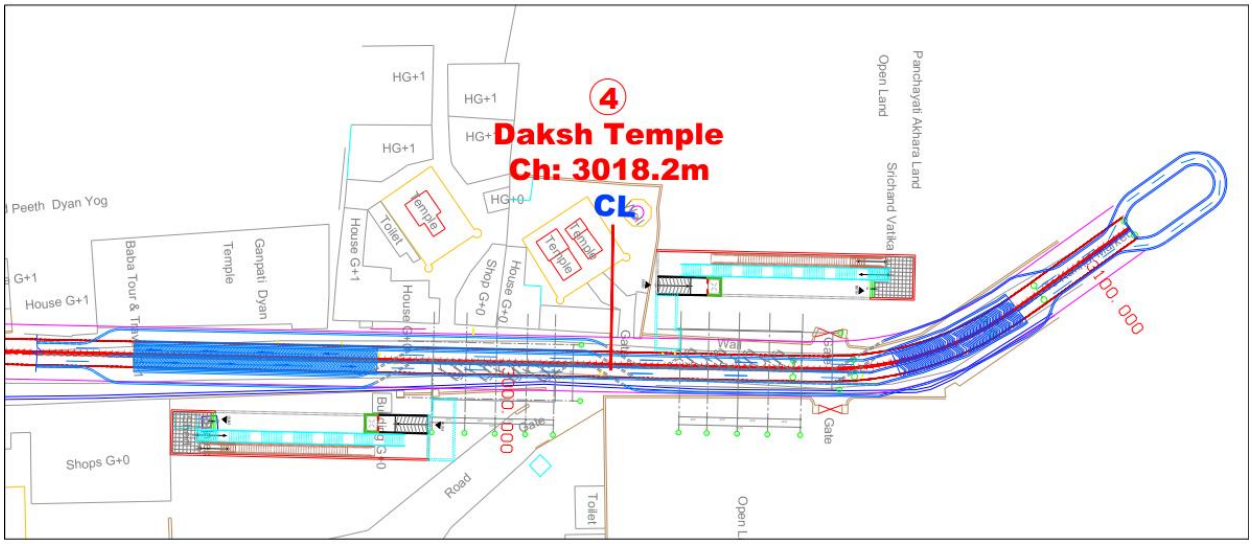


Figure 5-18: Daksh Temple Station

5.3.19 Laltaro Bridge Station

Chainage	:	620.6m
Inter Station Distance	:	620.6m
Track Level	:	10.472m
Station type	:	Elevated, Type-1
Station Details	:	The station is located on Har-Ki-Pauri marg adjacent to the main Ambala-Dehradun-Haridwar Marg (NH-43). This station will cater to Nearby Residential developments, Ashrams, Hospitals. Two entries are proposed, one on either side of the station.

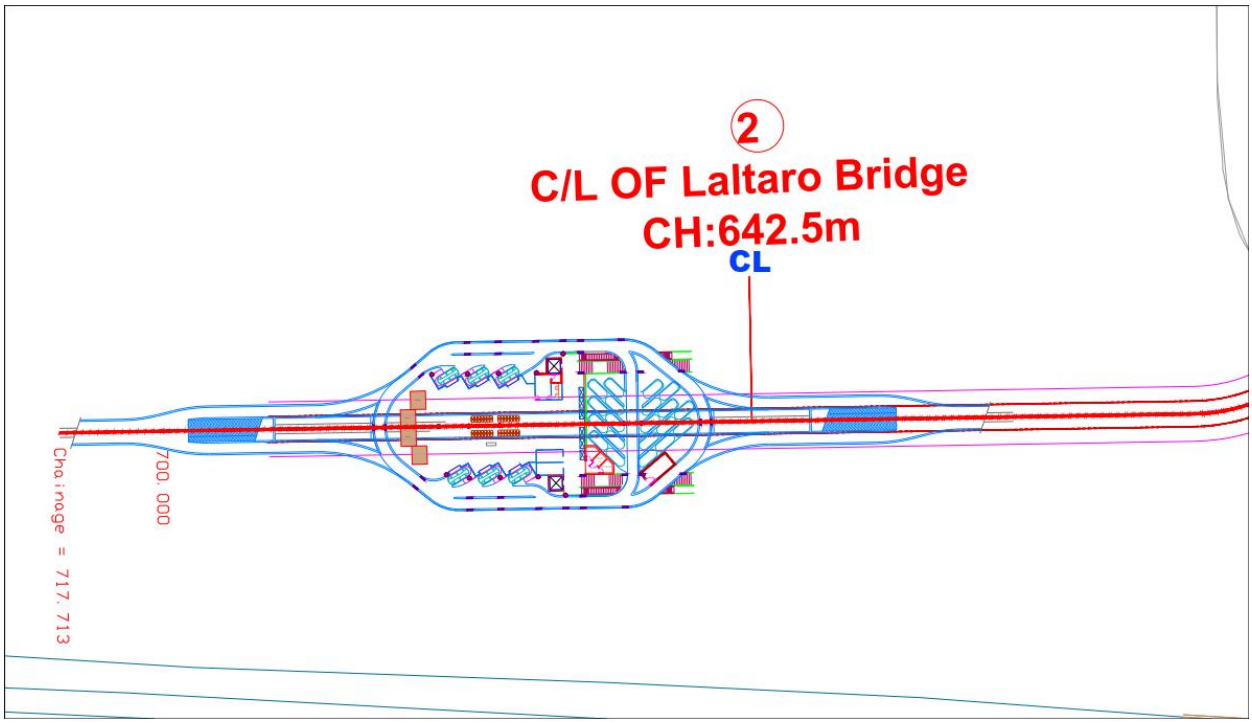


Figure 5-19: Lal Taro Station

5.3.20 Jagjeetpur Station

Chainage	:	860.1m
Inter Station Distance	:	860.1m
Track Level	:	12.025m
Station type	:	Elevated, Type-3
Station Details	:	The station is located at intersection of Laksar Road and Jamalpur Road. Main source of passengers to this station are pilgrims staying in dharmshala and dense development around the locality. Two entries are proposed, one on either side of the station.

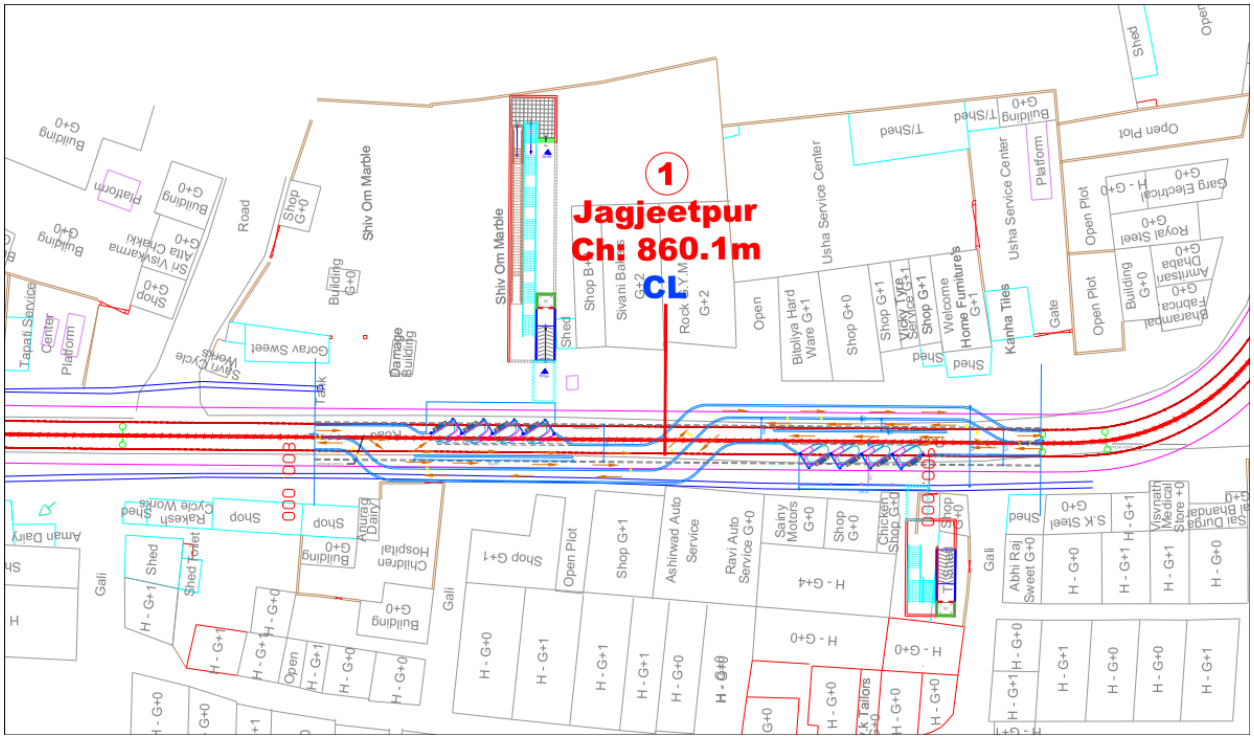


Figure 5-20: Jagjeetpur Station

5.3.21 DAV School Station

Chainage	:	2275.0m
Inter Station Distance	:	1414.9m
Track Level	:	12.049m
Station type	:	Elevated, Type-2, Terminal station
Station Details	:	The station is located adjacent to DAV school. This station will cater to the DAV school and other Institutional developments in vicinity. Two entries are proposed, one on either side of the station.

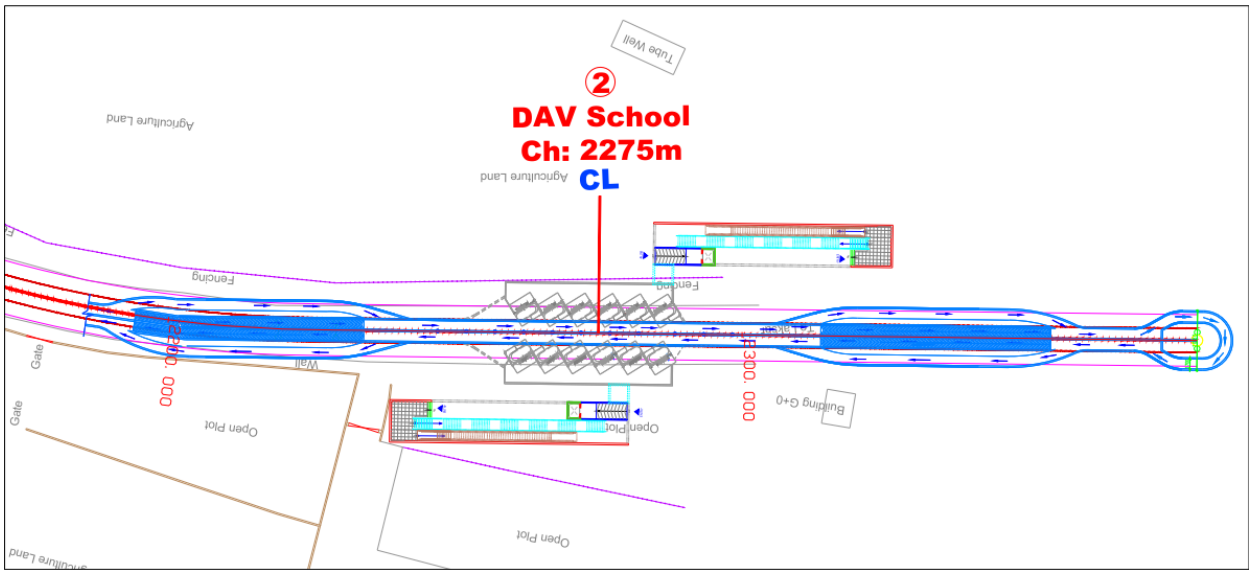


Figure 5-21: DAV School Station

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5.3.22 Berth Calculation at PRT Station

In view of the absence of any prevailing norms / codes which can be considered applicable for PRT, the assumption made for the sizing of the station are as follows:

1	Pod navigation time + berthing + de-berthing in station (maximum turnaround time in peak hour operation)	60 seconds
2	Average occupancy each POD	6 nos.
3	No. of time each Berth available for pod (Per Hour)	60 nos.
4	Per hour Passenger handling capacity of each berth	360 passengers

NORMAL SCENARIO-2051								
S. No.	Station Name	Daily Boarding	Daily Alighting	PHPDT (10% of Daily Traffic + 2% Surge Factor) *	No. of Bays Proposed	Passenger Handling per Bay per hour	Total Capacity per hour	Remarks
Corridor 1: Sitapur to Bharat Mata Temple (14 Stations including one interchange)								
1	Sitapur	3443	0	413	6	360	2160	ok
2	Jwalapur	8396	308	1008	12	360	4320	ok
3	Arya Nagar	7542	726	905	12	360	4320	ok
4	Ram Nagar	3887	651	466	12	360	4320	ok
5	City Hospital	40901	4099	4908	16	360	5760	ok
6	Rishikul	7890	5819	946	8	360	2880	ok
7	Haridwar Track-way Station	14106	6938	1693	12	360	4320	ok
8	Valmiki Chowk	6545	6553	786	7	360	2520	ok
9	Mansadevi Ropeway Gate	3170	12914	1550	14	360	5040	ok
10	Har-Ki-Pauri	1318	7353	882	14	360	5040	ok
11	Kharkhari	501	2998	360	12	360	4320	ok
12	Motichur	630	15745	1889	6	360	2160	ok
13	Shantikunj	86	9478	1137	8	360	2880	ok
14	Bharat Mata Temple	0	987	118	8	360	2880	ok
Corridor 2: City Hospital to Ganeshpuram (Terminal) (5 Stations including one interchange)								
15	Kankhal Chowk	546	3698	444	8	360	2880	ok
16	Kankhal	265	5253	630	8	360	2880	ok
17	Ganeshpuram	7782	9878	1185	8	360	2880	ok
18	Daksha Temple	0	1250	150	8	360	2880	ok
Corridor 3: Valmiki Chowk to Lal taro Bridge (2 Stations including one interchange)								
19	Lal Taro Bridge	0	4707	565	6	360	2160	ok

NORMAL SCENARIO-2051								
S. No.	Station Name	Daily Boarding	Daily Alighting	PHPDT (10% of Daily Traffic + 2% Surge Factor) *	No. of Bays Proposed	Passenger Handling per Bay per hour	Total Capacity per hour	Remarks
Corridor 4: Ganeshpuram to DAV School(3 Stations including one interchange)								
20	Jagjeetpur	114	2089	251	8	360	2880	ok
21	DAV school	0	5678	681	12	360	4320	ok

Note (*)- The figure which is higher for boarding/ alighting have been considered for calculation of requirement of bays.

Maximum number of boarding/ deboarding bays at each station have been proposed and indicated in the drawings/ design this has been done to ensure that there is no shortfall / bottleneck in times of festivals / mela etc.

POORNIMA MELA DAY SCENARIO-2051								
S. No.	Station Name	Daily Boarding	Daily Alighting	PHPDT (10% of Daily Traffic + 2% Surge Factor) *	No. of Bays Proposed	Passenger Handling per Bay per hour	Total Capacity per hour	Remarks
Corridor 1: Sitapur to Bharat Mata Temple (14 Stations including one interchange)								
1	Sitapur	6907	0	829	6	360	2160	ok
2	Jwalapur	16485	400	1978	12	360	4320	ok
3	Arya Nagar	18109	1013	2173	12	360	4320	ok
4	Ram Nagar	7173	923	861	12	360	4320	ok
5	City Hospital	86497	4387	10380	16	360	5760	Severe Space constraint at site
6	Rishikul	18958	7213	2275	8	360	2880	ok
7	Haridwar Track-way Station	24626	22414	2955	12	360	4320	ok
8	Valmiki Chowk	18013	21350	2562	7	360	2520	Space constraint at site
9	Mansadevi Ropeway Gate	4398	41599	4992	14	360	5040	ok
10	Har-Ki-Pauri	1318	22920	2750	14	360	5040	ok
11	Kharkhari	501	3382	406	12	360	4320	ok
12	Motichur	630	15745	1889	6	360	2160	ok
13	Shantikunj	86	9478	1137	8	360	2880	ok
14	Bharat Mata Temple	0	987	118	8	360	2880	ok
Corridor 2: City Hospital to Ganeshpuram (Terminal) (5 Stations including one interchange)								
15	Kankhal Chowk	817	6729	807	8	360	2880	ok

POORNIMA MELA DAY SCENARIO-2051								
S. No.	Station Name	Daily Boarding	Daily Alighting	PHPDT (10% of Daily Traffic + 2% Surge Factor) *	No. of Bays Proposed	Passenger Handling per Bay per hour	Total Capacity per hour	Remarks
16	Kankhal	387	8051	966	8	360	2880	ok
17	Ganeshpuram	18269	23086	2770	8	360	2880	ok
18	Daksh Temple	0	1250	150	8	360	2880	ok
Corridor 3: Valmiki Chowk to Laltaro Bridge (2 Stations including one interchange)								
19	Lal Taro Bridge	0	14104	1692	6	360	2160	ok
Corridor 4: Ganeshpuram to DAV School (3 Stations including one interchange)								
20	Jagjeetpur	174	3945	473	8	360	2880	ok
21	DAV school	0	14368	1724	12	360	4320	ok

Note *(*)- The figure which is higher for boarding/ alighting have been considered for calculation of requirement of bays*

Maximum number of boarding/ de-boarding bays at each station have been proposed and indicated in the drawings/ design this has been done to ensure that there is no shortfall / bottleneck in times of festivals / mela etc.

Chapter -6
Operation Plan, Depot & Maintenance Facilities

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CHAPTER 6
OPERATION PLAN, DEPOT AND MAINTENANCE FACILITIES

6.1 INTRODUCTION

The Personal Rapid Transit (PRT) system is an innovative on-demand system for urban environments. The system uses driverless electric vehicles that run on a dedicated network of guide ways. The lightweight and flexible nature of the system enables it to be retrofitted into a broad range of environments and provide seamless transportation that is environmentally friendly and operationally efficient. In absence any standards issued by Centre/State Govt. with respect to PODs/ PRT system, the details of the PRT system have been taken from the internet mainly and details of an advice note comprising of different PRT System and its benefits are enclosed at Attachment- 6.1. These are approximate & can vary from supplier to supplier.

6.2 CAR SIZE

The following optimum size of the car, as opted for this corridor, has been chosen for this corridor as mentioned in the Table below.

Table 6-1 Size of the POD Car

Description	Length	Width	Height
POD (PRT) Cars	3.5 m to 4 m	1.4 m to 2 m	1.8 m to 2.4 m

6.3 PASSENGER CARRYING CAPACITY

The seats are facing front and rear of the cars proving flexible accommodations for 4 to 6 passengers.

6.4 WEIGHT

The tentative weights of PRT (POD) car have been estimated as in Table below, referring to the experiences internationally, the average passenger weight has been taken as 65 kg.

Table 6-2 Weight of POD Cars (Approx.)

Description	Gross Weight #	Tare Weight #
POD (PRT) Cars	-	-

Tare weight should be as low as possible. Gross weight will be including 6 passengers

6.5 PERFORMANCE PARAMETERS (INDICATIVE)

Items	Values
Design Speed	100 kmph
Operating Speed (Maximum)	90 kmph
Average Speed	40~ 60 kmph
Maximum acceleration	>0.80 m/s^2
Normal deceleration	1.0 m/s^2
Emergency Braking deceleration rate (Minimum)	3 m/s^2
Braking System	Electromagnetic regenerative braking system

6.6 CAR DESIGN AND BASIC PARAMETERS

The important criteria for selection of PRT (POD) Cars are as under:

- Proven equipment with high reliability
- Passenger safety feature
- Energy efficiency
- Light weight equipment and car body
- Optimized scheduled speed
- Aesthetically pleasing Interior and Exterior
- Low Life cycle cost
- Flexibility to meet increase in traffic demand

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The car should have high rate of acceleration and deceleration.

6.7 SELECTION OF TECHNOLOGY – LOW LIFE CYCLE COST

Low life cycle cost is achieved by the way of reduced scheduled and unscheduled maintenance and high reliability of the sub-systems. It is possible to achieve these objectives by adopting suitable proven technologies. Selection of following technologies has been recommended to ensure low life cycle cost.

6.7.1 Car Body/ Chassis

The car bodies shells/ frame with stainless steel or aluminum car body shells/ frame which leads to energy saving due to its lightweight with self-colored ABS panels with high glass acrylic capping. The separate fabricated frames for mounting of suspension, steering, motor/transmission and batteries. The upper frames are required to support exterior and interior panels of body, side doors and interior panels/hatches. It should have bumper structure to absorb impact energy.

6.7.2 Suspension and Steering System

Use of reliable suspension system on front and rear using predominantly aluminum machined wishbones, coil cover damper units and standard automotive joints, bearings and bushes.

6.7.3 Braking System

The brake system shall consist of

- A Drive motor regenerative braking
- A Service braking (normal operations)
- Emergency brakes
- A fail-safe parking brakes
- A safety interlocks between brakes, motor and door.

The regenerative electro dynamic braking will be the main brake power of the pod cars.

6.7.4 Power Train and Traction Battery System

Traction battery system is that in which a battery is required to provide the traction in the system through the synchronous AC motor. The vehicle main energy source will be Lithium ion battery with converter which gives the ac power to the motor and it propels the all 4 wheels sufficient to cover of minimum 250 km in single charge. Stations and maintenance yard will have the charging stations with combinations of AC and DC Charger. Battery charging is undertaken during off-peak hours and during non-operating period. The discharged POD car shall be parked on the Charger location for charging the POD Cars. The POD car at the Berth location shall be charged in between the duration to park on the berth and boarding of the passenger.

The Power train system should be compatible with the signaling system with their VCS (Vehicle Control System) and AVP (Automatic Vehicle Protection) systems.

6.7.5 Interior

Passenger capacity of a car is maximized in a PRT System by providing front & rear of cars for seating and utilizing the remaining space for using the passenger bags or the wheel chair of specially-abled passenger. Therefore, all the equipment's are mounted on the under frame for maximum space utilization. Interior panel is well flushed with high glass acrylic capping. Interior panel have equipped with sufficient lighting and vehicle signs, symbols, warnings & other passenger safety information. All safety switches should have illuminated for passenger's usages.

Interior View

6.7.6 Passenger Door

One door of adequate width, on each side of the coach has been considered. These doors shall be of such dimensions and location that all the passengers inside the car are able to evacuate within least possible time without conflicting movement. As the alignment passes through elevated section above ground, automatic door closing mechanism is envisaged from consideration of passenger safety. Passenger doors are controlled electrically by a switch in cars. Electrically controlled door operating mechanism has been preferred over pneumatically operated door to avoid cases of air leakage and sluggish operation of doors.

Passenger Door

6.7.7 Air–Conditioning

With 6 passenger and doors being closed from consideration of safety and with windows being sealed type to avoid transmission of noise, air conditioning of coaches has been considered essential. It shall be provided with air conditioning units capable of cooling, heating and dehumidifying and thus automatically controlling interior temperature throughout the passenger area all the times under varying ambient conditions up to full load. Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the car, during an emergency condition, such as fire outside the car causing excessive heat and smoke to be drawn in to the car.

6.7.8 Emergency Detrainment Door

An emergency door for easy detrainment of the passenger on the track has been provided at the centre of the front side of each cabin or side passenger doors as emergency evacuation door which has an easy operation with one handle type controller.

6.7.9 Communication

The PRT (POD) cars are provided with continuous communication with base Operational Control Centre (OCC) for easy monitoring of the individual car in all sections at all the time.

Public Address and Passenger Information Display System is provided in the car so that passengers are continuously advised of the next stoppage station, final destination station, interchange station, emergency situations if any, and other messages. The PRT (POD) cars are provided with Talk Back Units inside the cars, which permit conversation between passengers and the controllers in OCC in case of any emergency.

6.7.10 Noise and Vibration

The PRT/ POD Cars will pass through heavily populated urban area. The noise and vibration for a PRT system becomes an important criterion from public acceptance view point and running noise of the Pod car should be less than 45 dBA.

6.7.11 Passenger Safety Features

(i) ATP/ ATO/ UTO

PRT car uses a combination of systems engineering, railway engineering and automotive engineering in its PRT systems and these all coalesce to form the overall control system. This combines features of ATC and ATP as well as autonomous vehicle control systems. The control system is the heart of the PRT system and it is being controlled by Vehicle control system (VCS) and automatic vehicle protection system (AVP) to ensure absolute safety in the vehicle operation. It is an accepted fact that 60-70% of the accidents take place on account of human error. Adoption of this system reduces the possibility of human error.

(ii) Fire

The PRT/POD Car is provided with fire retarding materials having low fire load, low heat release rate, low smoke and toxicity inside the cars.

The electric cables used are also normally low smoking zero halogen type which ensures passenger safety in case of fire. One fire extinguisher in car is to be provided. All materials used for construction of PRT shall comply with international standards for fire and smoke.

Fresh air intake to the saloon area of the car shall have smoke detection system to prevent entry of external smoke into the saloon area.

Smoke and Fire alarms has been installed in cars to inform the Network Controllers in OCC of smoke or fire in the vehicle so that an appropriate emergency services response can be arranged if required.

(iii) Emergency Door

The PRT/POD car is provided with emergency doors at both ends of the car or side passenger doors as emergency evacuation door to ensure well directed evacuation of passengers in case of any emergency including fire in the Car. Selection of Emergency evacuation methodology is to be defined in the technical requirement by the authority.

(iv) Crash Worthiness Features

The PRT/ POD car is provided with bumper structure designed to progressively absorb the impact energy and limit passenger deceleration and prevents injuries to passengers in low speed impacts.

(v) Obstruction Deflection Device (ODD)

ODD shall be mounted on front of car which shall be able to deflect obstacles such as metal block, wooden block or plastic bottle with water etc. After detection and deflection of obstacle, emergency brake shall be applied to stop the car automatically.

(vi) Passenger Saloon Surveillance System (CCTV)

The Passenger Saloon Surveillance System (PSSS) shall comprise of a close circuit television (CCTV) network using surveillance cameras to be installed in POD Cars and direct feed of the CCTV should be provided in the control centre.

(vii) Tyre-Pressure Monitoring

A tyre-pressure monitoring system (TPMS) is fitted to each vehicle to provide continuous monitoring of tyre condition. Loss of tyre pressure will be detected and reported to control centre before an unsafe condition can result.

In absence of any guidelines/ standards used by centre/State govt., the salient features of proposed system have been taken from internet and are indicative to supplier. The tentative features of proposed POD cars are as under:

Table 6-3 Salient Features (Tentative) of PRT System

S. No.	Parameter	Details
1	**Guide way**	
1.1	Width	1,700 mm- 2,300 mm
1.2	Depth	450 mm
1.3	Height above roadway	5,700 mm
1.4	Column spacing	18,000 mm
1.5	Max. Gradient	10%
1.6	Min. radius	5 m
2	**Traction system**	
2.1	Traction Battery System	Lithium ion
2.2	Motor continuous power	As per Design
2.3	km (minimum) (normal operating condition)	250 km
2.4	Recharging (AC)	1.5 to 2 hours
2.5	Recharging (DC)	10- 15 minutes
3	**Car composition**	
3.1	1 POD car	Single POD car
4	**Coach Body Shell/ Chassis**	Stainless Steel/ Aluminium
5	**Car Dimensions**	
5.1	Length	3,500 mm to 4,000 mm
5.2	Width	1,400mm to 2,000 mm
5.3	Height	1,800 mm to 2,400 mm
5.4	Floor height (min.)	300 mm
6	**Designed Passenger Loading**	
6.1	Maximum no. of Passengers	6
7	**Weight (kg)**	
7.1	Tare weight	As low as possible
7.2	Gross weight	Tare weight + weight of 6 passengers
8	**Speed**	
8.1	Design Speed	100 kmph
8.2	Operating Speed (Maximum)	90 kmph
8.3	Average Speed	40~ 60 kmph
9	**Traction Motors Ventilation**	Self
10	**Acceleration on level tangent track**	As define in para 6.5
11	**Deceleration on level tangent track**	As define in para 6.5
12	**Type of Chassis**	Fabricated
13	**Suspension Systems**	As per design

S. No.	Parameter	Details
14	**Brakes**	- A Drive motor regenerative braking - A fail safe electromagnetic 'hold off' motor brakes - A fail safe electromagnetic 'hold off' rear wheel brakes - A safety interlocks between brakes, motor and door - A fail-safe parking system
15	**Detrainment Door**	Front/ Side Passenger Door
16	**Type of Doors**	Sliding
17	**Lighting**	LED based with dimmer control
18	**Passenger Seats**	Stainless Steel/ Plastic/ Cushion Type
19	**Cooling**	
19.1	Motor	Forced
19.2	Battery	Self
19.3	Battery Charger	Self
20	**Control System**	Vehicle Control System
21	**Traction Motors**	AC Synchronous motor
22	**Temperature Rise Limits**	
22.1	Traction Motor	Temperature Index **minus 70°C**
22.2	Battery Box	10°C temperature margin for Junction temperature
22.3	Battery Charger	IEC specified limit **minus 20°C**
23	**Air Conditioning**	- Cooling, Heating &Humidifier (As required) - Automatic controlling of interior temperature throughout the passenger area at 25°Cwith 60% RH all the times under varying ambient Conditions up to full load.
24	**PA/PIS**	Required
25	**Passenger Surveillance (CCTV)**	Required
26	**Battery**	Li-ion
27	**Headlight type**	LED
28	**Operation**	Driverless ATO/ATP

6.8 OPERATION PHILOSOPHY

The underlying operation philosophy is to make the PRT System more attractive and economical, the main features being:

- Selecting the most optimum frequency of Pod Car services to meet sectional capacity requirement during peak hours on most of the sections

- Economical & optimum train service frequency not only during peak period, but also during off-peak period
- Optimization of system reliability for achieving best possible availability on line
- A Pod Car of having 4 to 6 passenger capacity with high frequency service
- Multi-tasking of operation and maintenance staff.

6.9 STATIONS

Corridor-wise station detail for the proposed Haridwar PRT System is given below:

Table 6-4 Detail of Proposed PRT Stations in Haridwar

S. No.	Station Name	Chainage (m)	Inter Distance between Two Stations (m)	Station Type
Corridor-1: Sitapur-Bharat Mata Temple				
1	Sitapur	-29.90	75.1	Elevated
2	Jwalapur	398.6	428.5	Elevated
3	Arya Nagar	1704.1	1305.5	Elevated
4	Ram Nagar	2762.6	1058.5	Elevated
5	City Hospital	3760.2	997.6	Elevated
6	Rishikul	4709.5	949.3	Elevated
7	Haridwar Railway Station	6119.5	1410.0	Elevated
8	Valmiki Chowk	6781.2	661.7	Elevated
9	Mansadevi Ropeway Gate	7638.2	857.0	Elevated
10	Har-Ki-Pauri	8130.0	491.8	Elevated
11	Kharkhari	9519.6	1389.6	Elevated
12	Motichur	10925.2	1405.6	Elevated
13	Shantikunj	13278.4	2353.2	Elevated
14	Bharat Mata Temple	14382.4	1104.0	Elevated
Corridor-2: City Hospital to Daksh Temple				
1	City Hospital	0.00	0.0	Elevated
2	Kankhal Chowk	598.4	598.4	Elevated
3	Kankhal	1127.8	529.4	Elevated
4	Ganeshpuram	1976.8	849.0	Elevated
5	Daksh Temple	3018.2	1041.4	Elevated
	Dead End	3109.9	91.7	
Corridor-3: (Spur) Valmiki Chowk to Laltaro Bridge				
1	Valmiki Chowk	0.00	0.00	Elevated
2	Lal Taro Bridge	620.6	620.6	Elevated
	Dead End	693.8	73.2	
Corridor-4: Ganeshpuram to DAV School				
1	Ganeshpuram	0.00	0.0	Elevated
2	Jagjeetpur	860.1	860.1	Elevated
3	DAV School	2275.0	1414.9	Elevated
	Dead End	2379.3	104.3	

6.10 SALIENT FEATURES OF PRT OPERATION PLAN

- Running of services for 16 hours of the day
- Scheduled speed for this corridor has been considered as 60 kmph.

6.11 TRAFFIC DEMAND

Peak hour peak direction traffic demands (PHPDT) for the Haridwar PRT System corridors: corridor -1 Sitapur-Bharat Mata Temple, Corridor -2 City Hospital to Daksh Temple, Corridor -3 Valmiki Chowk to Laltaro Bridge and Corridor -4 Ganeshpuram to DAV School in the year 2021, 2031, 2041 and 2051for the purpose of planning are indicated in Attachment I/A, I/B.I/C and I/D respectively.

6.12 SYSTEM INFORMATION

To meet the above projected traffic demand, the possibility of running Pod Cars in year 2021, 2031, 2041 and 2051 with different headway has been examined.

6.13 PRT OPERATION PLAN

PRT operation plan with Pod Cars with carrying capacity of 6 persons for the Haridwar PRT Systems are being planned: for all the 4 corridors in the year 2021,2031,2041 and 2051are given below:

(i) **Year 2021(Refer Attachment I/A1):** Train operation plan with 4 passenger capacity Pod Car is being planned for all 4 Corridors, The PHPDT for normal Day and Mela days has been considered in Train operation plan.

For Normal Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the normal day operation headway of 22 seconds, 8 seconds and 12 Seconds respectively to meet the demand PHPDT during normal day.

In Corridor-2: (City Hospital – Daksh temple) with the normal day operation headway of 17 seconds has been planned to cater the demand PHPDT during normal day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 75 seconds has been planned to cater the demand PHPDT during normal day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 39 seconds has been planned to cater the demand PHPDT during normal day.

For Mela Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the headway of 10 seconds, 3 seconds and 13 Seconds respectively to meet the demand PHPDT during mela day.

In Corridor-2: (City Hospital – Daksh temple) with headway of 8 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 20 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 16 seconds has been planned to cater the demand PHPDT during mela day.

(ii) **Year 2025 (Refer Attachment I/A1-1):** Train operation plan with 4 passenger capacity Pod Car is being planned for all 4 Corridors, The PHPDT for normal Day and Mela days has been considered in Train operation plan.

For Normal Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the normal day operation headway of 16 seconds, 6.5 seconds and 11 Seconds respectively to meet the demand PHPDT during normal day.

In Corridor-2: (City Hospital – Daksh temple) with the normal day operation headway of 13 seconds has been planned to cater the demand PHPDT during normal day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 63 seconds has been planned to cater the demand PHPDT during normal day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 31 seconds has been planned to cater the demand PHPDT during normal day.

For Mela Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the headway of 7.5 seconds, 3 seconds and 10.7 Seconds respectively to meet the demand PHPDT during mela day.

In Corridor-2: (City Hospital – Daksh temple) with headway of 7 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 20 seconds has

been planned to cater the demand PHPDT during mela day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 13.5 seconds has been planned to cater the demand PHPDT during mela day.

(iii) **Year 2031(Refer Attachment I/B1):** Train operation plan with 4 passenger capacity Pod Car is being planned for all 4 Corridors, The PHPDT for normal day and mela days has been considered in train operation plan.

For Normal Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the headway of 12 seconds, 5 seconds and 9 Seconds respectively to meet the demand PHPDT.

In Corridor-2: (City Hospital – Daksh temple) with the headway of 10 seconds has been planned to cater the demand PHPDT.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 50 seconds has been planned to cater the demand PHPDT.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 24 seconds has been planned to cater the demand PHPDT.

For Mela Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-ki-Pauri) and third (Har- ki-Pauri to Bharat Mata Temple) with the headway of 5 seconds, 2.5seconds and 9Seconds respectively to meet the Demand PHPDT during mela day.

In Corridor-2: (City Hospital – Daksh temple) with the normal day operation headway of 5 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 17 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 10 seconds has been planned to cater the demand PHPDT during mela day.

(iv) **Year 2041 (Refer Attachment I/C1):** Train operation plan with 4 passenger capacity Pod Car is being planned for all 4 Corridors, The PHPDT for normal Day and Mela days has been considered in train operation plan.

For Normal Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-

Pauri to Bharat Mata Temple) with the headway of 8 seconds, 4 seconds and 6.5 Seconds respectively to meet the demand PHPDT.

In Corridor-2: (City Hospital – Daksh temple) with the headway of 7.5 seconds has been planned to cater the demand PHPDT.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 40 seconds has been planned to cater the demand PHPDT.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 18 seconds has been planned to cater the demand PHPDT.

For Mela Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the headway of 4 seconds, 2seconds and 7Seconds respectively to meet the demand PHPDT during mela day.

In Corridor-2: (City Hospital – Daksh temple) with the headway of 4 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 13 seconds has been planned to cater the demand PHPDT during melal day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 8 seconds has been planned to cater the demand PHPDT during mela day.

(v) **Year 2051 (Refer Attachment I/D1):** Train operation plan with 4 passenger capacity Pod Car is being planned for all 4 Corridors, The PHPDT for normal Day and Mela days has been considered in Train operation plan.

For Normal Days

In Corridor-1: the margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with the headway of 6.5 seconds, 3 seconds and 5 Seconds respectively to meet the demand PHPDT.

In Corridor-2: (City Hospital – Daksh temple) with the headway of 6 seconds has been planned to cater the demand PHPDT.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 30 seconds has been planned to cater the demand PHPDT.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 15 seconds has been planned to cater the demand PHPDT.

For Mela Days

In Corridor-1: The margin of PHPDT for different station is quite high, so to optimize and delivered the economical operation plan the section has been divided in 3 loops, first (Sitapur – City Hospital), second (City Hospital to Har-Ki-Pauri) and third (Har-Ki-Pauri to Bharat Mata Temple) with headway of 3 seconds, 2 seconds and 5Seconds respectively to meet the demand PHPDT during mela day.

In Corridor-2: (City Hospital – Daksh temple) with the headway of 3 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-3: (Valmiki Chowk to Laltaro Bridge) with the headway of 10 seconds has been planned to cater the demand PHPDT during mela day.

In Corridor-4: (Ganeshpuram to DAV School) with the headway of 6seconds has been planned to cater the demand PHPDT during mela day.

The PHPDT capacity provided on the route of proposed PRT System in Haridwar in different years of operation is tabulated below:

Table 6-5 Capacities Provided for Haridwar PRT System for Normal Days

Corridors	Particular	2021	2025	2031	2041	2051
All Corridors	Car	1	1	1	1	1
Corridor 1a (Sitapur – City Hospital)	Headway (sec.)	22	16	12	8	6.5
	Max. PHPDT Demand	654	894	1,253	1,707	2,225
	PHPDT Capacity available	655	900	1,200	1,800	2,215
Corridor 1b (City Hospital – Har-Ki-Pauri)	Headway(sec.)	8	6.5	5	4	3
	Max. PHPDT Demand	1,819	2,187	2,739	3,681	4,849
	PHPDT Capacity available	1,800	2,215	2,880	3,600	4,800
Corridor 1c (Har-Ki-Pauri – Bharat Mata Temple)	Headway (sec.)	12	11	9	6.5	5
	Max. PHPDT Demand	1,124	1,322	1,619	2,155	2,799
	PHPDT Capacity available	1,200	1,309	1,600	2,215	2,880
Corridor 2 (City Hospital – Daksh Temple	Headway (sec.)	17	13	10	7.5	6
	Max. PHPDT Demand	858	1,080	1,412	1,892	2,446
	PHPDT Capacity available	847	1,108	1,440	1,920	2,400
Corridor 3 (Valmiki Chowk – Laltaro Bridge)	Headway (sec.)	75	63	50	40	30
	Max. PHPDT Demand	191	228	283	364	471
	PHPDT Capacity available	192	229	288	360	480
Corridor 4	Headway (sec.)	39	31	24	18	15

Corridors	Particular	2021	2025	2031	2041	2051
(Ganeshpuram – DAV School)	Max. PHPDT Demand	366	461	603	776	953
	PHPDT Capacity available	369	465	600	800	960

Note: - Corridor 1 has been divided in 3 loops to optimize the PHPDT demand and capacity.

Table 6-6 Capacities Provided for Haridwar PRT System for Mela Days

Corridors	Particular	2021	2025	2031	2041	2051
All Corridors	Car	1	1	1	1	1
Corridor 1a (Sitapur – City Hospital)	Headway (sec.)	10	7.5	5	4	3
	Max. PHPDT Demand	1,429	1,953	2,739	3,745	4,949
	PHPDT Capacity available	1,440	1,920	2,880	3,600	4,800 (7200) #
Corridor 1b (City Hospital – Har-Ki-Pauri)	Headway(sec.)	3	3	2.5	2	2
	Max. PHPDT Demand	4,393	4,991	5,888	7,894	10,462
	PHPDT Capacity available	4,800	4,800	5,760	7,200 (10,800) #	7,200 (10,800) #
Corridor 1c (Har-Ki-Pauri – Bharat Mata Temple)	Headway (sec.)	13	10.7	9	7	5
	Max. PHPDT Demand	1,141	1,343	1,645	2,191	2,837
	PHPDT Capacity available	1,108	1,346	1,600	2,057	2,880
Corridor 2 (City Hospital – Daksh Temple	Headway (sec.)	8	7	5	4	3
	Max. PHPDT Demand	1,812	2,218	2,828	3,741	4,862
	PHPDT Capacity available	1,800	2,057	2,880	3,600	4,800
Corridor 3 (Valmiki Chowk – Laltaro Bridge)	Headway (sec.)	20	20	17	13	10
	Max. PHPDT Demand	690	748	836	1,090	1,423
	PHPDT Capacity available	720	720	847	1,108	1,440
Corridor 4 (Ganeshpuram – DAV School)	Headway (sec.)	16	13.5	10	8	6
	Max. PHPDT Demand	905	1,114	1,427	1,857	2,360
	PHPDT Capacity available	900	1,067	1,440	1,800	2,400

Note: - Corridor 1 has been divided in 3 loops to optimize the PHPDT demand and capacity.
The maximum capacity has been considered with 4 passengers per car only, however the maximum passenger capacity in a car/ Pod is 6, so for Year 2051& 2041 Mela Day Passenger Carrying capacity with 6 passengers per car is more than the traffic demand requirements.

6.14 POD CAR FREQUENCY

The frequency of the PRT system is as per the requirements; however, the system is design to cater the highest PHPDT as per the Table above.

No services are proposed between 00:00 hrs to 5.00 hrs, which are reserved for maintenance of infrastructure.

6.15 VEHICLE-KILOMETRE

Based on above planning, after considering maintenance period and assuming 340 days in service in a year, Pod Car-km for Haridwar PRT System, is enclosed as **Attachment II**.

6.16 YEAR-WISE RAKE REQUIREMENT

Based on Car and headway as decided above to meet Peak Hour Peak Direction Traffic Demand, rake requirement has been calculated and enclosed as **Attachment III**.

Requirements of coaches is calculated based on following assumptions-

Assumptions –

(i) Pod Car Composition planned as under;

- Car Carrying Capacity of 4-6 passengers
- Car requirement has been calculated based on headway to cater maximum demand.

(ii) Repair and maintenance reserve has been estimated as 10% of total requirement (Bare).

(iii) The calculated number of rakes in fraction is rounded off to next higher number.

(iv) Schedule speed is taken as: 60 kmph.

(v) Total Turn round time is taken as 2 min at terminal stations& other stations.

6.17 COST ESTIMATE

The estimated cost per Pod car excluding taxes and duties may be assumed as INR 40 lakhs per Car. For the year 2025, total rakes requirement for mela days is 514 Pod cars are required for Haridwar PRT System for all 4 corridors. Hence budget provision of Rs. 205.6 Crores (approx.) is to be kept in the estimate for Pod Cars.

Normal Days

Attachment - I/A1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year: 2021

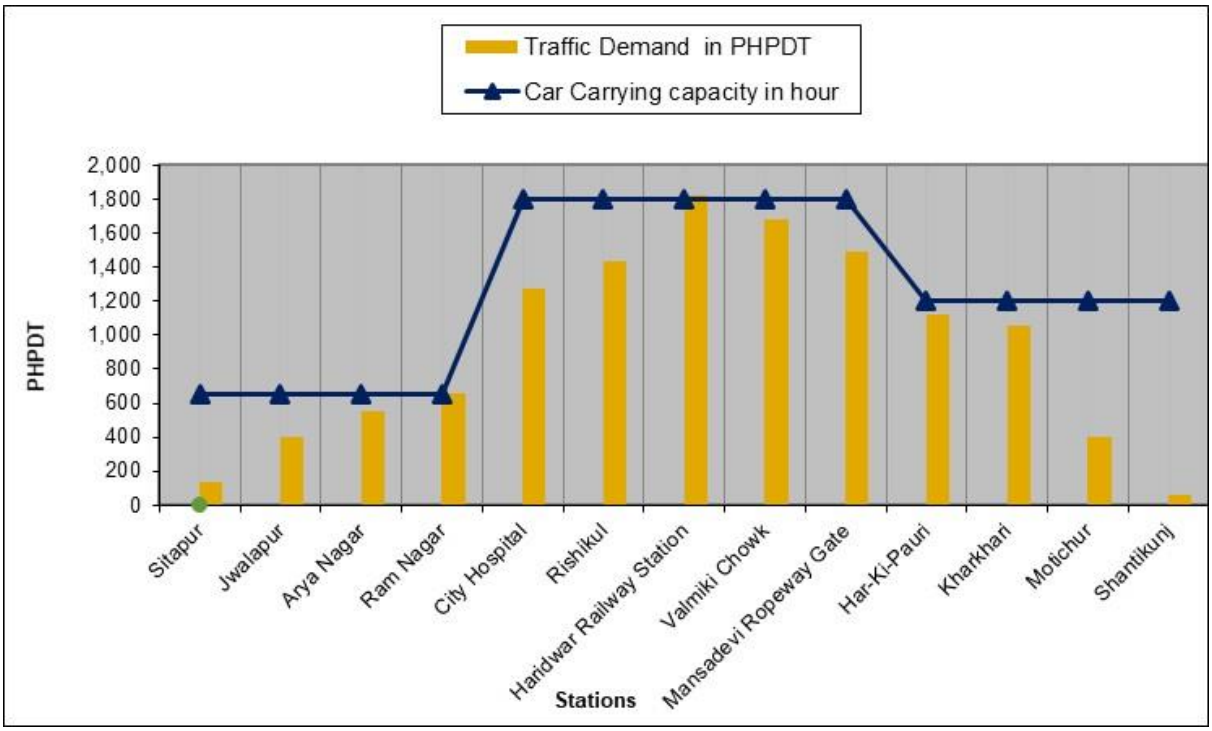
Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.13

Headway (min) 0.37

Headway (min) 0.20

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Sitapur	Jwalapur	133	655
2	Jwalapur	Arya Nagar	397	655
3	Arya Nagar	Ram Nagar	555	655
4	Ram Nagar	City Hospital	654	655
5	City Hospital	Rishikul	1274	1,800
6	Rishikul	Haridwar Railway Station	1434	1,800
7	Haridwar Railway Station	Valmiki Chowk	1819	1,800
8	Valmiki Chowk	Mansadevi Ropeway Gate	1681	1,800
9	Mansadevi Ropeway Gate	Har-Ki-Pauri	1487	1,800
10	Har-Ki-Pauri	Kharkhari	1124	1,200
11	Kharkhari	Motichur	1059	1,200
12	Motichur	Shantikunj	405	1,200
13	Shantikunj	Bharat Mata Temple	61	1,200



Mela Days

Attachment - I/A1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year: 2021

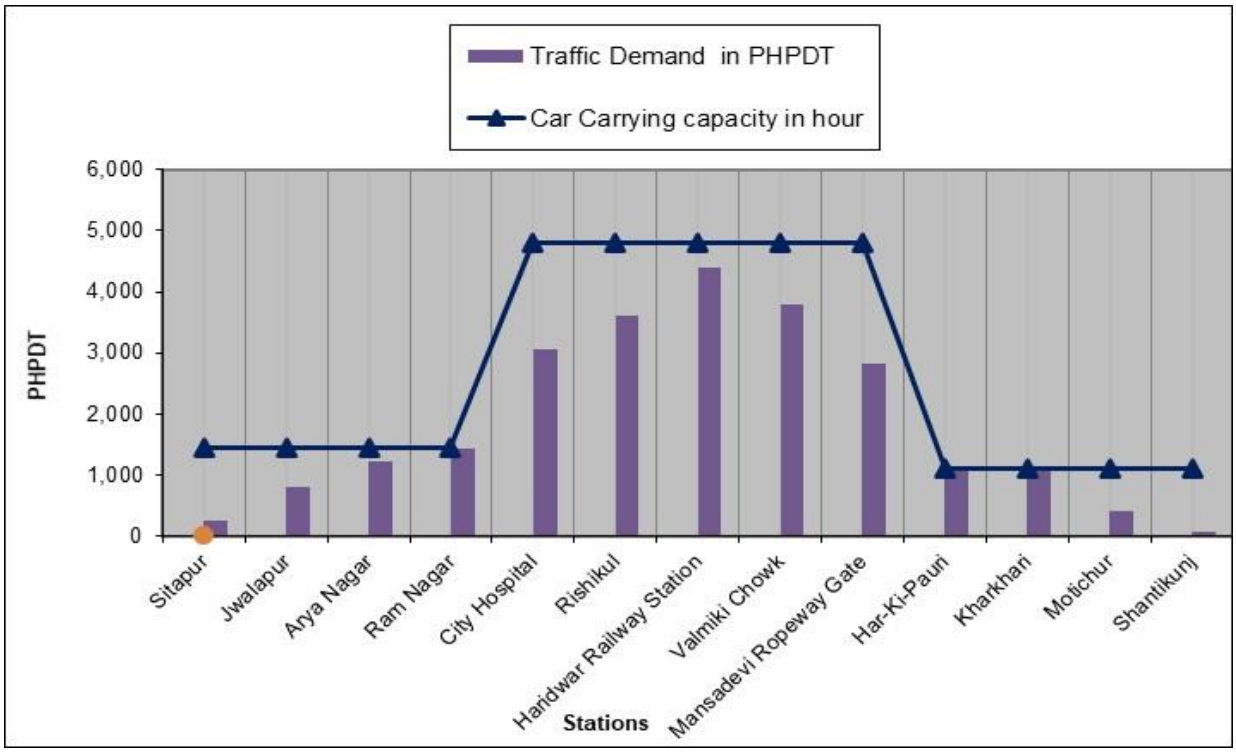
Passenger Capacity @ 6 persons/Pod-Car: 4

Section 2 Headway (min) 0.05

Section 1 Headway (min) 0.17

Section 3 Headway (min) 0.22

S.N	Section	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Section1	Sitapur	Jwalapur	251	1,440
2		Jwalapur	Arya Nagar	805	1,440
3		Arya Nagar	Ram Nagar	1215	1,440
4		Ram Nagar	City Hospital	1429	1,440
5	Section2	City Hospital	Rishikul	3055	4,800
6		Rishikul	Haridwar Railway Station	3599	4,800
7		Haridwar Railway Station	Valmiki Chowk	4393	4,800
8		Valmiki Chowk	Mansadevi Ropeway Gate	3786	4,800
9		Mansadevi Ropeway Gate	Har-Ki-Pauri	2824	4,800
10	Section3	Har-Ki-Pauri	Kharkhari	1141	1,108
11		Kharkhari	Motichur	1059	1,108
12		Motichur	Shantikunj	405	1,108
13		Shantikunj	Bharat Mata Temple	61	1,108



Normal Days

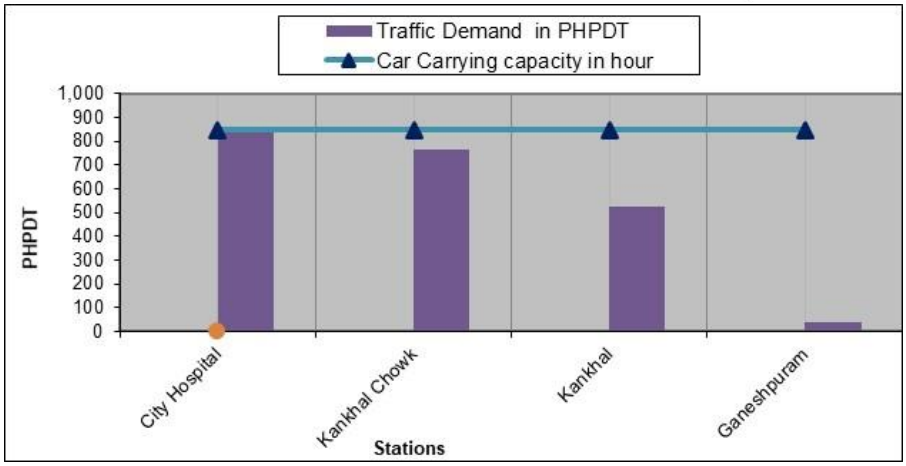
Attachment - I/A2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year: 2021
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.28

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	858	847
2	Kankhal Chowk	Kankhal	767	847
3	Kankhal	Ganeshpuram	525	847
4	Ganeshpuram	Daksh Temple	39	847



Mela Days

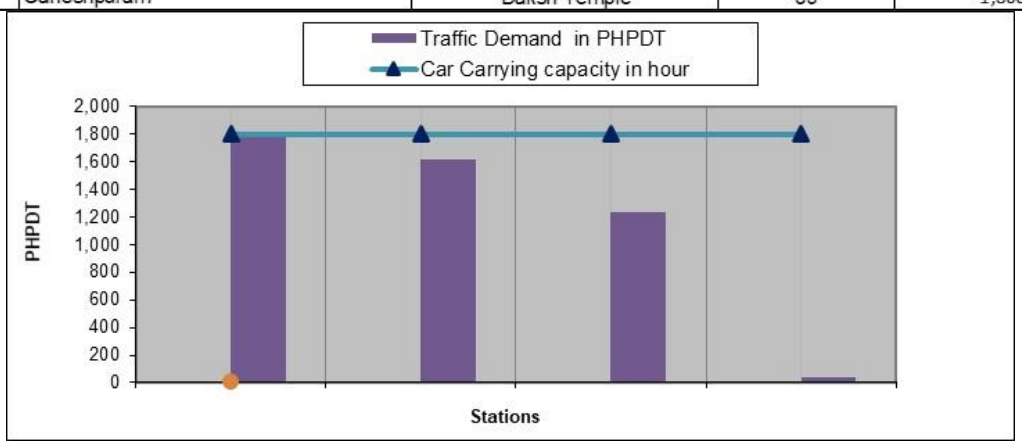
Attachment - I/A2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year: 2021
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.13

S.N	From	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	1812	1,800
2	Kankhal Chowk	Kankhal	1620	1,800
3	Kankhal	Ganeshpuram	1235	1,800
4	Ganeshpuram	Daksh Temple	39	1,800



Normal Days

Attachment - I/A3

PHPDT Demand and Capacity Chart

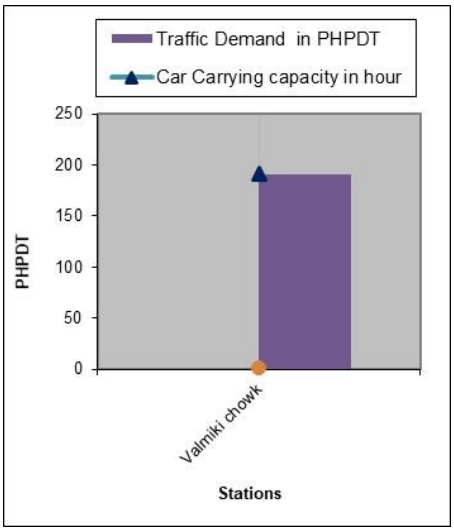
Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2021

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 1.25

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	191	192



Mela Days

Attachment - I/A3

PHPDT Demand and Capacity Chart

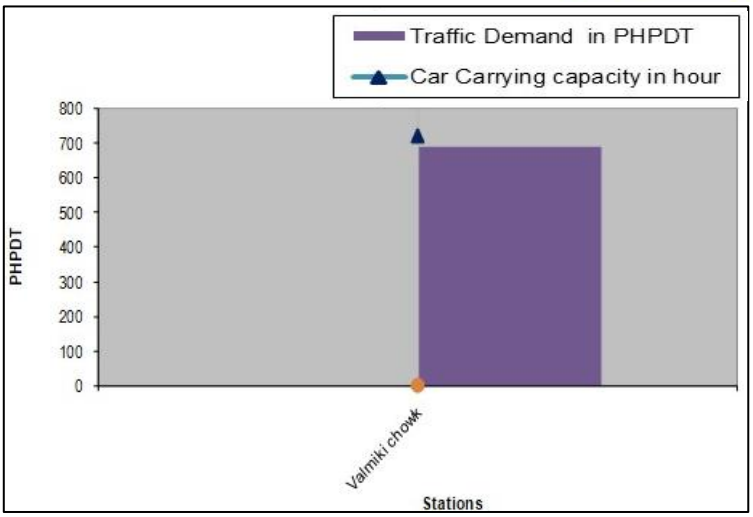
Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2021

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.33

S.II	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	690	720



Normal Days

Attachment - I/A4

PHPDT Demand and Capacity Chart

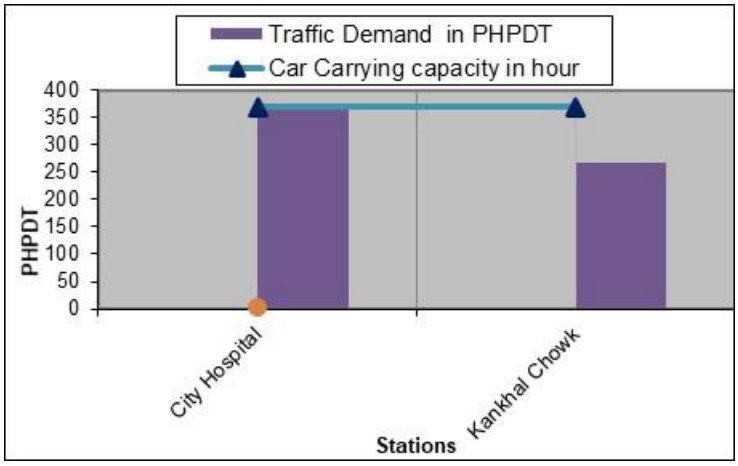
Corridor-4 (Ganeshpuram - DAV School)

Year: 2021

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.65

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	366	369
2	Jagjeetpur	DAV School	267	369



Mela Days

Attachment - I/A4

PHPDT Demand and Capacity Chart

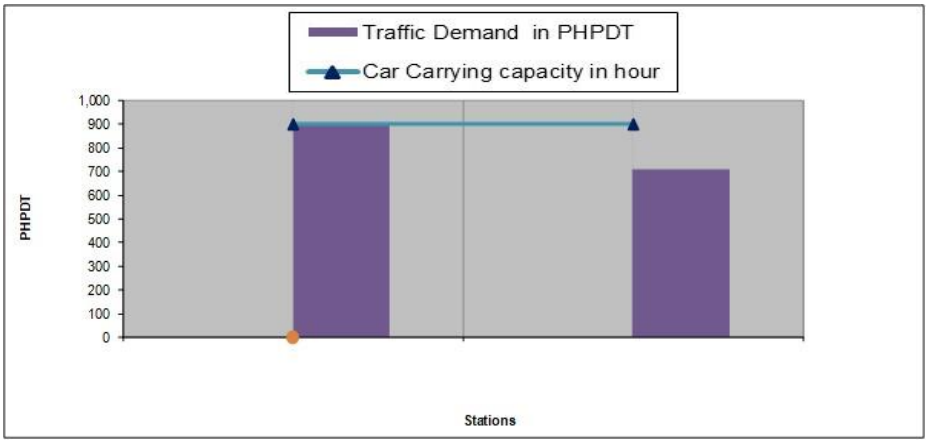
Corridor-4 (Ganeshpuram - DAV School)

Year: 2021

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.27

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	905	900
2	Jagjeetpur	DAV School	713	900



Normal Days

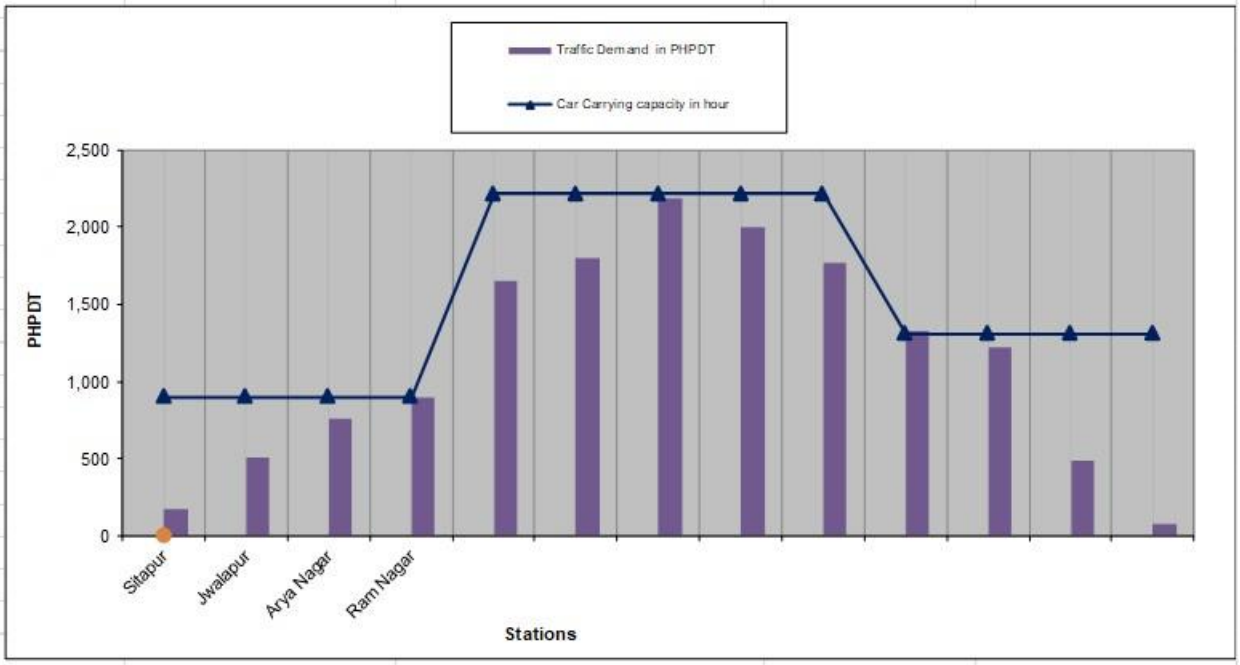
Attachment - I/A1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.11
Headway (min)	0.27
Headway (min)	0.18

S.No	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Sitapur	Jwalapur	175	900
2	Jwalapur	Arya Nagar	507	900
3	Arya Nagar	Ram Nagar	754	900
4	Ram Nagar	City Hospital	894	900
5	City Hospital	Rishikul	1653	2,215
6	Rishikul	Haridwar Railway Station	1798	2,215
7	Haridwar Railway Station	Valmiki Chowk	2187	2,215
8	Valmiki Chowk	Mansadevi Ropeway Gate	2001	2,215
9	Mansadevi Ropeway Gate	Har-Ki-Pauri	1765	2,215
10	Har-Ki-Pauri	Kharkhari	1322	1,309
11	Kharkhari	Motichur	1226	1,309
12	Motichur	Shantikunj	484	1,309
13	Shantikunj	Bharat Mata Temple	73	1,309



Mela Days

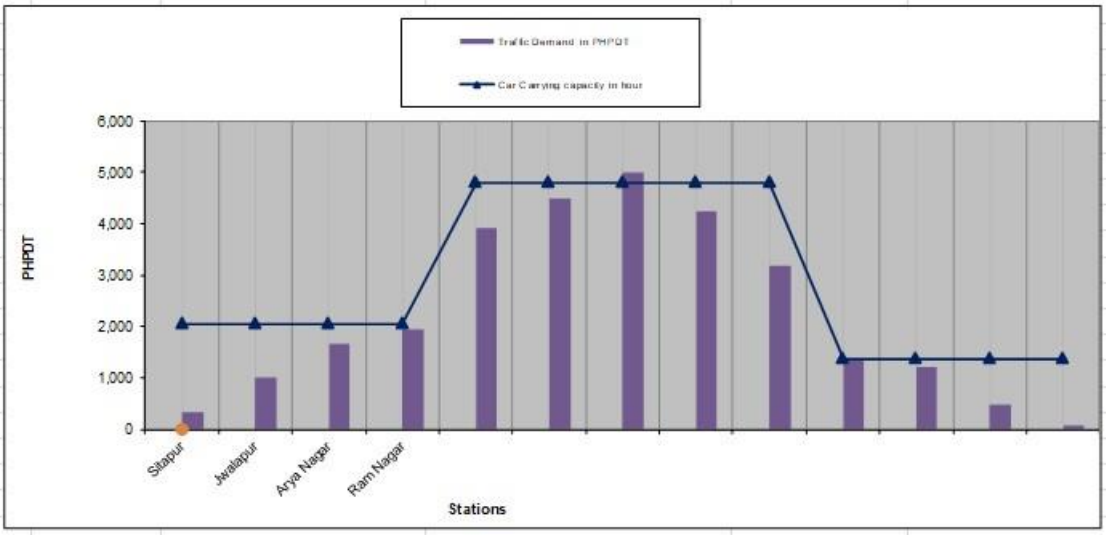
Attachment - I/A1

PHPDT Demand and Capacity Chart

4

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Section 2 Headway (min)	0.05
Section 1 Headway (min)	0.12
Section 3 Headway (min)	0.18

S.N	Section	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Section1	Sitapur	Jwalapur	333	2,057
2		Jwalapur	Arya Nagar	1010	2,057
3		Arya Nagar	Ram Nagar	1660	2,057
4		Ram Nagar	City Hospital	1953	2,057
5	Section2	City Hospital	Rishikul	3908	4,800
6		Rishikul	Haridwar Railway Station	4497	4,800
7		Haridwar Railway Station	Valmiki Chowk	4991	4,800
8		Valmiki Chowk	Mansadevi Ropeway Gate	4234	4,800
9		Mansadevi Ropeway Gate	Har-Ki-Pauri	3190	4,800
10	Section3	Har-Ki-Pauri	Kharkhari	1343	1,371
11		Kharkhari	Motichur	1226	1,371
12		Motichur	Shantikunj	484	1,371
13		Shantikunj	Bharat Mata Temple	74	1,371



Normal Days

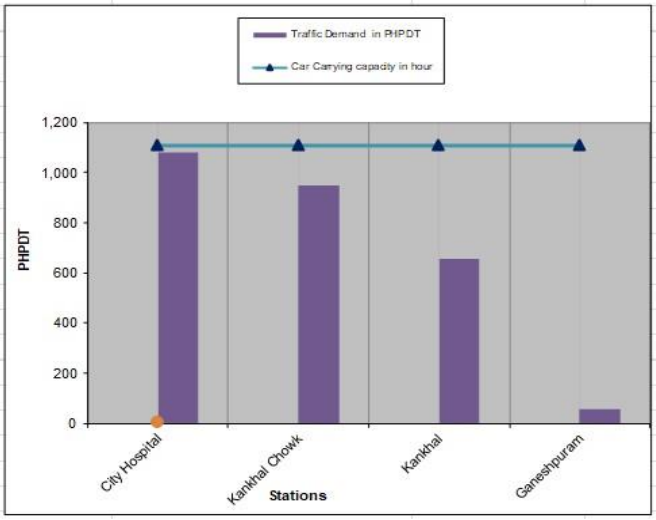
Attachment - I/A2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.22

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	1080	1,108
2	Kankhal Chowk	Kankhal	950	1,108
3	Kankhal	Ganeshpuram	657	1,108
4	Ganeshpuram	Daksh Temple	59	1,108



Mela Days

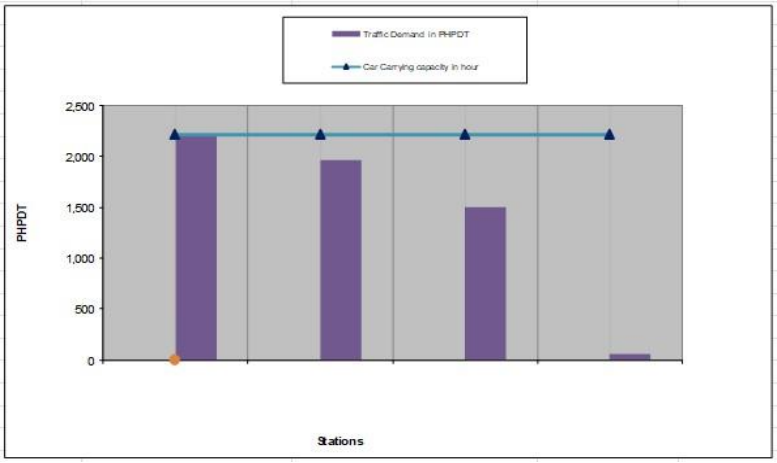
Attachment - I/A2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.11

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	2218	2,215
2	Kankhal Chowk	Kankhal	1961	2,215
3	Kankhal	Ganeshpuram	1499	2,215
4	Ganeshpuram	Daksh Temple	59	2,215



Normal Days

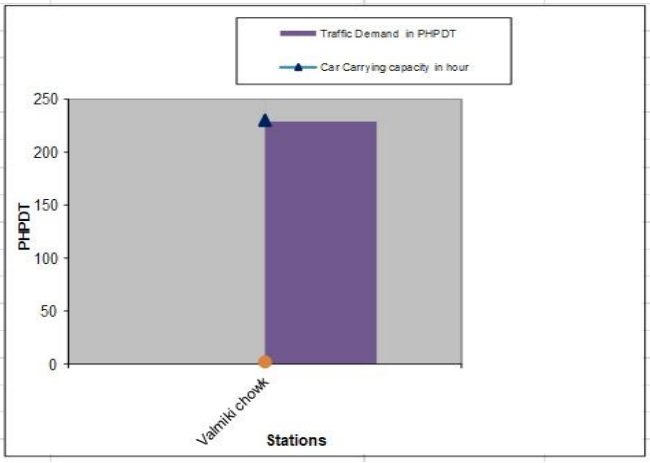
Attachment - I/A3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	1.05

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	228	229



Mela Days

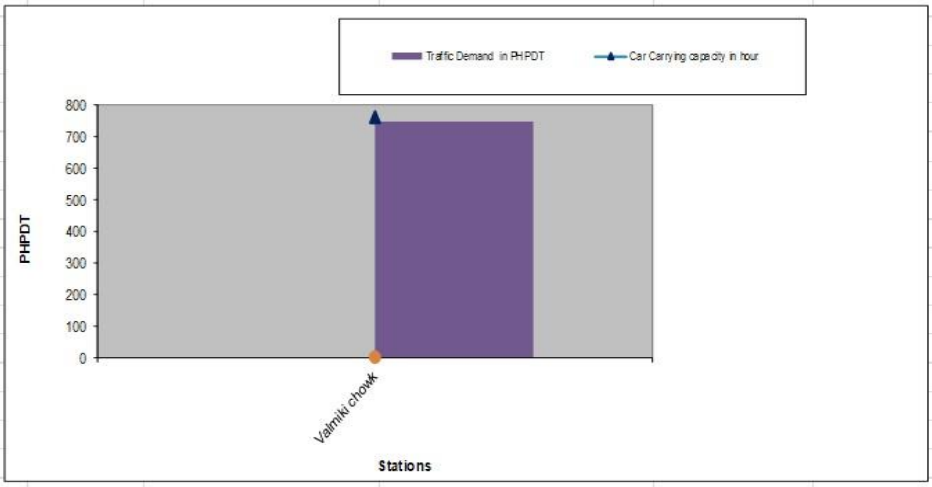
Attachment - I/A3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.32

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	748	758



Normal Days

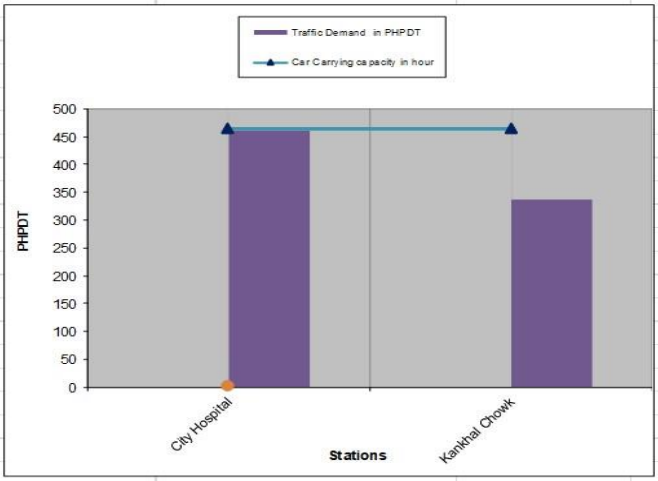
Attachment - I/A4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.52

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	461	465
2	Jagjeetpur	DAV School	337	465



Mela Days

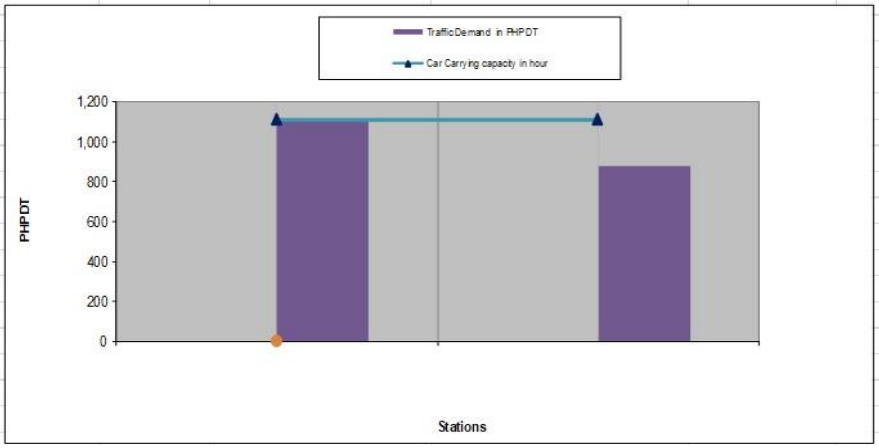
Attachment - I/A4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year:	2025
Passenger Capacity @ 6persons/Pod-Car:	4
Headway (min)	0.22

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	1114	1,108
2	Jagjeetpur	DAV School	875	1,108



Normal Days

Attachment - I/B1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year: 2031

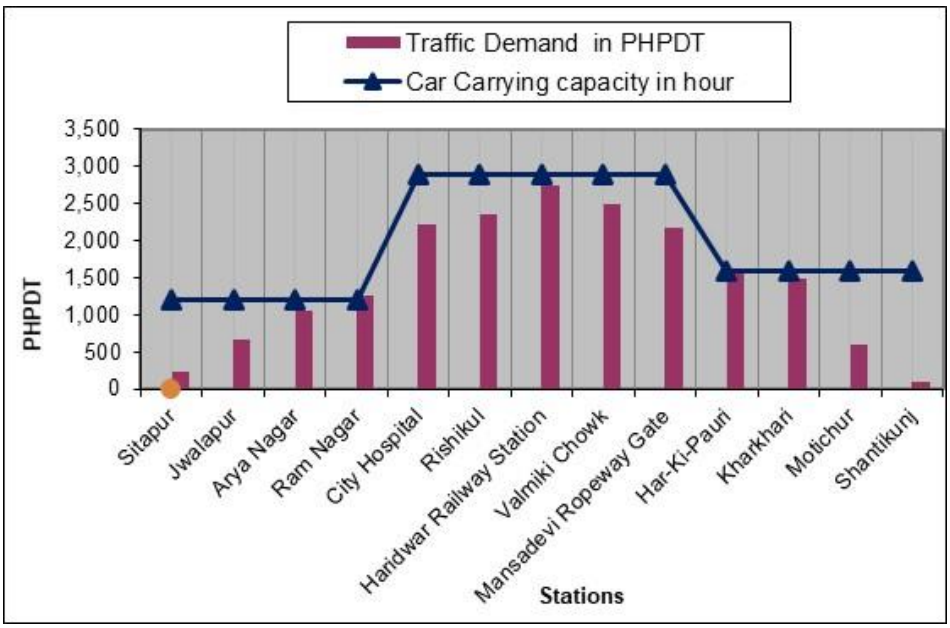
Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.08

Headway (min) 0.20

Headway (min) 0.15

S.No	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Sitapur	Jwalapur	237	1,200
2	Jwalapur	Arya Nagar	671	1,200
3	Arya Nagar	Ram Nagar	1052	1,200
4	Ram Nagar	City Hospital	1253	1,200
5	City Hospital	Rishikul	2221	2,880
6	Rishikul	Haridwar Railway Station	2344	2,880
7	Haridwar Railway Station	Valmiki Chowk	2739	2,880
8	Valmiki Chowk	Mansadevi Ropeway Gate	2480	2,880
9	Mansadevi Ropeway Gate	Har-Ki-Pauri	2181	2,880
10	Har-Ki-Pauri	Kharkhari	1619	1,600
11	Kharkhari	Motichur	1476	1,600
12	Motichur	Shantikunj	602	1,600
13	Shantikunj	Bharat Mata Temple	92	1,600



Mela Days

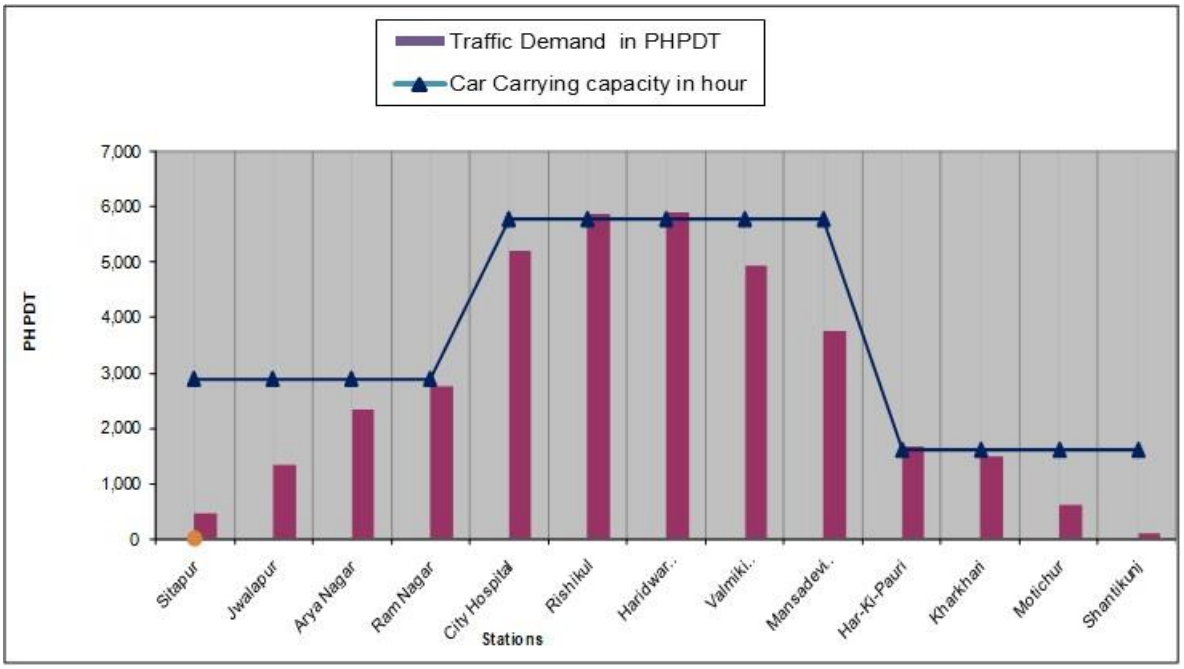
Attachment - I/B1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year:	2031
Passenger Capacity @6persons/Pod-Car:	4
Section 2 Headway (min)	0.04
Section 1 Headway (min)	0.08
Section 3 Headway (min)	0.15

S.N	Section	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Section1	Sitapur	Jwalapur	456	2,880
2		Jwalapur	Arya Nagar	1318	2,880
3		Arya Nagar	Ram Nagar	2328	2,880
4		Ram Nagar	City Hospital	2739	2,880
5	Section2	City Hospital	Rishikul	5187	5,760
6		Rishikul	Haridwar Railway Station	5843	5,760
7		Haridwar Railway Station	Valmiki Chowk	5888	5,760
8		Valmiki Chowk	Mansadevi Ropeway Gate	4907	5,760
9		Mansadevi Ropeway Gate	Har-Ki-Pauri	3740	5,760
10	Section3	Har-Ki-Pauri	Kharkhari	1645	1,600
11		Kharkhari	Motichur	1476	1,600
12		Motichur	Shantikunj	602	1,600
13		Shantikunj	Bharat Mata Temple	93	1,600



Normal Days

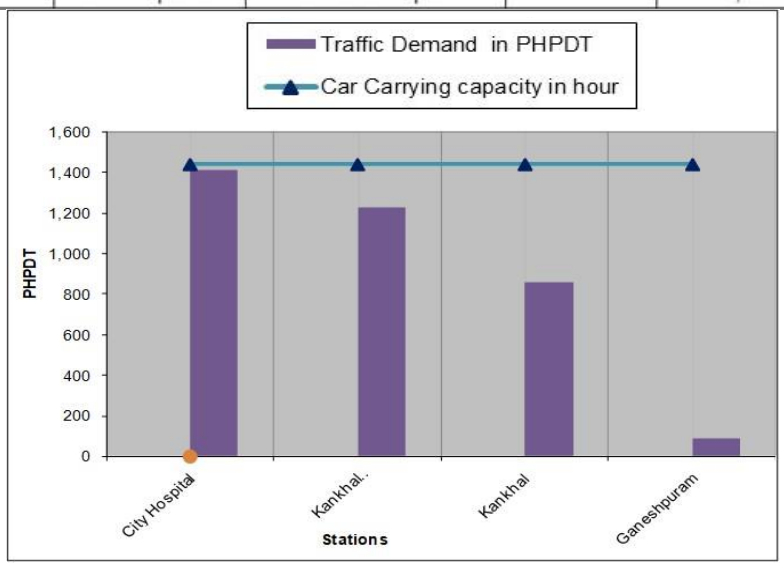
Attachment - I/B2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year: 2031
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.17

S.No	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	1412	1,440
2	Kankhal Chowk	Kankhal	1224	1,440
3	Kankhal	Ganeshpuram	854	1,440
4	Ganeshpuram	Daksh Temple	88	1,440



Mela Days

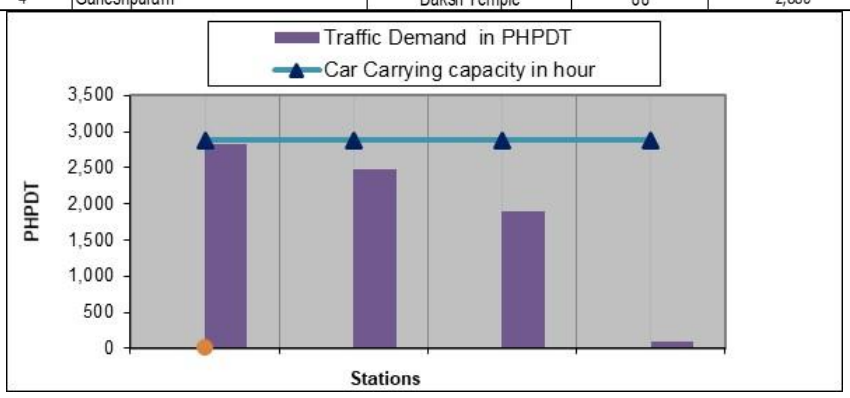
Attachment - I/B2

PHPDT Demand and Capacity Chart

Corridor-2 (City Hospital - Daksh Temple)

Year: 2031
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.08

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	2828	2,880
2	Kankhal Chowk	Kankhal	2472	2,880
3	Kankhal	Ganeshpuram	1894	2,880
4	Ganeshpuram	Daksh Temple	88	2,880



Normal Days

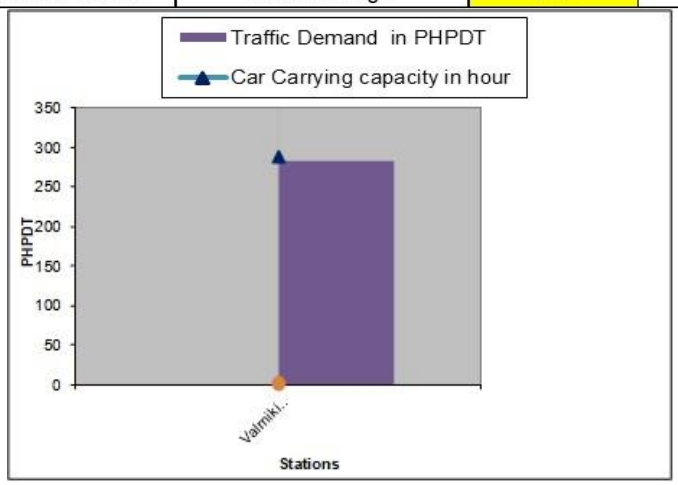
Attachment - I/B3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2031
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.83

S.No	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	283	288



Mela Days

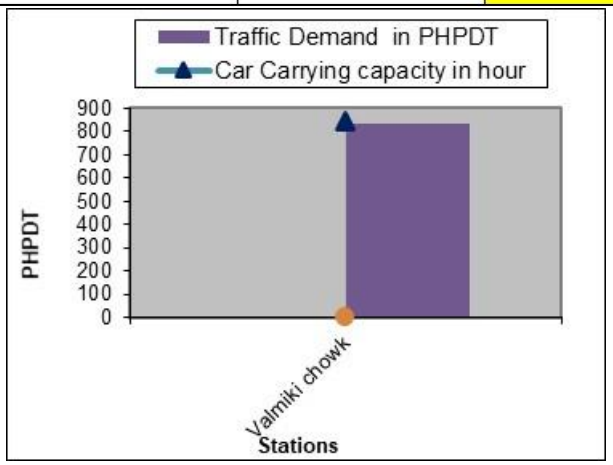
Attachment - I/B3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2031
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.28

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	836	847



Normal Days

Attachment - I/B4

PHPDT Demand and Capacity Chart

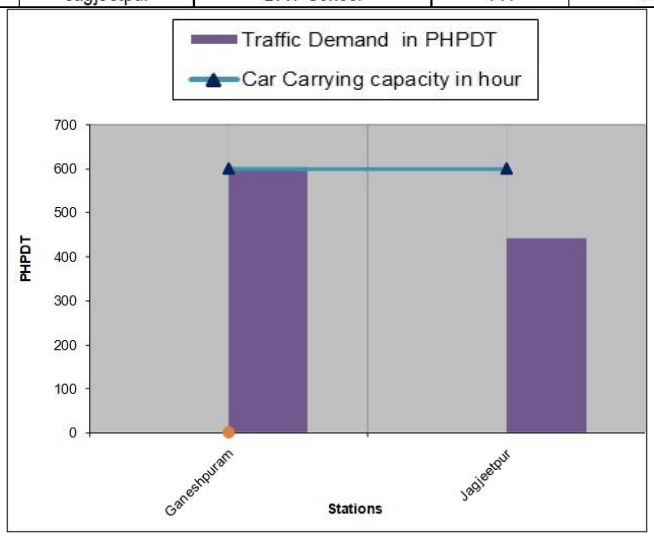
Corridor-4 (Ganeshpuram - DAV School)

Year: 2031

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.40

S.No.	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	603	600
2	Jagjeetpur	DAV School	441	600



Mela Days

Attachment - I/B4

PHPDT Demand and Capacity Chart

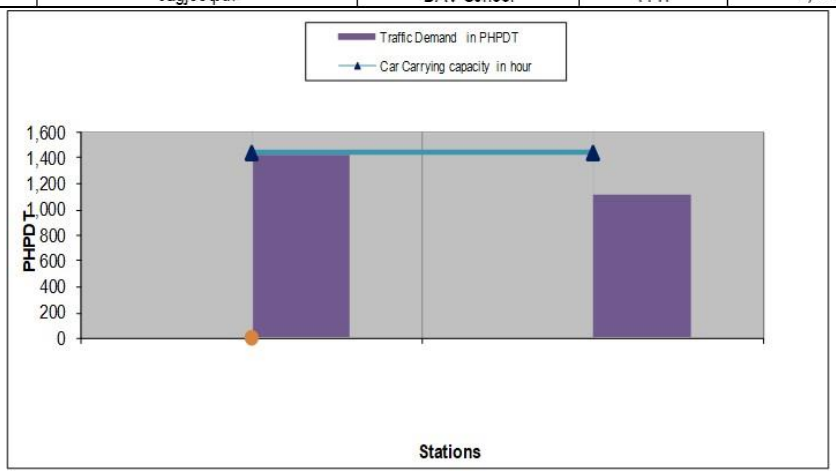
Corridor-4 (Ganeshpuram - DAV School)

Year: 2031

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.17

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	1427	1,440
2	Jagjeetpur	DAV School	1117	1,440



Normal Days

Attachment - I/C1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year: 2041

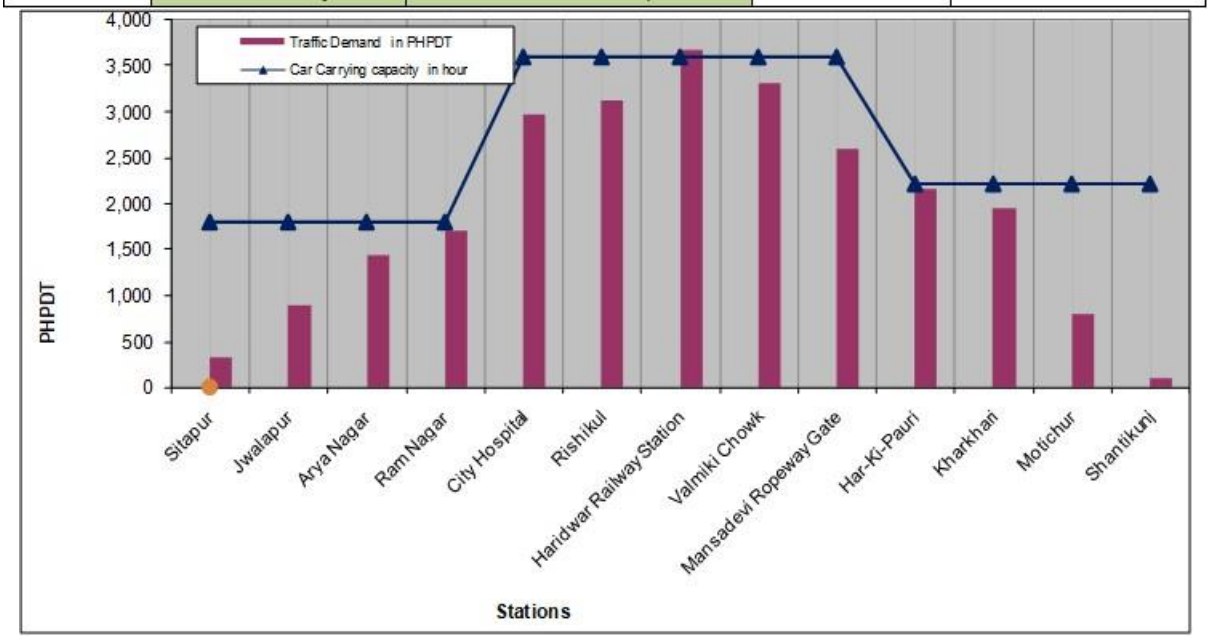
Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.07

Headway (min) 0.13

Headway (min) 0.11

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Sitapur	Jwalapur	322	1,800
2	Jwalapur	Arya Nagar	898	1,800
3	Arya Nagar	Ram Nagar	1433	1,800
4	Ram Nagar	City Hospital	1707	1,800
5	City Hospital	Rishikul	2983	3,600
6	Rishikul	Haridwar Railway Station	3136	3,600
7	Haridwar Railway Station	Valmiki Chowk	3681	3,600
8	Valmiki Chowk	Mansadevi Ropeway Gate	3325	3,600
9	Mansadevi Ropeway Gate	Har-Ki-Pauri	2601	3,600
10	Har-Ki-Pauri	Kharkhari	2155	2,215
11	Kharkhari	Motichur	1959	2,215
12	Motichur	Shantikunj	789	2,215
13	Shantikunj	Bharat Mata Temple	97	2,215



Mela Days

Attachment - I/C1

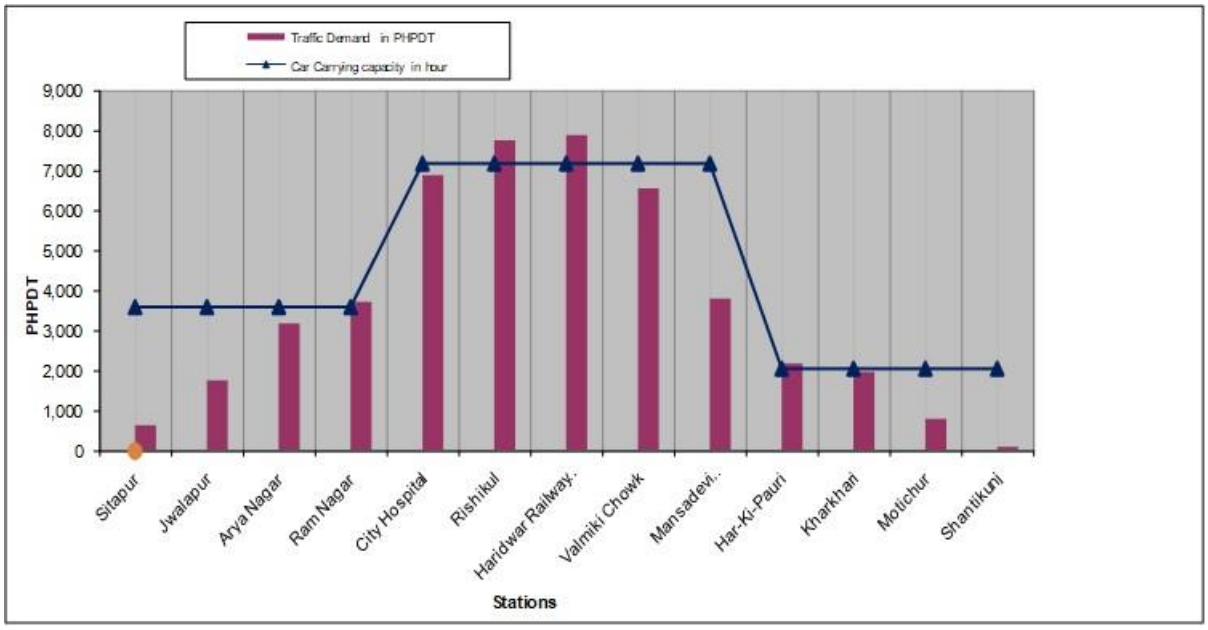
PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year:	2041
Passenger Capacity @ 6persons/Pod-Car:	4
Section 2 Headway (min)	0.03
Section 1 Headway (min)	0.07
Section 3 Headway (min)	0.12

S.N	SECTION	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Section 1	Sitapur	Jwalapur	616	3,600
2		Jwalapur	Arya Nagar	1767	3,600
3		Arya Nagar	Ram Nagar	3194	3,600
4		Ram Nagar	City Hospital	3745	3,600
5	Section 2	City Hospital	Rishikul	6915	7,200
6		Rishikul	Haridwar Railway Station	7775	7,200
7		Haridwar Railway Station	Valmiki Chowk	7894	7,200
8		Valmiki Chowk	Mansadevi Ropeway Gate	6567	7,200
9		Mansadevi Ropeway Gate	Har-Ki-Pauri	3825	7,200
10	Section 3	Har-Ki-Pauri	Kharkhari	2191	2,057
11		Kharkhari	Motichur	1959	2,057
12		Motichur	Shantikunj	789	2,057
13		Shantikunj	Bharat Mata Temple	96	2,057

Note: - The PHPDT of some station is higher than the carrying capacity with 4 passengers per car, however with maximum 6 passengers per car Traffic demand meets with car carrying capacity.



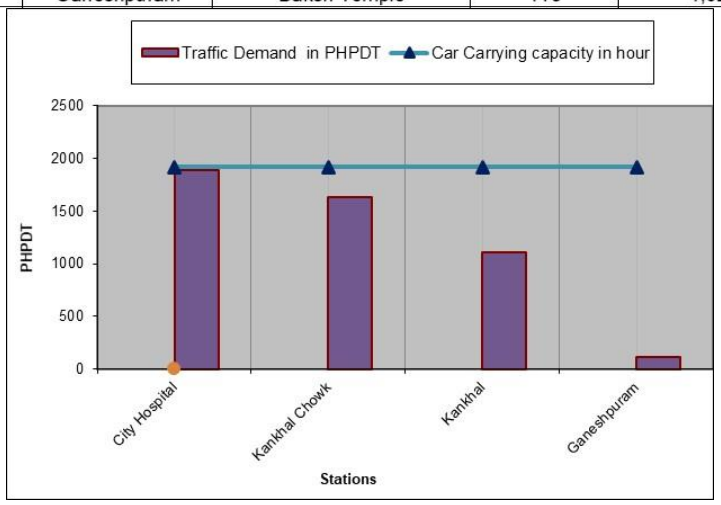
Normal Days

Attachment - I/C2

PHPDT Demand and Capacity Chart
Corridor-2 (City Hospital - Daksh Temple)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.13

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	1892	1,920
2	Kankhal Chowk	Kankhal	1637	1,920
3	Kankhal	Ganeshpuram	1113	1,920
4	Ganeshpuram	Daksh Temple	118	1,920



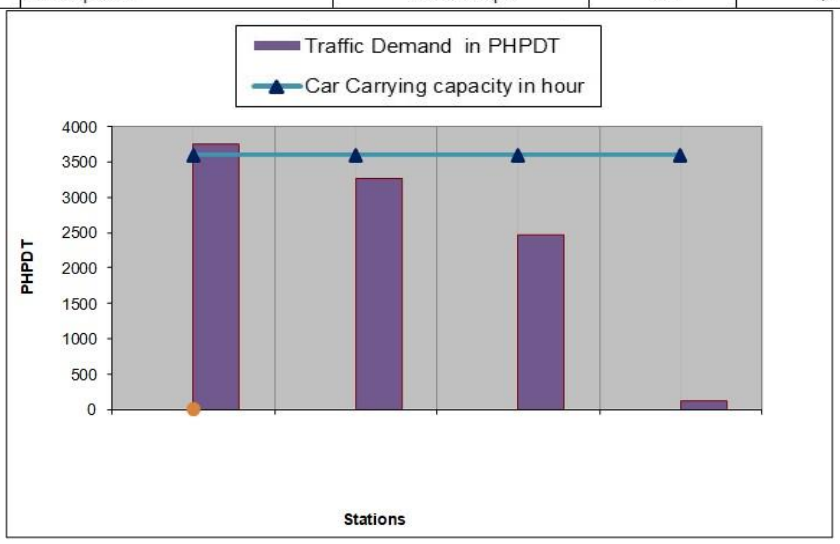
Mela Days

Attachment - I/C2

PHPDT Demand and Capacity Chart
Corridor-2 (City Hospital - Daksh Temple)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.07

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	3741	3,600
2	Kankhal Chowk	Kankhal	3275	3,600
3	Kankhal	Ganeshpuram	2476	3,600
4	Ganeshpuram	Daksh Temple	118	3,600



Normal Days

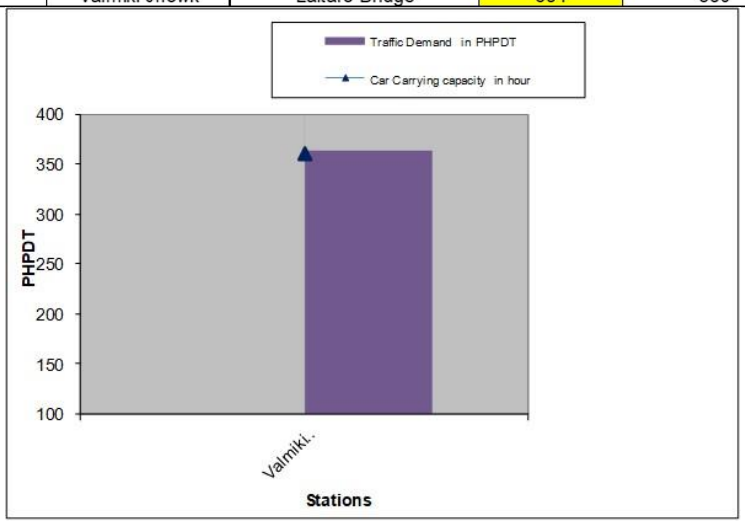
Attachment - I/C3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.67

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	364	360



Mela Days

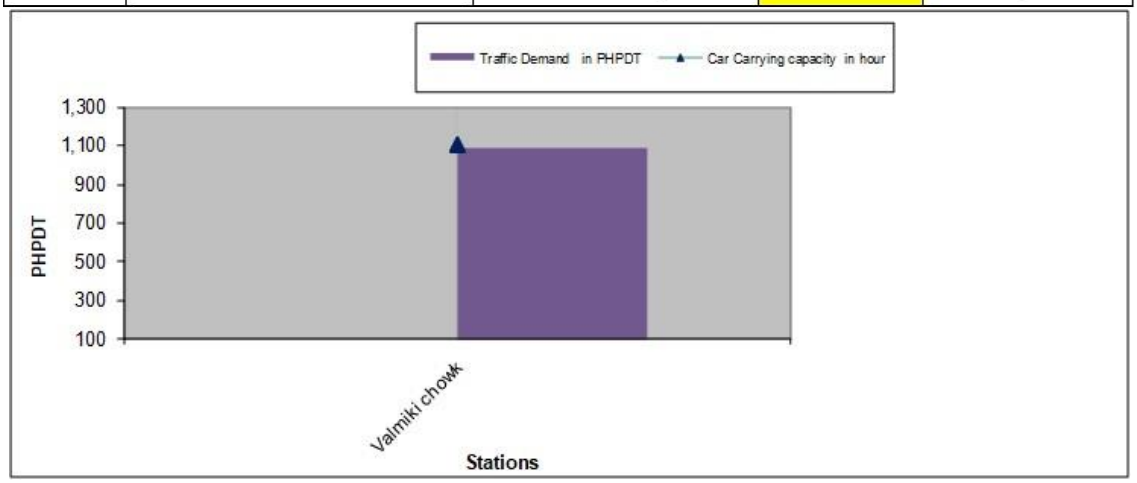
Attachment - I/C3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.22

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	1090	1,108



Normal Days

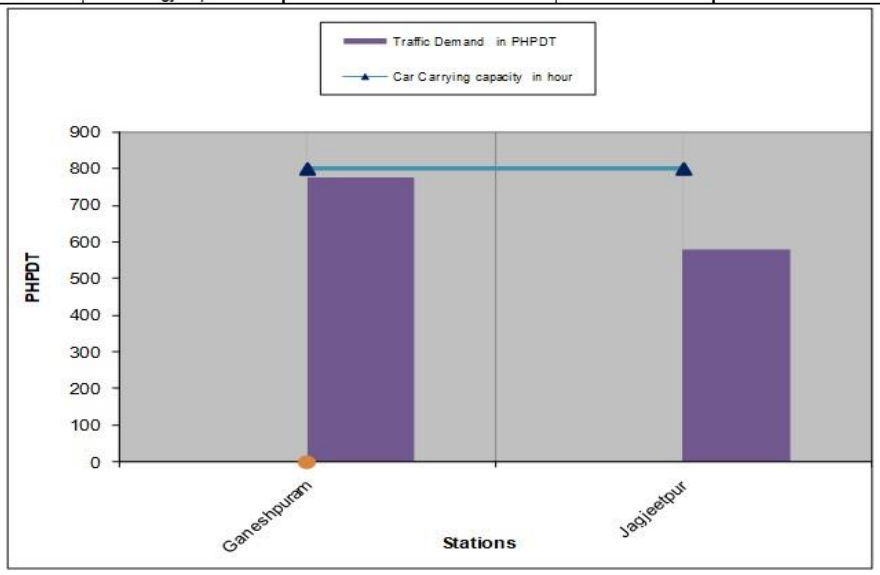
Attachment - I/C4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.30

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	776	800
2	Jagjeetpur	DAV School	579	800



Mela Days

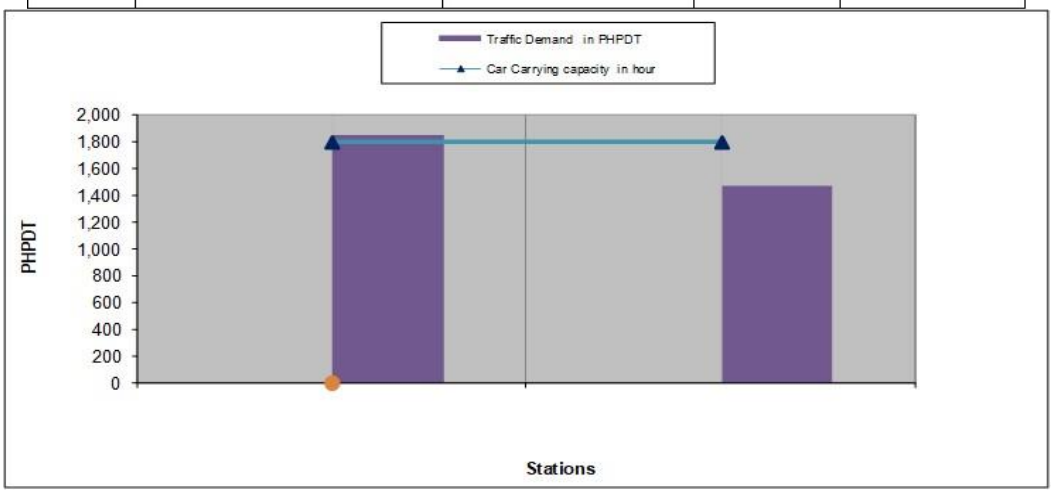
Attachment - I/C4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year: 2041
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.13

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	1857	1,800
2	Jagjeetpur	DAV School	1481	1,800



Normal Days

Attachment - I/D1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year: 2051

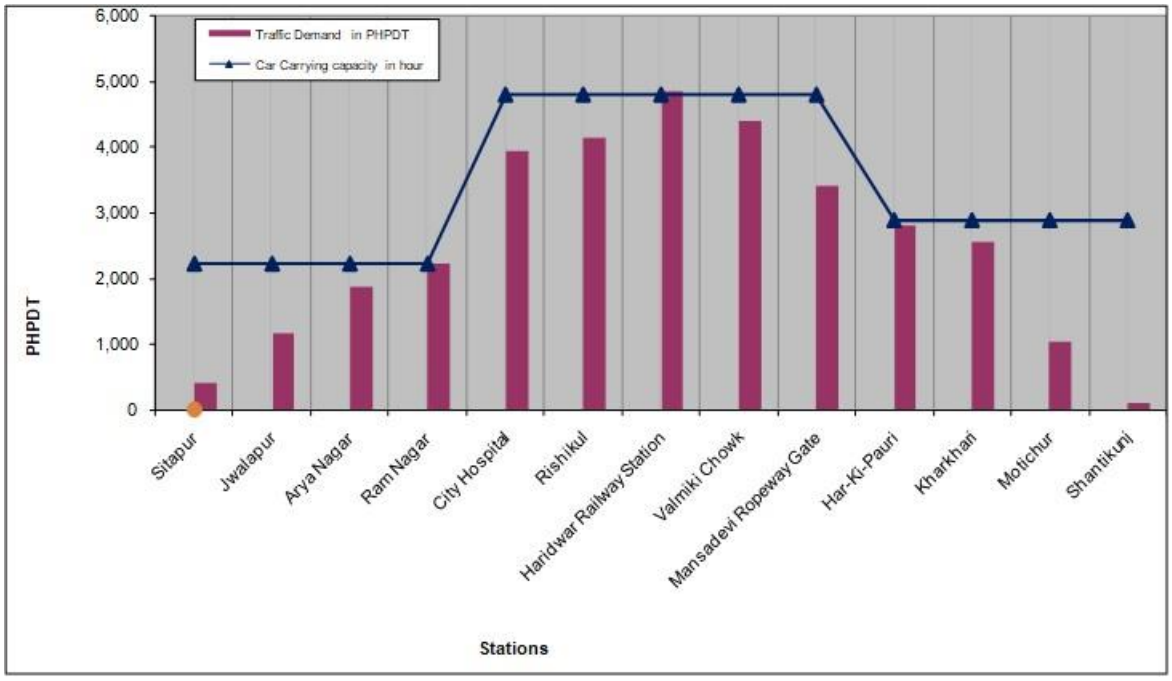
Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.05

Headway (min) 0.11

Headway (min) 0.08

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Sitapur	Jwalapur	405	2,215
2	Jwalapur	Arya Nagar	1,153	2,215
3	Arya Nagar	Ram Nagar	1,874	2,215
4	Ram Nagar	City Hospital	2,225	2,215
5	City Hospital	Rishikul	3,925	4,800
6	Rishikul	Haridwar Railway Station	4,132	4,800
7	Haridwar Railway Station	Valmiki Chowk	4,849	4,800
8	Valmiki Chowk	Mansadevi Ropeway Gate	4,377	4,800
9	Mansadevi Ropeway Gate	Har-Ki-Pauri	3,403	4,800
10	Har-Ki-Pauri	Kharkhari	2,799	2,880
11	Kharkhari	Motichur	2,549	2,880
12	Motichur	Shantikunj	1,038	2,880
13	Shantikunj	Bharat Mata Temple	99	2,880



Mela Days

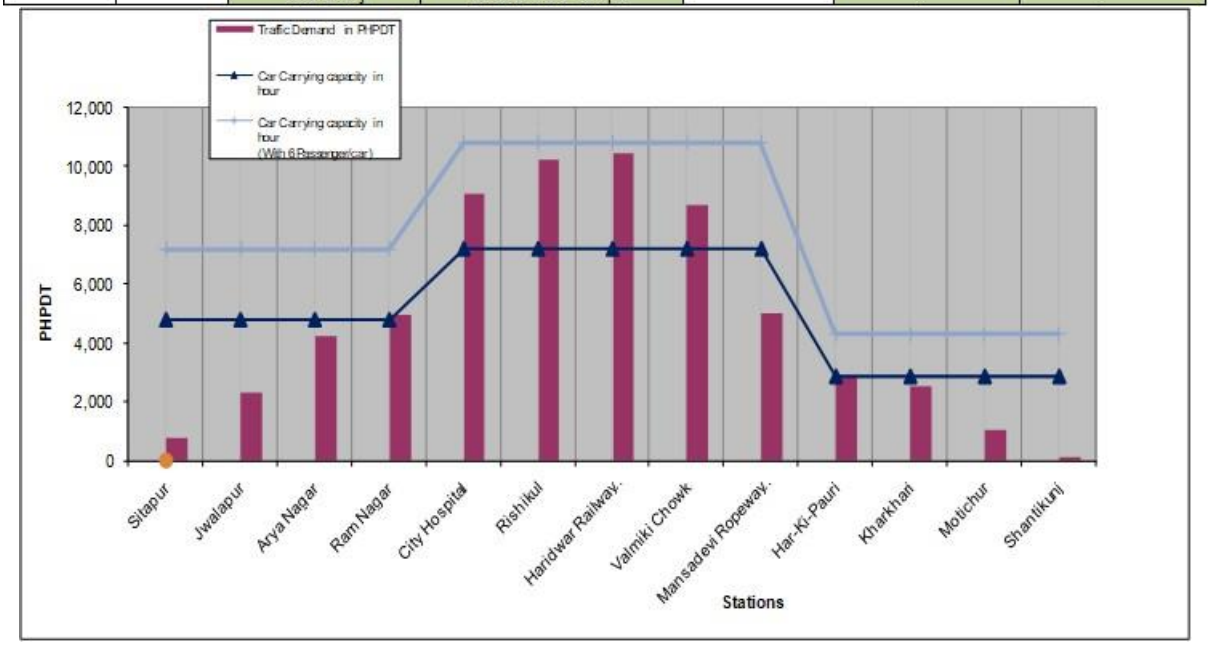
Attachment - I/D1

PHPDT Demand and Capacity Chart

Corridor-1 (Sitapur - Bharat Mata Temple)

Year:	2051	2051
Passenger Capacity @ 6persons/Pod-Car:	4	6
Section 2 Headway (min)	0.03	0.03
Section 1 Headway (min)	0.05	0.05
Section 3 Headway (min)	0.08	0.08

S.N	SECTION	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour (With 4 Passenger/car)	Car Carrying capacity in hour (With 6 Passenger/car)
1	Section 1	Sitapur	Jwalapur	779	4,800	7,200
2		Jwalapur	Arya Nagar	2299	4,800	7,200
3		Arya Nagar	Ram Nagar	4249	4,800	7,200
4		Ram Nagar	City Hospital	4949	4,800	7,200
5	Section 2	City Hospital	Rishikul	9067	7,200	10,800
6		Rishikul	Haridwar Railway Station	10241	7,200	10,800
7		Haridwar Railway Station	Valmiki Chowk	10462	7,200	10,800
8		Valmiki Chowk	Mansadevi Ropeway Gate	8718	7,200	10,800
9		Mansadevi Ropeway Gate	Har-Ki-Pauri	5023	7,200	10,800
10	Section 3	Har-Ki-Pauri	Kharkhari	2837	2,880	4,320
11		Kharkhari	Motichur	2549	2,880	4,320
12		Motichur	Shantikunj	1038	2,880	4,320
13		Shantikunj	Bharat Mata Temple	99	2,880	4,320



Normal Days

Attachment - I/D2

PHPDT Demand and Capacity Chart

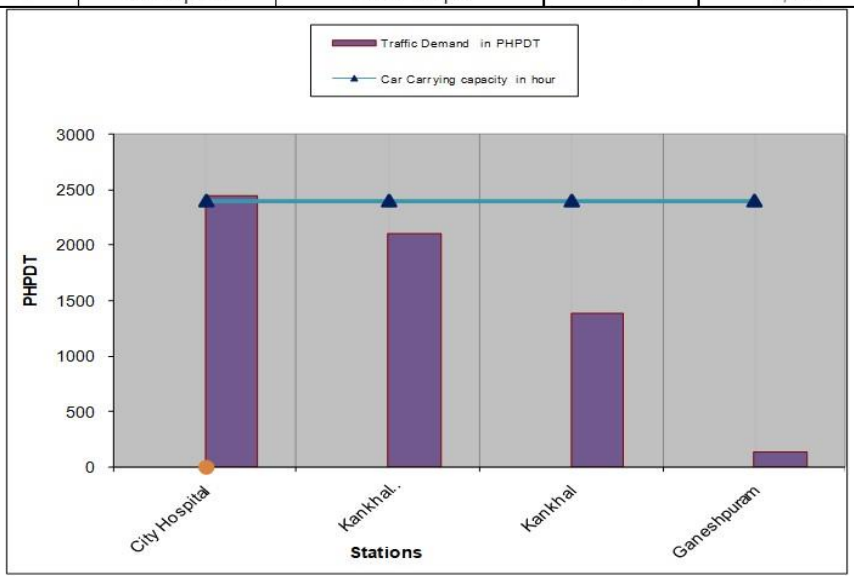
Corridor-2 (City Hospital - Daksh Temple)

Year: 2051

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.10

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	2446	2,400
2	Kankhal Chowk	Kankhal	2102	2,400
3	Kankhal	Ganeshpuram	1381	2,400
4	Ganeshpuram	Daksh Temple	135	2,400



Mela Days

Attachment - I/D2

PHPDT Demand and Capacity Chart

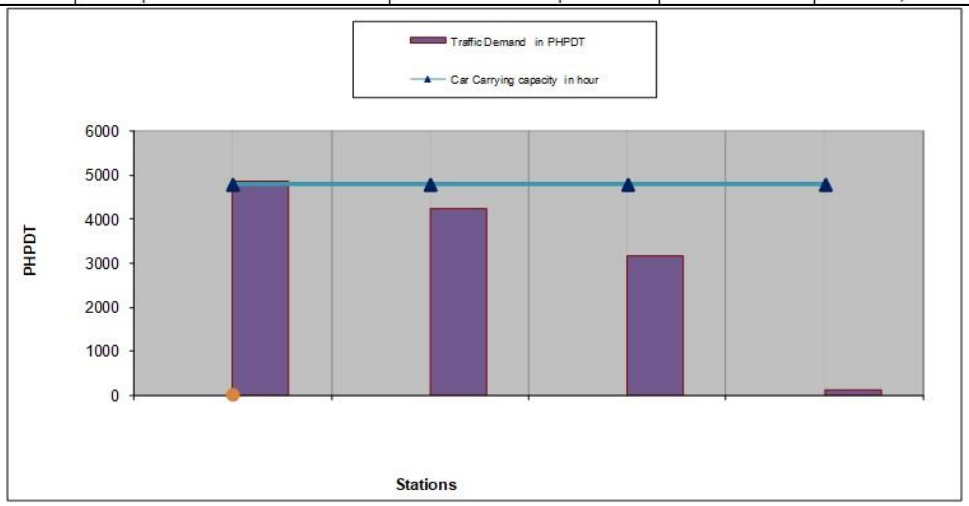
Corridor-2 (City Hospital - Daksh Temple)

Year: 2051

Passenger Capacity @ 6persons/Pod-Car: 4

Headway (min) 0.05

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	City Hospital	Kankhal Chowk	4862	4,800
2	Kankhal Chowk	Kankhal	4243	4,800
3	Kankhal	Ganeshpuram	3158	4,800
4	Ganeshpuram	Daksh Temple	135	4,800



Normal Days

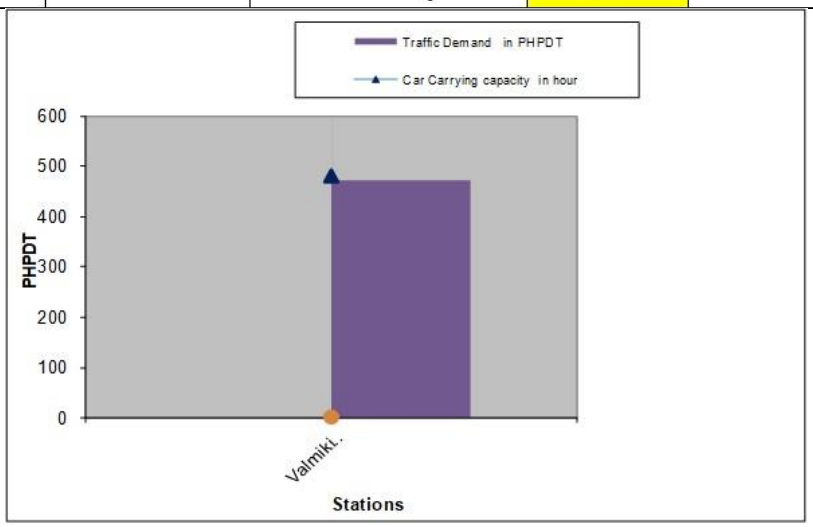
Attachment - I/D3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2051
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.50

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	471	480



Mela Days

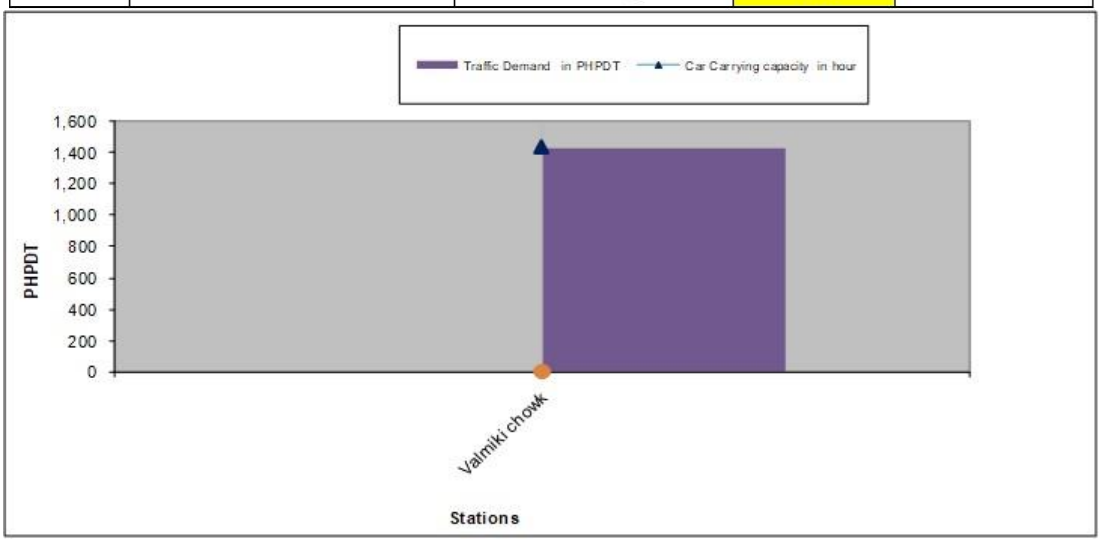
Attachment - I/D3

PHPDT Demand and Capacity Chart

Corridor-3 Valmiki Chowk - Laltaro Bridge)

Year: 2051
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.17

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Valmiki chowk	Laltaro Bridge	1423	1,440



Normal Days

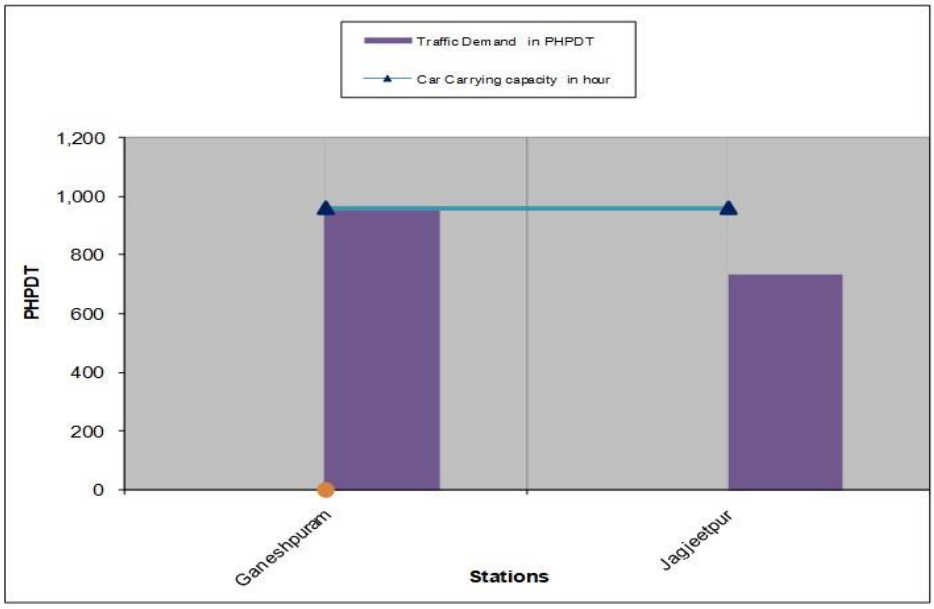
Attachment - I/D4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year: 2051
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.25

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	953	960
2	Jagjeetpur	DAV School	735	960



Mela Days

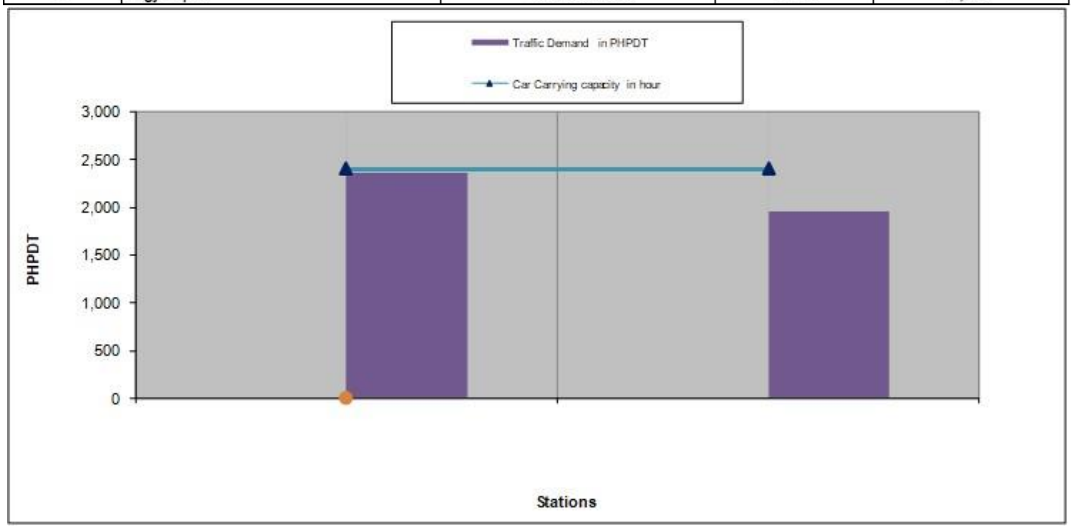
Attachment - I/D4

PHPDT Demand and Capacity Chart

Corridor-4 (Ganeshpuram - DAV School)

Year: 2051
Passenger Capacity @ 6persons/Pod-Car: 4
Headway (min) 0.10

S.N	FROM	TO	Traffic Demand in PHPDT	Car Carrying capacity in hour
1	Ganeshpuram	Jagjeetpur	2360	2,400
2	Jagjeetpur	DAV School	1943	2,400



Attachment II

Vehicle-km for Normal Days

Year	2021	2025	2031	2041	2051
All Corridors Length (km)	20.74	20.74	20.74	20.74	20.74
No. of cars in composition	1	1	1	1	1
No. of working Days in a year	340	340	340	340	340
Average Trip km for all sections	2	2	2	3	3
Total Trip in hour for 1 Pod Car	15	15	15	12	12
Total running of Pod Car in a day	16	16	16	16	16
Daily Car-km	480	480	480	576	576
Annual Car-km (10^5)	1.63	1.63	1.63	1.96	1.96

Vehicle-km for Mela Days

Year	2021	2025	2031	2041	2051
All Corridors Length (km)	20.74	20.74	20.74	20.74	20.74
No. of cars in composition	1	1	1	1	1
No. of working Days in a year	340	340	340	340	340
Average Trip km for all sections	2	2	2	3	3
Total Trip in hour for 1 Pod Car	15	15	15	12	12
Total running of Pod Car in a day	16	16	16	16	16
Daily Car-km	480	480	480	576	576
Annual Car-km (10^5)	1.63	1.63	1.63	1.96	1.96

Normal Days

Attachment III

RAKE REQUIREMENT for 2021

S. No.	Section From	Section To	Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement Bare	Car Requirement Traffic Reserve	Car Requirement R&M	Total cars
1a	Sitapur	City Hospital	3.800	60	2021	0.37	4.00	2		2	10.00	27.00	0	3	30
1b	City Hospital	Har-Ki-Pauri	4.400	60	2021	0.13	4.00	2		2	10.00	75	0	8	83
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2021	0.20	6.00	2		2	14.00	70.00	0	7	77
											Total Car requirement	190			

S. No.	Section From	Section To	Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement Bare	Car Requirement Traffic Reserve	Car Requirement R&M	Total cars
2	City Hospital	Daksh Temple	3.100	60	2021	0.28	3.00	2	0	2	8.00	28.00	0	3	31

S. No.	Section From	Section To	Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement Bare	Car Requirement Traffic Reserve	Car Requirement R&M	Total cars
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2021	1.25	1.00	2	0	2	4.00	3.00	0	0	3

S. No.	Section From	Section To	Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement Bare	Car Requirement Traffic Reserve	Car Requirement R&M	Total cars
4	Ganeshpuram	DAV School	2.200	60	2021	0.65	2.00	2	0	2	6.00	9.00	0	1	10

Total rake Required in 2021 234

Mela Days

Attachment III

RAKE REQUIREMENT for 2021

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2021	0.17	4.00	2		2	10.00	60	0	6	66
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1b	City Hospital	Har-Ki-Pauri	4.400	60	2021	0.05	4.00	2		2	10.00	200	0	20	220
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2021	0.22	6.00	2		2	14.00	65	0	7	72
									Total Car requirement			358			

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2021	0.13	3.00	2	0	2	8.00	60	0	6	66

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2021	0.33	1.00	2	0	2	4.00	12	0	1	13

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2021	0.27	2.00	2	0	2	6.00	23	0	2	25

Total rake Required in 2021 462

Normal Days

RAKE REQUIREMENT for 2025

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2025	0.27	4.00	2		2	10.00	38.00	0	4	42
1b	City Hospital	Har-Ki-Pauri	4.400	60	2025	0.11	4.00	2		2	10.00	92	0	9	101
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2025	0.18	6.00	2		2	14.00	76.00	0	8	84
										Total Car requirement		227			
2	City Hospital	Daksh Temple	3.100	60	2025	0.22	3.00	2	0	2	8.00	37.00	0	4	41
3	Vallin Chowk	Laltaro Bridge	0.760	60	2025	1.05	1.00	2	0	2	4.00	4.00	0	0	4
4	Ganeshpuram	DAV School	2.200	60	2025	0.52	2.00	2	0	2	6.00	12.00	0	1	13
										Total rake Required in 2025		285			

Mela Days

RAKE REQUIREMENT for 2025

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2025	0.12	4.00	2		2	10.00	86	0	9	95
1b	City Hospital	Har-Ki-Pauri	4.400	60	2025	0.05	4.00	2		2	10.00	200	0	12	212
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2025	0.18	6.00	2		2	14.00	80	0	5	85
									Total Car requirement			392			
2	City Hospital	Daksh Temple	3.100	60	2025	0.11	3.00	2	0	2	8.00	74	0	4	78
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2025	0.32	1.00	2	0	2	4.00	13	0	1	14
4	Ganeshpuram	DAV School	2.200	60	2025	0.22	2.00	2	0	2	6.00	28	0	2	30
										Total rake Required in 2025				514	

Normal Days

RAKE REQUIREMENT for 2031

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2031	0.20	4.00	2		2	10.00	50	0	5	55
1b	City Hospital	Har-Ki-Pauri	4.400	60	2031	0.08	4.00	2		2	10.00	120	0	12	132
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2031	0.15	6.00	2		2	14.00	93	0	9	102
									Total Car requirement			289			

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2031	0.17	3.00	2	0	2	8.00	48	0	5	53

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2031	0.83	1.00	2	0	2	4.00	5	0	1	6

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2031	0.40	2.00	2	0	2	6.00	15	0	2	17

Total rake Required in 2031 365

Mela Days

RAKE REQUIREMENT for 2031

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2031	0.08	4.00	2		2	10.00	120	0	12	132
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1b	City Hospital	Har-Ki-Pauri	4.400	60	2031	0.04	4.00	2		2	10.00	240	0	24	264
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2031	0.15	6.00	2		2	14.00	93	0	9	102
									Total Car requirement			498			

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2031	0.08	3.00	2	0	2	8.00	96	0	10	106

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2031	0.28	1.00	2	0	2	4.00	14	0	1	15

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2031	0.17	2.00	2	0	2	6.00	36	0	4	40

Total rake Required in 2031 659

Normal Days

RAKE REQUIREMENT for 2041

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2041	0.13	4.00	2		2	10.00	75	0	8	83
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1b	City Hospital	Har-Ki-Pauri	4.400	60	2041	0.07	4.00	2		2	10.00	150	0	15	165
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2041	0.11	6.00	2		2	14.00	129.0	0	13	142
									Total Car requirement			390			
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2041	0.13	3.00	2	0	2	8.00	64.00	0	6	70
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2041	0.67	1.00	2	0	2	4.00	6.0	0	1	7
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2041	0.30	2.00	2	0	2	6.00	20.0	0	2	22

Total rake Required in 2041 489

Mela Days

RAKE REQUIREMENT for 2041

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2041	0.07	4.00	2		2	10.00	150	0	15	165
1b	City Hospital	Har-Ki-Pauri	4.400	60	2041	0.03	4.00	2		2	10.00	300	0	30	330
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2041	0.12	6.00	2		2	14.00	120	0	12	132
									Total Car requirement			627			
2	City Hospital	Daksh Temple	3.100	60	2041	0.07	3.00	2	0	2	8.00	120	0	12	132
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2041	0.22	1.00	2	0	2	4.00	18	0	2	20
4	Ganeshpuram	DAV School	2.200	60	2041	0.13	2.00	2	0	2	6.00	45	0	5	50

Total rake Required in 2041 829

Normal Days

RAKE REQUIREMENT for 2051

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2051	0.11	4.00	2		2	10.00	92	0	9	101
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1b	City Hospital	Har-Ki-Pauri	4.400	60	2051	0.05	4.00	2		2	10.00	200	0	20	220
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2051	0.08	6.00	2		2	14.00	168	0	17	185
									Total Car requirement			506			
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2051	0.10	3.00	2	0	2	8.00	80.00	0	8	88
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2051	0.50	1.00	2	0	2	4.00	8.00	0	1	9
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2051	0.25	2.00	2	0	2	6.00	24.00	0	2	26

Total rake Required in 2051 629

Mela Days

RAKE REQUIREMENT for 2051

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1a	Sitapur	City Hospital	3.800	60	2051	0.05	4.00	2		2	10.00	200	0	20	220
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1b	City Hospital	Har-Ki-Pauri	4.400	60	2051	0.03	4.00	2		2	10.00	300	0	30	330
S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
1c	Har-Ki-Pauri	Bharat Mata Temple	6.100	60	2051	0.08	6.00	2		2	14.00	168	0	17	185
									Total Car requirement			735			

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
2	City Hospital	Daksh Temple	3.100	60	2051	0.05	3.00	2	0	2	8.00	160	0	16	176

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
3	Valmiki Chowk	Laltaro Bridge	0.760	60	2051	0.17	1.00	2	0	2	4.00	24	0	2	26

S. No.	Section		Length (km)	Schedule speed (kmph)	Year	Headway (min)	Run time (min)	Turn round time (min)	Any other time to be considered* (min)	Total round time+any other time	Total round trip time (min)	Car Requirement			Total cars
	From	To										Bare	Traffic Reserve	R&M	
4	Ganeshpuram	DAV School	2.200	60	2051	0.10	2.00	2	0	2	6.00	60	0	6	66

Total rake Required in 2051 1003

6.18 DEPOT- CUM- WORKSHOP AT RISHIKUL

It is proposed to establish one depot- cum- workshop with following functions and facilities:

- Major overhauls of all the Cars
- All minor schedules and repairs
- Lifting for replacement of heavy equipment and testing thereafter
- Repair of heavy equipment
- Layout of Parking area, Inspection area, minor repairs and heavy repair overhauling workshop and cleaning of Pod cars
- Operational and functional safety requirements
- Ancillary buildings for other maintenance facilities
- Electrical & Mechanical Services, power supply and distribution system
- Water Supplies, Drainage & Sewerage

The Depot planning is based on following assumptions:

- Enough space should be available for establishment of a Depot-Cum-workshop
- All inspection, workshop and parking area are designed to accommodate Maximum no. of cars
- Only 1/4th of Pod cars parking facilities are planned in the proposed depot-cum-workshop and other 3/4th Pod cars parking facility should be provided on mainline to reduce the dead mileage and maintained the high frequency of headways in seconds
- In case of space constraint for depot two storied parking area can also be planned

6.19 DEPOT CONFIGURATION COMPRISES

6.19.1 Location

Depots shall be designed to be off-line in suitable locations on the network to allow for the rapid deployment of empty vehicles to as many adjacent stations as possible in the shortest possible transit time. Large networks may require a distributed depot system in order to satisfy this requirement.

6.19.2 Entry/ Exit Alignment

Depots shall require both an entry diverge and an exit merge with the network. The entry section shall be designed to allow for at least one vehicle in each feeder lane to queue prior to

entering the depot main building at the “Depot Entry” point for that particular depot lane, and the exit section shall be designed to allow for at least one vehicle in each depot lane to queue prior to being programmed to re- join the network and proceed to a specific berth/station (the “Depot Exit” point).

6.19.3 On-line / Off-line

All “Service” Depot layouts should include a vehicle re-cycle loop to enable vehicles to be moved automatically from the Parking area to “Service Bays” and then after servicing back to the parking area.

6.19.4 Depot Protection

For the safety of personnel, areas where the vehicles are under automatic control (the Vehicle Movement Area – VMA) must be segregated from areas where the vehicle requires manual handling (i.e., maintenance, washing etc). The area in which vehicles are stored and charged shall be separated from any servicing or office/store area with each separated area being equipped with its own separate fire/smoke and burglar alarm systems – these system specifications shall be discussed in detail and subject to agreement with individual Clients. No staff will be allowed to enter the VMA unless the complete VMA in the depot is shutdown.

6.19.5 Doors

In order to satisfy the requirement to segregate the VMA, the moving of a vehicle from the VMA to a manual handling area, such as a service depot, must be controlled. This will be accomplished by an ‘air lock’ concept that allows a vehicle to enter a depot from the VMA through an outer door (or bollard) under automatic control and be switched safely to manual control before staff can gain access to it through an inner door.

An ‘Air lock door’ (or automatic bollards) will be provided at both entry to, and exit from the service depot for all vehicles coming on or off the network, or moving to or from storage. Dimensions of doors will need to take account of clearance requirements due to horizontal and vertical alignments.

Depot entrances shall be of sufficient size to allow vehicles to be moved and loaded onto a road vehicle for transportation to other facilities. All external depot doors shall be heavy duty and lockable such that the depot is secure when not operational.

6.19.6 Network Access Point

A Network Access Point for the introduction of new vehicles shall be provided at the major Service Depot in each application.

6.19.7 Provision for Cleaning and Recovery Vehicles

A suitable secure parking location for the network cleaning machine will be required at one depot on the network. This vehicle shall require direct access to the network from this parking position. It is assumed that this will not be an automatic vehicle.

6.20 DEPOT EQUIPMENT

6.20.1 Vehicle Wash Bay

All "Service" Depots will be designed with a vehicle washing facility that may be manual, semi-automatic or fully automatic depending on the size of the fleet stored in that depot. Wherever possible, consideration should be given to recycle waste water.

For automatic wash plant shall be provided on both sides to enable the navigation sensors to operate. Allowance shall also be made for a transponder to be located beneath the vehicle.

Cleanliness of the Pod Car is essential. Following schedules are recommended for Indian environment:

S. No.	Type of Inspection	Maintenance Cycle	Time	Maintenance Place
1	Outside cleaning (wet washing on automatic washing plant)	3 Days	10 mins.	Single Pass-through Automatic washing plant of Depot
2	Outside heavy Cleaning (wet washing on automatic washing plant and Front Face, Vestibule/ Buffer area. Floor, walls inside / outside of cars and roof. Manually)	30 days	1 – 2 hrs.	Automatic washing plant & cleaning & washing shed

6.20.2 Water Supply

A water supply will be required for the vehicle washing facility and for the staff facilities (kitchen, toilets etc) this should be a clean mains supply but its provision may be site dependent.

6.20.3 Drainage

Depot drainage shall be designed to connect into existing systems and the necessary consents obtained from the local authorities. Design parameters such as maximum flow rates, oil interceptors etc shall be agreed with the local authority.

6.20.4 Detergents/ Cleaning Agents

All fluids to be used in the depot shall be identified for the purposes of safe materials handling

and to ensure appropriate specification of materials against corrosion. Special measures may also be necessary for fluid storage and drainage.

6.21 MAINTENANCE AND SERVICING

Year-wise planning of maintenance facility setup at depot cum workshop based on planned pod car requirement in TOP is tabulated below:

6.21.1 Requirement of Parking Area, Service Lanes and Workshop stations

Year	No. of Car	Parking & Charging Facility	Service Lanes	Workshop	Remarks
2021	462	100 cars parking with 50 battery charging facility to be provided	Two bay to cater 24 cars at a time.	4 Workshop station with facilities of overhauling of different heavy equipment's overhauling and cater the maintenance facilities.	Only 1/4th of Pod cars parking facility has been taken in depot, the others 3/4th Pod cars parking facility should be provided in mainline to reduced dead mileage and maintained the high frequency of headways in seconds.
2025	514				
2031	659				
2041	829				
2051	1003				

- The service equipment in a "Service" Depot shall include basic equipment for changing tyres/wheels, and other modular units that may require routine changing. These may necessitate a pit or vehicle lift. Major items that require lengthy service or overhaul periods plus major refurbishment work will be carried out off-site.
- Where possible a vehicle lift will be provided in preference to inspection pits.
- Inspection pits will only be used where headroom issues mean that a vehicle lift cannot be accommodated.
- A 'rolling road' table may also be required, for routine inspections and testing.
- "Service" Depots shall be designed with a store room, suitable for the storage of spare parts.
- Service parts stored should be finalized during design & delivery of the system but it should include items that may require regular servicing such as tyres and wheels and other suspension parts, plus at least one set of each of the control sub-systems, motors, and other major electronic sub-assemblies. In addition, a full set of body parts may be stored in case of the requirement to replace such parts.

6.21.2 Inspection and Maintenance requirements at Depot

Facilities for carrying out inspection activities shall be provided in the Service Bay for following Systems / Equipment's of a Pod Car:

- PA/ PIS
- Mechanical components, Suspension etc
- Batteries
- Air conditioner
- Brake modules
- Traction Motor
- Vehicle doors &internal fittings
- CCTV
- Smoke Sensors & others Sensors
- Power system including converter, circuit breaker etc.
- Signalling & Telecom Equipment's

6.22 BATTERY CHARGING EQUIPMENT

All "Service" Depots shall have facility of fast-charging facility typically in the service bay area of the depot and AC Charging facility at all inspection and Parking Facility area.

6.23 POWER SUPPLY

The power supply should be 415v 3-phase and may require conversion from local supply in which case suitable transformer and circuit protection equipment may need to be housed in the station area.

Power requirements within the depot will include: -

- Lighting
- Battery chargers (in parking area)
- AC & DC Battery chargers (in service depot)
- Power outlets, in service depot, office, and welfare facilities.
- Vehicle lift(s)
- Environmental control, heating and air conditioning (if required)
- CCTV/Fire alarm/Access control

6.24 CCTV AND SECURITY

The arrival of a vehicle at the “Depot Entry” point shall be signalled both audibly and visually to the staff working at that depot and an approaching vehicle’s presence should be sensed and displayed on a CCTV screen in the main depot area.

CCTV coverage, smoke and burglar alarms shall be required to ensure secure operation both during network operation and throughout the daily network shutdown if applicable.

CCTV at the depot will be provided by fixed focal length cameras, placed such that the entire operating area is covered, quantity of cameras will be governed by site layout, but should be the minimum required to provide complete coverage without the need for any pan/tilt/zoom (PTZ) capability. The cameras will be connected to the control room by a fibre optic network, where the video will be viewed and recorded. The CCTV system will incorporate movement detection and foreign object detection capability.

6.25 DEPOT ACCOMMODATION

6.25.1 Building

The building structure and architecture will be designed to cater all maintenance requirements/ planning requirements.

6.25.2 Lighting, Heating and Ventilation

All depots shall be designed to be fully enclosed and heated for winter operation as required. All depots shall be provided with lighting and climate control (heating and cooling) and ventilation.

6.25.3 Office Area

“Service” Depots shall be designed with a simple office that will allow for communication with the “Network Controller” by phone and by CCTV.

The indicative layout of a Depot is presented below.

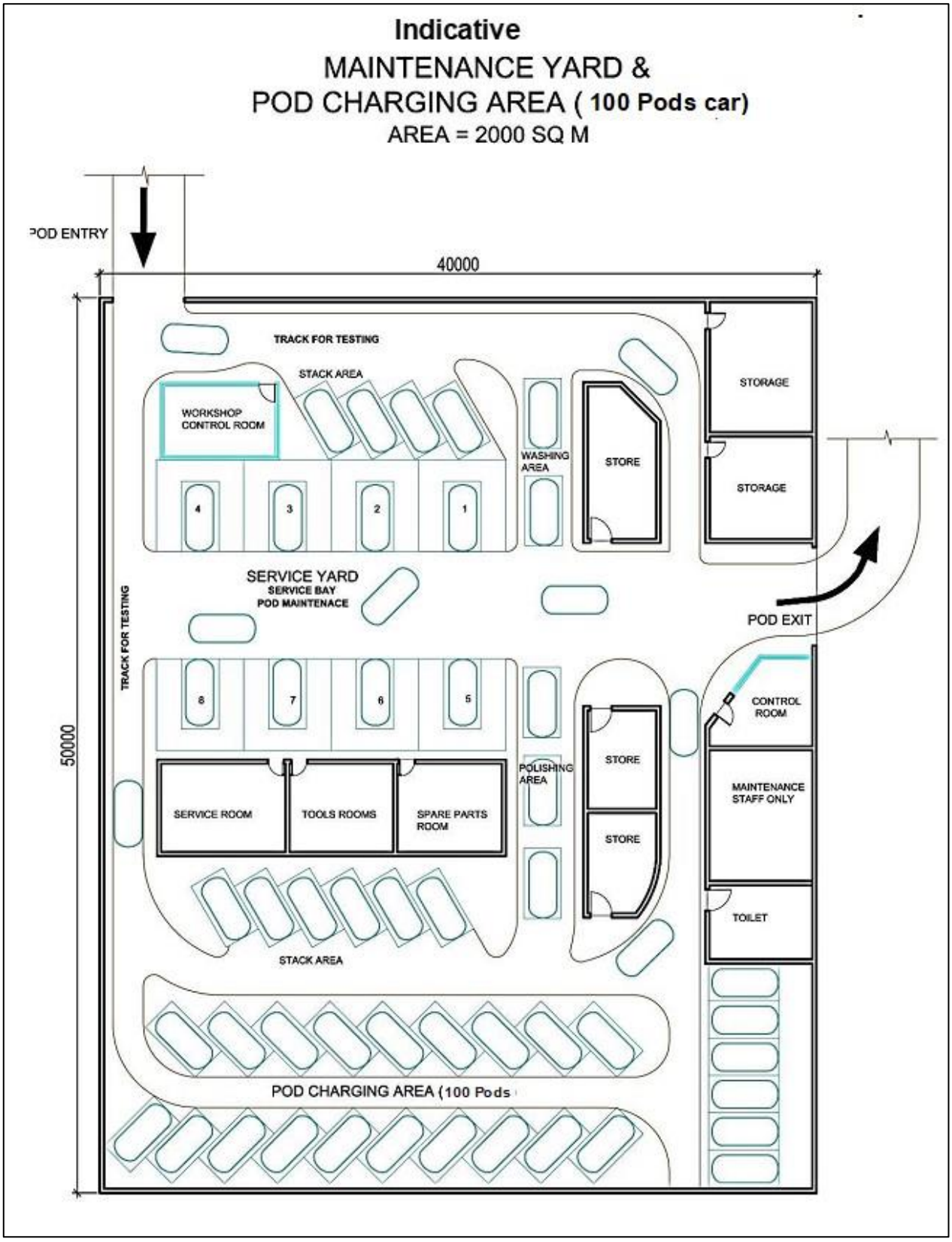


Figure 6-1: Indicative Layout of Depot

Figure 6-2: Personal Rapid Transit (PRT) POD Car Images

6.26 ADVICE NOTE FOR PROMOTERS CONSIDERING PRT (VERSION-1: JULY 2012)

6.26.1 Introduction

Purpose of Advice Note

This Advice Note is intended to provide practical help to promoters considering Personal Rapid Transit or PRT and highlights those matters they will need to consider.

We recommend that promoters first should refer to the Guidance Note for Light Rail, Ultra Light Rail and Personal Rapid Transit which provides general guidance on the preparation and evaluation of major scheme business cases. This is the first important step to be taken in seeking funding for any scheme.

This Advice Note is also aimed at encouraging more local authorities becoming aware of the advantages of PRT and therefore helping them to come forward with proposals to suit their communities.

This Advice Note is intended for promoters in England outside London. However, much of its contents may also be of interest to potential promoters of schemes in London, Scotland, Wales and Northern Ireland.

This Advice Note focuses on Personal Rapid Transit. Other Advice Notes are available for light rail and ultra-light rail transit modes.

We would also recommend that promoters should consult UK Tram as to the most effective ways of developing local transport proposals.

What is Personal Rapid Transit

Personal Rapid Transit (PRT) is a new form of transport, based on the use of small (typically 4-6 passengers) vehicles operating on a dedicated small scale guideway network. It offers passengers trips with no waiting and no stopping, direct to any point served by the system.

This contrasts with all existing forms of public transport, which involve both waiting and multiple stops during the trip. PRT provides public transport which is designed to compete with the car in urban areas and to offer major attractions in sustainability, passenger convenience and cost. PRT is particularly attractive when used in conjunction with existing modes of transport.

PRT is now in operation at Heathrow airport and Masdar City Abu Dhabi and a system is also under construction for operation in Suncheon, South Korea. Practical demonstration of its effectiveness, reliability and reduced cost and, in particular, the exceptionally positive response of passengers, has led to recognition that PRT can offer a valuable new contribution to transport infrastructure.

The three established PRT manufacturers are Ultra Global PRT Ltd, based in Bristol, England, 2getthere based in Utrecht, Holland, and Vectus based in Uppsala, Sweden. Ultra supplied the Heathrow pod system operating at London Heathrow Airport between Terminal 5 and its Business car park. The 2getthere system is operating at Masdar City in Abu Dhabi. Vectus is implementing a system at Suncheon Bay, South Korea, planned to open in 2013.

6.26.2 Characteristics of PRT

PRT is a type of small automated guided transit (AGT), a class of system which also includes larger vehicles such as driverless metros and airport automatic people movers, and smaller systems such as group rapid transit (GRT). Worldwide there are over 150 fully driverless AGT systems in operation. These carry over 2 billion passengers per year and have a record of no fatality or serious injury in the past 10 years.

In PRT designs, vehicles are sized for individual or small group travel, typically carrying 4-6 passengers per vehicle. Guideways are arranged in a network topology and, importantly, all stations are located off line. This approach allows for nonstop, point-to-point travel, bypassing all intermediate stations. The point-to-point service has been compared to a driverless taxi or a horizontal lift (elevator).

6.26.2.1 User Benefits

From the user's perspective, PRT offers many benefits:

- Immediate service: passengers rarely need to wait for a vehicle, since the empty vehicle management system ensures that one will usually already be available at the station.
- Practical operations have demonstrated that the average passenger waiting time is around 10 seconds.
- Nonstop travel: due to off-line stations, the journey is nonstop from start to destination, anywhere on the network.
- Travel is reliable, predictable and congestion free, affording passengers greater certainty in their journeys. There is no need to plan trips, consider schedules, or transfer between vehicles.
- Personal transport: passengers only share with desired companions.
- Faster than other urban transport, typically by a factor of two. Although average speeds are modest (around 25 mph), non-stop service and low waiting ensures short trip times.
- Travel is safe: PRT systems are certified to safety levels at least as good as trains, approximately 10 times higher than automotive safety. Segregation implies less conflict with non-users.
- Accessibility: The system is available to all, including the young, the old, and those with disabilities.

6.26.2.2 Community Benefits

In addition to user benefits, PRT provides sustainable urban transport with major benefits to non-users and to the community as a whole.

- PRT is energy efficient: light, small, efficient vehicles traveling non-stop and only on demand result in significant energy savings. PRT uses less than half of the energy of a car, and is more energy efficient than conventional public transport.
- PRT meets sustainability targets; satisfying the requirement for reduced carbon emissions. There are no emissions at point of use.
- PRT is exceptionally quiet, routinely below background noise levels.

- Lightweight vehicles permit light infrastructure. Small vehicles and guide-ways imply less land take and less visual intrusion.
- PRT reduces congestion: studies indicate significant modal shifts away from the car, freeing up both road capacity and parking space and allowing greater pedestrianization.
- Installation flexibility: small scale infrastructure may be readily integrated into buildings. Small turn radii (~5m) and high gradients (up to 10%) are readily achievable.
- PRT is complementary to other transport modes. Links to PRT can attract passengers to existing public transport (see Section 6.26.4.2)

6.26.2.3 Business Benefits

PRT systems can also offer a greater overall return on investment at local level than other forms of transport, especially when the opportunities for capturing land value uplift through integrated planning are realised.

- Much lower capital cost than conventional modes (see Section 6.26.5 for more details).
- Reduced operating costs (see Section 6.26.5 for more details).
- Rapid construction: the small scale of the infrastructure, typically prefabricated off site, gives low infrastructure build times.
- Less disruption: due to the small scale of the infrastructure compared to conventional modes.
- Increased usage of conventional modes (see Section 6.26.4.2).
- Increased land values due to improved accessibility.
- Opportunities for advertising and sponsorship revenue.
- Excellent first and last impression for city or campus applications.

6.26.3 Current Systems

6.26.3.1 Overall Descriptions

Listed below are the PRT systems currently operating. All offer the key features of PRT described in this document. For each system, details of a lead contact person are provided. These people have said that they would be happy to discuss the characteristics of their system with promoters considering whether to develop a new scheme.

Ultra PRT

Location: Heathrow Airport

Opened: April 2011

Track length (km): 3.8 Vehicles: 21

Stations: 3Passenger journeys (millions): 0.5

Contact: Fraser Brown
Fraser.Brown@ultraglobalprt.com

2Getthere

Location: Masdar City Abu Dhabi
Opened: Nov 2010

Track length (km): 1.7

Vehicles: 13

Stations: 5

Passenger journeys (millions): 0.5
Contact: Robbert Lohmann

Vectus

Location: Suncheon Bay, South Korea
Opened: Due 2013

Track length (km): 10 Vehicles: 40

Stations: 2

Passenger journeys (millions): - NA
Contact: Martin Pemberton

6.26.3.2 Comparative PRT Specifications

These details have been brought together by ATRA IG, the PRT Industry group. **Important Note**: Stated characteristics reflect systems as designed for current applications; there is much scope for tailoring parameters and performance of each system as required for future applications.		2getthere 	Ultra global prt 	VECTUS INTELLIGENT TRANSPORT
	Data Basis	**Masdar Application**	**Heathrow Application**	**Suncheon Application**
Key system design aspects				
Vehicle Power principle		Battery stored electric	Battery stored electric	Electrical

Power Transfer method		Automatic charging via automated connection at berths and in maintenance facility	Automatic opportunity charging via automatic connection at berths and in charging lanes	Current collection
Drive principle		Electric motor driving vehicle wheels	Electric motor driving vehicle wheels	Linear motor and /or electric motor driving vehicle wheels
Vehicle Support Method		Semi-solid tyres on level road surface	Pneumatic tyres on level road surface	Proprietary low friction solid polymer wheels on steel track
Vehicle Guidance Method		Dead reckoning with magnetic markers	Kerb referenced electronic steering	Captive to steel track
Vehicle Emergency Evacuation	-	Both sides	Front hatch (onto passive guideway)	Both sides
Vehicle Size & Accessibility				
Dimensions LxWxH	mm	3920x1460x 2010	3700x1470x 1800	3736x2010x 2500
Floor Space	m^2	1.7	≥1.7	3.4
Door opening area (HxW)	mm	1750x1050	≥1500x900	1950x900
Level entry		Yes	Yes	Yes
Number of passengers per vehicle	-	4 adults, 2 children	4 adults, 2 children	4 adults, 4 children
Wheelchair accommodation capability	-	Yes (ADA compliant)	Yes (RVAR/ADA compliant)	Yes (RVAR compliant)
Luggage	-	Between seats	Between seats	Between seats
Weight - empty and (maximum)	kg	1400 (2050)	850 (1300)	1500 (2500)
Payload	kg	650	450	1000
Performance characteristics				
Maximum Speed	km/hr	40	40	70
Maximum speed in curve (with radius: 20/50/100m)	km/hr	16/26/36	18/28/40	16/26/36
Typical Acceleration and Deceleration	m/s^2	0.8	1.25	1.2

Maximum Emergency Deceleration (current/projected)	m/s^2	4.7	2.5 / 5	5
Maximum Range (at maximum payload)	km	60	20	Not applicable
Platform Gap	mm	< 30	< 20	< 30
Platform Step	mm	<10	5	< 10
Energy Usage				
Energy Consumption @ 30 km/h (empty	kWh/ km	0.17	0.09	0.23
Vehicle				
Energy Consumption @ 30 km/h (full vehicle)	kWh/ km	0.19	0.13	0.24
Equivalent Carbon usage (full vehicle@30 km/h, and 0.545 kg CO^2/kWh)	g CO^2/passenger km	0.023	0.018	0.022
Control System				
Controls concept		Asynchronous / Synchronous	Synchronous-based, asynchronous aspects	Asynchronous
Controls Topography		Distributed	Distributed	Distributed
Automatic Vehicle Protection system		Fixed Block in combination with Obstacle detection	Fixed block system	Radio based Dynamic Moving Block
Obstacle Detection	-	Front and Rear	Operator monitored CCTV	Optional front
Dynamic rerouting		Not currently	In stations	Yes
Emergency recovery		Manual drive (joystick) + tow bar	Low speed recovery mode + dedicated tow vehicle if necessary	Reverse operation + Push/Tow with other vehicles
Current application headway	seconds	5	6	4
Infrastructure				
Max. Track Gradient	%	10	10	10
Minimum Radius (centre line)	m	5.5	5	5
Track Width (at grade / elevated)	mm	1750 / 1850 without walkway	1750 / 2100	1400/1400

Typical system (track and vehicle) square clearance envelope (W*H)	mm	1750 - 1850 / 2300 Without walkway	1750 / 2100*2000	2100 * 2500
Berth concept(s)		Angled independent or straight in-line	Angled independent or straight in-line	In-line
Maximum throughput 1 berth/hour	Vehicles	~120	~120	160-200
Minimum multi berth station length per independent berth	m	Depends on berth angle: @Masdar: 4.3 at30degrees	3.2	4.5
Minimum multi berth station width per independent berth (inc vehicle and passenger areas)	m	Depending on angle of the berth	4	NA
Interaction with Passengers				
Information		Touch Screen with audio and custom defined content	Automated interactive display and audio at berths and in vehicles.	A/V passenger information displays in vehicles and stations
Communication initiation		CCTV, Intercom, Medical Assistance request button, Emergency Stop button	Information and Emergency Assistance request buttons in vehicles and stations	Information and Emergency Assistance request buttons in vehicles and stations
Communication		2 way audio intercom and CCTV monitoring at berths and in vehicles	2 way audio intercom and CCTV monitoring at berths and in vehicles	2 way audio intercom and CCTV monitoring at stations and in vehicles
Destination Selection		Application Dependent	Application Dependent	Application Dependent
Facility for ride sharing		Yes	Yes	Yes
Emergency Response				
CCTV		Yes	Yes	Yes
Intercom		Yes	Yes	Yes
Operator		Yes	Yes	Yes

6.26.4 Exploiting the Benefits of PRT

6.26.4.1 Introduction

This chapter offers advice to promoters on how best to exploit the attributes of PRT and the type of application where it is best suited. In deciding whether PRT is the most appropriate mode, promoters will need to think about how to best use its particular attributes to optimize the scheme they intend to consider. Promoters should talk to those who have already developed and delivered PRT systems and look at the measures they have taken to make their projects successful. Promoters should take note of the published and anticipated work of UK Tram.

As discussed in Section 6.26.2, PRT offers a series of major potential benefits. In the right circumstances it is:

- Highly flexible
- Attractive to users
- Sustainable
- Lower cost, both capital and operating
- Efficient - compared to other modes with equivalent capacity

6.26.4.2 PRT as a Part of the Transport System

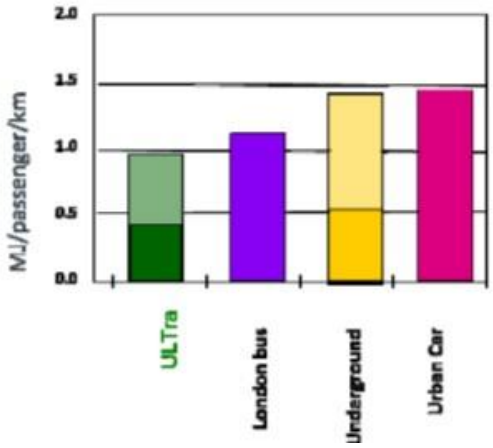
It is widely recognised that, despite high levels of subsidy, consumer satisfaction with present public transport services is low. Private cars have intrinsic advantages over collective modes, deriving from their greater flexibility of use. A key issue is the “last mile” problem. Current public transport only delivers passengers to the nearest stop, which can be some distance from the final destination desired. PRT can connect effectively to conventional public transport systems to solve this problem, thus attracting passengers to existing public transport. Independent studies by Arup and the University of Leeds have shown that using PRT to provide a network link to conventional transport can increase the take up of conventional public transport by factors of between 2 and more than 3 (Ref 1). PRT offers a new approach to meeting a core objective of Transport policy, attracting more users onto public transit.

PRT has the capability of adding major value to new developments by providing quicker links to major activity centers. It can also support satellite offices or parking locations or locations that might be difficult to access by private car. Integration of PRT into Master Plans to maximize the land-use and value added is a critical aspect of developing a satisfactory business case. PRT may be seen as a key ingredient in the creation of truly integrated transport solutions.

6.26.4.3 PRT as Sustainable Transport

PRT provides:

- Light-weight low speed electric vehicles
- Movement only when there is user demand
- Regenerative braking avoids ‘stop & go’ waste
- No on-site emissions
- Low external noise (below back ground levels)
- Low resource use



This means that PRT, as well as having no emissions at point of use, uses lower energy than all other modes, including mass transit modes, meaning lower carbon emissions. (Shown in diagram).

Thus, PRT offers a new approach to meeting a core objective of energy policy, i.e. the introduction of sustainable transport.

6.26.4.4 PRT Issues

PRT is not necessarily the best solution for all transport problems. For example, heavy commuter loads, such as those in the biggest cities like London, require much higher capacity systems. As noted above, PRT can help the heavy modes to do their job better by taking passengers to and from the major stations served by such modes. In more modest size cities PRT may be justified for a ‘feeder’ role in delivering city centre commuters.

Long point to point links is another application where PRT may not necessarily be the best solution. PRT will normally offer cost benefits over rail modes, but long corridor routes do not exploit the anywhere to anywhere capability which is a key attraction of PRT. Also, PRT may not have high enough speed to deliver acceptable trip times on longer routes. However, PRT has very little waiting, while for conventional transport it is necessary to add a wait time. This time is a function of frequency, but could well be 10 minutes or more for a conventional mode. It will be a matter of judgment whether the combined times from arrival at the station to leaving the vehicle at the destination would be more attractive by conventional transport or PRT.

PRT deals with high demand by using many small vehicles rather than single large vehicles. This is the key to providing low waiting times. Where large demand is expected, stations must be sized with sufficient berths to permit the demand to be dealt with satisfactorily. Operating experience has shown that during peak periods passengers are very prepared to share vehicles. Thus, PRT capacity automatically increases when it is needed. Maximum capacity depends on system details (see specifications in Section 3.2). It has been demonstrated that a 5 berth station can deal with upto 40 passengers per minute i.e. 2400 per hour. For

comparison, a 40 passenger bus is projected to take 100 seconds to fully load (Ref2). If clearance of large passenger numbers is a key operational requirement, it will be necessary to examine the various commercial systems available to determine which technology best satisfies the need.

6.26.4.5 Project Risks

PRT is a new system. Any such system must involve elements of project risk. Experience from operations has been very positive, demonstrating excellent reliability. Technology risks for modest scale systems can be considered as low. Risks associated with PRT can reasonably be regarded as being manageable. An objective evaluation of risk and reward will be a necessary part of a procurement action.

In the opinion of the suppliers, PRT is a “hard target” from the security point of view due to the extensive use of actively monitored CCTV, in Stations, Guideway and Vehicle. Experience to date has revealed zero security problems in current operations. However a review of the most suitable approach to security is recommended as part of the operational design process.

6.26.5 PRT Costs

6.26.5.1 Introduction

Many of the costs for a Promoter establishing a new transport system are associated with the planning and approval process, as described in the wider Guidance Note for Light Rail, Ultra Light Rail and Personal Rapid Transit covering the preparation and evaluation of major scheme business cases. This Chapter is intended to provide broad guidance on the likely level of Capital and operating costs involved, which are a critical part of establishing a business case for any scheme.

Given the flexibility of PRT, there is not a "one size fits all" cost calculator, and the unique characteristics of a site will determine the overall capital cost requirements for a particular application. Costs are particularly influenced by system ridership. Guideway and control system costs will remain fairly constant once a route has been established, but station capacity (berths and locations) and number of vehicles (with attendant maintenance and maintenance facility costs) can all vary significantly dependent on the volume of passenger movements required.

Capital costs are therefore a function of the ease or difficulty in installation, expressed as cost per km, and the anticipated demand on the system, expressed as vehicles per km on the peak route. Figure below shows a typical cost envelope for low capacity/high capacity, easy installation/difficult installation. This is a total cost per km of one way track including all infrastructure, systems and vehicles. Figure 2 gives the approximate breakdown by price of a medium capacity system.

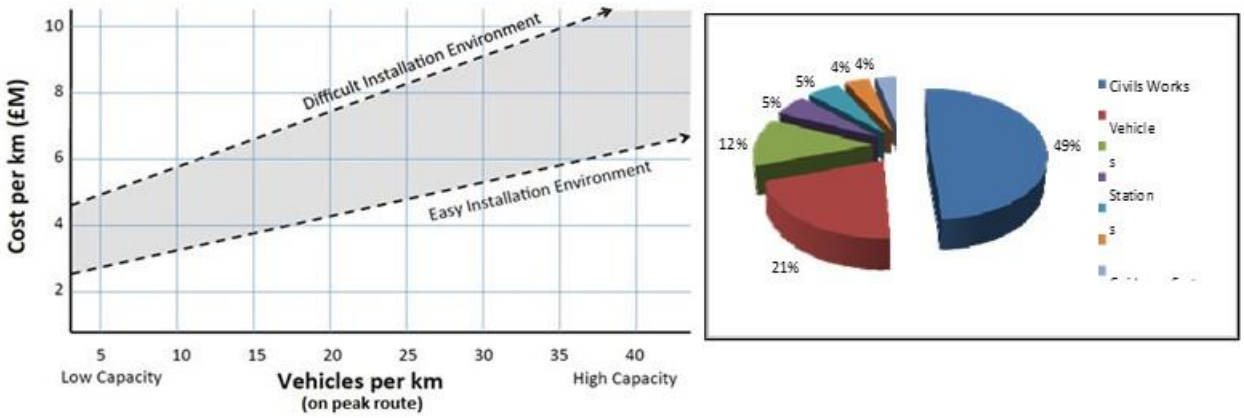


Figure 6-3: Capital Cost Trends and Cost Breakdown for Typical PRT

6.26.5.2 Primary Capital Cost Drivers

The primary cost drivers for a PRT system application are as follows:

- System size (particularly if custom elements are required);
- Station Density - stations required per guideway-km;
- Peak system loading, average journey length, and desired average passenger wait time;
- Average vehicle occupancy during peak, and totality of flow (# empty vehicle movements);
- Amount of single versus bi-directional guideway;
- Amount of elevated/at-grade/tunnel/culvert/cantilever guideway;
- Proportion of standardized components (e.g. guideway curve sections)
- Deployment context (urban/public areas or semi open/closed, controlled access such as airports & private campus areas), and associated security requirements;
- Integration with other site facilities/roads/pedestrian areas etc;
- Customer's aspirations for station design;
- Customer requirements for custom vehicle appearances and characteristics.

As a simple example, an application of PRT in which all of the guideway and stations are at grade will have a significantly reduced base cost due to the large contribution of the elevated guideway. However, other factors (e.g. extra security requirements, severance issues, land costs) may lessen the benefits of this reduction, and increase costs elsewhere.

6.26.5.3 Cost Comparison to Other Rail and Other Systems

The basic cost drivers for automated transport systems, including PRT, are common engineering issues rather than specific features of the technology. The high cost of line haul

systems, is primarily associated with their (comparatively) large size.

An automated system can be divided into three main parts: the infrastructure, control system and vehicles. Typically, the infrastructure costs for both traditional and PRT systems dominate the cost comparisons, with the (elevated) guideway being the largest cost of the infrastructure. Comparable results for the weight of the elevated superstructure of three examples shown below are as follows:

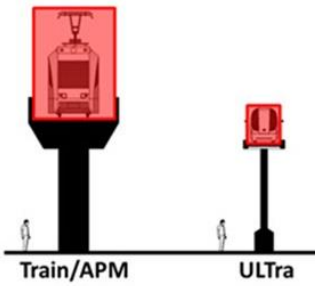
- PRT(ULTra) Combined weight guideway 4.6kN/m (0.46tonnes/m)
- Monorail (Sydney) Steel guideway beam 13.5kN/m (1.35tonnes/m)
- LRT(KL) Combined weight guideway 45.3kN/m (4.53 tonnes/m)

Ultra Heathrow

Kuala Lumpur LRT

Sydney Monorail

PRT is a transport facility of a considerably smaller mass and scale than rail and other systems, and as such offers potential for lower capital cost projects in comparison with conventional systems of the same overall passenger capacity, combined with additional benefits described in Section 6.26.2.



6.26.5.4 Operating and Maintenance Costs

The level of automation provided by a PRT system eliminates drivers and reduces operator work load in the control room. Automatic control and management of vehicle operations with respect to demand levels ensures that the system uses energy to move passengers in the most economical way. Computerized demand management systems ensure that operational planning is matched with expected demand levels, feeding performance data back into the system to provide continual improvements to service levels and customer experience.

The O&M costs for a PRT system range from 3%-5% of capital cost per annum. Much of this cost is fixed by the requirement to man the control room on a full time basis. The number of staff required only varies modestly with

System size. This means that the O&M cost of a small system (<50 vehicles) will be towards the high end of this range, while the cost for a larger system (say >100 vehicles) will be towards

the lower end of the range. Specific cost estimates will require detailed consideration of the details of the system planned.

Capital Replacement Costs: Using the typical breakdown figures given in earlier section, assuming the design infrastructure life of 50 years and vehicles/systems replacement life of 8 years, gives a projected Capital Replacement cost of about 5%.

6.26.6 Procurement Strategy

PRT is a new technology and many independent consultants, traditionally used by promoters for advice on specifications and procurement will be unfamiliar with the specific features and characteristics of PRT. It is therefore recommended that the technology supplier is selected early in the procurement process to work alongside the chosen transport planner and infrastructure designer during the design stages. Bringing these experts together at an early stage in the definition of the scheme is likely to provide a more cost effective system, fully exploiting PRT capabilities, while also reducing both interface risks and subsequent integration risks.

6.26.7 Regulatory Basis

6.26.7.1 Introduction

Specific clearance of any new PRT system under the UK regulations is a formal requirement. As a minimum the PRT systems must comply with the UK Disability Discrimination Act (DDA) 2005 and the safety regulations enforced by the Office of the Rail Regulator (ORR). These two aspects are amplified below.

All current operating PRT systems have passed through an extensive regulatory approval process based on existing standards and norms. It is believed by the vendors that all systems are broadly comparable in their ability to deliver a system which is satisfactory under the various National regulations. However, at present there are currently no UK or European PRT specific design standards. The US continues to develop the ASCE APM standards to cover PRT. However, if these US design standards are used it will be necessary to introduce variations to comply with UK legislation and some specific design features of the European PRT systems.

6.26.7.2 Physical Accessibility

The design of all new PRT vehicles will need to comply with the ‘The Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010’, referred to as RVAR 10 which came into force on 6th April 2010. The infrastructure elements would be expected to follow the principles laid down in the DfT's publication, "Inclusive Mobility", as far as reasonably practicable. In addition, under the Disability Discrimination Act (DDA) 2005, suppliers of transport services have a duty, as far as reasonably practicable, not to discriminate against disabled people and

must design their policies and procedures to comply with this requirement.

Early contact with the DfT's Rail Vehicle Accessibility Group and the Disability Policy Unit is advisable. Early input can help to ensure that all accessibility issues are addressed for the whole scheme. Whilst the above Acts and Regulations set the minimum framework standards for access to public transport, the promoter will need to pay careful consideration to determine the full extent of the DDA provision for each scheme.

6.26.7.3 Safety Regulation

PRT systems come within 'The Railways and Other Guided Transport Systems (Safety) Regulations 2006' (ROGS), enforced by the Office of Rail Regulation (ORR). The Regulation differentiates between main line rail and other guided transport systems that operate at speeds below 40 km/h. As most PRT systems typically operate at speeds below 40km/h the transport operator can put the system into use provided that the safety of the system is verified by an independent competent person (or persons). Should a PRT scheme with vehicle speeds greater than 40km/h be considered, early discussion with the ORR is essential.

The promoter should consider carefully the contractual arrangements and responsibilities for compliance with ROGS when selecting the PRT system supplier, the infrastructure provider and the transport operator. Early discussions with ORR and HMRI on the safety responsibilities of the various Duty Holders are advisable.

6.26.7.4 Safety Management System

Before bringing the PRT system into service, the transport operator must establish a satisfactory Safety Management System (SMS). The general requirements of the SMS are defined (within ROGS) but there is no requirement for it to be approved and no certificate is required.

One of the requirements of the SMS is that, before any new or altered vehicles or infrastructure are placed into service, the transport operator must establish a written safety verification scheme (compliant with Schedule 4 of the ROGS), appoint a competent person and the competent person must undertake that safety verification.

The ‘competent person’ must have sufficient skills, knowledge, experience and resources to undertake the safety verification and be independent of the management or operation of the scheme. In practice the ‘competent person’ may be a small team of experts.

6.26.7.5 Guidance on ROGS

Guidance on ROGS can be found on the ORR website www.rail-reg.gov.uk. HMRI encourages promoters of new systems to contact them as early as possible in the development process and then maintain regular dialogue throughout this process so that they can discuss relevant safety issues before designs become fixed.

Chapter -7
Power Supply Arrangements

7.1 Power Requirements

7.2 Need for High Reliability of Power Supply

7.3 Sources of Power Supply

7.4 Power Factor Improvement

7.5 Emergency Power Supply

7.6 LT Panel

7.7 UPS System

7.8 Inverter

7.9 Station Lighting

7.10 Elevator & Escalator

7.11 POD Battery & Battery Charger

7.12 Other Facility

7.13 Solar Photo Voltaic (PV) Power System

7.14 Energy Saving Measures

7.15 Electric Power Tariff

CHAPTER 7
POWER SUPPLY ARRANGEMENTS

7.1 POWER REQUIREMENTS

Power supply is required for charging of Pod cars, station services (e.g., lighting, lifts, escalators, signalling & telecom, fire-fighting, etc) and workshops, depots & other maintenance infrastructure within premises of PRT system.

The report consists of providing the detail for Electrical Power consumption of the 21 nos. of PRT Stations and a maintenance yard including control room for the PRT system of Haridwar. There are three type of station 1st type having 2 berths platform, 2nd type having 4 berths platform and 3rd is 6 berths platform stations. In which 7 no's of stations of 2 berths, 4 berths & 6 berths platform are planned.

It has been assumed to take the power supply feeder from local distribution agency to feed each PRT stations. All the PRT stations shall take electricity supply from the existing Distribution company substation. For emergency supply, UPS & Inverter shall be provided on each station and interchange and terminal station have facility of Diesel Generator.

The Maintenance yard has its own 11 KV HT Panel, Transformer & LT Panel. The power requirement of the maintenance yard is higher due to the 50 Nos. of charging points will be provided for Pod cars charging. Diesel Generator shall be provided for essential requirement of the Maintenance Yard.

The power requirements of a PRT system are determined on peak-hour demands of power requirements. Broad estimation of power demand is made based on the following requirements:-

i. Elevated station load with 250 – 370 KW (each)

ii. Depot load – 870 KW

Keeping in view of the PRT operation plan and demand of power requirements projected for the year 2021, 2025, 2031, 2041 and 2051 are summarized in The Table below:

*Table 7-1 : Power Demand Estimation**

PRT Corridors	Load	Total Power Demand (Year)				
		2021	2025	2031	2041*	2051*
All Corridor's total power Demand (i) Bharat Mata Temple – Sitapur. (ii) City Hospital – Daksh Temple. (iii) Valmiki Chowk – Laltaro Bridge (iv) Ganeshpuram – DAV School.	AUX.	7.0 MW	7.0 MW	7.0 MW	7.7 MW	8.5 MW

** The demand estimation for year 2041 & 2051 has been escalated 10 % from 2031 and 2041 respectively due to Pod car requirements and the detailed calculations of power demand estimation are attached at Annexures 7.1.*

7.2 NEED FOR HIGH RELIABILITY OF POWER SUPPLY

The proposed Haridwar PRT system is being designed to handle about 4393 passengers per direction during peak hours when cars are expected to run within seconds of intervals in 2021 or so. Interruption of power at night is likely to cause alarm and increased risk to travelling public. Lack of illumination at stations, non-visibility of appropriate signage's, disruption of operation of lifts and escalators is likely to cause confusion, anxiety and ire in commuters, whose tolerance level are low on account of stress. Effect on signal and communication may affect PRT operation and passenger safety as well. Therefore, uninterrupted power supply is mandatory for efficient operation of this PRT system

To ensure reliability of power supply, it is essential that two sources of power Supply at each station with auto transfer switch for reliability and have adequate redundancies.

7.3 SOURCES OF POWER SUPPLY

It has been considered that 11KV HT connection shall be made available for Maintenance depot only and the all PRT stations shall receive LT supply from the local distribution agency.

7.4 POWER FACTOR IMPROVEMENT

The supply Authorities require that the power factor of the system should be maintained at a minimum of 0.95. It is intended that automatic power factor control equipment shall be provided within the system to maintain a power factor of well above 0.95. The following parameters of design shall be adopted.

- Power factor relay: An automatic 3 phase power factor controller shall be provided with the following design parameters
- Adequate number of steps as required by detailed design

- The relay shall monitor all three phases independently and provide correction in each phase to ensure that power factor is maintained on each phase.
- Capacitor steps shall be site settable
- Over voltage protection of capacitors
- Measurement of current, voltage, power factor, real KW, reactive KVAR and apparent KVA.
- Automatic /manual mode selection

7.5 EMERGENCY POWER SUPPLY

The Emergency Power supply shall be feed to the Maintenance yard only. Maintenance yard may have 50 to 100% back up from the Diesel Generator sets as per requirement. AMF panel shall be providing with the DG set.

7.6 LT PANEL

The LT Panel shall be provided with adequate size of ACBs/MCCBs. The bus bars of the panel shall be made of aluminum strips and the panel shall be in compartmentalized design.

The LT Panel shall be located inside the PRT station building. The LT Panel shall be suitable for 415V, 50Hz, 3 phase 4 wire system. The fault level of the system will be maintained as per requirement of the Local supply agency. The size of feeder cables shall be so, selected to have economy in overall distribution as well as to have minimum voltage drop in the system (max. 5%).

The electric supply from the LT Panel shall be distributed to the actual load centres through suitable sized 415V, 50Hz, 3 phase, 4 wire, 1.1 KV grade Al FRLS XLPE cables. All the panels including main low voltage panel and distribution boards shall have some spare feeders for operational flexibility.

Design of the complete distribution system shall be such that maximum voltages drop at the farthest point from the transformers shall be restricted to 5% which is compliance with the Indian Electricity Rule.

7.7 UPS SYSTEM

UPS shall be with N+N configuration with Full IGBT type. The UPS shall provide the supply to the control room equipment, AFC Gate, CCTV & EPABX system. UPS ensure uninterrupted power supply for a minimum period of 120/60 Minute as per requirement.

The UPS modules shall be located within a fully enclosed, free standing, system cabinet which shall contain automatic parallel connection terminals, communication cables, individual module isolators, input/output power terminals and an integral wrap around maintenance bypass switch. For a parallel configurations single points of failure shall be eliminated whereby each UPS module is autonomous, incorporating individual active components such as Power Units, Static Bypass Switches, CPU's, Control Panels and Separate Battery Sets. The Maintenance Free Batteries shall be use of high efficiency.

7.8 INVERTER

The inverter power shall be provided to the 30% of Light common area, Ticket counter, office area, exit sign & Fire Alarm System. Inverter shall provide the power supply for a minimum period of 120 Minute.

The Inverter modules shall be located within a fully enclosed, free standing, system cabinet which shall contain power terminals and an integral wrap around maintenance bypass switch. The Maintenance Free Batteries shall be use of high efficiency.

7.9 STATION LIGHTING

High efficiency LED light fixtures shall be provided as per relevant standards.

7.10 ELEVATOR & ESCALATOR

2 Nos. escalator & 2 Nos. elevator at each PRT station proposed, however Nos. may increase or decrease as per the requirement. The elevator is for the disabled person & all facility inside the Lift as per easily operated to the disabled.

7.11 POD BATTERY & BATTERY CHARGER

The POD Car max. Operating speed (maximum) is proposed to 90 kmph. The average speed of the POD is 40 to 60 kmph. so, the selection of battery shall be such that to fulfil the requirement. It is recommended to use Lithium-ion battery to achieve the requirement however OEM can recommend other type of batteries also. The batteries shall be capable to run the POD car minimum 250 km in single charge.

The charging time shall be as less as possible at the parking POD area. The POD Car at the Berth location shall be charged in between the duration to park on the berth & boarding of the passenger. In 2 berth stations & 4 berths stations, 10 No's charger shall be installed & In 6 berth stations, 15 No's charger shall be installed. The discharged POD shall be parked on the Charger location for charging the POD car. Final nos. of charging station shall be dependent of

nos. of PODs operating within the systems and charger should be mix of the AC & DC Chargers as per requirements during design.

7.12 OTHER FACILITY

I. **Fire Alarm System**

It is proposed to have Addressable Fire Detection & Alarm systems which are as per NBC – Part-IV / EN-54/NFPA-72.

II. **CCTV System**

For the surveillance of the stations the CCTV cameras inside the Stations are installed.

For the surveillance of the stations the CCTV cameras inside the Stations are installed.

III. **Public Address System**

Public address (PA) with speakers shall be provided in the station building for accouchements to the passengers.

7.13 SOLAR PHOTO VOLTIC (PV) POWER SYSTEM

At the available space solar panel may be installed which may be through RESCO (Renewable Energy Service Company). The details of load calculation of solar power can be finalized only after actual space availability, it may be assumed that in every 12 sqm., installation of 1KWp solar plant can be generate of 4KWH (4 Unit) power per day.

7.14 ENERGY SAVING MEASURES

Energy charges of any PRT system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The proposed system of Haridwar PRT System includes the following energy saving features:

i. Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc.).

ii. Machine-room less type lifts with gearless drive has been proposed with 3-phase VVVF drive. These lifts are highly energy efficient.

iii. The proposed heavy-duty public services escalators will be provided with 3-phase VVVF drive, which is energy efficient & improves the power factor. Further, the escalators will be provided with infrared sensors to automatically reduce the speed (to idling speed) when

not being used by passengers.

iv. The latest state of art and energy efficient electrical equipment (e.g., transformers, motors, light fittings etc.) has been incorporated in the system design.

v. LED lights to be used in the station area and Depot area.

7.15 ELECTRIC POWER TARRIF

The cost of electricity is a significant part of Operation & Maintenance (O&M) charges of the PRT System, Therefore, it is the key element for the financial viability of the Project. The annual energy consumption is assessed to be about 17.3 million units for Corridor- initial years (2021) and 19.0 million units for years (2025), which will be increased respectively as per the additions in the system. In addition to ensuring optimum energy consumption, it is also necessary that the electric power tariff be kept at a minimum in order to contain the O & M costs. Therefore, the power tariff for Haridwar PRT System should be at effective rate of purchase price. The power tariff of Uttarakhand Electricity Regulatory Commission for the railways for financial Year 2016-17 demand charges Rs. 240/KVA/month and energy charges Rs.4.91/kVAh. It is proposed that Government of Uttarakhand takes necessary steps to fix power tariff for Haridwar PRT System at “No Profit No Loss” basis. Similar approach has been adopted for Delhi Metro.

Annexure: 7.1

Haridwar PRT System				
Power Requirement				
S. No.	**Details**	**Unit.**	**Total Quantity**	**Total Requirement**
1	Station Load for 2 Berth Station (7 no's of station)			1764 KW
2	Station Load for 4 Berth Station (7 no's of station)			1809 KW
3	Station Load for 6 Berth Station (7 no's of station)			2593 KW
4	Total Power load Requirement for Depot			870 KW
5	Total Power demand requirement for PRT System			7036 KW
				7.0 MW
1	**Station Load Calculation for 2 berth station**	**Unit**	**Total Quantity**	**Total Requirement**
a	Total Area of Station	sq. m.	150	
b	Internal lighting Load			2 KW
c	External Lighting Load			2 KW
d	Elevator Electrical Load (2 elevators 10 KW each)			20 KW
e	Escalator Electrical Load (2 escalators 15 KW each)			30 KW
f	AFC Gate Load			2 KW
g	Track Lighting			2 KW
h	Pods Charging Load (10 Pods charging with 23kw each pod)			230 KW
i	Cleaning Machine Load			2 KW
j	Plumbing Load			10 KW
k	Fire Fighting Equipment Load			---
l	Air-conditioning electrical load			10 KW
m	Miscellaneous			5 KW
n	Total Electrical Load			315 KW
o	Electrical Load after overall Diversity@ 80% (incl. LV System)			252 KW
2	**Station Load Calculation for 4 berth station**	**Unit**	**Total Quantity**	**Total Requirement**
a	Total Area of Station	sq. m.	320	
b	Internal lighting Load			4 KW
c	External Lighting Load			4 KW
d	Elevator Electrical Load (2 elevators 10 KW each)			20 KW
e	Escalator Electrical Load (2 escalators 15 KW each)			30 KW
f	AFC Gate Load			4 KW
g	Track Lighting			4 KW

h	Pods Charging Load (10 Pods charging with 23kw each pod)			230 KW
i	Cleaning Machine Load			2 KW
j	Plumbing Load			10 KW
k	Fire Fighting Equipment Load			---
l	Air-conditioning electrical load			10 KW
m	Miscellaneous			5 KW
n	Total Electrical Load			323 KW
o	Electrical Load after overall Diversity@ 80% (incl. LV System)			258 KW
3	**Station Load Calculation for 6 berth station**	**Unit**	**Total Quantity**	**Total Requirement**
a	Total Area of Station	sq. m.	1300	
b	Internal lighting Load			13 KW
c	External Lighting Load			6 KW
d	Elevator Electrical Load (2 elevators 10 KW each)			20 KW
d	Escalator Electrical Load (2 escalators 15 KW each)			30 KW
f	AFC Gate Load			6 KW
g	Track Lighting			4 KW
h	Pods Charging Load (15 Pods charging with 23kw each pod)			345 KW
i	Cleaning Machine Load			4 KW
j	Plumbing Load			10 KW
k	Fire Fighting Equipment Load			---
l	Air-conditioning electrical load			15 KW
m	Miscellaneous			10 KW
n	Total Electrical Load			463 KW
o	Electrical Load after overall Diversity@ 80% (incl. LV System)			370 KW
4	**Total Power Requirement for Depot**	**Unit**	**Total Quantity**	**Total Requirement**
a	Total Area of Depot	sq. m.	2000	
b	Internal Lighting Load			20 KW
c	External Lighting Load			10 KW
d	Control room load			30 KW
e	Pod Charging Load (50 pods charging with 23 KW each)			1150 KW
f	Service Station Load (12 stands with 20 kw each)			240 KW
g	Total Electrical Load after Diversity @ 60%			870 KW
h	DG Set Requirement Load in KVA			1088 KVA
i	At 90% Loading Selection of DG Set			1208 KVA
j	Selection of DG			2 X 650 KVA

Energy Consumption Detail

S. No.	Description		Total Auxiliary Requirement	Total Energy consumption (million units)
1	Auxiliary Energy Consumption			
a	Total auxiliary load except Pod Charging		1706 KW	
b.	Yearly Aux. Energy Consumption with 16 hrs./day and 365 days working with 80% diversity factor (in million units)			8.0
Pod Car Energy Consumption Normal Day				
c.	**Pod Car Consumption with 16 hour/ day running with 265 day with 10 % cars reserve for maintenance.**		**Total Pod Car energy Consumption Requirements (in millions units)**	**Total energy Consumption (millions units)**
i.	Year 2021 (234 cars)		5.4	
ii.	Year 2025 (285 cars)		6.5	
iii.	Year 2031 (365 cars)		8.4	
iv.	Year 2041 (489 cars)		11.2	
v	Year 2051 (629 cars)		14.4	
Pod Car Energy Consumption Mela (Pooja) Day				
d	**Pod Car Consumption with 16 hour/ day running with 100 day with 10 % cars reserve for maintenance.**		**Total Pod Car energy Consumption Requirements (in millions units)**	
i.	Year 2021 (462 cars)		4.0	
ii.	Year 2025 (514 cars)		4.4	
iii.	Year 2031 (659 cars)		5.7	
iv.	Year 2041 (829 cars)		7.2	
v.	Year 2051 (1003 cars)		8.7	
Total (Aux + Pod Car (Normal +Mela Day)) Energy consumption (in million units)				
e	**Operation Year**		**Total Energy Consumption (in million units)**	
i.	Year 2021		17.3	
ii.	Year 2025		19.0	
iii.	Year 2031		22.1	
iv.	Year 2041		26.4	
v.	Year 2051		31.1	
Note:	**Assumption taken: -**			
	Total No. of Station with 2 Berth station	**7**	**Station having less footfall**	
	Total No. of Station with 4 Berth station	**7**	**Station having more footfall**	
	Total No. of Station with 6 Berth station	**7**	**Terminal & interchange & other main Station**	

Chapter -8

Signalling & Telecommunication

8.1 Introduction

8.2 Signalling system

8.3 System Description and Specifications

8.4 Headway

8.5 Telecommunication System

8.6 Major Components of Telecommunication System

8.7 Major Functions of Communication system

8.8 S&T Related Utility Requirements

8.9 S&T Related Safety Features

8.10 Safety Legislation

8.11 Fare Collection System

CHAPTER 8
SIGNALLING & TELECOMMUNICATION

8.1 INTRODUCTION

This Chapter provides the main design features of the Signalling, Telecommunication and AFC systems for operation of a Personal Rapid Transit (PRT) System in Haridwar city. PRT is an automatic on-demand transport system that has been designed to be both cost-effective and environmentally friendly. It is in essence a personal automatic taxi. The PRT vehicle maintains average journey speeds well above that of road traffic in an urban environment resulting in short travel time.

PRT also referred as POD cars are sized for individual or small group travel, typically carrying no more than six passengers per vehicle. This allows for nonstop, point-to-point travel, bypassing all intermediate stations. The point-to-point service has been compared to a taxi or a horizontal lift (elevator).

The PRT system uses small electric vehicles automatically controlled on a dedicated guide way. While the maximum Operating speed is typically 90 kmph & the average speed is 40 to 60 kmph. The PRT vehicle is based on conventional automotive technologies and is battery powered, and can negotiate inclined surfaces for ascent and descent.

Proposed Personal Rapid Transit (PRT) system can be an innovative mobility solution within major attraction and destination in the pilot project area. It will reduce the vehicular congestion; reduce air and noise pollution, increase road safety, savings of time and fuel in the pilot area. Being very flexible and having nominal space requirements, the PRT system can be implemented with minimum conflict on ground. The innovative design of the PRT system provides many operational, economic, and environmental benefits, including:

- Low capital and operational costs
- Flexible routing
- 24-hour availability if required
- On-demand service, with no transfers
- Greater privacy
- Zero on-site emissions
- Extremely low overall energy use

8.2 SIGNALLING SYSTEM

The Signaling system shall be designed so as to provide the highest level of safety &security along with efficiency in PRT services / operations. It consists of following functions:

- Central control
- Autonomous Vehicle Control
- Automatic Vehicle Protection System (AVP)

8.3 SYSTEM DESCRIPTION AND SPECIFICATIONS

Requirements of the PRT are planned to be achieved by adopting Central control system based Autonomous Vehicle Control and Automatic vehicle Protection System as detailed below:

8.3.1 Central Control

The central control system is heart of the PRT concept. Each POD has its own control system which is driving the POD but there is a central control system which acts a bit like air traffic control.

Once the passenger has confirmed their destination, central control immediately begins the process for carrying out their chosen journey.

It ensures all vehicles launched on non-conflicting paths. The central control system responds to the passenger's request by allocating a vehicle for the journey and instructing the vehicle on the required path and timing for that journey. The Major functions of central control system are as follows:

- Routing and scheduling of vehicles
- Empty vehicle movement management
- Fault detection and response
- Display of system information to Network Controllers

8.3.2 Autonomous Vehicle Control

The system will maintain vehicle to prescribed path using sensors. Once the vehicle has received its instructions from central control it will continue to its destination without any need for further central control input. On arrival at the destination station further instructions are received to specify the berth or wait point for the vehicle to go to Sensing technology is used in the existing PRT system to provide both lateral and longitudinal navigation information that the vehicle uses to determine its exact location within the guideway and so follow a specified path

and speed profile to complete the desired journey. Additionally, embedded guideway transponders are also used to confirm vehicle locations when required, for example at station berths. The vehicle control system is also fed a variety of inputs from sensors that allows it to constantly monitor the vehicle status. A HUMS (Health and Usage Monitoring System) processes these inputs to confirm that all vehicle systems are operating within normal limits. If any of these parameters fall outside the expected range this is flagged, and the vehicle can perform any appropriate response. This allows many vehicle problems to be captured early, before they become critical and have any effect on the vehicle, so minimizing impact on network operations.

In order to ensure the better & effective control mechanism, tests of existing & new vehicle control technologies should be carried out. We should examine various control methods based on next generation GPS Lateral/Longitudinal Guidance, embedded guideway magnets, latest's optical and radar sensing technologies, embedded guideway transponders and local sensors based on Ultrasonic or appropriate sensors.

Once allocated a route by the central control system, each vehicle exploits telematics and IT technology to operate relatively autonomously. For instance, ultrasonic and appropriate sensors embedded around the outside of the vehicle read indentations on the sides of the track and, enabling the vehicle to know its exact position both laterally and longitudinally.

8.3.3 Automatic Vehicle Protection System

The system will use moving block signaling to ensure vehicle separation. Vehicles far enough behind the stopped vehicle would either be pulled into a nearby station or be rerouted onto a different branch of the network before reaching the incident, in order that they could avoid the blocked link.

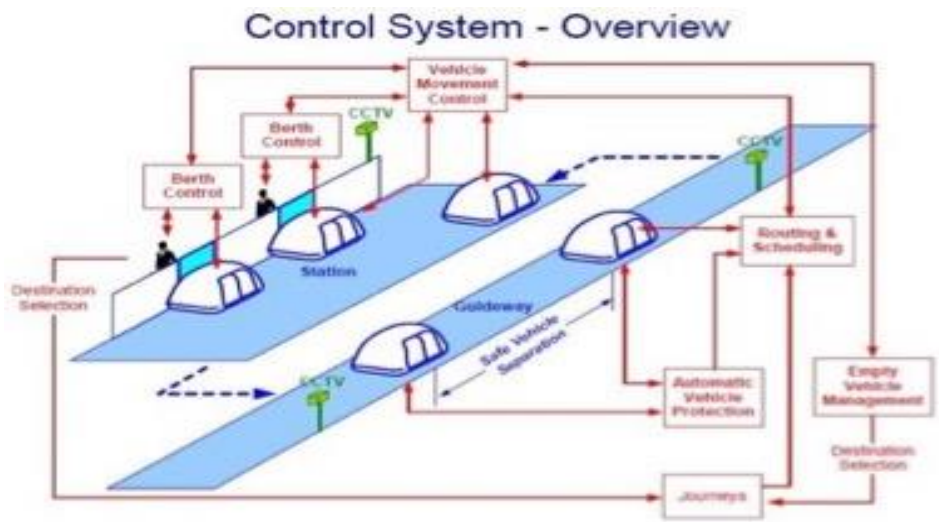


Figure 8-1: Overview of Heathrow PRT control system

8.4 HEADWAY

Spacing of vehicles on the guideway influences the maximum passenger capacity of a track, so designers prefer smaller headway distances. Computerized control theoretically permits headway up to two-second recommended for cars at an average speed of 40 to 60 kmph, since multiple vehicles can be braked simultaneously.

8.5 TELECOMMUNICATION SYSTEM

The communication system handles the transmission of critical control and status messages and exchange of other information between the control system and PRT vehicles. The communications system is a vital part of the PRT operation, delivering routing and scheduling instructions to the vehicles from a central control center, and communicating their progress and status back to control. For the communication among vehicles as well as with the elements of the network infrastructure (stations, intersections etc.) the wireless communication (Radio based) system is used. Therefore, the control structure of PRT is a complex, distributed, real-time system.

8.6 MAJOR COMPONENTS OF TELECOMMUNICATION SYSTEM

8.6.1 Closed Circuit Television (CCTV)

It is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. The CCTV system uses Internet Protocol (IP) cameras connected to the fiber optic backbone. The pictures are displayed in the control room on an array of monitors.

Figure 8-2: PRT (Heathrow) CCTV system

8.6.2 Fixed Optical Fiber Bearer Network

A fiberoptic line works by sending pulses of light down a fiber optic cable. The system consists of a fixed optical fiber bearer network, and radio links to the vehicles. The fiberoptic network

runs along the guideway in a cable tray and connects the control room to all stations and to equipment cabinets placed at regular intervals around the guideway.

8.6.3 Guideway Equipment Enclosures (GEE)

Guideway equipment enclosures (GEE) are the radio access points that allow communication with the moving vehicles. Control and monitoring data, video and voice messages are transmitted via this media.

Figure 8-3: In Vehicle Communication

8.7 MAJOR FUNCTIONS OF COMMUNICATION SYSTEM

The main functions of PRT Communication system include:

- Automatic driverless control and crossway merging control – which enables smooth merging operation in automated vehicle systems
- Graphical User Interface (GUI), which can show all relevant status information about Vehicles, Stations and other network elements. This interface also allows controllers audio communication with passengers either in vehicles, berths or stations.
- The delivery of vehicle control data, from central control and from station management systems.
- The delivery of vehicle monitoring data to the controllers.
- System infrastructure management communications (lighting control, power monitoring)
- Guideway and Station CCTV monitoring.
- In-vehicle voice communications between passenger and system controller for emergency purposes. There are also in-vehicle CCTV cameras for security monitoring purposes.

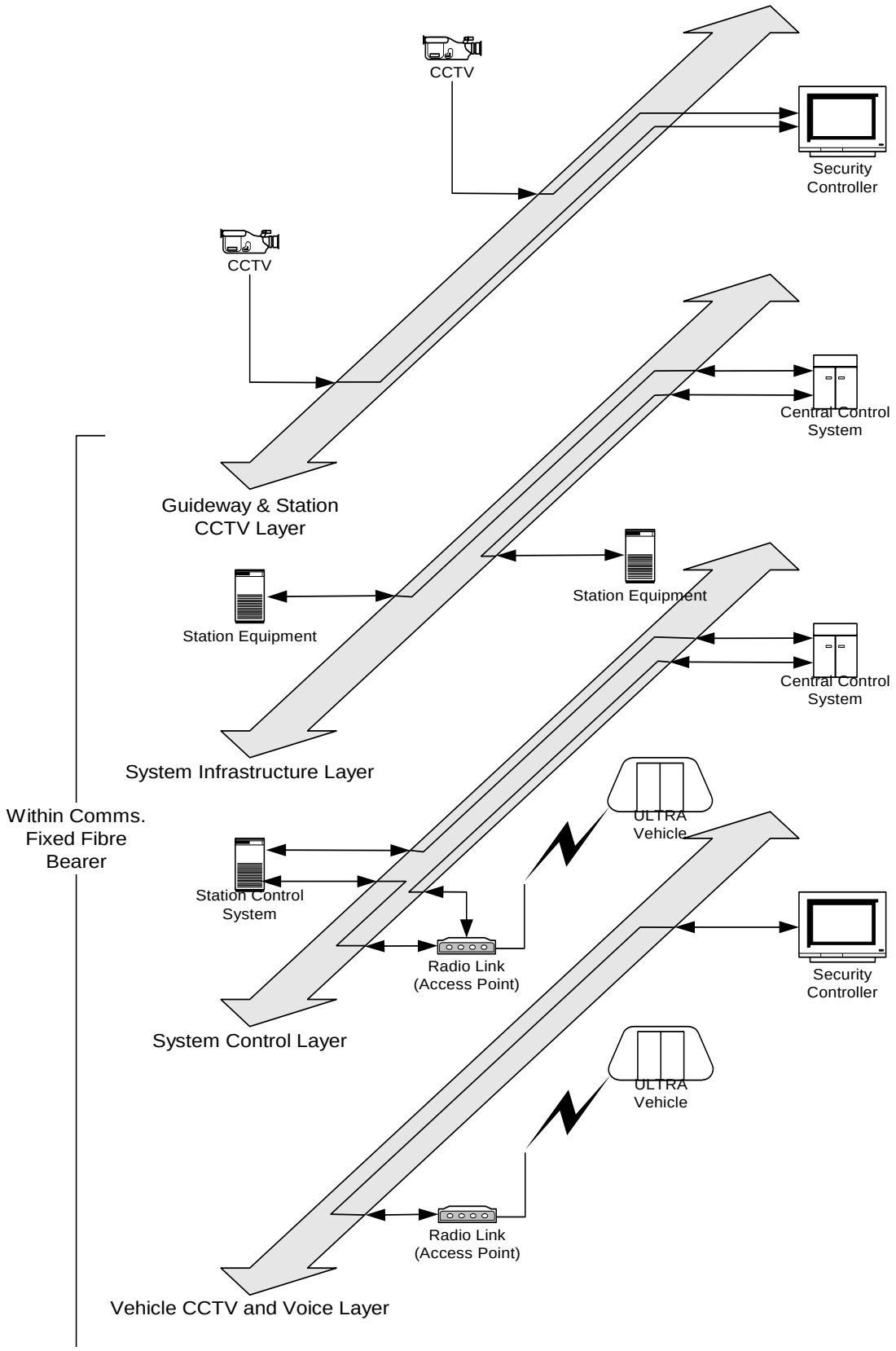


Figure 8-4: Overview of Communication system

8.8 S&T RELATED UTILITY REQUIREMENTS

8.8.1 Central Control Room

The Central Control Room is the heart of the whole PRT system which will coordinate, guide and monitor all functional activities and would be round the clock manned for smooth operation; ideally can be located in one floor of the PRT Office Building. The control room is the focal point of the system for monitoring the correct operation of the system (including CCTV) and the communication centre with other linked transport systems and the passengers should they need help or advice.

8.8.2 UPS System

UPS shall be with N+N configuration with Full IGBT type. The UPS shall provide the supply to the control room equipment, Flap Gate, CCTV & EPABX system. UPS ensure uninterrupted power supply for a minimum period of 60 Minute.

The UPS modules shall be located within a fully enclosed, free standing, system cabinet which shall contain automatic parallel connection terminals, communication cables, individual module isolators, input/output power terminals and an integral wrap around maintenance bypass switch. For a parallel configurations single points of failure shall be eliminated whereby each UPS module is autonomous, incorporating individual active components such as Power Units, Static Bypass Switches, CPUs, Control Panels and Separate Battery Sets.

8.8.3 Cabling

The cabling system shall generally comply with BS-6387, maintaining circuit integrity after exposure to fire for 2 hours and with a mechanical protection against moderate impact and water spray. All cables shall be Low smoke halogen free to prevent the release of toxic or corrosive fumes under fire conditions.

8.8.4 CCTV

For the surveillance of the stations the CCTV cameras inside the Stations are installed. The CCTV shall be IP 66 (waterproof type) for external purpose & PTZ/ bullet type for the internal surveillance of the building. The camera shall be thermal IP camera provides high-sensitivity thermal images. The camera shall produce crisp and clear images day and night, even in challenging environments with smoke, dust, haze or fog.

The Network video recorder (NVR) for the CCTV shall be placed in the control centre. NVR systems record and store video footage directly from the network it lives on. These systems work with an advanced type of camera, called IP cameras. IP cameras can actually capture and process video and audio data themselves. They do so, using either an Ethernet cable or wirelessly via an existing WiFi network.

8.8.5 Public Address System

Public address (PA) with speakers shall be provided in the station building for announcement to the passenger. The complete system consists of speaker power amplifier, microphone, tuner, cassette deck, compact disc and zone selection relay unit will be wired back to the fire command centre and other selected security points. The system wiring will adopt a dual circuit design for speakers in each area for the purpose of higher reliability. In the event of fire or emergency the PA system shall be over ridden by an emergency switch in the Main FCC operator console and public announcement shall be received at all areas via EVC system Emergency (EVC) announcements will be broad cat from the FCC to all areas (either as common announcement or according to zoning and staging of any evacuation based on the management fire strategy for the complex).

8.8.6 Data & Voice Communication System

It is proposed to have data access & voice point in all ticket counter. All administration area / BOH areas will have data port for network connection. The total number of data & voice points envisaged in data centre. All data & voice points will be network through a LAN protocol using immediate switch / Patch panel. All data cabling for data & voice system will be through CAT-6e cables. The data rack of the data rack shall be placed in the control room. The laying of the cat cable is through cable tray, floor raceway & appropriate mean.

8.9 S&T RELATED SAFETY FEATURES

- Continuous fault monitoring and automatic response: detection of faults allows vehicles to be slowed, stopped or rerouted to prevent any potential collisions.
- Independent Automatic Vehicle Protection System: prevents vehicle collisions in the event of other control system or vehicle failures.
- Station berth doors: - Automatically controlled, full-height barrier (doors) are fitted to each station berth to prevent passenger access to the VMA (Vehicle Movement Area) and guideway when no vehicle is berthed. The operation of the sliding berth doors is initiated and synchronized with the operation of the vehicle doors.
- Video surveillance of station areas, the guideway and inside each vehicle: Video surveillance with monitoring of the system is available at the control room and has round the clock recording designed to contribute to passenger safety and security, and discourage vandalism on the system.
- Uninterruptable power supplies to all critical system components: allowing the system to be brought to a safe state in the event of a power failure.
- Vehicles launched on pre-planned synchronized journeys. Vehicles will not be launched on routes unless it is known that the path will be clear over the entire journey.
- Vehicles will perform the same speed profiles around the network under normal operating

conditions, thus reducing the probability of an undesired interaction.

- Each vehicle will be fitted with a load-weight system to prevent vehicle operation in an over-weight condition.
- Voice communication: Direct communication between the Controller and passengers, and between the Controller and all stations, will be designed to have direct benefits in both passenger reassurance and in prevention of potentially hazardous situations.
- Off-line vehicle maintenance: Vehicle problems will normally be corrected off guideway (i.e. at the depot or stations). Any vehicle identified as having a mechanical or other operational difficulty will, whenever possible, complete its current journey and will then be directed to the depot or taken out of service at the station for corrective action.

8.10 SAFETY LEGISLATION

No safety legislation available in India for POD system till date. International Safety norms in practice may be followed for Haridwar PRT system.

8.10.1 Existing Legislation – Heathrow PRT System

The primary legislation applicable to the operation the Heathrow PRT Phase 1 application is ROGS (Railways and Other Guided Transport Systems) (Safety) Regulations.

The relevant regulations within ROGS have been identified and applied to the Heathrow PRT Phase 1 application, in particular the appointment of a 'competent person, to verify the safety of the System, For the Heathrow PRT Phase 1 application, ATS is identified as the 'Transport Operator' and the 'Infrastructure Manager', in accordance with ROGS Phase 1 System.

8.10.2 Assessment against APM standard

The Heathrow Phase 1 PRT System has been reviewed against the American Society of Civil Engineers (ASCE) Automated People Mover (APM) standards. The extent to which the System complies with the ASCE APM standards and comments on the underlying reasons for and implications of deviations from the standards is described. It is intended to support the safety argument on the basis that a system that fully complied with the ASCE APM standards would be considered to be acceptably safe. The document draws on inputs from previous reviews and engineering judgment from ATS Ltd Engineering and Operations Staff.

The issues of the four parts of the ASCE APM Standards considered are:

1. ANSI/ASCE/T&DI 21-05 [7-2]
2. ANSI/ASCE/T&DI 21.2-08 [7-2]
3. ANSI/ASCE/T&DI 21.3-08 [7-2]
4. ANSI/ASCE/T&DI 21.4-08 [7-2]

According to National Highway Authority of India (NHAI) recommendations the APM standards and US safety norms will be incorporated for the implementation of PRT Projects in India. (Annexure A 8.1)

8.11 FARE COLLECTION SYSTEM

The PRT stations, in all the locations will be integrated. The ticket management system will curtail the time spent by passengers in procuring tickets before boarding the PRT vehicle. All conventional ticketing methodologies are possible including:

- Automatic Ticketing machines
- Manned Ticket offices
- Smartcard systems

Any of the above or better ticketing system should be provided for Haridwar PRT System.

Annexure A- 8.1

EXPRESSION OF INTEREST (EOI)

भा रा रा प्रा
NHAI

NATIONAL HIGHWAYS AUTHORITY OF INDIA (NHAI)

MINISTRY OF ROAD TRANSPORT AND HIGHWAYS

GOVERNMENT OF INDIA

INVITES EXPRESSION OF INTEREST (EOI) FOR PUBLIC PRIVATE PARTNERSHIP IN DEVELOPMENT OF PERSONAL RAPID TRANSIT (PRT) SYSTEM DELHI-GURGAON PILOT PROJECT CORRIDOR (LENGTH: 12.30 KMS) FROM KM 24.00 AT NH-8 (DELHI HARYANA BORDER) – KM 33.50 (RAJIV CHOWK, GURGAON) – NH-248A SOHNA ROAD ON DESIGN, BUILD, FINANCE, OPERATE AND TRANSFER ("DBFOT") BASIS

Expression of Interest
(EOI)

January 2018
G-5 & 6, Sector-10, Dwarka, New Delhi - 110075

2. Project Overview

The Personal Rapid Transit System at Gurgaon shall have a route length of approximately 12.3 kilometers connecting the Delhi Haryana Boarder with the Rajiv Chowk, Gurgaon & Sohna Road in Gurgaon. The project will start from Km 24 NH 8 (Delhi Haryana Border) – Km 33.5 (Rajiv Chowk, Gurgaon) – NH 248 A Sohna Road.

2.1 Project Site

The Project site will be located in Gurgaon. The project Site will include the required Right of Way (RoW) of Section of NH 8 between Km 23 to Km 33 and section of NH 248 A (Sohna Road) between Rajiv Chowk, Gurgaon and Sector 72 on Sohna Road.

Apart from above the Site would also include the HUDA/ HSIIDC Green Belt adjoining the NH 8 Right of Way on both sides.

2.2 Station Details

The PRT Station design comprises the following elements:

- Berth (vehicle docking stands – number dependent on the local conditions and demand estimates)
- Envelope (pax weather protection)

The PRT System may comprise fourteen stations i.e. Udyog Vihar, Cyber City, Shyam Chowk , Atlas Chowk, Sector 25, IFFCO Chowk, Signature Tower Chowk, Sector 31, Jharsa Road , Rajiv Chowk, Gurgaon, Tau Devi Lal stadium, Sector 38, Subhash Chowk and Sector 47. The locations are tentative. The same is to be finalized in consultation with NHAI based on final design of the system.

3. Norms for PRT Safety and Other Technical Specification Standards

3.1 The proposed PRT system should comply with ASC APM Safety standards. These standards have been prepared by the ASCE (American Society of Civil Engineers) Automated People Mover Standards Committee. It establishes the minimum set of requirements necessary to achieve an acceptable level of safety and performance for an APM system. An APM is defined as a guided transit mode with fully automated operation, featuring vehicles that operate on guideways with exclusive right-of-way. The overall goal of this standard is to assist the industry and the public by establishing standards for APM systems. As such it may be used in the safety certification process.

The title and content of the 3 parts are as follows:

- *APM Standards – Part 1: Operating environment, Safety requirements, System dependability, Automatic Train Control (ATC), Audio and visual Communications; ASCE 21-96*
- *APM Standards - Part 2: Vehicles, Propulsion and Braking;*
- *ASCE 21-98 APM Standards - Part 3: Electrical, Stations, Guideways; ASCE 21-00*

- *ANSI/ASCE/T&D1 21.4-08 Automated People Mover Standards-Part 4*

  - Part 1 of the Standard, provides general information and definitions followed by discussions of the operating environment, safety requirements, system dependability, automatic train control subsystems, and audio and visual communications.
  - Part 2 provides general information on vehicles and Propulsion and Braking Systems (PBS). Topics dedicated to vehicles include vehicle capacity and load, structural design, coupling, fire protection, and electrical systems. PBS topics include methodology, functions, component design and testing.
  - Part 3 provides information on electrical equipment, stations, and guideways including emergency evacuation and access as well as structural design criteria for the guideway.
  - Part 4 is a minimum set of requirements for maintaining an acceptable level of safety and performance for an APM in passenger operation. Part 4 consists of information regarding Security; Emergency Preparedness; System Verification and Demonstration; Operations, Maintenance, and Training Operational Monitoring.

The standards are not particularly detailed or specific, but are clearly the most comprehensive set of standards for a fully automatic public transport system. On many aspects reference is made to other standards and specifications as NFPA Publications for fire safety and Military Standards for developing System Safety program and Hazard Analysis. The standard includes minimum requirements for the design construction, operation and maintenance of APM systems.

3.2 The proposed PRT system should comply with the general safety requirements mentioned below:

The PRT system is to be designed as a "light" mass transit system which may also act as a feeder to the regular Metro or Railway systems. Its "light" design/nature will enable access into crowded residential/market areas for 'last mile connectivity' and also keep capital cost of infrastructure per running kilometer much lower than for Metros or Rail infrastructure.

In order to achieve a proper safety level, the PRT systems should establish specific safety requirements/standards and adhere to these during design, construction and operation stage. Some generic requirements that are applicable to an automated PRT-system worth mentioning are:

- ALARP-principle
- Continuous Improvements
- Barriers against single failure accidents.

3.2.1 Some specific requirements that are relevant for a PRT-system are:

3.2.1.1 Infrastructure (guideway and stations):

Chapter -9
Disabled Friendly Features

9.1 Introduction

9.2 Content

9.3 PRT Transport

9.4 Information Signs and Announcements

9.5 PRT Stations

9.6 Information Systems

9.7 General and Accessible Toilets

9.8 Drinking Water Units

9.9 Visual Contrasts

9.10 Emergency Egress/Evacuation

9.11 Alerting Systems

9.12 Written Evacuation Procedure

9.13 Emergency Evacuation Route

9.14 Way Guidance Systems

9.15 Fire Residents Doors

9.16 Street Design

9.17 Traffic Signals

9.18 Subway and Foot Over Bridge

9.19 Alighting and Boarding Areas

9.20 Approach

9.21 Car Park

CHAPTER 9
DISABLED FRIENDLY FEATURES

9.1 INTRODUCTION

The objective of making this chapter is to create a user-friendly automated transport system in India which can ensure accessibility to persons with disabilities, people travelling with small children or are carrying luggage, as well as people with temporary mobility problems (e.g. a leg in plaster) and the elderly persons.

The design standards for universal access to Public Transport Infrastructure including related facilities and services, information, etc. would benefit people using public transport.

The access standards given here are extracted from Indian Roads Congress Code, IRC 103: 2012, Guidelines for Pedestrian Facilities; Model Building Bye-Laws, 2011 and National Building Code, 2005. Central Public Works Department's (CPWD) "Space Standards for Barrier Free Built Environment for Disabled and Elderly Persons", 1998 and 2013 edition (under revision by MoHUA), Harmonising Guidelines and Space Standards for Barrier-Free Built Environment for persons with Disability and Elderly Persons and international best practices / standards and international best practices / standards

Further, it has also been attempted to provide guidelines/ standards for alighting and boarding area, approach to station, drop-off and pick-up lanes along with taxi/auto rickshaw and bus drop-off points along the footpath (sidewalk), kerb ramp, road intersection, median/pedestrian refuge, traffic signals, subway and foot over bridge etc. to achieve a seamless development around the PRT stations.

9.2 CONTENT

9.2.1 Personal Rapid Transit System (POD Cars)

- Way finding
- Signage
- Automated Kiosks
- Public Dealing Counters
- Audio-visual Displays
- Public Telephones
- Tactile Paving - Guiding & Warning

- Steps & Stairs
- Handrails
- Ramps
- Lifts/Elevators
- Platform/Stair Lift
- Visual Contrasts

9.2.2 Street Design

- Footpath (Sidewalk)
- Kerb Ramp
- Road Intersection
- Median/Pedestrian Refuge
- Traffic Signals

9.2.3 Alighting and Boarding Area

- Approach
- Car Park
- Drop-off and Pick-up Areas
- Taxi/Auto Rickshaw Stand
- Bus Stand/Stop

9.3 PRT TRANSPORT

9.3.1 General

- PRT which operates on specially built guideways is a highly effective mode of transport.
- Every POD is designed to be a fully accessible carriage.
- Staff should be trained in methods of assistance and be at hand on request.
- Stations for all PRT system should be fully accessible with extra wide turnstiles where possible alongside wheelchair accessible doorways
- Staff should be on hand to assist persons with disabilities and elderly to enter or exit through convenient gates.
- All new railway stations should be designed to be fully accessible.
- For persons with hearing impairments, an electronic sign board (digital display)

should be displayed on each platform at conspicuous location for all announcements made by the railways.

- For persons with visual impairments audio system announcing the station names and door location should be available.

9.3.2 Accessible POD Cars

The POD cars should have the following features:

- POD car doors should be at least 900 mm wide;
- The gap between the car doors and the platform should preferably be less than 12 mm;
- Identification signage should be provided on the doors of wheelchair accessible car.
- If the car door and the platform cannot be at the same level, then at least one car doors should have apparatus such as a hydraulic lift or pull-out ramp installed in the doorway for wheelchair users.

9.3.3 Wheel Chair Space

- Space for a wheel chair should be available at the side of the door,
- The space should be indicated inside and outside the car by using the international symbol of access; and
- Wheel stoppers and ring-strap or other appropriate safety grip should be provided for wheelchair users.

9.3.4 Seats

- An appropriate number of designated seats for passengers with disabilities and elderly people should be provided near the doors.

9.3.5 Aisles

- Aisles should be at least 900 mm wide.

9.4 INFORMATION SIGNS AND ANNOUNCEMENTS

A map of PRT routes should be installed. This should be in Braille/raised numbers as well. In each car, there should be an announcement and provision of a visual display of the names of stations route. This display should be in raised numbers with sharp contrast from the background.

9.5 PRT STATIONS

9.5.1 Level Approach

- Approach route should not have level differences. If the station is not on the same level as the walkway or pathway, it should have a ramp.
- Walkway surfaces should be non-slip.
- Approach walkway should have tactile pavements for persons with visual impairments.

9.5.2 Station Entrances and Exits

- These should have a minimum width of 1800mm and is level or ramped.

9.5.3 Reservation and Information Counters

- Should have clear floor space of at least 900 mm x 1200 mm in front of the counters
- Ticket vending machines shall be designed for universal operability.
- Full range of facilities/services available shall be accessible on the ticket vending machines.
- In case manual ticket counters are provided, there should be at least one low counter at a height of 750 mm to 800 mm from the floor with clear knee space of 750 mm high by 900 mm wide by 480 mm deep.
- At least one of the counters should have an induction loop unit to aid people with hearing impairments; and
- The manual counters should have pictographic maps indicating all the services offered at the counter and at least one of the counter staff should be sign language literate.

9.5.4 Station Facilitates

- There should be at least one unisex accessible toilet at street level
- Ticket Gates
- At least one of the ticket gates should:
- Be minimum 900 mm wide to allow a wheelchair user through; and
- Have a continuous line of guiding paver for people with visual impairments.

9.5.5 Platforms

The platforms should:

- Have a row of warning paver installed 600mm before the track edge along the POD boarding/de-boarding gate.
- Have non-slip and level flooring;
- Have seating installed for people with ambulatory disabilities;
- Be well illuminated lux level 35 to 40;
- There should be no gap or difference in level between the POD entry door and the platform.
- All platforms should provide accessible level entrance to the POD Car.

9.5.6 Way Finding

- Way finding references should be available at decision points.
- Colour can be used to identify routes and provide assistance in locating doors, walls and hazards. Proper colour contrast between different elements greatly improves visibility for all users and is critical for persons with low vision. For example, colour contrasting of door frames can assist in locating doors, and likewise floors should be contrasted with walls. In addition, furniture should contrast with walls and floors so as not to create an obstacle.
- Structural elements such as columns should be colour contrasted or brightly marked so as to be visible to those who may have a visual disability.
- Generally, patterns on flooring should be avoided or else should be minimal and small to avoid visual confusion.
- In addition to identifying hazards or warnings, tactile floor surfaces can also be used to inform that there is a change in area (e.g. leaving a corridor and entering a boarding area).
- Tactile systems should be consistent throughout the building. For example, terminals should not have carpeting in some boarding areas and tile in others as this may create confusion for those who rely on tactile surfaces to guide them to their destination.
- Good lighting assists those with a visual disability to see better and allows people who have a hearing impairment to lip read easier. However, care should be taken to properly direct lighting and to use matte finishes on floors, walls and signage, so as not to create glare which may create difficulties for all travelers.
- Adjustable louvers/Blinds can be used to adjust lighting levels in areas where the natural lighting changes significantly throughout the day.

9.5.7 Signage

- Signs must be clear, concise, and consistent. All travelers need clear information

about the purpose and layout of terminals to maintain a sense of direction and independent use of all facilities. Using internationally and nationally established symbols and pictograms with clear lettering and Braille ensures universal accessibility cutting across regional/cultural and language barriers. A cohesive information and signage system can provide visual (e.g., signs, notice boards), audible (e.g., public address and security systems, induction loops, telephones, and infrared devices), and/ or tactile information (e.g. signs with embossed lettering or Braille).

9.5.8 Sign Design Specification

- The sign should be in a prominent position.
- The face of the sign should be well-illuminated by natural or artificial light.
- Letters should be simple such as Arial, Helvetica medium, and san serif or similar and numbers should be Arabic.
- The colour of the text should be in a colour that contrasts with the sign board.
- The sign board should also contrast with the wall on which it is mounted.
- The surface of the sign should not be reflective.
- Some signs such as those adjacent to or on a toilet door may be embossed so that they can be read by touch.
- Illuminated signs should not use red text on a dark background.
- Signs should be supplemented by Braille where possible.

Figure 9-1: Way finding signage

Figure 9-2: International Symbol of Accessibility

9.5.9 Automated Kiosks

- Automated kiosks should be accessible for wheelchair users.
- Should be clearly marked with international symbol of accessibility.
- Should have Braille buttons and audio announcement system for persons with vision impairments.
- Operations should be easy to understand and operate for persons with learning disabilities, intellectual disabilities, and elderly persons.

9.5.10 Public Dealing Counters

- Ticketing, Information, Check-in, Helpdesk, Restaurants, Shops, etc. should have public dealing counters.
- Information or help desks should be close to the terminal entrance, and highly visible upon entering the terminal. In addition, they should be clearly identified and accessible to both those who use wheelchairs and those who stand.
- It should provide information in accessible formats, viz. Braille leaflets for persons with vision impairments.
- Ideally, these desks should have a map of the facility that desk attendants can view with passengers, when providing directions.
- Staff manning the counters should know sign language.
- Information desk acoustics should be carefully planned and controlled as a high level of background noise is confusing and disorienting to persons with hearing impairment.
- Lighting should be positioned to illuminate the receptionist/person manning the counter and the desk top without creating glare.
- Lighting should not create shadows over the receptionist staff, obscuring facial detail and making lip reading difficult.
- There should be a hearing enhancement system such as a loop induction unit, the availability of which is clearly indicated with a symbol.
- One of the counters should not be more than 800mm from the floor, with a minimum clear knee space of 650mm high and 280mm-300mm deep.

9.5.11 Audio-visual Displays

- Terminal maps should be placed so that they are readily visible to persons who are standing and persons who use wheelchairs. They should also be accessible to persons with a visual disability (i.e., tactile maps). Other alternatives include electronic navigation systems or audio maps.

- Enable captioning at all times on all televisions and other audiovisual displays that are capable of displaying captions and that are located in any portion of the terminal.
- The captioning must be in high contrast for all information concerning travel safety, ticketing, check-in, delays or cancellations, schedule changes, boarding information, connections, checking baggage, individuals being paged by bus railway or airlines, vehicle changes that affect the travel of persons with disabilities, and emergencies (e.g., fire, bomb threat).

9.5.12 Rest Areas/ Seating

- Seating area/ benches should be provided along the circulation path at regular intervals so that passengers do not need to walk more than 50 to 60 meters before being able to sit and rest.
- Where seating is provided, designated seating for passengers with disabilities is to be provided at boarding gates and departure areas within viewing distance of communication boards and/or personnel and identified by the symbol of access.
- Public transit operators should provide seating in passenger service areas where there may be long waiting lines or times, including at ticket sales counters, check-in counters, secured screening and during inter-country travel in customs areas and baggage retrieval areas.
- Designated seating should be provided for at boarding gates and departure areas within viewing distance of communication boards, and within hearing range of audio announcements as well. Such seating areas should be identified by the symbol of accessibility and shelter should be provided where this seating is outdoors.
- In outdoor settings, seating should be provided along with the planned hawker spaces.
- At waiting lounges for persons with disabilities chairs should have armrests and backrest.

9.5.13 Tactile Paving-Guiding & Warning

(a) Tactile Guiding Paver (Line-Type)

It is recommended to install a row of tactile guidance paver along the entire length of the proposed accessible route for visual impaired persons. Care must be taken to ensure that there are no obstacles, such as wall, pillar, uneven surfaces, Soffit (underside /open area under the stairs, along the route traversed by the guidance paver. Also, there should be clear headroom of at least 2.1 meters height above the tactile guidance paver, free of protruding objects such as overhanging advertisement panel and signage, along the entire length of the walk.

(b) Tactile Warning Paver (Dot-Type)

Indicate an approaching potential hazard or a change in direction of the walkway, and serve as a warning of the approaching danger to persons with visual impairments, preparing them to tread cautiously and expect obstacles along the travel path, traffic intersections, doorways, stairs, etc. They are used to screen off obstacles, drop-offs or other hazards, to discourage movement in an incorrect direction, and to warn of a corner or junction. Two rows of tactile warning paver should be installed across the entire width of the designated accessible passenger pathway at appropriate places such as before intersections, terminal entrances, obstacles such as signage, and each time the walkway changes direction.

9.5.14 Places to Install Warning Paver

- In front of an area where traffic is present.
- In front of an entrance/exit to and from a staircase or multi-level crossing facility.
- Entrances/exits at public transport terminals or boarding areas.

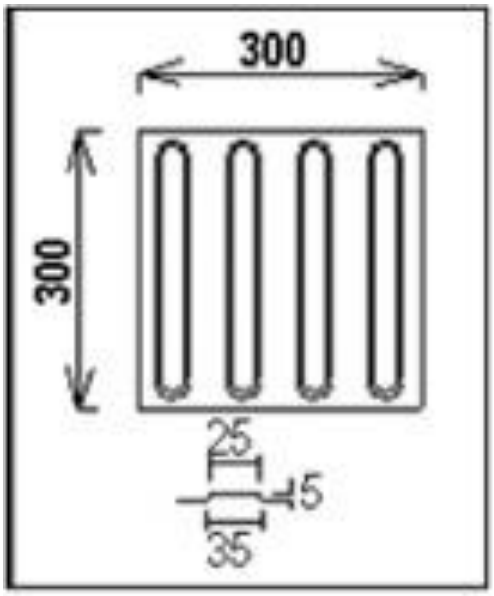


Figure 9-3- Guiding paver

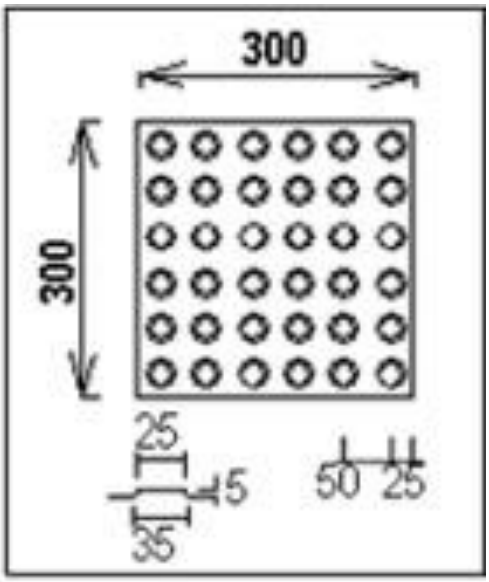


Figure 9-4- Warning paver

Figure 9-5: Tactile Path

9.5.15 Doors

Whatever the type of entrance door, it must be wide enough to accommodate passenger traffic comfortably.

- The recommended minimum clear opening width of an internal door is 900mm minimum.
- Where doors comprise two leaves (i.e., double doors), each leaf should be 900mm min. wide, so that persons carrying large items and people using wheelchairs do not have to open both leaves.
- Manual doors should incorporate kick plates 300-400mm high to withstand impact of wheelchair footrest (this is especially important where doors are glazed).
- Also be fitted with vision panels at least between 900mm and 1500mm from floor level.
- Be color contrasted with the surrounding wall and should not be heavier than 22N to open.
- Lever handles and push type mechanisms are recommended. When a sliding door is fully open, handles should be usable from both sides.
- Where revolving doors or turnstiles are used, an alternative wheelchair-accessible entrance must also be provided.

- A distance of 400mm should be provided beyond the leading edge of door to enable a wheelchair user to maneuver and to reach the handle.
- To ensure maximum clarity for persons with visual impairments, the entrance should be easily distinguishable from its surroundings by the effective use of landscaping, signage, colour (preferably yellow/orange), tonal contrast and tactile surfacing.
- Door hardware should be positioned between 900-1000mm above floor (figure 28).
- Operable devices such as handles, pulls, latches and locks should:
    1. Be operable by one hand
    2. Not require fine finger control, tight grasping, pinching or twisting to operate
- Glazed doors and fixed glazed areas should be made visible by use of a clear, colour and tone contrasted warning or decorative feature that is effective from both inside and outside and under any lighting conditions, e.g., a logo, of minimum dimensions 150mm by 150mm (though not necessarily square), set at eye level.

9.5.16 Steps & Stairs

- Steps should be uniform with the tread not less than 300mm and the risers 150mm.
- The risers should not be open.
- The steps should have an unobstructed width of 1200mm minimum.
- All steps should be fitted with a permanent colour and tone contrasting at the step edge, extending the full width of the step, reaching a minimum depth of 50mm on both tread and riser.
- Have continuous handrails on both sides including the wall (if any) at two levels
- Warning paver to be placed 300mm at the beginning and at the end of all stairs.
- Nosing to be avoided.
- The staircase should be adequately and uniformly illuminated during day and night (when in use). The level of illumination should preferably fall between 100-150 lux.
- The rise of a flight between landings must be no more than 1200mm.
- There should be no more than 12 risers in one flight run.
- The stair covering and nosing should be slip-resistant, non-reflective, firmly-fixed and easy to maintain.
- Soffit (underside /open area under the stairs) of the stairs should be enclosed or protected.
-

9.5.17 Handrails

- Handrails should be circular in section with a diameter of 38-45mm and formed from materials which provide good grip such as timber, nylon or powder coating, matt finish metal finishes.
- The handrail should contrast in colour (preferably yellow/orange) with surrounding surfaces.
- At least 50mm clear of the surface to which they are attached and should be supported on brackets which do not obstruct continuous hand contact with the handrail.
- The handrail should be positioned at two levels- 760mm and 900mm above the pitch-line of a flight of stairs.
- Handrail at foot of the flight of stairs should extend 300mm beyond the stairs in the line of travel and returning to the wall or floor or rounded off, with a positive end that does not project into the route of travel.

9.5.18 Ramps

- Ramp's gradient should ideally be 1 in 20 and no greater than 1 in 12.
- Width of the ramp should not be less than 1200mm and preferred width is 1800mm.
- The steeper the gradient, the shorter the length of ramp between landings.
- On long ramps, a horizontal resting space should be provided every 6 meters.
- Surface materials should be slip-resistant, non-reflective, firmly-fixed and easily maintained
- The edge of the ramp should have an edge protection with a minimum height of 100mm.
- Landings every 750mm of vertical rise.
- A tapping or lower rail should be positioned so that its bottom edge is no higher than 200mm above ground level.
- Handrails on the ramps should be on both sides at two levels: upper at 900mm and lower at 760mm; both ends to be rounded and grouted; extend 300 mm beyond top and bottom of ramp.
- A row of tactile warning paver should be placed 300mm beginning and end of each run.
- Landings should be provided at regular intervals as indicated in the table below.

Table 9-1 : Specifications for Ramps

Level difference	Minimum gradient of Ramp	Ramp Width	Handrail on both sides	Comments
≥ 150 mm ≤ 300 mm	1:12	1200 mm	√	
≥ 300 mm ≤ 750 mm	1:12	1500 mm	√	Landings every 5 meters of ramp run.
≥ 750 mm ≤ 3000mm	1:15	1800 mm	√	Landings every 9 meters of ramp run.
≥ 3000 mm	1:20	1800 mm	√	Landings every 9 meters of ramp run.

9.5.19 Lifts/ Elevators

A carefully designed lift makes a huge contribution to the accessibility of a multi-storied terminal building for persons with disabilities.

- Lift locations should be clearly signposted from the main pedestrian route and recognizable through design and location.
- The colour and tone of the lift doors should contrast with the surrounding wall finish to assist in their location. Lift doors with metallic finishes such as steel grey and silver should be avoided as they are difficult to identify by persons with low vision.
- The lift lobby shall be of an inside measurement of 1800mm X 2000mm or more. A clear landing area in front of the lift doors of minimum dimensions 1500mm x 1500mm should be provided.
- By making the landing area distinguishable by floor surface and contrast, it will aid location and recognition of core areas. This could comprise a change in floor finish from thin carpet to vinyl/PVC, or cement/mosaic floor to carpet.
- Changes in floor finish must be flushed. There should be no level difference between lift door and the floor surface at each level; the gap if unavoidable should not be more than 12mm.
- The floor level/location should be indicated on the wall adjacent to or just above the call buttons, and opposite the lift doors where possible.

9.5.20 Lift Dimensions

Provisions of at least one lift shall be made for people using wheelchairs with the following car dimensions:

- Clear internal depth -1500 mm minimum
- Clear internal width - 1500 mm minimum
- Entrance door width - 900 mm minimum

9.5.21 Lift Controls

- The lift call button should be wall-mounted adjacent to the lift and should contrast with wall finish, either by using a contrasting panel, or a contrasting border around the button panel.
- The call buttons should be located within the range 800-1000mm above floor finish.
- Buttons should not be touch sensitive, but should require a light positive pressure and should ideally be large enough to be operable by the palm of the hand if required.
- The control buttons inside the lift should be positioned on the side wall rather than front wall to allow access from the back and front of the lift car, by mobility aid users like wheelchair users.
- The control buttons should contrast with their surroundings and illuminate when pressed and should incorporate highly visible tactile embossed (NOT engraved) characters and in Braille.
- Time of closing of an automatic door should be more than 5 seconds and the closing speed should not exceed 25 meters per second. There should be a provision of censor enabled closing.
- In larger lifts, controls should be positioned on both side walls, at least 400mm from front wall and between 800-1000mm above floor level.

9.5.22 Car Design

- Internal walls should have a non-reflective, matt finish in a colour and tone contrasting with the floor, which should also have a matt, non-slip finish.
- Use of reflective materials such as metal (stainless steel for example) can be problematic in creating sufficient contrast with control buttons, emergency telephone cabinet, etc. for persons with low vision and the use of such materials should be avoided wherever possible.
- A mirror (750mm above floor level) on the rear wall can be useful to persons using wheelchairs and other mobility aids should they need to reverse safely out of the lift car or view the floor numbers.
- Internal lighting should provide a level of illumination of minimum 100 lux (approximately 50-75 lux at floor level), uniformly distributed, avoiding the use of spotlights or down lighters.
- A grab bar should be provided along both sides and the back wall, 900mm above floor level.
- Handrails should be of tubular or oval cross section, in order to be easily gripped and capable of providing support.

- Handrails should be positioned so that there is a clear space behind the handrail to allow it to be grasped i.e., knuckle space should be 50mm.

9.6 INFORMATION SYSTEMS

- Lifts should have both visual and audible floor level indicators
- Audible systems are also usually capable of incorporating additional messages, such as door closing, or, in the case of an emergency, reassurance (with manual over-ride allowing communication with lift occupants).
- Announcement system should be of 50 decibels.
- The display could be digital or segmented LED, or an appropriate alternative. A yellow or light green on black display is preferred to a red on black display as it is easier to read.

9.7 GENERAL AND ACCESSIBLE TOILETS

9.7.1 Signages

- All signage of general toilets should be in bold and contrasting colors.
- For persons with low vision and vision impairments: male pictogram in triangle and female pictogram in circle, marked on plates along with Braille & raised alphabets, to be mounted on wall next to door near the latch side, at a height between 1400mm-1600mm.
- Warning strip/ thin rubber door mat to be provided 300mm before and after the toilet entrance.
- Tactile paver to be provided for urinals, WC and washbasins for persons with vision impairments.

9.7.2 Accessible Toilets

- Should have the international symbol of accessibility displayed outside for wheelchair access.
- The toilet door should be an outward opening door or two-way opening or a sliding type and should provide a clear opening width of at least 900mm.
- It should have a horizontal pull-bar, at least 600mm long, on the inside of the door, located so that it is 130mm from the hinged side of the door and at a height of 1000mm.

9.7.3 Water Closet (WC) Compartment Dimensions

- The dimensions of a unisex toilet are critical in ensuring access. The compartment should be at least 2200mm and 2000mm. This will allow use by both manual and motorized wheelchair users.
- Layout of the fixtures in the toilet should be such that a clearing maneuvering space of 1500mm x 1500mm in front of the WC and washbasin.

9.7.4 WC Fittings

- Top of the WC seat should be 450-480mm above finished floor level, preferably be of wall hung or corbel type as it provides additional space at the toe level.
- An unobstructed space 900mm wide should be provided to one side of the WC for transfer, together with a clear space 1200mm deep in front of the WC.
- WC should be centered 500mm away from the side wall, with the front edge of the pan 750mm away from the back wall. Have a back support. The WC with a back support should not incorporate a lid, since this can hinder transfer.
- L-shape grab bar at the adjacent wall and on the transfer side (open side) swing up grab bar shall be provided.
- The cistern should have a lever flush mechanism, located on the transfer side and not on the wall side and not more than 1000mm from the floor.

9.7.5 Grab Bars

- Grab bars should be manufactured from a material which contrasts with the wall finish (or use dark tiles behind light colored rails), be warm to touch and provide good grip.
- It is essential that all grab rails are adequately fixed, since considerable pressure will be placed on the rail during maneuvering. Grab bars should sustain weight of 200kgs minimum.
- A hinged type moveable grab bar should be installed adjacent to the WC on the transfer side. This rail can incorporate a toilet tissue holder. A distance of 320mm from the centre line of the WC between heights of 200-250mm from the top of the WC seat. It should extend 100-150mm beyond the front of the WC.
- A fixed wall-mounted L- shape grab bar (600mm long horizontal and 700mm long vertical) on the wall side should be provided. It should be placed at a height of 200-250mm above the WC seat level.

9.7.6 Wash Basins

- Hand washbasins should be fitted on cantilevered brackets fixed to the wall.
- The basin should be fixed no higher than 750mm above the finished floor level.

- Be of dimensions 520mm and 410mm, mounted such that the top edge is between 800- 900mm from the floor; have a knee space of at least 760mm wide by 200mm deep by 650-¬680mm high.
- The position of the basin should not restrict access to the WC i.e., it should be located 900mm away from the WC.
- A lever operated mixer tap fitted on the side of the basin closest to the WC is useful as it allows hot and cold water to be used from a seated position on the WC.
- The hand drying facilities should be located close to the hand washbasin between 1000-1200mm.
- Lever type handles for taps are recommended.
- Mirror's bottom edge to be 1000mm from the floor and may be inclined at an angle.

9.7.7 Fixtures and Fittings

- Contrast between fittings and fixtures and wall or floor finishes will assist in their location. For example, using contrasting fittings, or dark tiles behind white hand washbasins and urinals, contrasting soap dispensers and toilet roll holders. Contrast between critical surfaces, e.g., floors, walls and ceilings help to define the dimensions of the room.
- Towel rails, rings and handrails should be securely fixed to the walls and positioned at 800-1000mm from the floor.
- The mirror should be tilted at an angle of 300 for better visibility by wheelchair users.
- It should have lower edge at 1000mm above floor finish and top edge around 1800mm above floor finish.
- Hooks should be available at both lower-1200mm and standard heights- 1400mm, projecting not more than 40mm from the wall.
- Where possible, be equipped with a shelf of dimensions 400mm x 200mm fixed at a height of between 900mm and 1000mm from the floor.
- Light fittings should illuminate the user's face without being visible in the mirror. For this reason, most units which have an integral light are unsatisfactory.
- Large, easy to operate switches are recommended, contrasting with background to assist location, at a maximum height of 1000mm above floor finish.
- All toilet facilities should incorporate visual fire alarms.
- Alarms must be located so that assistance can be summoned both when on the toilet pan i.e., at 900mm height and lying on the floor i.e., at 300mm, from floor surface. Alarms should be located close to the side wall nearest the toilet pan,

750mm away from rear wall and at 900mm and 200mm above floor finish level.

9.7.8 Signage of Accessible Toilets

- All unisex accessible toilets to have access symbol in contrast colours. A distinct audio sound (beeper/clapper) may be installed above the entrance door for identification of the toilets.

Figure 9-6- Signage for accessible washroom

9.7.9 Accessible Urinals

- At least one of the urinals should have grab bars to support ambulant persons with disabilities (for example, people using mobility aids like crutches).
- A stall-type urinal is recommended.
- Urinals shall be stall-type or wall-hung, with an elongated rim at a maximum of 430mm above the finish floor. This is usable by children, short stature persons and wheelchair users.
- Urinal shields (that do not extend beyond the front edge of the urinal rim) should be provided with 735mm clearance between them.
- Grab bars to be installed on each side, and in the front, of the urinal.
- The front bar is to provide chest support; the sidebars are for the user to hold on to while standing.

9.8 DRINKING WATER UNITS

- Drinking water fountains or water coolers shall have up front spouts and control.
- Drinking water fountains or water coolers shall be hand-operated or hand and foot-operated.
- Conventional floor mounted water coolers may be convenient to individuals in wheelchairs if a small fountain is mounted on the side of the cooler 800mm above the floor.
- Fully recessed drinking water fountains are not recommended.
- Leg and knee space to be provided with basin to avoid spilling of water. This allows

both front and parallel access to taps for persons using mobility aids like wheel chair, crutches etc.

9.9 VISUAL CONTRASTS

- Visual contrasts mean adequate contrast created by difference of at least 30 LRV (Light Reflectance Value) of the two surfaces/ objects and it helps everyone especially persons with vision impairments.
- Visual contrast should be provided between:
  1. Critical Surfaces (walls, ceiling and floor),
  2. Signage and background sign frame/ wall,
  3. Step edges and risers/ treads on steps,
  4. Handrails and background walls,
  5. Doors and surrounding walls,
  6. Switches/ sockets and background wall,
  7. Toilet fixtures and critical surfaces in toilet.
- Barriers and hazards should be highlighted by incorporating colours and luminance contrast.

9.10 EMERGENCY EGRESS/ EVACUATION

- Placement (accessibility) and visibility of such devices is very important. The following is to be considered for the installation of such alarm devices; fire alarm boxes, emergency call buttons and lit panels should be installed between heights of 800mm and 1000mm from the furnished floor surface. These should be adequately contrasted from the background wall and should be labelled with raised letters and should also be in Braille.
- A pre-recorded message, alerting an emergency to the control room or reception should be installed in the telephone and this should be accessible by a ‘hotkey’ on the phone keypad. This ‘hotkey’ should be distinct from the rest of the keypad.

9.11 ALERTING SYSTEMS

- In emergency situations, it is critical that people are quickly alerted to the situation at hand, for persons with disability the following needs to be considered.
- Consider having audible alarms with ‘voice instructions’ that can help guide them to the nearest emergency exit. As an alternative to the pre-recorded messages, these alarms may be connected to the central control room for on-the-spot broadcasts.
- Non-auditory alarms (visual or sensory) to alert persons with hearing impairments

should be installed at visible locations in all areas that the passengers may use (including toilet areas, etc.).

- Non-auditory alarms include:
- Flashing beacons
- Vibrating pillows and vibrating beds.
- Pagers or mobile phones that give out a vibrating alarm along with a flashing light (these may be issued to persons with vision or hearing impairments at the time of check-in or boarding the vehicle.)

9.12 WRITTEN EVACUATION PROCEDURE

A written evacuation procedure that details the egress plan for people with disability should be installed behind the entrance door in the accessible rest rooms. The evacuation procedure should be detailed in large print letters that contrast strongly against the background. Where possible, it should also incorporate raised letters and Braille. The evacuation route should be displayed on a high contrast tactile map for benefit of persons with vision impairments.

9.13 EMERGENCY EVACUATION ROUTE

- Designate routes that are at least 1200mm wide, to ensure that a person using a wheelchair and a non-disabled person are able to pass each other along the route. The route should be free of any steps or sudden changes in level and should be kept free from obstacles such as furniture, coolers, AC units and flower pots.
- Use Exit signage along the route. Orientation and direction signs should be installed frequently along the evacuation route and these should preferably be internally illuminated. The exit door signage should also be internally illuminated.
- A ‘way guidance lighting system’ consisting of low mounted LED strips to outline the exit route (with frequent illuminated direction indicators along the route) should be installed along the entire length of the evacuation route. Way guidance systems allow persons with vision impairments to walk significantly faster than traditional overhead emergency lighting. Moreover, emergency exit lights in green color and directional signals mounted near the floor have been found to be useful for all people in cases where a lot of smoke is present.

9.14 WAY GUIDANCE SYSTEM

- Luminance on the floor should be 1lux minimum provided on along the centre line of the route and on stairs.
- Install clear illuminated sign above exit and also directional signage along the route.
- The directional exit signs with arrows indicating the way to the escape route should

be provided at a height of 500mm from the floor level on the wall and should be internally illuminated by electric light connected to corridor circuits.

9.15 FIRE RESISTANT DOORS

- Fire resistant doors and doors used along the emergency evacuation route are generally heavy and the force required to open these is much higher than 25 Newtons, making it difficult for people with disability to negotiate these doors independently. There are, however, magnetic and other types of door holders available that can be connected to fire alarms so that they will hold the doors open normally but will release the doors when the fire alarm is activated.

9.16 STREET DESIGN

9.16.1 Footpath (Sidewalk)

Footpaths should be regarded as a transportation system which is connected and continuous, just like roadways and railways. They should not be sporadically placed where ever convenient, but instead should be provided consistently between all major attractions, trip generators, and other locations where people walk.

Footpath should:

- Be along the entire length of the road;
- Have height of a standard public step riser i.e., 150 mm maximum;
- Be at least 1800 mm wide;
- Have non-slip surface;
- Have tactile guiding paver for persons with visual impairments;
- Preferably have well defined edges of paths and routes by use of different colours and textures;
- Have no obstacles or projections along the pathway. If this is unavoidable, there should be clear headroom of at least 2200 mm from the floor level;
- The minimum 1.8m (width) x 2.2m (Height) Walking Zone should be clear of all obstructions – both horizontally and vertically.
- Footpath should have:
- Have kerb ramps where ever a person is expected to walk into or off the pathway; and
- Have tactile warning paver installed next to all entry and exit points from the footpath.

9.16.2 Kerb Ramp

- Kerb should be dropped, to be flush with walk way, at a gradient no greater than 1:10 on both sides of necessary and convenient crossing points. Width should not be less than 1200mm. If width (X) is less than 1200mm, then slope of the flared side shall not exceed 1:12.
- Floor tactile paving- Guiding & Warning paver shall be provided to guide persons with vision impairment so that a person with vision impairment does not accidentally walk onto the road.
- Finishes shall have non-slip surface with a texture traversable by a wheel chair.

9.16.3 Road Intersections

- Pedestrian crossings should be equipped with traffic control signal
- Traffic islands to reduce the length of the crossing are recommended for the safety of all road users
- Warning pavers should be provided to indicate the position of pedestrian crossings for the benefit of people with visual impairments
- Table tops (raised road level to the sidewalk height) are helpful in reducing the speed of traffic approaching the intersection

9.16.4 Median/Pedestrian Refuge

Raised islands in crossings should:

- Cut through and level with the street; or
- Have kerb ramps on both the sides and have a level area of not less than 1500 mm long in the middle; and
- A coloured tactile marking strip at least 600 mm wide should mark the beginning and end of a median/ pedestrian refuge to guide pedestrian with visual impairments to its location.

9.17 TRAFFIC SIGNALS

- Pedestrian traffic lights should be provided with clearly audible signals for the benefit of pedestrians with visual impairments;
- Acoustic devices should be installed on a pole at the point of origin of crossing and not at the point of destination;
- The installation of two adjacent acoustic devices such as beepers is not recommended in order to avoid disorientation;
- The time interval allowed for crossing should be programmed according to the

slowest crossing persons; and

- Acoustical signals encourage safer crossing behavior among children as well.

9.18 SUBWAY AND FOOT OVER BRIDGE

Subways and foot over bridges should be accessible for people with disabilities. This may be achieved by:

- Provision of signage at strategic location;
- Provision of slope ramps or lifts at both the ends to enable wheelchair accessibility;
- Ensuring that the walkway is at least 1500 mm wide;
- Provision of tactile guiding and warning paver along the length of the walkway;
- Keeping the walkway; free from any obstructions and projections; and
- Providing for seats for people with ambulatory disabilities at regular intervals along the walkway and at landings.

9.19 ALIGHTING AND BOARDING AREAS

All areas and services provided in the Mass Rapid Transit System (Metro/subway), bus terminuses, etc. that are open to the public should be accessible.

9.20 APPROACH

- Passenger walkways, including crossings to the bus stops, taxi stands, terminal / station building, etc. should be accessible to persons with disabilities.
- Uneven surfaces should be repaired and anything that encroaches on corridors or paths of travel should be removed to avoid creating new barriers. Any obstructions or areas requiring maintenance should be white cane detectable.
- Access path from plot entry and surface parking to terminal entrance shall have even surface without any steps.
- Slope, if any, shall not have gradient greater than 5%. The walkway should not have a gradient exceeding 1:20. It also refers to cross slope.
- Texture change in walk ways adjacent to seating by means of tactile warning paver should be provided for persons with vision impairment.
- Avoid gratings in walks.

9.21 CAR PARK

9.21.1 Signage

- International symbol of accessibility (wheelchair sign) should be displayed at approaches and entrances to car parks to indicate the provision of accessible parking lot for persons with disabilities within the vicinity.
- Directional signs shall be displayed at points where there is a change of direction to direct persons with disabilities to the accessible parking lot.
- Where the location of the accessible parking lot is not obvious or is distant from the approach viewpoints, the directional signs shall be placed along the route leading to the accessible parking lot.
- Accessible parking lot should be identifiable by the International Symbol of Accessibility. The signs should not be obscured by a vehicle parked in the designated lot.
- Vertical signs shall be provided, to make it easily visible, the sign should be at a minimum height of 2100 mm.

9.21.2 Symbol

International Symbol of Accessibility should be clearly marked on the accessible parking lot for drivers/riders with disabilities only.

- A square with dimensions of at least 1000 mm but not exceeding 1500 mm in length;
- Be located at the centre of the lot; and
- The colour of the symbol should be white on a blue background.

9.21.3 Car Park Entrance

The car park entrance should have a height clearance of at least 2400 mm.

Location:

- Accessible parking lots that serve a building should be located nearest to an accessible entrance and / or lift lobby within 30 meters. In case the access is through lift, the parking shall be located within 30 meters.
- The accessible route of 1200 mm width is required for wheelchair users to pass behind vehicle that may be backing out.

9.21.4 Accessible Car Parking Lot

The accessible car parking lot should:

- Have minimum dimensions 5000 mm × 3600 mm;
- Have a firm, level surface without aeration slabs;
- Wherever possible, be sheltered;
- Where there are two accessible parking bays adjoining each other, then the 1200 mm side transfer bay may be shared by the two parking bays. The transfer zones, both on the side and the rear should have yellow and while cross-hatch road markings;
- Two accessible parking lots shall be provided for every 25 no of car spaces.

Chapter -10
Environment & Social Impact Assessment

10.1 Purpose of the Report
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CHAPTER 10
ENVIRONMENT AND SOCIAL IMPACT ASSESSMENT

10.1 PURPOSE OF THE REPORT

The present study has been carried out for assessing the Environmental and Social Impacts for the proposed corridor. The report is prepared on the basis of primary data collection at site, in addition to secondary data. The environmental study is carried out for the PRT alignment proposed by DMRC.

10.2 PROJECT PROPONENT AND PROPOSAL

Uttarakhand Metro Rail Corporation (UKMRC) is the project proponent for the proposed PRT project. Detailed Project Report (DPR) is being prepared by DMRC. The proposed corridor interconnects various religious sites in Haridwar where people visit from different parts of country. The route length of the PRT corridors is 20.74 Km with 21 stations.

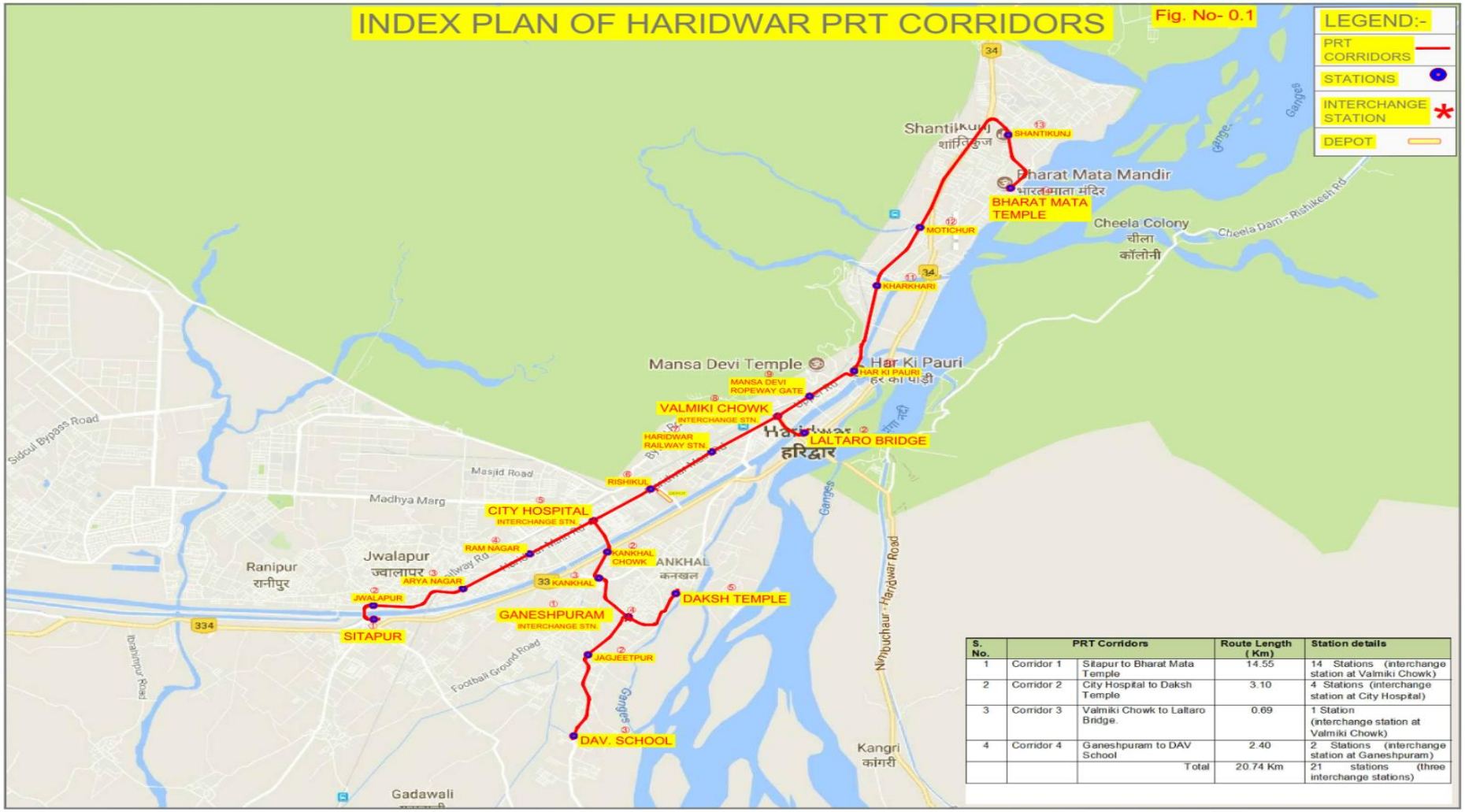
The Index Plan of proposed project has been depicted in **Figure 10.1**.

10.3 SCOPE OF WORK

The objective of the EIA &SIA study is to identify potential environmental and social impacts of the proposed Personalized Rapid Transport (PRT) and formulate strategies to avoid / mitigate the same. The scoping for the proposed environmental study is described below:

The scope of work to accomplish the above objective, comprise the following:

- Review literature and to collect data relevant to the study area;
- Conducting reconnaissance survey, field visits and study of Google earth maps for selection of sampling and monitoring locations for various environmental components;
- Understanding, collection compilation and collation of the baseline environmental data and conditions of the project area;
- Identifying the potential environmental impacts of the project proposal;
- Recommending appropriate mitigation measures to avoid/minimize the environmental impacts; and
- Preparing an environmental management plan for implementation.



S. No.	PRT Corridors		Route Length (Km)	Station details
1	Corridor 1	Sitapur to Bharat Mata Temple	14.55	14 Stations (interchange station at Valmiki Chowk)
2	Corridor 2	City Hospital to Daksh Temple	3.10	4 Stations (interchange station at City Hospital)
3	Corridor 3	Valmiki Chowk to Laltaro Bridge.	0.69	1 Station (interchange station at Valmiki Chowk)
4	Corridor 4	Ganeshpuram to DAV School	2.40	2 Stations (interchange station at Ganeshpuram)
		Total	20.74 Km	21 stations (three interchange stations)

Figure10.1 Index Plan of Proposed Project

The environmental studies have been confined to the situation around the deemed areas of direct influence caused by constructional and operational facilities along the proposed alignment. The report is prepared on the basis of collection of primary data at site, in addition to secondary data.

10.4 LEGAL, RAGULATORY AND INSTITUTIONAL FRAMEWORK

This section reviews the policies, regulations and administrative framework within which the project is to be implemented. The review includes sector specific Environmental Policies & Regulations of the Government of India and the institutional profile of various agencies such as MoEFCC, Uttarakhand Pollution Control Board and other bodies associated with the project.

10.4.1 Environmental Policies and Regulations

The Government of India has laid down various policy guidelines, regulations, acts and legislations for protection of environment and its components. Table 10.1 shows the details of relevant environmental legislations and implementing agencies. Acts and Regulations on Environmental Management are fairly extensive and take care of most of the aspects involved and the laws pertaining to them are quite stringent. However, as per MoEFCC notifications Railways Projects are not covered to seek prior Environmental Clearance from MoEFCC.

Table 10-1: Environmental Legislations Applicable to the Project

S. No.	Act/Regulation	Objectives	Implementing /Responsible Agency
1	Air (Prevention and Control of Pollution) Act, 1981 amended 1987	To control and monitor air pollution as per prescribed limits set by CPCB	Uttarakhand Environment Protection and Pollution Control Board.
2	The Water (Prevention and Control of Pollution) Act, 1974 amended 1988	To control and monitor water pollution as per prescribed limits	Uttarakhand Environment Protection and Pollution Control Board.
3	Environment Protection Act, 1986	Protection of Environment.	MoEFCC
4	Hazardous and Other Wastes (Management and Trans boundary Movement Rules, 2016	Handling of Hazardous wastes generated in the project during construction and operations	Uttarakhand Environment Protection and Pollution Control Board
5	Ancient Monuments and Archaeological Sites and Remains Act, 1958 amended 2010	Preservation of culture and historical remains.	Archaeological Survey of India (ASI), State Archaeological Department
6	The Explosives Act (& Rules), 1884 (revised in	Regulations regarding the use of explosives	Controller of Explosives

S. No.	Act/Regulation	Objectives	Implementing /Responsible Agency
	1983). Other relevant codes of BIS and National Building Codes 1983	and precautionary measures while blasting and quarrying	
7	The Public Liability Insurance Act & Rules, 1991	Imposes liability on the owner to provide immediate relief in respect of death/injury or damage to any person/property arising out of accident/activity implementation	All project proponents including the State Public Works Departments
8	Indian Motor Vehicles Act, 1988 (1989), 2019	To check vehicular air and noise pollution	Motor Vehicles Department, Govt. of Uttarakhand
9	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Rules for acquisition of land by Government	Department of Settlement and Land Records, Revenue Departments Govt. of Uttarakhand
10	Noise Pollution Rules 2000 amended 2002 & 2006	Regulation regarding control and management of Noise	CPCB and Uttarakhand Environment Protection and Pollution Control Board
11	Solid Waste Management Rules 2016	Managing the solid wastes generated at the project	Local Authorities
12	C & D Waste Management Rules, 2016	C & D Waste generated during construction	Uttarakhand Environment Protection and Pollution Control Board/ Haridwar Municipal Corporation
13	Fly ash Notification, 2016	Use of flyash in construction	Uttarakhand Environment Protection and Pollution Control Board
14	CGWA Guidelines 2015, 2019 and 2020	Tubewell Permission / Construction Rain water harvesting system	CGWA

10.4.2 Various Environment Permissions Required

References to EIA notification, Railway Projects are not covered to seek prior Environmental Clearance from MoEFCC/ SEIAA. Various permissions related to environment required for the project during Preconstruction, Construction and Operation phase of the project. The key permissions required for the project are listed below.

Table 10-2: Key Environmental Clearances Required

S. No.	Permissions/ Clearances	Acts / Rules / Notifications / Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				
	Permission for felling of trees	Forest Conservation Act (1980) Procedural Guidelines developed by the Department of Environment, GoM; Tree removal will be guided as per state government rules.	DNN/ District Collector	MDDA
B. Implementation Stage				
	Consent to operate hot mix plant, crushers, batching plant	Air (Prevention and Control of Pollution) Act 1981	Uttarakhand Environment Protection &Pollution Control Board	Contractor
	Permission for withdrawal of ground water	Environment (Protection) Act, 1986	Central Ground Water Authority	Contractor
	Permission for sand mining from river bed	Environment (Protection) Act, 1986	Mining Department/ MoEF	Contractor
	Authorization for Storage and Disposal of Hazardous Waste	Hazardous Waste (Management and Handling) Rules 1989	Uttarakhand Environment Protection &Pollution Control Board	Contractor
	Disposal of bituminous and other wastes	Hazardous Waste (Management and Handling) Rules 1989	Local civic body to use local solid waste disposal site	Contractor
	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act 1974	Uttarakhand Environment Protection &Pollution Control Board	Contractor
	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Department of Transport, Govt. of Uttarakhand authorised testing centres	Contractor
	Roof Top Rain Water Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines	Central Ground Water Authority/ DNN	Contractor
	Permission for groundwater extraction for drinking purpose	Environment (Protection) Act, 1986	CGWA	Contractor
	Employing Labour/	The Building and Other	District Labour	Contractor
	workers	Construction Workers	Commissioner	
		(Regulation of Employment and Conditions of Service) Act, 1996		

If sand and aggregates are sourced from the mines owned by contractor permission will be required separately from mining department and clearance from Uttarakhand Pollution Control Board and State SEIAA.

10.4.3 Institutional Framework

Various institutions will be involved for implementation of environmental management during construction and operations of the project like UKMRC, Uttarakhand Pollution Control Board, CPCB, MoEFCC and Municipal Authorities.

10.5 APPROACH AND METHODOLOGY

The alignment was fixed based on technical feasibility, socio-economic acceptability, and environmental sustainability for PRT Corridor. The environmental study is carried out for the alignment proposed by DMRC. The approach is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The analysis of assessment depends upon the reliable data generated/ available on environmental attributed. This study has documented the baseline data for various parameters of physical, ecological and environmental pollution (air, water, noise and vibration). The impacts are assessed for various phases of project cycle namely Impacts due to project location, impacts due to project design, impacts due to project construction, and impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs were estimated and budgeted for. The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The national acts, legislation and laws along with guidelines were consulted with a view to ensuring compliance with various requirements. Environmental baseline data for environmental attributes from primary and secondary sources were collected and compiled. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief.

10.6 PROJECT AREA

The proposed PRT project will be located in Haridwar city in Uttarakhand State.

10.6.1 Type of Project

The proposed project is a PRT project between Sitapur to Bharat Mata Temple with spur lines

to Lal Taro Bridge, Daksh Temple in Kankhal and DAV School in Haridwar city.

10.6.2 Need of the Project

The PRT project is to interconnect various religious sites in the holy city Haridwar where pilgrims visit in large numbers from all parts of the Nation.

10.6.3 Project Description

The proposed Haridwar PRT system will comprise of 21 stations. The main purpose is to provide seamless connectivity across the city, commercial zones, Railway Station, Bus Stand, tourist places like Har ki Pauri Mansa Devi Temple, Bharat Mata Temple, Daksh Temple etc. Total route length of 20.74 km. PRT stations are located at major transit area with high footfall and are planned for to connect important tourist attractions at Haridwar. Stations are planned within the walkable distances for the passengers from their origin/destinations. Maintenance yard and a control room for the operation and maintenance of the full system are planned near Rishikul.

10.7 EXISTING ENVIRONMENT

In order to assess the impacts of the proposed project, field visits were made to understand the environmental profile of the project influence area. This involved field inspections at the proposed locations, collection of secondary information for all the environmental components and discussions with the officials and local people. The profile presented below comprises of the following:

- Physical Environmental Components such as Meteorology, Geology, Topography,
- Air Quality, and Water quality
- Land Environment such as soil quality
- Biological Environmental Components such as flora and fauna

10.7.1 Physical Environment

The components of physical environment discussed in this section include:

- Meteorological parameters (climate, temperature, rainfall etc.)
- Geology and seismicity
- Topography
- Ambient air quality
- Water quality

- Ambient noise levels

For all the parameters, information was collected from field study, the Indian Meteorological Department, various Government Departments and discussions with the officials.

10.7.2 Climate, Temperature and Rainfall

The hydrometereological observations for Roorkee observatory are given in Table 10.4. Temperature begins to rise from March (29.1°C) and reaches to its maximum in May (39.2°C), with the commencement of monsoon season by mid-June, the temperature begins to fall. During the winter season in the month of November to February the temperature ranges between 10.5°C and 6.1°C. The relative humidity is highest in monsoon season (85% in the morning and 79% in the evening). The lowest humidity is observed during the month of April and May i.e. 24% (in evening) and 40% in May (in morning). The mean monthly wind speed is highest in the summer season when it goes up to 7.4 and 7.2 km/hour in the month of May and June and the minimum wind speed is observed during winter when it is 2.6 km/hour in the month of October. The potential evapotranspiration is maximum in the month of May 198.9 mm and minimum 38.5 mm in the month of December.

The average normal annual rainfall in Hardwar district is 1156.4 mm, out of which 84% is received during monsoon season and only 16% occurs during non-monsoon period. The district receives heaviest rainfall in northern part. The rainfall gradually decreases towards south. The monthly distribution of rainfall during the monsoon season over the district shows that July and August are the wettest month in the district having a rainfall 342.6 and 336.8 mm, respectively. The rainfall during the month of July and August is more or less the same. The monsoons retreat in the first fortnight of October giving a meagre rainfall of about 31 to 34 mm. Maximum rainfall occurs in the foothills of Himalayas and gradually decreases towards south.

10.8 GEOLOGY AND SEISMICITY

Geologically the area may be divided into three zones viz. Swales, Bhabar and Gangetic Alluvial Plains from North to South. Siwalik Range: This forms the outermost part of Himalaya and comprises Tertiary Group of rocks. In Bhagwanpur block only Upper and Middle Siwaliks are exposed. The Upper Siwaliks is constituted of boulders, pebbles, sand and clay. The boulders and pebbles are mostly of quartzite's. Middle Siwaliks comprises mainly grey micaceous sandstone and siltstone. Older Alluvium (Piedmont Plains or Bhabar): The Piedmont Plains are formed along the foothills of Siwaliks. It is formed by flooding hill torrents and nallahs (locally termed as 'Rao'). Alluvial fans in the piedmont zones are wider and longer when formed along mature streams. The Older Alluvium consists of polycyclic sequence of brown to grey silt, clay with boulders and pebbles.

10.8.1 Seismicity of Project Area

The seismic hazard map of India was updated in 2002 by the Bureau of Indian Standards (BIS) as per IS:1893 (Part-1)-2002. The area under study and its surroundings are seismically active falls in Seismic Zone-IV. The Seismic map & recent earthquake map is given as **Fig 10.2**.

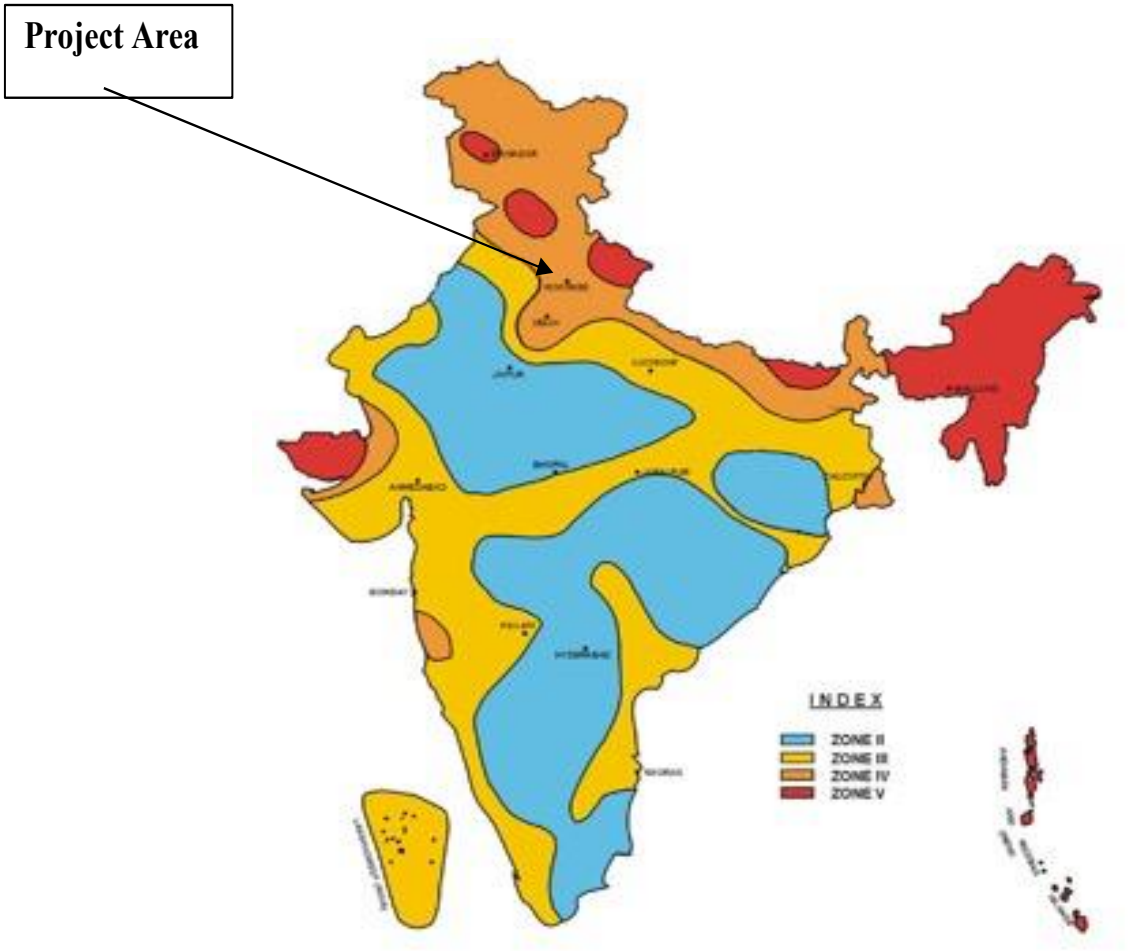


Figure 10.2 Seismic Map of India.

10.9 PHYSIOGRAPHY

The terrain is mostly flat. The height of ground surface in project area is 275to 315m above the mean sea level (MSL). The general slope of the ground close to site is mostly from north to south direction.

10.10 AMBIENT AIR QUALITY

Air Quality data was generated, compiled and collated for PM_{10}, $PM_{2.5}$, Nitrogen Oxides (NOx), Carbon mono-oxide (CO) earlier in Sep 2017. The Air quality was monitored in accordance with the guidelines of the Ministry of Environment and Forests / Central Pollution Control Board

under National Ambient Air Quality Standards as per National Ambient Air Quality Standards (NAAQS 2009) issued on 18th November 2009 by Ministry of Environment and Forests, Govt. of India. Fresh monitoring data has been generated between 18th to 20th November 2020 which has been given in the following Table 10.3.

10.10.1 Observed Air Quality

The values of all the parameters as observed during the monitoring are given in Table 10.3 for different monitoring stations. Data given in the Table shows the observed level of pollutants at the monitoring stations. National Ambient Air Quality Standards (NAAQS), as specified by the Central Pollution Control Board (CPCB), Ministry of Environment and Forests.

Table 10-3: Observed Ambient Air Quality

S. No	Location	Date	PM_{10}	$PM_{2.5}$	SO2	NOx	CO
	Regulatory Standards		**100**	**60.0**	**80**	**80**	**2000**
	Sep 2017						
1	Sitapur	9 to10 Sep	85	29.0	22.4	25.7	1298
			89	28.6	23.1	28.7	1327
2	Jwalapur	10 to11 Sep	88	29.8	26.2	30.6	1085
			87	27.3	25.7	29.4	1010
3	Arya Nagar Chowk	10 to11 Sep	78	25.2	23.5	33.6	1200
			81	23.2	24.1	30.5	1265
4	Haridwar Railway Station	11 to12 Sep	93	34.0	25.5	33.2	1150
			92	34.2	23.6	35.1	1320
5	Laltaro Bridge	11 to12 Sep	87	33.6	24.6	37.4	1270
			87	34.2	25.4	36.1	1040
6	Har-ki-Podi	12 to 13 Sep	88	31.5	21.6	27.4	1070
			85	32.9	23.3	30.4	1130
7	Shantikunj	12 to 13 Sep	88	32.0	21.8	30.6	1070
			90	33.3	23.6	33.2	1080
	Nov 2020						
1	City Hospital	18-11-20	89	36	23.4	28.9	1277
2	Rishikul	18-11-20	93	38	25.3	22.8	1301
3	Valmiki Chowk	19-11-20	92	37	25.2	23.2	1356
4	Bharat Mata Temple	19-11-20	85	29	19.1	18..2	1374
5	Ganesh Puram	20-11-20	88	34	20.1	19.8	1178
6	DAV School	20-11-20	86	32	21.2	25.2	1076

It is to be noted that the particulate levels of the levels of all parameters are within prescribed limits. The gaseous parameters are within permissible limits. These levels are during the lockdown period when traffic intensity is quite low.

10.11 WATER RESOURCES AND QUALITY

The Ganges emerges from the mountains to touch the plains. The water in the river Ganges is mostly clear and generally cold, except in the rainy season, during which soil from the upper regions flows down into it. The river Ganges flows in a series of channels separated from each other called aits, most of which are well wooded. Other minor seasonal streams are Ranipur Rao, Pathri Rao, Ravi Rao, Harnaui Rao, Begham Nadi etc.

10.11.1 Ground Water

Hardwar district comes under Ganga river system. The main tributaries of Ganges like Solani, Ratmau Rao and Banganga and their feeding nallahs drain the area. These tributaries are ephemeral in nature. As far as canal irrigation is concerned, western part of the district is well covered with 300 km length canal network. Bhagwanpur block comes under non-command area. Hence, there is an immense pressure on ground water due to which water levels are declining at faster pace. There are 225 State Government tube-well sand 32930 private tube-wells. The ground water abstraction for drinking, domestic and agriculture purposes is higher in Bhagwanpur block as compared to other blocks. Most of the tube-wells are drilled in central and southern part of the block. The northern part of the block has a smaller number of tube-wells.

10.11.2 Hydrogeology

The ground water conditions in alluvial parts of Hardwar district are considerably influenced by the varying lithology of the subsurface formations. The fluvial deposits of Indogangetic Plains exhibit significant variations, both laterally and vertically. The main source of water, which sustains groundwater in the district, is rainfall. The other sources of groundwater replenishment are infiltration from canals and irrigation return flow. The common ground water abstraction structures in Hardwar district are shallow and deep tube-wells. Dug wells are also used for drinking and other domestic purposes up to a limited extent. Most of the dug wells have been abandoned. Hydrogeological surveys carried out in Hardwar district show that water levels range from 0.78 to 50.20 m bgl in pre-monsoon period and from 0.64 to 48.56 m bgl during post-monsoon period, respectively. The northern and northeastern parts of the district comprise boulders, pebbles, gravels, sand and clay, which form a good recharge zone. The water levels in this area range from 4.02 to 50.20 m bgl. The deepest water level was recorded at Laldang in Bahadrabad block. The water level in gangetic alluvium ranges from 0.64 to 24.13 m bgl. The deepest water level is recorded at Bhagwanpur town.

Alluvium is the main water bearing formation in the area, which consists of coarse sand, fine sand and silt. Ground water in Hardwar district occurs under unconfined, confined and semi-confined conditions. The aquifers are separated with thick clay with considerable thickness, which act as confining layers. The water level data suggests the presence of multilayer aquifer system. The first one is unconfined and the others are semi-confined to confined. The depth of first unconfined aquifer ranges from 4 to 8 m bgl and the others are 18 to 25 m bgl, 40 to 60 m

bgl and 90 to 120 m bgl. Due to variable thickness of clay layers, the aquifers become double layered from west to east.

10.11.3 Water Quality

Water quality is the physical, chemical and biological characteristics of water. The most common standards used to assess water quality are related to drinking water, safety of human contact, and for health of ecosystems. An understanding of the various factors influencing water quality is thus very important as human health is largely dependent on the quality of water available for our use. Water sampling was done at two locations in 2017 and two locations in Nov 2020.The observed Ground water quality has been given in the Table below.

Table 10-4: Observed Ground Water Quality

Location Parameter	Sitapur HP	Chandra Arya Chowk TW	Standard
Date of Sampling	**12-09-2017**	**12-09-2017**	
Colour, Hazen	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable
Turbidity, NTU	3.4	3.5	1 (5) Max
pH	7.78	7.87	6.5-8.5 Max
Total Hardness as $CaCO_3$, Mg/l	259	264	200 (600) Max
Chloride as Cl, Mg/l	140	144	250 (1000) Max
Total Iron as Fe, Mg/l	0.08	0.09	0.3 Max
Total Dissolved Solids, Mg/l	1219	1289	500 (2000) Max
Sulphates as SO_4, Mg/l	179	123	200 (400) Max
Nitrates as No3, Mg/l	36.1	34.1	45 Max
Fluorides as F, Mg/l	1.59	1.57	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	0.01 Max
Copper as Cu,Mg/l	BDL	BDL	0.05 (1.5) Max
Manganese as Mn,Mg/l	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C6H5OH,Mg/l	BDL	BDL	0.001 (0.002) Max
Mercury as Hg,Mg/l	BDL	BDL	0.001 Max
Cadmium as Cd,Mg/l	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	0.01 Max
Arsenic as As,Mg/l	BDL	BDL	0.05 Max
Cyanide as Cn,Mg/l	BDL	BDL	0.05 Max
Zinc as Zn, Mg/l	1.31	1.45	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6 ,Mg/l	BDL	BDL	0.05 Max
Total Alkalinity as Caco3,Mg/l	184.3	177.2	200 (600) Max

Location Parameter	Sitapur HP	Chandra Arya Chowk TW	Standard
Aluminium as Al,Mg/l	BDL	BDL	0.03(2) Max
Boron as B, Mg/l	BDL	BDL	0.5(1) Max
Bacteriological Analysis			
Coliform, MPN/100Ml	Nil	Nil	10 Max
E-Coli/Ml	Negative	Negative	Negative

Source: Monitored results

Table 10-5: Observed Ground Water Quality (Continued)

Location Parameter	Bharat Mata Temple	Ganesh pura	Standard
Date of Sampling	**20-11-2020**	**20-11-2020**	
Colour, Hazen	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable
Turbidity, NTU	3.1	3.6	1 (5) Max
pH	7.56	7.51	6.5-8.5 Max
Total Hardness as $CaCO_3$, Mg/l	248	239	200 (600) Max
Chloride as Cl, Mg/l	95	101	250 (1000) Max
Total Iron as Fe, Mg/l	0.07	0.08	0.3 Max
Total Dissolved Solids, Mg/l	543	498	500 (2000) Max
Sulphates as SO_4, Mg/l	79	82	200 (400) Max
Nitrates as No3, Mg/l	32.1	30.1	45 Max
Fluorides as F, Mg/l	1.39	1.27	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	0.01 Max
Copper as Cu,Mg/l	BDL	BDL	0.05 (1.5) Max
Manganese as Mn,Mg/l	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C6H5OH,Mg/l	BDL	BDL	0.001 (0.002) Max
Mercury as Hg,Mg/l	BDL	BDL	0.001 Max
Cadmium as Cd,Mg/l	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	0.01 Max
Arsenic as As,Mg/l	BDL	BDL	0.05 Max
Cyanide as Cn,Mg/l	BDL	BDL	0.05 Max
Zinc as Zn, Mg/l	0.81	0.76	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6 ,Mg/l	BDL	BDL	0.05 Max
Total Alkalinity as Caco3,Mg/l	158.3	147.2	200 (600) Max
Aluminum as Al,Mg/l	BDL	BDL	0.03(2) Max

Location Parameter	Bharat Mata Temple	Ganesh pura	Standard
Boron as B, Mg/l	BDL	BDL	0.5(1) Max
Bacteriological Analysis			
Coliform,MPN/100Ml	Nil	Nil	10 Max
E-Coli/Ml	Negative	Negative	Negative

Source: Monitored results

Groundwater quality is quite good. However, total dissolved solids and fluoride are a little higher than the desirable limits. All other parameters are well within the desirable limits. The water can be used for domestic purpose after primary treatment. However, groundwater cannot be used for construction as per NGT orders. Surface water samples were also collected and tested. The observed water quality is given in **Table 10.6**.

Table 10-6: Surface Water Quality at Monitoring Sites

Location Parameter	UGC Laltaro	Ganga-Shantikunj	Standard
Colour, Hazen	Colourless	Colourless	5 (15) Max
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Taste	Agreeable	Agreeable	Agreeable
Turbidity, NTU	6.2	7.6	1 (5) Max
pH	7.76	7.79	6.5-8.5 Max
Total Hardness as $CaCO_3$,Mg/l	277	258	200 (600) Max
Dissolved Oxygen	7.5	7.1	Min 6
Chloride as Cl, Mg/l	159	156	250 (1000) Max
Total Iron as Fe, Mg/l	0.08	0.10	0.3 Max
Total Dissolved Solids, Mg/l	190	211	500 (2000) Max
Sulphates as So4, Mg/l	94	199	200 (400) Max
Nitrates as No3, Mg/l	30.3	35.3	45 Max
Fluorides as F, Mg/l	1.39	1.59	1.0 (1.5) Max
Lead as Pb, Mg/l	BDL	BDL	0.01 Max
Copper as Cu,Mg/l	BDL	BDL	0.05 (1.5) Max
Manganese as Mn,Mg/l	BDL	BDL	0.1 (0.3) Max
Phenolic Compound as C6H5OH,Mg/l	BDL	BDL	0.001 (0.002) Max
Mercury as Hg,Mg/l	BDL	BDL	0.001 Max
Cadmium as Cd,Mg/l	BDL	BDL	0.01 Max
Selenium as Se, Mg/l	BDL	BDL	0.01 Max
Arsenic as As,Mg/l	BDL	BDL	0.05 Max
Cyanide as Cn,Mg/l	BDL	BDL	0.05 Max

Location Parameter	UGC Laltaro	Ganga-Shantikunj	Standard
Zinc as Zn, Mg/l	1.34	1.32	5 (15) Max
Detergent as MBAS, Mg/l	BDL	BDL	0.2 (1.0) Max
Chromium as Cr+6 ,Mg/l	BDL	BDL	0.05 Max
Total Alkalinity as Caco3,Mg/l	176.1	185.3	200 (600) Max
Aluminum as Al,Mg/l	BDL	BDL	0.03(2) Max
Boron as B, Mg/l	BDL	BDL	0.5(1) Max
Bacteriological Analysis			
Coliform, MPN/100Ml	394	131	10 Max
E-Coli/Ml	211	79	Negative

10.12 NOISE LEVELS

Noise levels have been monitored using digital sound level meter. Leq noise levels have been recorded as dB (A) and reported in the report. Ambient Noise level measurements have been carried out to know the existing noise level along the proposed corridor of PRT and its vicinity that could be affected due to the proposed project. The observed hourly Leq values of noise levels are given in **Table 10.7** and the allowable noise levels are given in **Table 10.8**.

Table 10-7: Measured Noise Levels dB (A)

S. No.	Location	Date		Lmax	Lmin	Leq	L_{10}	L_{50}	L_{90}
	Year 2017								
1	Sitapur	9 to10 Sep	Day	86.6	58.2	70.6	73.2	68.1	62.4
			Night	72.1	54.1	63.6	70.4	60.2	57.3
2	Jwalapur	10 to11 Sep	Day	82.2	56.1	67.2	70.3	66.3	58.5
			Night	72.5	50.0	55.3	62.2	57.1	50.2
3	Haridwar Bus Stand	11 to12 Sep	Day	78.9	53.5	71.4	67.8	66.5	61.7
			Night	71.5	48.4	63.2	66.6	61.3	56.1
4	Haridwar Railway Station	11 to12 Sep	Day	78.7	54.8	67.5	74.7	62.5	57.6
			Night	65.6	46.2	52.9	63.2	51.2	49.7
5	Laltaro Bridge	11 to12 Sep	Day	72.6	51.9	67.1	70.2	64.6	60.2
			Night	67.5	51.8	66.2	63.2	60.2	56.7
6	Har ki Podi	12 to 13 Sep	Day	79.7	53.5	66.2	72.6	62.9	56.9
			Night	73.9	46.4	60.1	67.3	573	52.1
7	Shantikunj	12 to 13 Sep	Day	65.6	46.3	57.7	62.6	58.9	52.8
			Night	61.5	44.6	52.4	56.3	49.8	46.1
	Year 2020								
1	City Hospital	18-11-20	Day	85.4	58.2	71.2	76.2	67.1	62.6
			Night	71.2	54.6	62.6	69.4	63.2	55.3
2	Rishikul	18-11-20	Day	82.5	56.4	67.2	70.3	66.3	58.5
			Night	71.5	51.0	55.2	64.2	57.1	51.2
3	Valmiki Chowk	19-11-20	Day	86.6	58.2	70.6	73.2	68.1	62.4
			Night	70.1	53.1	64.6	71.4	63.2	56.3
4	Bharat Mata	19-11-20	Day	69.6	50.2	58.1	68.2	60.6	56.2

S. No.	Location	Date		Lmax	Lmin	Leq	L_{10}	L_{50}	L_{90}
	Temple		Night	62.5	51.2	56.2	60.3	58.2	53.7
5	Ganesh Puram	20-11-20	Day	72.4	51.5	63.1	69.2	60.6	56.2
			Night	67.4	53.8	61.2	63.2	58.2	54.6
6	DAV School	20-11-20	Day	70.6	50.1	62.5	67.2	62.6	56.2
			Night	66.5	50.8	59.2	62.3	59.1	53.7

Table 10-8: Allowable Noise Levels dB (A)

Category of Area/Zone	Day Time 6.00 AM-10.00 PM	Night Time 10.00 PM-6.00 AM	EPA-1986, Noise pollution (Regulation/ Control),Rule-2000, PCLS/02/1992, IVth Edition.
Industrial Area	75	70	
Commercial Area	65	55	
Residential Area	55	45	
Silence Area	50	40	

Observed Noise levels were found to exceed the permissible noise limits for commercial areas. The noise levels are higher both during day time as well as night time.

10.13 SOIL QUALITY

Soil samples have been collected from the Aerocity so as to assess its physic-chemical parameters for the purpose of assessing its suitability for plantation and vegetation support characteristics. Soil samples have been collected from surface up to a depth of 30 cm. The soil quality has been given in **Table 10.9**.

Table 10-9: Observed Soil Quality

S. No.	PARAMETERS	Har ki Podi	Hardwar Railway Station	Rshikul	DAV School
	Sample Code	**S-1**	**S-2**	**S3**	**S4**
1.	pH	7.50	7.98	7.53	7.63
2.	Organic Matter (%)	1.84	1.34	1.73	1.65
3.	Nitrogen (kg/Hectare)	331.0	169.2	261.0	269.2
4.	Phosphorus (kg/Hectare)	2.38	4.11	2.82	4.02
5.	Sodium (mg/100gm)	11.27	9.26	11.22	11.25
6.	Calcium (ppm)	1563	1853	1663	1737
7.	Potassium (kg/Hectare)	131	127	128	130
8.	Magnesium (ppm)	68	158	88	128
9	Electrical Conductivity	625	736	676	702
10	Texture (%)				
	Sand	82.21	77.2	80.27	79.73
	Slit	16.49	11.6	15.68	13.76
	Clay	1.34	11.2	4.05	116.51

It has been observed that during the study period, the pH of the soil is 7.50 and 7.58 indicating

that the soil is slightly alkaline in nature. The soil is predominantly of sandy silt type containing high percent of sand with smaller grain size. The nitrogen values ranged between 169.2 and 331 Kg/ ha. Phosphorus content is very less in the soil. The analysis infers that the soil in the vicinity of the is not fertile land.

10.14 BIOLOGICAL ENVIRONMENT

The Motichur, Ranipur ranges and Chilla Gates are just about 9 km from Haridwar. Rajaji National Park is Indian national park and tiger reserve that encompasses the Shivaliks, near the foothills of the Himalayas. The park is spread over 820 km2 and three districts of Uttarakhand: Haridwar, Dehradun and Pauri Garhwal. In 1983, three wildlife sanctuaries in the area namely, Chilla, Motichur and Rajaji sanctuaries were merged into one. Rajaji National Park has been named after C. Rajagopalachari (Rajaji), a prominent leader of the Freedom Struggle, the second and last Governor-General of independent India and one of the first recipients of India's highest civilian award Bharat Ratna (in 1954).

10.14.1 Flora

Rajaji National Park of India is nestled between the Shivalik ranges and the Indo-Gangetic plains. Broad leaved deciduous forests, riverine vegetation, scrubland, grasslands and pine forests form the range of flora in this park. The dense jungle here are home to vivacious wildlife. The varied topography of the national park is also responsible for vivid animal life inhibited here. The under-wood is light and often absent, consisting of Rohini Mallotusphilippensis, Amaltas Cassia Fstula, Shisham Dalbergiasissoo, Sal Shorearobusta, Palash Butea Mono-sperma, Arjun Terminaliaarjuna, Khair Senegalia Catechu, Baans Dendrocalamusstrictussemul Bombaxceiba, Sandan, Chamaror Ehretia, Amla Phyllanthusemblica, Kachnar Bauhieniavariegata, Ber Ziziphusmauritiana, ChillaCasearia, Bel Aeglemarmelos, etc.

10.14.2 Fauna

Rajaji National Park is predominantly formed from dense green jungles, and this environment forms a habitat for a number of animals. The park is at the northwestern limit of distribution for both elephants and tigers in India. The park is most renowned for its elephants. The mountain goat, goral is another noteworthy resident. It is mainly confined to the precipitous pine-covered slopes. Besides the huge pachyderms and the nimble goats, you might come across huge herds of chital, sometimes as many as 250 to a herd. sambar, barking deer, hog deer, nilgai, wild pigs and sloth bears also inhabit these forests though you may not always catch a glimpse of these. The rhesus macaque and the common langur are fairly common here. Tigers and leopards are the prime predators in Rajaji. The leopard cat, jungle cat, civet and yellow-throated marten are other carnivores. Mammals like the hyena, jackal and the Bengal fox scavenge in the park. The Himalayan black bear though uncommon, can be sighted in the higher reaches of the park. Other wild animals found in the park include:

- Asian elephant
- Bengal tiger
- Leopard
- Jungle cat
- Striped hyena
- Goral
- Indian hare
- Sloth bear
- Himalayan black bear
- King cobra
- Jackal
- Barking deer
- Sambhar
- Wild boar
- Rhesus macaque
- Indian langur
- Indian porcupine
- Monitor lizard
- Python

Over 315 species of birds are found in the park, whereas the wider region has over 500 species of birds, including both residents and migrants. The most prominent avian species include pea fowl, vultures, woodpeckers, pheasants, kingfishers and barbets, supplemented by a number of migratory species during the winter months. The park is also home to the great pied hornbill, pied kingfisher and the fire tailed sunbird. This area is the first staging ground after the migratory birds cross over the Himalayas into the Indian subcontinent. The rivers which flow through the park harbors species of fish such as trout and mahseer.

Trees have been counted along the PRT alignment including station areas. Tree with Girth at Breast Height (GBH) 30 cm have been counted in Right of Way (ROW) as per the alignment drawing. The alignment does not pass through any forest area. A total of 244 trees have been found in the project area including station areas and corridor running section. The details are given in **Table 10.10**.

Table 10-10: Details of Trees on PRT Corridor

S. No.	Corridor	Number of Trees
1	Sitapur	25
2	Sitapur to Ram Nagar	15
3	Ram Nagar to Railway Station	59
4	Valmiki Chowk	12
5	Lal Taoo Bridge	19
6	Motichur	3
7	City Hospital to Daksha Temple	104
8	Ganeshpuram	3
9	Jagjeetpur	4
	Total	**244**

10.15 SOCIO-ECONOMIC CONDITIONS

Haridwar is the headquarters and the largest city of the district. The total geographical area of the Haridwar Township is about 42.01sq.km and is situated at the height of 249 m above mean sea level. Haridwar is the gateway to the four pilgrimages of Uttarakhand. History depicts that it is the starting point of the two holy rivers Ganga and the Yamuna. Haridwar's chief object of pilgrimage is Har-ki-pauri—the bathing ghat, or steps, along the river. Haridwar is also one of the four places where Kumbh Mela occurs after rotation of every twelve Years and Ardh-Kumbh Mela is organized after six years of every Kumbh. Large numbers of pilgrims gather there annually at the beginning of the Hindu solar year in April.

As of 2011 India census, Haridwar district had population of 18,90,422 (2011) & Haridwar city has 3,20,892 population in 2011. As per Census 2001, average household size is about 5.4 persons. Haridwar has an average literacy rate of 70%, higher than the national average of 59.5%.

Haridwar hosts about 8 million religious tourists every year. The giant public sector unit BHEL a large unit of Hindustan Lever and three engineering units have their impact on the tertiary sector of the economy of the town. In private sector also, some large industrial units are functioning in the fringes of Haridwar, which have impact on the economy of the town; and many more units which are in the offing, will also indirectly strengthen the economy of this town. As the economy grows, the rate of in-migration of workers will grow concomitantly, which will reflect on the growth of population. Besides the tourist population, a large number of daily religious visitors and visitors who come on different business in this head quarter town (Haridwar town is the Head Quarter of District Haridwar) constitute the floating population.

The giant public sector unit BHEL (population 47,000 in its colony - as per census 2011), a large unit of Hindustan Lever (employment 559 - as per CDP Haridwar 2007), and three engineering units (together employing 11,040 workers - as per CDP Haridwar 2007) have their impact on the tertiary sector of the economy of the town. In private sector also, some large industrial units are functioning in the fringes of Haridwar, which have impact on the economy of

the town; and many more units which are in the offing, will also indirectly strengthen the economy of this town. As the economy grows, the rate of in-migration of workers will grow concomitantly, which will reflect on the growth of population.

As per CDP Haridwar 2007 and IMaCS primary survey 2017, majority of the households in Haridwar are in below poverty line and poor income groups, at present more than 15% population is below the national (GoI) poverty line. There is a considerable proportion of population in the lower expenditure group and it is evident that they spend most of their income. Families in the middle-income groups have maximum savings in Haridwar.

Haridwar is considered as the point of entry to Char Dham, the four main centers of pilgrimage in Uttarakhand region viz. Badrinath, Kedarnath, Gangotri and Yamunotri. Haridwar, with its rich heritage attracts millions of tourists on religious occasions every year and especially during Kumbh Mela and Ardh Kumbh Mela. Haridwar has neighbouring tourist attractions which makes it a tourist hub in the region.

10.15.1 Socio-Economic Survey

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/ people and to examine the impacts of the proposed PRT alignment on their conditions. There can be two types of impacts on the PAPs. One is the displacement of residential house and another is displacement of commercial establishments. The alignment of PRT project has been modified in view of the comments received from UKMRC. It has been observed that a few structures are getting affected due to the location of stations and area to be acquired in running sections on turns and curves.

The details of the structures have been worked out on the basis of drawings and the affected structures have been identified. However, these have not been physically verified and contacted due to the ongoing COVID pandemic. These will be contacted, physically verified and surveyed once the restrictions are lifted by the State Government for free movement and public interaction. Details of affected structures including commercial, Residential and Institutional like Ashram, Dharamshaa etc. and the Government structures like Substation buildings are given in Table 10.11.

It is to be noted that the structure details are taken considering ROW of 9 m including about 4.5 m for the viaduct structure and about 4.5 m as buffer area marked for safety and working space. During physical verification ad survey the structures on the margin of ROW may not be required for actual acquisition. It would be finalized when permitted to conduct field visits and public interactions.

Table 10-11: Details of Affected Private Structures

S. No.	Location	Structures			
		Commercial	Residential	Institutional	Govt.
1	PRT stations	7	1	1	0
2.	PRT Alignment Running Section	5	8	2	2
	Total	**12**	**9**	**1**	**2**

10.16 ARCHAEOLOGICAL SITES AND SENSITIVE RECEPTORS

The proposed alignment does not pass through any of the Archaeological monuments or heritage sites.

10.17 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION

10.17.1 General

The project is designed keeping in view population growth, future traffic demands and environmental protection aspects. Negative impacts likely to result from the proposed development have been listed under the following headings:

- Impacts due to Project Location;
- Impacts due to Project Design;
- Impacts due to Construction; and
- Impacts due to Project Operation.

For each of these headings, potential impacts have been considered, while recommendations for mitigating measures have been given. Positive impacts of the project have also been given.

10.17.2 Environmental Impacts

This section identifies and appraises the negative impacts on various aspects of the environment likely to result from the proposed development. It is important to mention that the negative environmental impacts listed below are based on the assumption that no negative impact mitigation measure or benefit enhancements are adopted. •Land Environment

- Water Environment
- Air Environment
- Noise Environment

- Biological Environment
- Socio-Economic Environment

The impacts on the above environmental components have been further assessed during various phases of project cycle namely project location, project design, construction and operation.

10.17.3 Impacts Due to Project Location

During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed. These impacts are:

- Impacts on Physiography and Topography
- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems,
- Socio-economic impacts;
- Project Affected People (PAPs);
- Impact on Historical and Cultural Monuments

The construction and operational phases of the proposed development shall comprise of various activities, each of which may have an impact on the environmental parameters. The environmental attributes have been studied to evaluate impacts on the environment during the construction and operation phases of the both PRT Corridor. Due to the proposed construction of PRT Corridor, the water environment, air environment, noise, soil, land environment, ecological environment and socio-economic factors are identified as the significant environmental components likely to be affected. The potential impacts due to location, during construction and operational phases of the PRT Corridor on various environmental components are predicted quantitatively/qualitatively and discussed in the following sections.

10.17.4 Impact on Physiography and Topography

The PRT alignment passes through the flat terrain. The project site is having north south slope of about 2m per km. The alignment is proposed at the center of the roads. However, impact on the physiography and topography of the area would be insignificant during construction and operation phase of the project. An effort shall be made to minimize any change in physiography.

10.17.5 Change of Land Use Pattern

The ROW of the roads along which the alignment is planned is sufficiently wide and hence no

land is required for acquisition as long as the alignment is in the centre of the road. However, at curved portions, the alignment could not be kept in the centre of the road and land acquisition at such locations is inevitable. To the extent possible the Entry and Exit points of stations were planned on the footpaths. The details of land permanently required for depot, running sections, stations, ramp, parking, property development etc. are indicated in the **Table10.12**.

Table 10-12: Land Requirement/ Change in Land Use

S. No.	Particulars	Code	Land m^2		
	STATIONS				
A	**Sitapur- Bharat Mata Temple**		**Govt.**	**Private**	**Total**
1	Sitapur	S1	1351.9	0.0	1351.9
2	Jwalapur (lift)	J1	0.0	6.7	6.7
	(lift)	J2	0.0	6.7	6.7
3	City Hospital	CH1	50.6	0.0	50.6
		CH2	70.2	0.0	70.2
4	Haridwar Railway Station	HRS1	6.8	0.0	6.8
5	Mansadevi Ropeway Gate	MRG1	0.0	137.3	137.3
6	Har Ki Pauri	HP1	12.5	0.0	12.5
		HP2	35.7	0.0	35.7
7	Kharkhari (for Lift)	K1	0.0	6.7	6.7
8	Motichur	M1	0.0	182.1	182.1
	Total		**1527.7**	**339.5**	**1867.2**
B	**City Hospital- Daksha Temple**				
1	Kankhal Chowk	KC1	0.0	2	2
2	Ganeshpuram	G1	0.0	324.8	324.8
	Total		**0.0**	**326.8**	**326.8**
C	**Ganeshpuram- DAV School**				
1	DAV School	DS-1	0.0	4.8	4.8
		DS-2	0.0	148.4	148.4
	Total		**0.0**	**153.2**	**153.2**
D	**Valmilki Chowk- Laltaro**		**0.0**	**0.0**	**0.0**
	Lal Taro Bridge	**LB-1**	**2288.1**	**0.0**	**2288.1**
	TOTAL STATIONS		**3815.8**	**819.5**	**4635.3**
	RUNNING SECTIONS				
1	Land b/w Road	RS-1	440.9	0.0	440.9
2	Land b/w Road	RS-2	896	0.0	896
3	In front of Primary School	RS-3	141.1	0.0	141.1
4	After Railway Bridge Y turn	RS-4	93.7	0.0	93.7
5	Abhishek Trust	RS-5	0.0	46.3	46.3
6	Hotel Ganga	RS-6	0.0	97.2	97.2
7	Sringeri Math & Rawatpura	RS-7	0.0	33.8	33.8
8	Shiv Swarup Dharamshala	RS-8	0.0	12.9	12.9
9	Along Canal	`RS-9	0.0	34.6	34.6
10	Along Canal	RS-10	0.0	12.9	12.9

S. No.	Particulars	Code	Land m^2		
11	Canal- Road Turn	RS-11	0.0	213.7	213.7
12	Power House-Substation	RS-12	26.4	0.0	26.4
13		RS-13	34.4	0.0	34.4
14	Bharat Marble	RS-14	0.0	358.2	358.2
	Total Running Sections		**1632.5**	**809.6**	**2442.1**
	Depot		**17370.0**	**0.0**	**17370.0**
	Grand Total		**22818.3**	**1629.1**	**24447.4**

Additionally, property development is proposed near DAV school for which it is proposed that Uttarakhand Government will provide 10 ha of Government Land free of cost.

10.18 LOSS OF CULTURAL AND HISTORICAL MONUMENTS

No historical/ cultural monument will be affected as a result of the proposed development of project. However, the project is meant to provide connectivity to the existing temples which have historical and heritage importance, there may be requirement to seek prior permission from ASI/ State Archaeological Department because of the limits of 100m and 300m as given in Archaeological Sites and Remains (Amendment and Validation) Act 2010.

10.18.1 Mitigation

The laws and regulations applicable for keeping the heritage intact will be observed. No local archaeological, historical, cultural and religious heritage sites will be affected as a result of the proposed alignment.

10.19 LOSS OF VEGETATION / TREES

A total 244 trees are located in the Right of Way (ROW) of corridor. An attempt will be made to minimize the tree felling by cutting only those trees which will be essentially required for the working. Trees are assets in purification of urban air, which by utilizing CO2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO2 conversion will get effected and the losses are reported below:

i. Total number of Trees : 244

ii. Decrease in CO2 absorption @ 21.8 Kg/year/ tree for 8 years: : 42.55 Tonnes

iii. Oxygen production @ 49 Kg/year per tree for 8 years : 95.65 Tonnes

The average consumption of oxygen for a person is about 182 kg/ year. It means these trees will meet the requirement of about 525 people round the year. There will be plantation of ten times of felled trees as compensatory afforestation which will exceed the generation of oxygen and absorption of carbon dioxide over time.

10.19.1 Mitigation

An attempt shall be made to minimize the tree felling. As remediation of tree felling, it is suggested to plant ten saplings for each tree felled. Thus, 2440 trees would be planted. Moreover, UKMRC would chalk out the plantation program in close coordination with forest department. A provision of 82.96 Lakh has been made @ Rs. 3400/- per tree to be planted and maintained for a period of three years. An attempt would be made to minimize the felling of trees to the bare minimum while working and undertaking construction work. The left-out trees shall be protected by providing metal or brick tree guard around the tree at a distance of one metre surrounding the tree.

10.20 UTILITY/ DRAINAGE PROBLEMS

The alignment is underground. The alignment is likely to cross drains and number of utility services, viz. water mains, sewer, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. It is essential to maintain these utilities/ services in working condition during the construction stage by temporary/permanent diversions or by supporting in position. In addition, cross drainage works such as bridges, culverts etc. may be required. Since these affect construction and project implementation time schedule / costs for which necessary planning / action shall be accounted for well in advance. The details on affected utilities are available in DPR. The drainage system along the route alignment may not be adequate to cater to construction run off. Hence as a precautionary measure during construction, care shall be taken by the contractors to ensure that the construction debris and silt do not move into the existing drains leading to its blockade.

Mitigation

Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of PRT alignment, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.
- Since the alignment is underground, the utilities came across on the alignment will be shifted in advance by organizations responsible for 394 utilities and services.

10.21 SOCIO-ECONOMIC IMPACT ON PAPS

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/ people and to examine the impacts of the proposed PRT alignment on their conditions. There can be two types of impacts on the PAPs.

One is the displacement of residential house and another is displacement of commercial establishments. It was found that no private structure or any family was affected at the proposed station areas.

10.22 IMPACTS DUE TO PROJECT DESIGN

Considered impacts, due to project designs are:

- Lighting,
- Risk Due to Earthquake.

10.22.1 Lighting

The platforms, concourse, staircase and escalator areas both for underground and elevated stations will be provided adequate and uniform LED lighting to provide pleasant and cheerful environment. Maximum illumination level proposed is 200Lux which provides normal lighting.

10.22.2 Risk Due to Earthquake

The project area falls under seismic zone IV as per the Seismic Zoning Map of India (IS 1893, Part-I, 2002). Necessary seismic factors suggested by Indian Meteorology Department (IMD) and Bureau of Indian Standards shall be incorporated suitably while designing the structures to safeguard against earthquake risks as per Bureau of Indian Standards specification.

10.23 IMPACTS DUE TO PROJECT CONSTRUCTION

Although environmental hazards related to construction works are mostly of temporary nature, it does not mean that these should not be considered. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are:

- Pollution and health risk at construction site,
- Traffic diversion and risk of existing building,
- Excavated soil disposal problems,
- Impact on Air Quality and Dust Generation,
- Increased water demand and Dewatering,
- Waste Water and Sewage
- Impact due to Supply of Construction Material,
- Disposal of Construction and Demolition Waste,

- Impacts due to batching plant and casting yard,
- Noise Pollution.
- Vibrations
- Subsidence
- Ecology
- Hazardous Wastes
- Socioeconomic impacts
- Loss of Archeological Monuments

10.23.1 Pollution and Health Risk at Construction Site

The construction activity will involve clearing of the site. An effort shall be made to minimize alteration of topography by avoiding unnecessary cuttings and excavations. The terrain is almost flat. Every care has to be taken to avoid damage to the topsoil. It has to be preserved and utilized.

Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc. causing pollution. However, it is proposed to have ready mix concrete (RMC) directly from batching plant for use at site. It would reduce the pollution at construction site.

Health risks include disease hazards due to lack of sanitation facilities in labour camps (water supply and human waste disposal) and insect vector disease hazards of local workers and disease hazards to the local population. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities. In addition to these, efforts need to be made to avoid water spills, adopt disease control measures. These risks could be reduced by providing adequate facilities in worker's camps, raising awareness amongst workers and follow the procedures prescribed for prevention of Covid-19 Pandemic. Problems could also arise due to difference in customs of workers from outside and local residents.

Mitigation Measures

Employment of local labour shall be preferred. The Contractor during the progress of work will provide, erect and maintain the necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the DMRC. All temporary accommodation must be constructed and maintained in such a fashion that hygienic, hospitable and safe conditions obtain. Uncontaminated water shall be made available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps.

Adequate washing and bathing places shall be provided and kept in clean and drained condition. Construction camps are the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force.

Sanitation Facilities: Construction sites and camps shall be provided with sanitary latrines and urinals/bio toilets. Sewerage drains should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner

Shelter at Workplace: At every workplace, shelter shall be provided separately for use of men and women labourers. Sheds shall be maintained in proper hygienic conditions.

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances shall be provided. Suitable transport shall be provided to facilitate taking injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 25 or more women are ordinarily employed, at least a hut shall be provided for use of children under the age of 6 years belonging to such women. Huts shall be provided with suitable and sufficient openings for light and ventilation. Size of crèches shall vary according to the number of women workers employed.

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defence against accidents and injuries. Contractor shall understand and accept that improper environmental sanitation is the primary hazard in any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor and at all times at Work Sites, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. The contractor shall employ a special group of environmental sanitation personnel to carry out following activities:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to

prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Employer. These shall be maintained in one line and level.

- The structure dimension of the barricade, material and composition, its colour scheme, UKMRC logo and other details shall be as per UKMRC directions.
- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exit fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.
- All surplus earth and debris shall be removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.
- Water logging on roads shall not be allowed.
- Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
- Flammable chemicals/ compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.

10.23.2 Traffic Diversions and Risk to Existing Buildings

Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during PRT construction of various corridors. Any reduction of road space during PRT construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow up to the construction time; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. Only temporary diversion plans will be required during construction of the PRT corridors. At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities. Total blockage of traffic along the section will be done wherever reasonably good alternate road is available. Keeping in view of future traffic growth and reduction of carriageway due to PRT construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement.

Mitigation Measures

Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during PRT construction of the corridor. During construction, adequate road width will be ensured for smooth flow of the road traffic and to avoid any congestion. The implementation of proposed corridor will ease the traffic congestion and reduce the traffic accidents as number of road vehicles will be reduced on the road. Any reduction of road space during PRT construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads etc. Maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period.

Various construction technologies are in place to ensure that traffic impedance is done at the minimum. They are:

- Only temporary diversion plans will be required during construction of the proposed PRT corridor.
- At the onset, all encroachments from road ROW will have to be removed. These encroachments vary from 'on-street' parking to informal activities.
- Keeping in view the future traffic growth and reduction of carriageway due to PRT construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution stage.

Traffic Management Guidelines: The basic objective of the following guidelines is to lay down procedures to be adopted by contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of station works are on the right-of-way. The conspicuity of workmen at all

times shall be increased so as to protect from speeding vehicular traffic.

- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

10.23.3 Impact on Topsoil

The soil all along the alignment is sandy-clay. The topsoil removed during the excavation will be stacked separately and will be used during the greenbelt development. The available vegetation and topsoil will be removed prior to commencement of earthwork. The construction activities will result in loss of topsoil to some extent in the area. Apart from localized constructional impacts no significant adverse impact on the soil in the surrounding area is anticipated.

Mitigation Measures

Prior to the start of the relevant construction, the Contractor shall submit his schedules for carrying out temporary and permanent erosion/ sedimentation control works. Top soil shall be stacked separately to be used subsequently for the purpose of plantation and greenery development. He shall also submit for approval his proposed method of erosion/sedimentation control on service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the project authority.

It shall be ensured that no toxic substance shall be used at construction site. Periodic investigation of heavy metals shall be done. The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other watercourses. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Top soil shall be preserved by the contractor and stacked separately at designated place and utilize it to cover the refilled area and to support vegetation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures. Contractor will

have to develop construction drainages for appropriate disposal; monitor the construction drains, minimize alteration of topography, install temporary grit chambers to curb turbidity and adjust temporary pier installations to minimize alterations of topography at water flowing locations. Measures will have to be taken for vegetation protection on slope faces, to cover the temporary stacks of sand and excavated earth with tarpaulin to restrict muddy water from flowing during rains

Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage or associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the project authority. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the project authority, and these shall be carried out at the Contractor's own expense. UKMRC would explore the users who need the excavated earth for their inhouse use like filling low lying areas etc. for disposal purpose.

10.23.4 Problems of Excavated Earth

Huge quantity of earthwork would be excavated for which a large number of excavators and dumper trucks would be required to excavate and transport the soil to earmarked areas of disposal. Alternatively, users of excavated earth may also be explored in the city. Where ever the Tunneling is planned this can lead to run off from unprotected excavated areas and can result in soil erosion, especially in the areas where the soil is prone to erodibility. There will be generation of muck.

Mitigation Measures

Excavated earth will be stacked properly at a maximum slope of 450. Adequate measures will be taken to prevent slope failures or landslides during execution. The soil would be used for refilling and residual soil would be utilized by Project Authority for internal use for refilling low-lying areas/ sites and, if surplus, it would be disposed off at designated locations as per Development Authority directions.

This will have to be disposed off at the designated sites allotted by local Authorities. The topsoil shall also be disturbed during the construction stage due to excavation and movement of vehicles and equipment. Exposure of loose soil to rain water can increase turbidity in the run-off for a very short duration; however, this impact is limited to the excavated surfaces during the rainy season for which care will be taken to channelize the water.

10.23.5 Impact on Air Quality and Dust Generation

Impact of construction activity on air quality is a cause for concern mainly in the dry months due to settling of dust particles. The main sources of emission during the construction period are the movement of equipment at site and dust emitted during the leveling, grading, earthworks, foundation works, and other construction related activities. The dust emitted during the above-mentioned activities depends upon the type of soil being excavated and the ambient humidity levels. The impact is likely to be for short duration and confined locally to the construction site itself. The composition of dust in this kind of operation is however mostly coarse particles, inorganic and non-toxic in nature. These are not expected to travel long distance before settling. Exhaust emissions from vehicles and equipment deployed during the construction phase also result in marginal increase in the levels of SO2, NOx, Particulates, CO and unburnt hydrocarbons. It may, therefore, be concluded that construction activities may cause changes in the particulate matter levels as well as gaseous pollutants in the vicinity of the station area. The impact will be confined within the project boundary and is expected to be negligible outside the project boundaries. Proper upkeep and maintenance of machinery and vehicles, sprinkling of water at construction site, providing sufficient vegetation etc. are some of the proposed measures that would greatly reduce the impact on the air quality during the construction phase of the project. The impact will, therefore be reversible, marginal, and temporary in nature. Measures to control air pollution and dust are given in the EMP.

Mitigation Measures

During the construction period, the impact on air quality will be mainly due to increase in PM10 along haul roads and emission from vehicles and construction machinery. Though the estimation of air quality during construction shows some impact on ambient air quality, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimise fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimize or control of air pollution. He shall maintain evidence of such design and equipment and make these available for inspection by Employer.
- Contractor’s transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within

permissible norms.

- The Contractor shall cover loads of dust generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards.
- The temporary dumping areas shall be maintained by the Contractor at all times until excavate is re-utilized for backfilling or as directed by Employer. Dust control activities shall continue even during any work stoppage.
- The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

Wheel Washing:

- The Contractor shall provide wet automated wheel washing facility with two stage sedimentation tank at the exit of Batching Plant, Casting Yard, and Underground stations. At other locations where there are space restrictions, the contractor shall adopt dry wheel cleaning mechanism with prior approval from employer.
- Wheel washing facility shall be provided with efficient drainage, incorporating silt traps to prevent any excessive build-up of water. These facilities should include water re-circulation mechanism to minimize water consumption.

Betonwash:

The Contractor shall provide Beton Wash facility (concrete recycling/wash plant) of suitable capacity at casting yard and/ or batching plant to reclaim slurry water and aggregate from transit mixer wash out. The contractor shall ensure the facility remains functional till the end of contract. The washing facility shall be provided with two stage sedimentation pit and efficient drainage system. The water from the final chamber of sedimentation tank shall be reused. The use of slurry water in concrete batching can be explored.

Mist Based Sprinkling System:

- The Contractor shall use nozzle-based mist system at construction sites such as underground station, launching shaft, depot, retrieval shaft, batching plant & casting yard as required to suppress dust.
- Nozzle based mist system shall also be used during the delivery and handling of sand and aggregate and other similar materials, when dust is likely to be generated.

Other Mitigation Measures

- Minimize idling of construction equipment
- Avoid altering the topography
- Cleaning and rinsing of the job sites
- Staggering of construction activities to avoid concentration
- Training and guidance of workers

10.23.6 Increased Water Demand and Dewatering

During the construction phase, water will be required for construction purposes (for concrete batching and curing) and dust suppression. The construction water shall be sourced from treated STP water. In addition to this, water will also be required for meeting domestic water requirement of work force including drinking water. The domestic water may be sourced from Nagar Nigam or purpose-built tube wells with due permission from CGWA. The water requirement during construction phase would be temporary and widely variable in nature. Possibility of availability of water, other than groundwater may also be explored for the construction phase.

Mitigation Measures

The public health facilities, such as water supply, sanitation and toilets are much needed at the labour camp. Water should be treated before use up to national drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The water carried sewerage solves the excreta disposal problems. The sewerage disposal systems should be adopted for sewage disposal. The water for domestic consumption shall be sourced from public water supply or alternatively designated borewells may be installed with due permission from statutory authority prior to installation of borewell.

The construction water shall be sourced from Municipal Authorities and other agencies responsible for sewage treatment and disposal in Haridwar. Alternatively, contractor shall arrange tie up for surface water supply or tanker water supply for construction activity.

10.23.7 Waste Water and Sewage

Impact on water quality during construction phase may be due to sewage generated from the construction work force stationed at the site. Temporary sanitation facilities like Bio-toilets will be set up for disposal of sanitary sewage generated by the work force as per the prevailing labour laws. Since, most of the construction work force will constitute of floating population, the demand of water and sanitation facilities will be very less and shall be managed by providing drinking water and sanitation facilities at the site during construction phase. Therefore, the overall impact on water quality during construction phase of proposed expansion project is likely to be short term and insignificant and reversible.

Mitigation Measures

Soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will not cause any water quality degradation in downstream water areas since there are no downstream water areas. All waste water shall be disposed off after treatment meeting out prescribed standards.

Waste water from stations will be domestic sewage only and the same will be disposed off through public sewers. Wastewater will be re-used for horticulture or other purpose as much as possible. No possibility is visualized that the effluents will cause noncompliance with the country's ambient water quality standards. Domestic Waste generated from project facility will be collected and disposed by Municipal Corporation.

Bio toilets:

The contractor shall provide bio toilets at every construction site. The general specification of bio-toilets is listed below:

- Single Cabin FRP Structure with water tank and bio-digester
- The cabin shall be made of FRP material
- Bio-Digester tank of required capacity (Bio Digester Tank will be minimum 5 mm thick FRP material)
- Very easy to install at site

10.23.8 Impact due to Supply of Construction Material

PRT construction is a material intensive activity. Huge quantity of different It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. Environmentally friendly

materials shall be preferred during construction.

It shall be ensured by contractors that source mine/ quarry shall be a legally registered mining lease having environmental clearance as per law. The materials shall be sourced from nearest mines to minimize the global warming impacts. Primarily GHG emission reduction on account of modal shift from the project is being calculated. However, GHG emission reduction on account of energy efficiency in newer PRT stations has also been attempted.

Mitigation Measures

The major construction materials to be used for construction of the proposed corridor are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor.

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste.

10.23.9 Generation of Construction and Demolition Waste

Construction and demolition (C&D) debris is defined as that part of the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste includes concrete, stones and dirt generated during excavation (sometimes collectively referred to as "fill material" or rubble). C& D Waste may also be generated from Pile caps, residual cement bags, residual steel scrap, excess construction material stacked at site etc.

Mitigation Measures

Waste prevention, reuse and recycling can not only save money, but also generate broad environmental benefits, including the conservation of natural resources. Reuse and waste prevention reduce the air and water pollution associated with materials manufacturing and transportation. This saves energy and reduces greenhouse gas production. The recycling of many materials requires less energy than production from virgin stock, and can also reduce transportation requirements and associated impacts. Opportunities for reducing C&D waste focus on three approaches, typically expressed as Reduce-Reuse-Recycle. Inert waste such as cured mortar, bricks, tiles, waste concrete, and mortar, left over aggregate and debris etc. generated during the construction phase shall be recycled and reused to the maximum extent possible.

An effort shall be made to recover embedded energy and to recycle the maximum quantity of C & D Waste to manufacture tiles, curb stones, paver block etc. The contractor shall store C&D waste separately at the site covered with tarpaulin and shall be used for low lying areas for land filling. An effort shall be there to reuse the maximum quantity of C & D waste on site itself. The earth-soil generated from construction works will be given to other agencies for land filling purposes. It is proposed to utilize the C&D waste at construction site. The waste shall be utilized in development of low-lying areas. C& D Waste Board shall be displayed on site as part of C & D waste management. The C & D waste shall be sent to C & D waste processing facility.

10.23.10 Impacts due to Casting Yard and Batching Plant

Batching plant and casting yards are required for casting of girders and segments to be used in construction of PRT corridor. During construction phase there would be establishment and operation of Batching Plant and Casting Yard which would be located in an area designated and allotted by Local Development Authorities. Number of batching plant and casting yards is anticipated to be one. There would be significant movement of men, material and machinery in batching plant and casting yard. Major water requirement of water will be at Batching plant and casting yard. It is expected that both batching and casting yard would be located at same complex. Huge quantity of Cement, aggregates and other construction materials would be used in each batching plant and casting yard. There would be generation of dust, noise, flue gases and other contaminants from the working of heavy machinery for handling and transporting the construction materials.

Mitigation Measures

There would be requirement to get NOC (Consent to establish) and Consent to operate under Water and Air Acts from State Pollution Control Committee so consent will be taken from Uttarakhand Pollution Control Board. Simultaneously, the authorization for storage and handling of hazardous chemicals to store and handle used oils and other such materials will also be sought from Uttarakhand Pollution Control Board and all the conditions would be complied with. All the mitigation measures for management of air pollution, waste- water, noise as well as movement of men and materials would be adopted in batching plant and casting yard.

10.23.11 Noise Pollution

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material to the construction site and the noise generating activity at the construction site itself. Heavy construction traffic for loading and unloading, fabrication and handling of equipment and construction materials are likely to cause an increase in the ambient noise levels. The areas affected are those close to the site. At the peak of the construction, marginal increase in noise levels is expected to occur locally at the construction site. The peak noise levels from continuous construction activity may be about 85-90 dB (A).

Mitigation Measures

The noise control measures during construction phase include provision of caps on the equipment and regular maintenance of the equipment. Workers would be provided with earmuffs and earplugs. Overall, the impact of noise generated on the environment is likely to be insignificant, reversible and localized in nature and mainly confined to the daytime.

During construction the exposure of workers to high noise levels especially near the machinery need to be minimized. This could be achieved by:

- Job rotation
- Training and guidance to workers to reduce noise
- Automation
- Use of low noise/ vibration generating construction equipment
- Selection of construction equipment matching the scale of construction
- Adjustment of working hours of noisy equipment
- Adoption of low noise generating construction methods
- Routine inspection and timely maintenance of construction equipment
- Make plan for movement of construction vehicles within prescribed speed without honking and loading within capacity
- Instruction and guidance to workers to minimize noise
- Construction of permanent and temporary noise barriers
- Use electric instead of diesel-powered equipment
- Use hydraulic tools instead of pneumatic tools
- Acoustic enclosures should be provided for individual noise generating construction equipment like DG sets
- Scheduling and staggering truck loading, unloading and hauling operation
- Schedule and stagger work to avoid simultaneous activities which generate high noise levels
- Anti drumming floor and noise absorption material
- Low speed compressor, blower and air conditioner
- Mounting of under frame equipment on anti-vibration pad
- Smooth and gradual control of door

- Provision of sound absorbing material in the supply duct and return grill of air conditioner
- Timely proper maintenance of vehicles asper manufacturer schedule
- Consideration regarding operation plan of construction equipment
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes
- Sound proof compartments control rooms etc.

Special acoustic enclosures should be provided for individual noise generating equipment, wherever possible. Workers in sections where periodic adjustment of equipment/ machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. During construction, there may be high noise levels due to pile driving, use of compressors and drilling machinery. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers. The pile driving operation can produce noise levels up to 100 dB (A) at a distance of 25-m from site. Suitable noise barriers can reduce the noise levels to 70 dB (A) at a distance of 15m from the piles. A safety precaution as stipulated in IS: 5121:2014 'Safety Code for Piling and other Deep Foundation' need to be adopted. Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds.

The contractor shall follow the following procedures, viz. the adoption of environmentally friendly ventilation facilities, installation of silencers and vibration isolators, installation of bending portion to the ventilation duct and maintenance of performance of ventilation facilities by routine inspection.

10.23.12 Impact on Ecology

Ecological impact is the effect that something has on living beings, i.e., organisms, and their non-living environment. The project site is not located in the vicinity of any forest area, ecosensitive locations, any protected habitats etc. The project is located in the city area to provide facilities to the residents of the city. The initial construction works at the project site involves land clearance, cutting, filling and leveling. These activities result in loss of vegetation (Trees & shrubs) at the site of station area where construction will be done using cut and cover. The cut and cover area is having trees. Only those trees would be felled which are essential for construction activity. The project is likely to fell 244 trees on the alignment. The trees to be felled are common trees like Shisham, Pipal, Neem, Babool etc,

No disruption to migration routes, habitat fragmentation, traffic accident of wildlife and livestock is anticipated. Project activities are likely to affect the avifauna by disturbance to nesting of birds which can be minimized by planting compensatory trees in the vicinity of felled trees. The construction shall not require removal of herbaceous vegetation which generally leads to loosening of topsoil.

Mitigation Measures

Impacts would be primarily confined to the station site during initial periods of the construction phase and would be minimized through adoption of mitigative measures like paving and surface treatment, water sprinkling and appropriate plantation program. As mentioned earlier, only those trees would be felled which are essential for construction activity and compensatory plantation would be done appropriately. There is no major water body all along the proposed alignment and vicinity of the project. The wastewater generated in the labour colony will be treated and used in the green cover development.

10.23.13 Hazardous Wastes

Hazardous wastes are wastes with properties that make them dangerous or potentially harmful to human health or the environment. Hazardous wastes like spent oil is likely to be generated at sites. All construction machinery will utilize the fuel and lubricants and ultimately generate significant quantity of used oil and lubricants. At many times they also spill on the floor. At times other hazardous wastes are generated.

Mitigation Measures

The contractor shall identify the nature and quantity of hazardous wastes generated as a result of his activities and shall file a ‘Request for Authorization’ with Uttarakhand Pollution Control Board along with a map showing the location of storage area. Outside the storage area, the contractor shall place a ‘display board’, which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place. It shall be the responsibility of the contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors. The contractor shall approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the UKPCB.

10.23.14 Energy Wastage

The construction activities involve establishment of contractor’s office, use of pumps and construction machinery consuming a lot of energy which also involves wastage of energy.

Mitigation Measures

The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon UKMRC request.

Measures to conserve energy include but not limited to the following:

- Use of energy efficient motors and pumps,
- Use of energy efficient lighting, which uses energy efficient luminaries,
- Adequate and uniform illumination level at construction sites suitable for the task,
- Proper size and length of cables and wires to match the rating of equipment, and
- Use of energy efficient air conditioner.
- Installation of renewable energy at site. These include solar power. By doing so, it will reduce the energy demand on grid.

The contractor shall design site offices with maximum daylight and minimum heat gain. The rooms shall be well insulated to enhance the efficiency of air conditioners and the use of solar films on windows may be explored.

10.23.15 Socio-Economic Impacts

Socio-economically this project would affect the society both positively as well as negatively. It would facilitate the people to get connected to the industrial and commercial hubs both existing as well as forthcoming. It would provide direct and indirect connectivity to various existing corridors of PRT. Simultaneously it is not affecting any private property. Airport police station and abandoned Air India buildings are getting affected. Inter departmental transfer of properties/ land will be required through departmental and Government procedures.

10.23.16 Loss of Historical and Cultural Monuments

No historical/ cultural monuments will be lost as a result of the proposed development. As per the provisions of Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 construction activities around the centrally protected monuments and sites are regulated as Prohibited area (Section 20A) up to 100m from boundary in all directions and Regulated Area up to 300 m (Section 20B).

10.24 IMPACTS DUE TO PROJECT OPERATION

Along with many positive impacts, the project may cause the following negative impacts during operation of the project

- Noise pollution
- Vibrations
- Pedestrianization and visual issues

10.24.1 Noise Pollution

The main sources of noise are traction motors, cooling fans, wheel-rail interaction, electric generator and miscellaneous noise from rolling stock. Because of the PRT there is reduction of vehicular traffic, the road traffic noise is expected to come down. It could be concluded that noise in the operation phase of the project would have minor or no negative impact. Thus, there is no requirement of any specific Noise abatement measures during operations for this corridor.

10.24.2 Water Supply and Sanitation

Public facilities such as water supply, sanitation and washrooms are very much needed at the station. The water requirement for stations would be for drinking, toilets, cleaning and also for other purpose like AC. Water shall also be required for firefighting. The water demand for one station works out to be about 100 kld.

Mitigation Measures

The water requirement for the station will be met through the public water supply system or purpose built tube-wells after taking necessary approvals from Uttarakhand Jal Sansthan. Practically, public facilities at stations have to be operated by regular staff or may be designated to any NGO working in the area in the field of sanitation as per policy of UKMRC. Requirement of drinking water supply at station shall be provided from Nagar Nigam.

10.24.3 Station Refuse

The collection and removal of refuse from stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from station includes garbage, rubbish, and floor sweepings. Food and paper waste are likely to be generated at stations, depot etc. during operations. It is expected that solid waste of about 0.8 – 1.2 cum/day will be generated at station. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authorities.

The paper wastes shall be recycled through authorized recyclers and the food wastes shall be treated through organic waste converter.

Mitigation Measures

Solid waste generated at stations shall be stacked at designated place and when sufficient quantity accumulates it shall be disposed off through covered trucks to land fill site designated and authorized by UKMRC. Solid waste shall be segregated as municipal and other wastes. Municipal wastes shall be segregated into dry and wet wastes. The maintenance of adequate

sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authority. The storage containers for this purpose need to be designed and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality. The paper wastes shall be recycled through authorized recyclers and the food wastes shall be treated through organic waste converter.

10.24.4 Impact due to Oil Spillage

During the operation of PRT, change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock can lead to Oil spillage leading to Oil Pollution.

Mitigation Measures

In order to curb oil pollution a grit chamber shall be constructed to trap the spilled oil for settling of suspended matter. The collected oil shall be properly stored in the impermeable container and auctioned to CPCB/Uttarakhand Pollution Control Board authorized recyclers, so as to avoid any ground water contamination.

10.25 E-WASTES

E-waste comprises discarded electronic appliances, of which computers and mobile telephones are disproportionately abundant because of their short lifespan. Other E waste contains tube lights, CGF, Timer capacitors, contactors, Relay, Detectors, Indicators, Float switch/ sockets, plastic items, electronic ballasts, addressable detectors, LCE boards/ V3F Drives, Computer servers, monitors, mouse, tvs' hard disks etc. E-waste contains valuable metals (Cu, platinum group) as well as potential environmental contaminants, especially Pb, Sb, Hg, Cd, Ni, polybrominated diphenyl ethers (PBDEs), and polychlorinated biphenyls. Burning E-waste may generate dioxins, furans, polycyclic aromatic hydrocarbons (PAHs), polyhalogenated aromatic hydrocarbons (PHAHs), and hydrogen chloride. The chemical composition of E-waste changes with the development of new technologies and pressure from environmental organizations on electronics companies to find alternatives to environmentally damaging materials'-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste

Mitigation Measures

E-waste generated from the operation and maintenance activities shall be disposed through authorized e-waste recyclers/collectors.

10.26 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of PRT system. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. Additionally, there may be possibility of flooding in project during underground construction activities and Fire outbreaks during construction and Operation and Maintenance. Mitigation plans will be required before start of construction.

10.26.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should identify sources of repair equipment, materials, labour and expertise for use during emergency.

10.26.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

10.26.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and fool proof communication system.

10.26.4 Emergency Measures

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

10.26.5 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power as per electricity Rules, at least 25% of the lights at the station, platforms for a period of 2 hours.

10.26.6 Fire Protection

The building materials should be of appropriate fire resistance standard. The fire resistance

period should be at least 2 hours for surface or overhead structures as per fire rules. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures
- Fire control measures
- Fire detection systems
- Means of escape
- Access for fireman
- Means of firefighting

(A) Fire Prevention

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provided,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Prohibition of smoking in fire prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.

(B) Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Uttarakhand Fire Services shall be provided through out station and ancillary buildings including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g., detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided and installed in the station controllers room, for the control, indication and monitoring of the whole detection and firefighting systems. While designing the firefighting system, Uttarakhand Fire& Emergency Services shall be taken into account for linking with the same.

10.27 CHECKLIST OF IMPACTS

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation of the review of multiple environmental objectives into a single value or a ranking or projects is the final step in impact assessment. There are many methods for carrying out impact assessment, which can be grouped into the following categories:

- Ad-hoc method
- Checklist
- Matrix
- Network
- Overlays
- Environmental Index
- Cost Benefit analysis

Each of the methods is subjective in nature and none of these is applicable in every case of the 7 methods listed above, checklist has been used and presented. Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A typical checklist identifying anticipated environmental impacts is shown in **Table 10.13**.

Table 10-13: Checklist of Impacts

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
A.	**Impacts due to Project Location**			
i.	Displacement of People		*	
ii.	Change of Land use and Ecology	*		

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
iii.	Loss of Cultural and Religious Structures		*	
iv.	Socio-economic Impacts			*
v.	Loss of Trees	*		
vi.	Drainage & Utilities Problems	*		
vii.	Impact on Physiography and Topography		*	
B.	**Impact due to Project Design**			
i.	Platforms - Inlets and Outlets		*	
ii.	Ventilation and Lighting		*	
iii.	Station Refuse	*		
iv.	Risk due to Earthquakes		*	
C.	**Impact due to Project Construction**			
i.	Top Soil Erosion, Pollution and Health risk	*		
ii.	Traffic Diversions	*		
iii.	Risk to Existing Buildings	*		
iv.	Problems of Soil Disposal and Seepage Risk	*		
v.	Dust Generation	*		
vi.	Increased Water Demand	*		
vii.	Supply of Construction Material	*		
viii.	Construction and Demolition Waste	*		
ix.	Batching Plant and Casting Yard	*		
x.	Noise	*		
D.	**Impact due to Project Operation**			
i.	Oil Pollution	*		
ii.	Noise	*		
iii.	Water supply and sanitation	*		
iv.	Pedestrian Issues		*	
v.	Visual Impacts		*	
vi.	Station Illumination		*	
vii.	Employment Opportunities			*
viii.	Enhancement of Economy			*
ix.	Mobility			*
x.	Safety			*
xi.	Traffic Congestion Reduction			*
xii.	Less fuel Consumption			*
xiii.	Less Air Pollution			*
xiv.	Carbon dioxide Reduction			*
xv.	Reduction in Buses			*
xvi.	Reduction in Infrastructure			*

10.28 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the PRT alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day-to-day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 10.14**, which defines actions to be undertaken during the design stage, pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practice good environmental sanitation (housekeeping) may intend to get unauthorized use of the easily available natural resources and other available infrastructure like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and worker's camp. Improper management of earthwork and similar activities would disrupt the natural drainage and increase soil erosion. Finally, the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract. Additionally, project authority should prepare and establish Environmental and Health Policy and Procedures as per earlier Phases and that should become an integral part of contract document. Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at PRT establishments including effective solid waste collection and disposal, wastewater disposal, upbringing of plantations and green area. Protection of earth slopes in earth stacks area would be a very important task. During the operation period, the PRT operating unit will be required to confirm receipt of the construction period mitigation report through the UKMRC and prepare a follow-on timetable of actions.

Table 10-14: ENVIRONMENTAL MANAGEMENT ACTION PLAN (EMP)

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
DESIGN PHASE				
PRT Alignment	The proposed corridor alignment was selected to minimise the land disturbance to avoid environmentally sensitive areas.	During Design	DPR	DMRC
Flood	Bridges shall be well designed. Adequate pumping facilities for underground working.	During Design	DPR and Design consultant	UKMRC
Inadequate design	Make sure that design provides for safety of structures against worst	DPR and detailed	DPR and design consultant	UKMRC

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
provision for safety against seismological hazard	combination of forces in the probability of an earthquake likely to occur in seismic zone-IV.	design stage		
PRE –CONSTRUCTION STAGE				
Water requirement	The requirement of water for construction purpose etc shall be planned and shall be arranged from available and authorized sources in order to avoid digging of Tube wells.	Pre construction stage	Contractor	UKMRC/ EMP implementing agency
Disposal of final treated effluent from treatment plant	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact on receiving bodies. As far as possible zero discharge rules may be adopted.	During design stage / and pre construction of treatment plant	Contractor	UKMRC/ EMP implementing agency
Batching Plant and Casting Yard	These facilities to be located away from habitation. Consent to Establish and Consent to Operate to be taken from UTTARAKHANDPOLLUTION CONTROL BOARD and to comply with all stipulations.	During Pre-construction Stage	Contractor	UKMRC/ EMP implementing agency
CONSTRUCTION PHASE				
Environmental Management and Monitoring	This will include institutional requirements, training, environmental management and monitoring	During and after construction	Contractor	UKMRC/ EMP implementing agency
Dust	Water should be sprayed during construction phase, wherever it is required to avoid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load. All dust suppression measures should be adopted	During construction	Contractor	UKMRC/ EMP implementing agency
Air Pollution	Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards. No vehicle without valid PUC certificate would be allowed at Construction Sites. All air pollution control measures to be adopted.	Beginning with and continuing throughout construction period	Contractor	UKMRC/ EMP implementing agency
Equipment Selection maintenance and operation	Construction plants and equipment will meet acceptable standards for emissions and will be maintained and operated in a manner that ensures that relevant air, noise, and discharge regulations are met.	During construction	Contractor	UKMRC/ EMP implementing agency
Noise	Noise standard at processing sites, will be strictly enforced as per GOI noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure.	Beginning and through construction	Contractor	UKMRC/ EMP implementing agency

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in Environmental Manual	Beginning and through construction	Contractor	UKMRC/ EMP implementing agency
Water				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into any rivers, drainage and irrigation system	Throughout construction period	Contractor	UKMRC/ EMP implementing agency
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose.	Beginning with and continuing throughout construction	Contractor	UKMRC/ EMP implementing agency
Sewerage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 meters.	Throughout construction period	Contractor	UKMRC/ EMP implementing agency
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards. Garbage will be collected in a tank and disposed off daily. Special attention shall be paid to the sanitary condition of camps. Camps will be located at a minimum distance of 200 m from water sources.	Before and during building of construction camps	Contractor	UKMRC/ EMP implementing agency
Soil				
Quarrying	Quarrying will be carried out at approved and licensed quarries only. All environmental mitigation measures shall be enforced at Quarry site also.	During construction	Contractor	UKMRC/ EMP implementing agency
Flora and Fauna				
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory Afforestation Policy under the Forest Conservation Act. Ten trees will be planted against every tree felled as per norms.	During and after completion of construction activities	PMC	PMC/ UKMRC
Social				
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	Contractor	UKMRC/ Traffic department
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation	During construction	Contractor	UKMRC/ Traffic department

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
	and traffic police department			
Safety with vehicles, people, livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through internet, radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	UKMRC/ Traffic department
Increase in Water-borne& Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups, if any	During construction At start-up Throughout construction	Contractor	UKMRC/ EMP implementing agency
Location of camps, depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	UKMRC/ EMP implementing agency
OPERATION PHASE				
Energy	Use of energy efficient lighting, air conditioners, motors and pumps. Uniform illumination and installation and use of renewable energy. The rooms shall be insulated and closed for better efficiency of ACs	After completion of construction	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Hazardous Waste Management	Generated Hazardous wastes should be stored after authorization from UTTARAKHAND POLLUTION CONTROL BOARD and shall be disposed to Authorized recyclers periodically	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Noise and Vibration	Suitable measures should be adopted to reduce the noise and vibrations like proper maintenance, adoption of location and design of special track work, vehicle modifications, changes in the track support system, building modifications, adjustments to the vibration transmission path, and operational changes. The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
WATER				
Public Toilets	Toilets at station may be designated	Operations	Sulabh / UKMRC	Sulabh/

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
	to NGO like Sulabh as being done at other stations. Drinking water for station staff may be sourced from DJB			UKMRC
Wastewater	Effluent from stations will be domestic sewage only and the same will be disposed off through public sewers.	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Maintenance of Storm Water Drainage System	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Beginning and end of monsoon	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Rainwater Harvesting	The rainwater harvesting system developed by UKMRC shall be maintained regularly. The working efficiency of the system shall be assessed once in three years.	Beginning and end of monsoon	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Solid Waste	Solid waste shall be stacked at designated place and when sufficient quantity accumulates it shall be disposed off through covered trucks to land fill site designated and authorized by UKMRC The storage containers for this purpose need to be designed and these should be equipped with side handles to facilitate handling.	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Equipment Selection maintenance and operation	Construction plants and equipment will meet acceptable standards for emissions and will be maintained and operated in a manner that ensures that relevant air, noise, and discharge regulations are met.	During construction	Contractor	UKMRC/ EMP implementing agency
Noise	Noise standard at processing sites, will be strictly enforced as per GOI noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure.	Beginning and through construction	Contractor	UKMRC/ EMP implementing agency
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in Environmental Manual	Beginning and through construction	Contractor	UKMRC/ EMP implementing agency
Water				
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into any rivers, drainage and irrigation system	Throughout construction period	Contractor	UKMRC/ EMP implementing agency
Wastage of water	Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict	Beginning with and continuing throughout construction	Contractor	UKMRC/ EMP implementing agency

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
	procedures while using the water for construction and drinking purpose.			
Sewerage disposal during construction at Service Centres	A minimum distance of any sewage or toilet facility from water sources should be 200 meters.	Throughout construction period	Contractor	UKMRC/ EMP implementing agency
Sanitation and Waste Disposal in Construction Camps	Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. Drinking water will meet Indian National Standards. Garbage will be collected in a tank and disposed off daily. Special attention shall be paid to the sanitary condition of camps. Camps will be located at a minimum distance of 200 m from water sources.	Before and during building of construction camps	Contractor	UKMRC/ EMP implementing agency
Soil				
Quarrying	Quarrying will be carried out at approved and licensed quarries only. All environmental mitigation measures shall be enforced at Quarry site also.	During construction	Contractor	UKMRC/ EMP implementing agency
Flora and Fauna				
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory Afforestation Policy under the Forest Conservation Act. Ten trees will be planted against every tree felled as per norms.	During and after completion of construction activities	PMC	PMC/ UKMRC
Social				
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	Contractor	UKMRC/ Traffic department
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor	UKMRC/ Traffic department
Safety with vehicles, people, livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through internet, radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor	UKMRC/ Traffic department

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
Increase in Water-borne& Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups, if any	During construction At start-up Throughout construction	Contractor	UKMRC/ EMP implementing agency
Location of camps, depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor	UKMRC/ EMP implementing agency
OPERATION PHASE				
Energy	Use of energy efficient lighting, air conditioners, motors and pumps. Uniform illumination and installation and use of renewable energy. The rooms shall be insulated and closed for better efficiency of ACs	After completion of construction	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Hazardous Waste Management	Generated Hazardous wastes should be stored after authorization from UTTARAKHAND POLLUTION CONTROL BOARD and shall be disposed to Authorized recyclers periodically	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Noise and Vibration	Suitable measures should be adopted to reduce the noise and vibrations like proper maintenance, adoption of location and design of special track work, vehicle modifications, changes in the track support system, building modifications, adjustments to the vibration transmission path, and operational changes.The public shall be educated about the regulations of noise and vibration pollution and its implications.	After completion of construction	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
WATER				
Public Toilets	Toilets at station may be designated to NGO likeSulabh as being done at other stations. Drinking water for station staff may be sourced from DJB	Operations	Sulabh / UKMRC	Sulabh/ UKMRC
Wastewater	Effluent from stations will be domestic sewage only and the same will be disposed off through public sewers.	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Maintenance of Storm Water Drainage System	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	Beginning and end of monsoon	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency
Rainwater Harvesting	The rainwater harvesting system developed by UKMRC shall be	Beginning and end of	UKMRC/EMP implementing	UKMRC/ EMP implementing

Environmental Impact	Mitigation Measures Taken or to be Taken	Time Frame	Implementing Organization	Responsible Organization
	maintained regularly. The working efficiency of the system shall be assessed once in three years.	monsoon	agency	agency
Solid Waste	Solid waste shall be stacked at designated place and when sufficient quantity accumulates it shall be disposed off through covered trucks to land fill site designated and authorized by UKMRC The storage containers for this purpose need to be designed and these should be equipped with side handles to facilitate handling.	Operations	UKMRC/EMP implementing agency	UKMRC/ EMP implementing agency

10.29 ENVIRONMENTAL MONITORING PLAN

10.29.1 Construction Phase

During construction stage environmental monitoring will be carried out for air quality, noise levels and water quality. The number could be modified based on need when the construction actually commences. The monitoring Schedule for Water Air, noise and ecology are presented in Table 10.15 below:

Table 10-15: Construction Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM_{2.5}$	2×24hours Twice/month During entire civil construction stage or even later, if directed by UKMRC	21 location (at station)
Water	Ground-water quality (IS 10500:2012)	Once a months During entire civil construction stage	7 location
Noise	Noise Level (Leq and Lmax)	24hours Once/ Month During entire civil construction stage or even later, if directed by UKMRC	21 location

10.29.2 Operation Phase

Even though the environmental hazards during the operation phase of the project are minimal, the environmental monitoring will be carried out for air, noise, water, waste water, solid waste and ecology during operation phase of the project. The parameters monitored during operation will be PM 2.5 and PM10 for air, pH, TSS, BOD, COD, oil and grease for waste water. However water quality parameters that will be monitored will be as per BIS 10500:2012. The monitoring program shall be conducted by an external agency under the supervision of UKMRC officials. The UKMRC will be responsible for successful environmental monitoring of the proposed project during operation phase in **Table 10.16** below.

Table 10-16: Operation Stage Monitoring Schedule

Item	Parameter	Frequency and Duration	Locations
Air	PM_{10}, $PM_{2.5}$	24 hours twice a year for 1.5 years	10 location
Noise	Noise Level (Leq)	24 hours Twice a year for 1.5 years	10 location

The results of Air quality, water quality, noise and vibrations will be submitted to management quarterly during construction phase and as per schedule during operation phase.

10.30 CONCLUSION

The proposed PRT Corridor is proved to have significant positive effects for the development of Haridwar. Benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, and air quality improvement are the obvious positive effects from these PRT corridors. Appropriate mitigation measures have been developed for consideration. The ESIA concludes that project impacts from both construction and operation will be minimal, and can be mitigated through the use of prevailing current practices and appropriate technologies. With the implementation of the EMP and the monitoring plan, the Project is not expected to have significant environmental impacts.

Chapter -11
Security Measures

11.1 Introduction

11.2 Necessity of Security

11.3 Three Pillars of Security

11.4 Phases of Security

11.5 Responsibilities and Partnerships

11.6 Safety Features

CHAPTER 11
SECURITY MEASURES

11.1 INTRODUCTION

The PRT is an effective form of transport, which will encourage existing car users to use safer public transport and significant benefits can be projected in terms of reduction of road injuries and fatalities. PRT also offers significant benefits in personal security. All trips are undertaken only with companions chosen by the traveller. During peak periods 90% of trips are available immediately on demand. Off peak, this figure rises to 100%, since vehicles can be assured to be available at all stations. Thus, the risks associated with waiting for public transport are almost eliminated. Moreover the high cost of infrastructure, its economic impotence, being the life line of city high news value, fear & panic and man casual ties poses greater threat to its security. Security is a relatively new challenge in the context of public transport. It addresses problems caused intentionally. Security differs from safety which addresses problems caused accidentally. Security problems or threats are caused by people whose actions aim to undermine or disturb the public transport system and/or to harm passengers or staff. These threats range from daily operational security problems such as disorder, vandalism and assault to the terrorist threat.

11.2 NECESSITY OF SECURITY

It is well known that public transportation is increasingly important for urban areas to prosper in the face of challenges such as reducing congestion and pollution. Therefore, security places an important role in helping public transport system to become the mode of choice. Therefore, excellence in security is a prerequisite for the system for increasing its market share. Uttarakhand Government/ Administration must ensure that security model must keep pace rapid expansion of the Transport System and changing security scenario.

11.3 THREE PILLARS OF SECURITY

Security means protection of physical Human and intellectual assets either from criminal interference, removal of destruction by terrorists or criminals or incidental to technological failures or natural hazardous events. There are three important pillars of security as mentioned under:

i. The human factor
ii. Procedures
iii. Technology

Staff engaging with the passengers creates a sense of re-assurance which cannot fully be achieved by technology. For human factor to be more effective staff has to be qualified, trained, well equipped and motivated. They should be trained, drilled and tested. The security risk assessment is the first step for understanding the needs and prioritizing resources. The organization of security should be clear and consistent. Security incidents, especially major ones, often happen without warning. Emergency and contingency plans must be developed communicated and drilled in advance.

There are number of technologies which can be used to enhance security e.g., surveillance systems. The objectives of the security systems are to differ i.e., making planning or execution of on attack too difficult, detect the planned evidence before it occurs deny the access after in plan of attack has been made and to mitigate i.e., lessen the impact severity as the attack by appropriate digits.

11.4 PHASES OF SECURITY

There are three phases of security as under:

i. **Prevention**: These are the measures which can prevent a security incidence from taking place. These can be identified by conducting a risk assessment and gathering intelligence. Prevention begins with the daily operational security -problems. Uncared for dirty, damaged property is a breeding ground for more serious crime.

ii. **Preparedness**: Plans must be prepared to respond to incidents, mitigate the impact. Staff accordingly carry out exercises. The results of the risk assessment give a basis for such plans.

iii. **Recovery**: Transport system must have laid down procedures/instructions for the quick recovery of normal service after an incident. Recovery is important for the financial health of the operation, but it also sends a clear message to public, it reassures passengers and gives them confidence to continue using the system. Communication is key to the quick restoration after such incidents. Restoration should also include an evaluation process for the lessons learnt.

11.5 RESPONSIBILITIES AND PARTNERSHIPS

Security is a sovereign function and hence is the responsibility of the state. Security in public requires clear governance. Responsibility should be clearly defined. In the present scenario, security is the responsibility of the Uttarakhand state govt. & decision regarding agency to be entrusted with the security would be required to be taken by State Govt. in consultation with State/ Central Intelligence Agencies. Additional precautions need to be taken during mela days.

11.6 SAFETY FEATURES

Safety has been an important consideration in the design and development of the PRT system from initial concept. The following list highlights some of the most important safety features that make PRT an inherently safe form of transport:

11.6.1 Infrastructure Safety Features

- One-way guideways: Eliminates the risk of head on vehicle collisions
- Guideway kerbs designed to contain vehicle: Minimizes risk of vehicle leaving guideway
- Segregated or elevated guideways: Minimizes risk of collisions between vehicles and other traffic or pedestrians
- Elevated guideway safety railing: Maintains safety for passengers in an emergency evacuation event and employees during construction and maintenance activities

11.6.2 Vehicle Safety Features

- Bumper structure designed to progressively absorb impact energy and limit passenger deceleration: prevents injuries to passengers in low-speed impacts
- Fail Safe Electromagnetic hold off brakes: will bring the vehicle safely to a halt in the event of a vehicle control system or power failure
- Door back off function: Stops doors closing if an obstruction is detected in the door to prevent injuries to passengers
- Smoke and Fire alarms: Informs Network Controllers of smoke or fire in the vehicle so that an appropriate emergency services response can be arranged if required.

11.6.3 Control Systems Safety Features

- Almost synchronous vehicle scheduling: Eliminates possibility of vehicles scheduled on conflicting paths.
- Continuous fault monitoring and automatic response: Detection of faults allows vehicles to be slowed, stopped or rerouted to prevent any potential collisions
- Independent Automatic Vehicle Protection System: Prevents vehicle collisions in the event of other control system or vehicle failures

11.6.4 Other Safety Features

- Berth doors in stations which only open when a vehicle is in the berth: Prevents passengers inadvertently entering the guideway
- Video surveillance of station areas, the guideway and inside each vehicle. Video surveillance with monitoring of the system is available at the control room and has round the

clock recording designed to contribute to passenger safety and security, and discourage vandalism on the system.

- Voice communication. Direct communication between the Controller and passengers, and between the Controller and all stations, will be designed to have direct benefits in both passenger reassurance and in prevention of potentially hazardous situations. The Controller will also be in direct communication with the emergency services.
- Uninterruptable power supplies to all critical system components: allowing the system to be brought to a safe state in the event of a power failure.

Chapter -12
Disaster Management Measures

12.1 Introduction

12.2 Need for Disaster Management Measures

12.3 Objectives

12.4 List of Serious Incidents Requiring Use of Provision of the Disaster Management Measures

12.5 Provisions under Disaster Management Act , 2005

12.6 Provisions at PRT Stations/ other Installations

12.7 Preparedness for Disaster Management

CHAPTER 12
DISASTER MANAGEMENT MEASURES

12.1 INTRODUCTION

Disaster is a crisis that results in massive damage to life and property, uproots the physical and psychological fabric of the affected communities and outstrips the capacity of the local community to cope with the situation. Disasters are those situations which cause acute distress to passengers, employees and outsiders and may even be caused by external factors. As per the disaster management act, 2005 "*disaster*" means "*a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area*". As per World Health Organisation (WHO):

"*Any occurrence that causes damage, economic disruption, loss of human life and deterioration of health and services on a scale sufficient to warrant an extra ordinary response from outside the affected community or area.*"

A disaster is a tragic event, be it natural or manmade, which brings sudden and immense agony to humanity and disrupts normal life. It causes large scale human suffering due to loss of life, loss of livelihood, damages to property and persons and also brings untold hardships. It may also cause destruction to infrastructure, buildings, communication channels essential services, etc.

12.2 NEED FOR DISASTER MANAGEMENT MEASURES

The effect of any disaster spread over in operational area of PRT System would deal with thousands of passengers daily in viaducts and stations. Disaster brings about sudden and immense misery to humanity and disrupts normal human life in its established social and economic patterns. It has the potential to cause large scale human suffering due to loss of life, loss of livelihood, damage to property, injury and hardship. It may also cause destruction or damage to infrastructure, buildings and communication channels of PRT System. Therefore, there is an urgent need to provide for an efficient disaster management plan.

12.3 OBJECTIVES

The main objectives of this Disaster Management Measures are as follows:

a) Save life and alleviate suffering.

b) Provide help to stranded passengers and arrange their prompt evacuation.

c) Instil a sense of security amongst all concerned by providing accurate information.

d) Protect PRT System property.

e) Expedite restoration of PRT operation.

f) Lay down the actions required to be taken by staff in the event of a disaster in PRT System in order to ensure handling of crisis situation in coordinated manner.

g) To ensure that all officials who are responsible to deal with the situation are thoroughly conversant with their duties and responsibilities in advance. It is important that these officials and workers are adequately trained in anticipation to avoid any kind of confusion and chaos at the time of the actual situation and to enable them to discharge their responsibilities with alertness and promptness.

12.4 LIST OF SERIOUS INCIDENTS REQUIRING USE OF PROVISIONS OF THE DISASTER MANAGEMENT MEASURES

PRT specific disasters can be classified into two broad categories e.g.: Man-made and Natural.

(A) Man Made Disaster

1. Terrorist attack
2. Bomb threat/ Bomb blast
3. Hostage
4. Release of Chemical or biological gas in POD cars or stations
5. Fire in PRT System buildings, underground/elevated infrastructures, power stations, depots etc.
6. PRT Vehicle accident and PRT Vehicle collision/derailment of a passenger carrying PRT Vehicle
7. Sabotage
8. Stampede

(B) Natural Disaster

1. Earthquakes
2. Floods
3. Storm

12.5 PROVISIONS UNDER DISASTER MANAGEMENT ACT, 2005

(A) The National Disaster Management Authority (NDMA)

Establishment of National Disaster Management Authority: -

1. With effect from such date as the Central Government may, by notification in the Official Gazette appoint in this behalf, there shall be established for the purposes of this Act(The Disaster Management Act, 2005),an authority to be known as the National Disaster Management Authority.
2. The National Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the Central Government and, unless the rules otherwise provide, the National Authority shall consist of the following:

a) The Prime Minister of India, who shall be the Chairperson of the National Authority, ex officio;

b) Other members, not exceeding nine, to be nominated by the Chairperson of the National Authority.

3. The Chairperson of the National Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the National Authority.
4. The term of office and conditions of service of members of the National Authority shall be such as may be prescribed.

(B) State Disaster Management Authority:

Establishment of State Disaster Management Authority: -

1. Every State Government shall, as soon as may be after the issue of the notification under sub-section (1) of section 3, by notification in the Official Gazette, establish a State Disaster Management Authority for the State with such name as may be specified in the notification of the State Government.
2. A State Authority shall consist of the Chairperson and such number of other members, not exceeding nine, as may be prescribed by the State Government and, unless the rules otherwise provide, the State Authority shall consist of the following members, namely:

a) The Chief Minister of the State, who shall be Chairperson, ex officio;

b) Other members, not exceeding eight, to be nominated by the Chairperson of the State Authority;

c) The Chairperson of the State Executive Committee, ex officio.

3. The Chairperson of the State Authority may designate one of the members nominated under clause (b) of sub-section (2) to be the Vice- Chairperson of the State Authority.
4. The Chairperson of the State Executive Committee shall be the Chief Executive Officer of

the State Authority, ex officio: Provided that in the case of a Union territory having Legislative Assembly, except the Union territory of Delhi, the Chief Minister shall be the Chairperson of the Authority established under this section and in case of other Union territories, the Lieutenant Governor or the Administrator shall be the Chairperson of that Authority: Provided further that the Lieutenant Governor of the Union territory of Delhi shall be the Chairperson and the Chief Minister thereof shall be the Vice-Chairperson of the State Authority.

5. The term of office and conditions of service of members of the State Authority shall be such as may be prescribed.

(C) Command & Control at the National, State & District Level

The mechanism to deal with natural as well as manmade crisis already exists and that it has a four tier structure as stated below: -

1. National Crisis Management Committee (NCMC) under the chairmanship of Cabinet Secretary
2. Crisis Management Group (CMG) under the chairmanship of Union Home Secretary.
3. State Level Committee under the chairmanship of Chief Secretary.
4. District Level Committee under the Chairmanship of District Magistrate.
5. All agencies of the Government at the National, State and district levels will function in accordance with the guidelines and directions given by these committees.

(D) Plans by Different Authorities at District Level and their Implementation

Every office of the Government of India and of the State Government at the district level and the local authorities shall, subject to the supervision of the District Authority:

1. Prepare a disaster management plan setting out the following, namely:

a) Provisions for prevention and mitigation measures as provided for in the District Plan and as is assigned to the department or agency concerned;

b) Provisions for taking measures relating to capacity-building and preparedness as laid down in the District Plan;

c) The response plans and procedures, in the event of, any threatening disaster situation or disaster;

2. Coordinate the preparation and the implementation of its plan with those of the other organizations at the district level including local authority, communities and other stakeholders;
3. Regularly review and update the plan; and
4. Submit a copy of its disaster management plan and of any amendment thereto, to the District Authority

12.6 PROVISIONS AT PRT STATIONS/ OTHER INSTALLATIONS

To prevent emergency situations and to handle effectively in case 'one arises' there needs to be following provisions for an effective system which can timely detect the threats and help suppress the same.

a) Fire Detection and Suppression System

b) Smoke Management

c) Station Power Supply System

d) DG Sets & UPS

e) Lighting System

f) Station Area Lights

g) Water Supply and Drainage System

h) Sewage System

i) Station Evacuation System

j) Any Other System Deemed Necessary

The above list is suggestive not exhaustive actual provisioning has to be done based on site conditions and other external and internal factors.

12.7 PREPAREDNESS FOR DISASTER MANAGEMENT

Being a technological complex system worked by new set of staff, with a learning curve to improve and stabilize with time, intensive mock drills for the staff concerned is very essential to train them to become fully conversant with the action required to be taken while handling emergencies. They also need to be trained in appropriate communication skills while addressing passengers during incident management to assure them about their well-being seeking their cooperation.

Since learning can only be perfected by 'doing', the following Mock Drills are considered essential:

a) Fire Drill

b) Rescue of a disabled POD car

c) Passenger evacuation from station

d) Drill for rescue & relief of POD car

e) Rescue of passengers between stations

f) Hot line telephone communication with state disaster management authority

Chapter -13
Multi Model Traffic Integration at PRT Stations

13.1 Background

13.2 Public Transport System in Haridwar

13.3 Planning for Integration of Public Transport Modes

13.4 Way Forward

CHAPTER 13
MULTI MODAL TRAFFIC INTEGRATION AT PRT STATIONS

13.1 BACKGROUND

The proposed PRT in Haridwar City has four corridors totaling approx. 20.74 km, consisting of 21 stations. Its four corridors cover many important origins and destinations. However, its reach will not be enough to reach all origins and destinations in the city. Fortunately, these corridors are planned for a multi-modal system, where the proposed PRT will be complemented by the Railway Station, Bus Station and Metrolite which are currently under implementation and feeder services to be deployed by Uttarakhand Government. The need is now to ensure that people have safe, comfortable and secure access to the above modes as well as seamless integration facilities.

13.2 PUBLIC TRANSPORT SYSTEM IN HARIDWAR

In terms of public transport services in the city, Haridwar has had a skeletal PT system for over a decade, leading to proliferation of auto-rickshaws operating as a shared mode on all major road corridors.

Uttarakhand Transport Corporation has a fleet of 2164 buses in Uttarakhand for intra-city and inter-city travels. UTC buses mainly serve long distance as well as medium distance inter-city trips from Haridwar Bus stand near Railway Station, Jawalapur Bus stop, BHEL Bus stop and GMOU Bus Stand. Private Buses also make long and medium distance intercity trips from different parts of the city and parked in Pantdeep Parking and Rishikul Parking Area and these operate from the same location; the long distanced private buses do not have any authorized off-street parking, terminals. So, they are seen to occupy the carriage-way of roads causing problems to traffic movements. In addition to this, some tourist buses also come to the city daily during the peak tourist season.

In Haridwar total road network length is 246 km, of which 214.1 km are under Municipal Corporation and 31.9 km are maintained by PWD.

There is an absence of organized public transport system for Haridwar. However, IPT as auto, vikram constitute of most of the public transport trips.

Table 13-1 : IPT Routes operated in Haridwar

City	Routes
Haridwar	Bus Stand – Shantikunj – Bhimgowda – Rishikesh
	Bus Stand – Shivalik Nagar – Sector 22 – Roshnabad
	Bus Stand – Hari Ki Pauri
	Chandi Chowk – Daksh Mandir – Kankhal
	Chandi Chowk – Chandi Devi Mandir
	Chandi Chowk – Rishikesh
	Har-Ki-Pauri – Railway station
	Har-Ki-Pauri – Mansa Devi
	Har-Ki-Pauri – Patanjali
	Har-Ki-Pauri – Kankhal
	Har-Ki-Pauri – Chandi Devi Mandir

Source: Comprehensive Mobility Plan for Metropolitan Area focusing Dehradun-Haridwar-Rishikesh, by UMTC

13.3 PLANNING FOR INTEGRATION OF PUBLIC TRANSPORT MODES

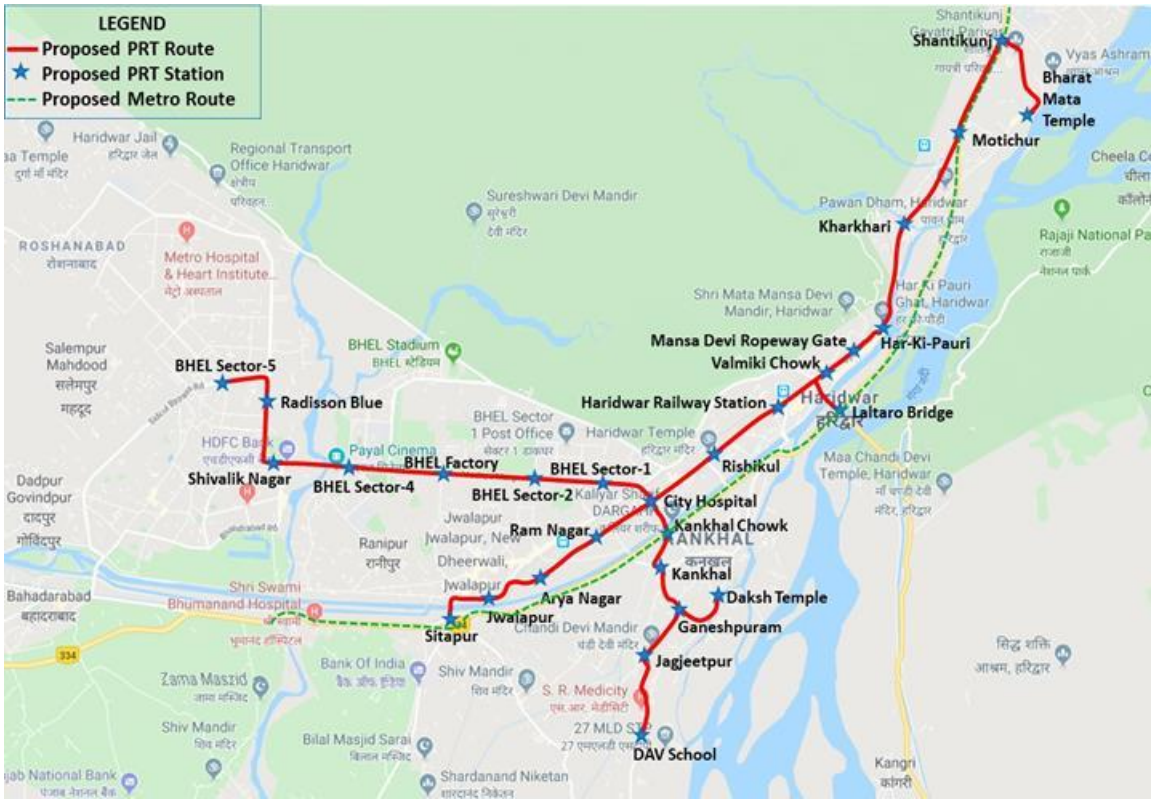


Figure 13-1 : Proposed PRT corridor in Haridwar City

The map above shows the PRT corridors proposed in Haridwar City. Along with this PRT feeder services and other city services, as per Comprehensive Mobility Plan for Metropolitan Area focusing Dehradun-Haridwar-Rishikesh, prepared by UMTC it is expected that the mode share of public transit in Uttarakhand will increase from the Base year (2018) 18% to 40% by 2038 under Sustainable Urban Transport Scenario (Transit Oriented Development Scenario).

However, there is a need to ensure that these three systems are integrated in such a manner that the commuters get benefit of single trip through fare integration as well enjoys a seamless physical transition from one mode to another. Along with this, there is a need to ensure that last mile connectivity through pedestrian and bicycle facilities are enhanced.

13.3.1 Multi-Modal Integration

The concept of Multi Modal integration involves a holistic approach for providing an integrated transport solution to the users of public transport. The Planning of Multi Modal integration is an approach to ease of the journey of the users using different modes, by offering seamless transfer from one mode to another, using common ticketing system. However, while planning for a well-integrated system various factors are to be considered:

Figure 13-2 : Multi Modal integration

Each intermodal station will consist of three main components:

- An integrated terminal facility with adequate facilities and amenities to cater to the requirements of all user groups
- A mixed-use development with shopping, office spaces and other commercial activity to enable people to fulfil all the needs by using public transport
- Provision of Park-and-Ride facility to encourage the use of public transport

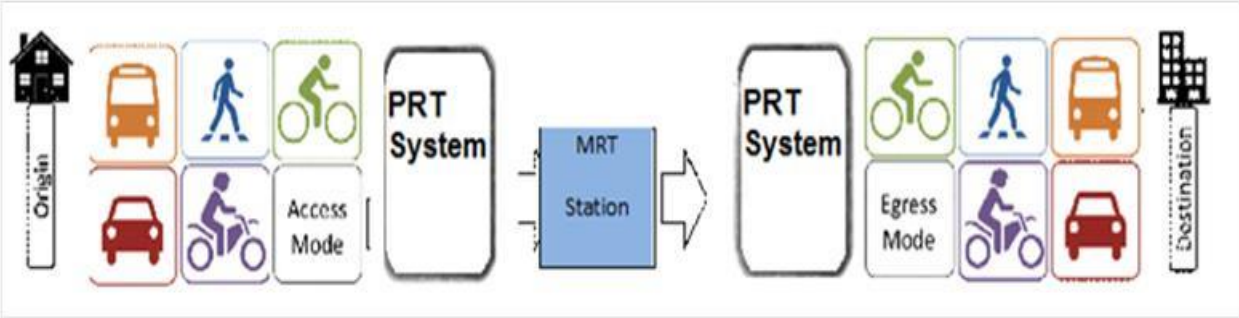


Figure 13-3: Multi Modal Integration of MRT Station

13.3.2 Last Mile Connectivity

PRT as a last mile connectivity actually impacts on overall ridership and usage of any mass transit system. It is essential to provide or improve last mile connectivity and link them for ease of access for users. Even if street infrastructure that comprises of last mile connectivity falls outside mass transit system and control, they remain critical components of an effective public transportation. The easier it is to access the MRT System, the more likely people are to use it. It has been seen that access beyond a distance of 400-500m is not comfortable enough to attract people onto the public transport system. The unavailability of this type of service is one of the main constraints to the use of public transport in urban areas. PRT provide last mile service to close proximity of MRT Station, Railway Station and other Transport hub.

Last Mile Connectivity refers to the provision of travel service from home or workplace to the nearest public transportation mode. A trip is considered as the entire journey between origin and destination. Commuters may utilize and combine different modes of transport for the entire trip. MRT feeder services i.e., PRT may cater to a majority of this kind of trip, but commuters always need to complete the access and egress part on their own.

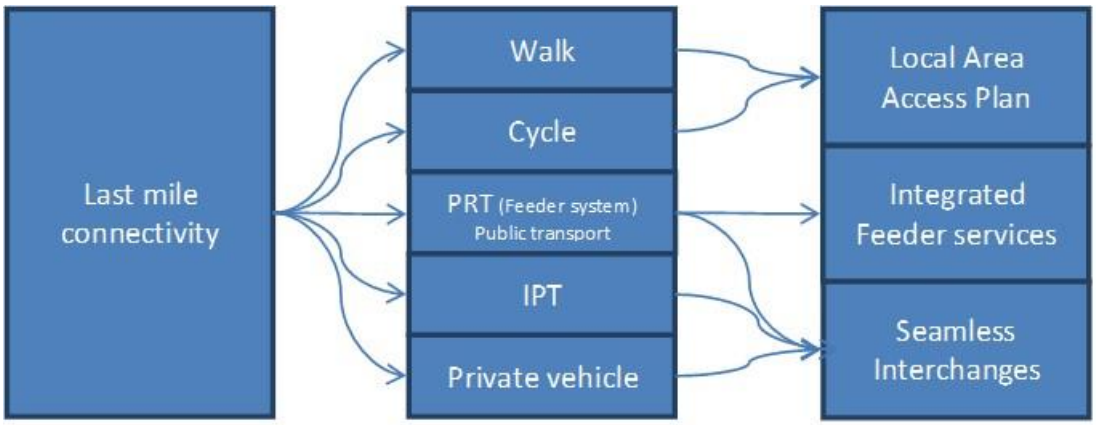


Figure 13-4: Different Aspects of Last Mile Connectivity

13.3.3 Physical Integration

Integration of NMT, para transit, feeder services and other public transport modes with MRT stations is possible by planning and designing seamless interchange stations which facilitates

physical integration of different access or egress modes.

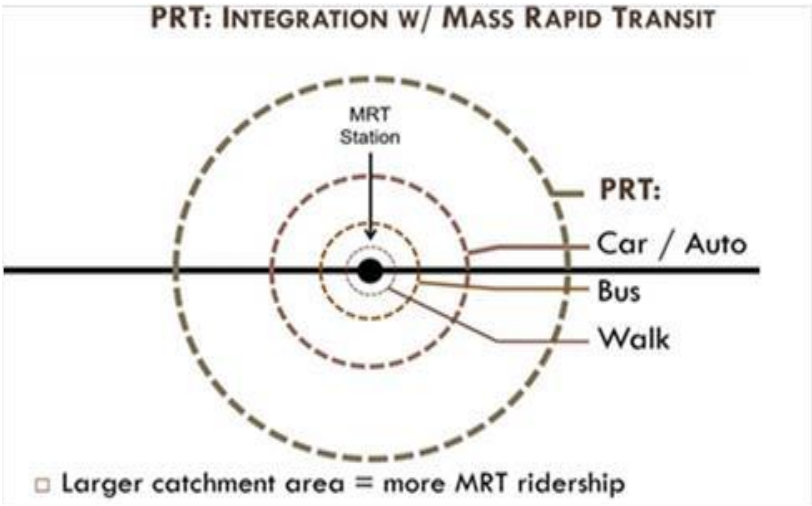
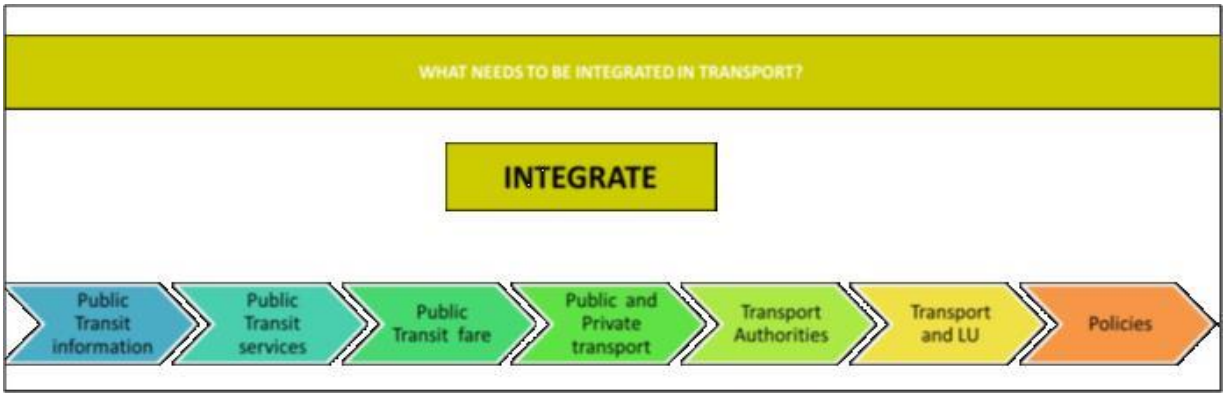


Figure 13-5: PRT Integration with MRTS

In order to develop an integrated public transport system, where one mode acts as a complementary mode to another mode rather than its competitor, a trunk and feeder system of transportation network is planned to be developed. Inter-change points are required to be seamless and barrier- free movement of passengers. Thus, for the cities of Haridwar, an effort has been made to thus identify locations and determine various typologies of interchanges that need to be developed for a seamless, barrier- free transportation experience.



Source: Integration for Seamless Transport, John Preston

Figure 13-6: Public Transport Integration

13.3.4 Interchange stations

Inter-change stations permit riders from particular mode of transport to move and board same or different mode in order to reach their desired destination. Interchanges can be of several types, depending on available modes of transport. Transfer may happen between the same modes or among different available public transport. Interchanges bring public transport

together. For example, PRT station can have interchanges with PRT on particular corridor connecting PRT station of different corridor or, PRT stations may have interchange with MRTS/BRTS, city services and even rail. Interchange helps to integrate various means of transport system under a common node.

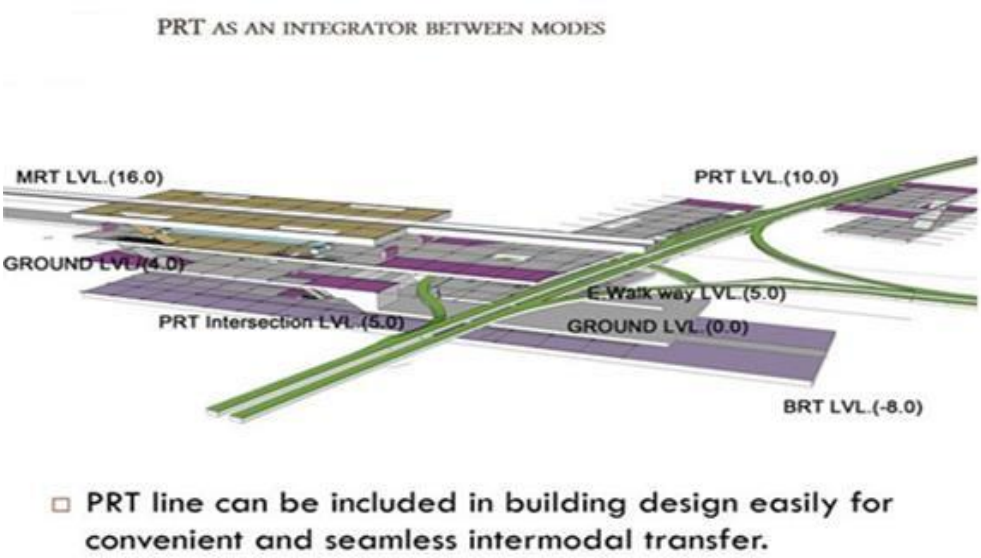


Figure 13-7: Interchange with other mode of Transport

Interchanges increases flexibility of movement and gives commuter option to avail multiple public transports at a common station.

13.3.5 Level of Interchange

Interchanges can be of different levels, depending on the types of interchange. The four modes of transport i.e. Railway, MRTS/LRTS, BRTS/City Bus and PRT are under different authorities. Uttarakhand Metro is a Special Purpose Vehicle (SPV) comes under Uttarakhand Metro Rail Corporation (UMRC), BRTS and city bus services are under Uttarakhand Municipal Corporation and Railways comes under Indian Railways. Design aspect of interchange needs prior planning for seamless mobility and transfer from one mode to other. The multiple authorities or institutions involved needs to take necessary decisions for efficient functioning.

Level 1: Level I interchange refers to the first type of interchange, which is regional-city level interchange. In this case there are interchange facilities provided for transfer between regional transport nodes like railway station and high capacity transit mode like metro/BRTS/LRT. In case if Haridwar, railway station is one such node which is being developed as a multi-modal hub, where transfer facilities between regional rail, regional buses, MRT/LRT, BRT/city buses and PRT would be developed. Haridwar is also a level 1 node providing interchanging opportunity between MRT/LRT, BRTS, PRTs and regional buses (UKSRTC).

Level 2: Level 2 inter-change refers to MRT/LRT- MRT/LRT, PRT-PRT interchange.

Level 3: Level 3 interchanges are those where MRT/LRT has to be integrated with the PRT/BRTS system.

Level 4: Level 4 interchanges are those where PRT/MRT/LRT has to be integrated with the open system of city bus services. In this level of interchange, city bus services will function more as a feeder to the MRT/LRT corridor.

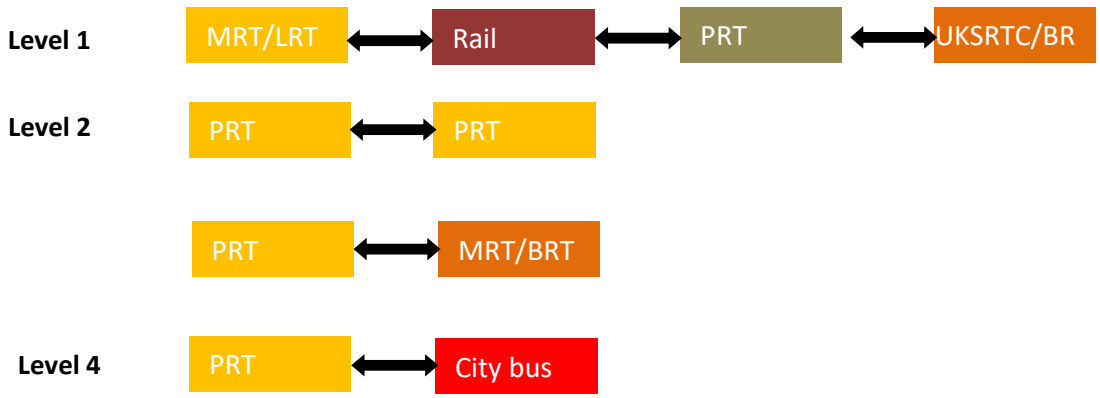


Figure 13-8 : Different Levels of Interchanges in Uttarakhand

Details of interchange and map showing the level of interchanges on PRT corridor are shown below:

Table 13-2 Levels of interchange for metro stations

Interchange Level	Interchange Station	PRT Corridor	Rail	Regional Bus	MRT/ LRT	PRT	BRTS	Bus
Level 1 (Regional Node-PRT)	Railway station Haridwar,	Sitapur-Bharat Mata Temple Corridor	√	√	√	√	-	√
Level 2 (PRT-PRT)	City Hospital, Valmiki Chowk Ganeshpuram	Sitapur-Bharat Mata Temple Corridor, City Hospital to Daksh Temple, Valmiki Chowk to Laltaro Bridge, Ganeshpuram to DAV School	-	-		√	-	-
Level 3 (PRT to MRT) (PRT to BRTS)	Laltaro Bridge	Valmiki Chowk to Laltaro Bridge	-		√	√		-

Level 4 (PRT to City Bus)	Railway station Haridwar, Sitapur, City Hospital, Laltaro Bridge Jagjeetpur	Sitapur-Bharat Mata Temple Corridor, City Hospital to Daksh Temple, Valmiki Chowk to Laltaro Bridge, Ganeshpuram to DAV School	-	-		√	-	√

13.3.6 Fare Integration

Fare integration involves ensuring that the public transport user pays for the entire journey once rather than paying separately for different journey legs. This helps in reducing travel time from origin to destination. The single fare system attracts passengers to use buses PRTS and MRTS because of the comfort and also saving of time in buying separate tickets for travel at bus/BRT Stops, PRT Stops and MRT stations. Such a single fare system can be implemented either through pre-paid travel cards or smart cards which help in reducing and eliminating the financial penalty imposed by inter-change enabling users to select the most appropriate route through the network. In Uttarakhand, an integrated fare structure for the multi-modal PT system of metrolite-BRTS-PRTS and city bus services is also being planned.

13.4 WAY FORWARD

In view of above deliberations in background, along with planning for Metro Rail System, PRTS in any city, there is a need for providing a transportation system which is seamlessly integrated across all modes and provides first mile as well as last mile connectivity. It is also necessary that various public transportation modes including Inter-mediate Public Transport (IPT) and feeder buses etc. work together in order to facilitate increase in ridership to the Public Transport system and provide ease of using the PRT system by the public at large.

The basic level of connectivity for any mass transit system would be linking local areas to the nearest mass transit station. The concept of “Local Area Access Plan (LAAP)” can be proposed which will help identify the road network along the Metro corridor that should be taken up for pedestrian and NMT improvement. It is important to look at each metro station and the surrounding area in detail. The land use for a distance of 500m from the corridor should be surveyed to understand nature of existing development. All prominent activities such as schools, colleges, hospitals, malls etc. should be mapped to ensure that the LAAP caters to all of them. At the same time, for each station, feeder services in the form of PRT and bus service can be identified.

Chapter -14
TOD And Value Capturing Financing

14.0 Background

14.1 Transit Oriented Development

14.2 TOD for the PRT corridors of Haridwar

14.3 Scope for the Transit Oriented Development & VCF

14.4 Extent of Transit Oriented Development (TOD) and Value Capture Financing (VCF)

14.5 Conclusion

CHAPTER 14
TOD AND VALUE CAPTURE FINANCING

14.1 BACKGROUND

Cities in the study area of Haridwar have been growing horizontally due to urbanization like-wise other cities of India. This has created problems of urban sprawl. This has also resulted in increase of trip length and higher usage of private vehicles, problems of pollution and increased demand of infrastructure. To address these issues, many cities have strengthened their public transport by developing various public transit systems such as metro rails, Bus Rapid Transit (BRT) System and PRT System. This is important to efficiently use these systems by encouraging the land use change with the transport infrastructure to make the cities healthy and deliverable.

In this direction, to take the full advantage of any such facility either being developed or planned to be developed Government of India has issued a National Transit Oriented Development Policy (NTOD) which is general in nature. However, the principles laid down in the policy can be applied to any city, especially those with upcoming mass transit system. The general guidelines as given in the National Transit Oriented Development Policy are to be followed to take full advantage of such development.

14.2 TRANSIT ORIENTED DEVELOPMENT

TOD integrates the land use and transport planning and aim to develop planned sustainable urban group centers. It propagates the mixed land use in the influence area of transit corridors. Normally the inter station distance between the stops of public transit system varies from 0.5 km to 1.5 km. It may be 0.5 km in case of Tramways and go upto 1.5 km in case of underground heavy metro system. TOD can be planned in the influence zone which is defined as the circle of 500-800 m radius or a square of 800 meter from the Transit stop being as centroids. With this influence area it necessitates the public to walk for a maximum distance of 800 meter. TOD policy increases the accessibility of these transit stations by creating pedestrian and non-motorized transport friendly infrastructure.

TOD aims to develop planned sustainable urban growth centres, having walkable and liveable communes with high density mixed land-use. Citizens have access to open green and public spaces and at the same time transit facilities are efficiently utilized.

TOD focuses on creation of high density mixed land use development in the influence zone of transit stations, i.e. within the walking distance of (500-800 m) transit station or along the corridor in case the station spacing is about 1km as shown in Figure 14.1.

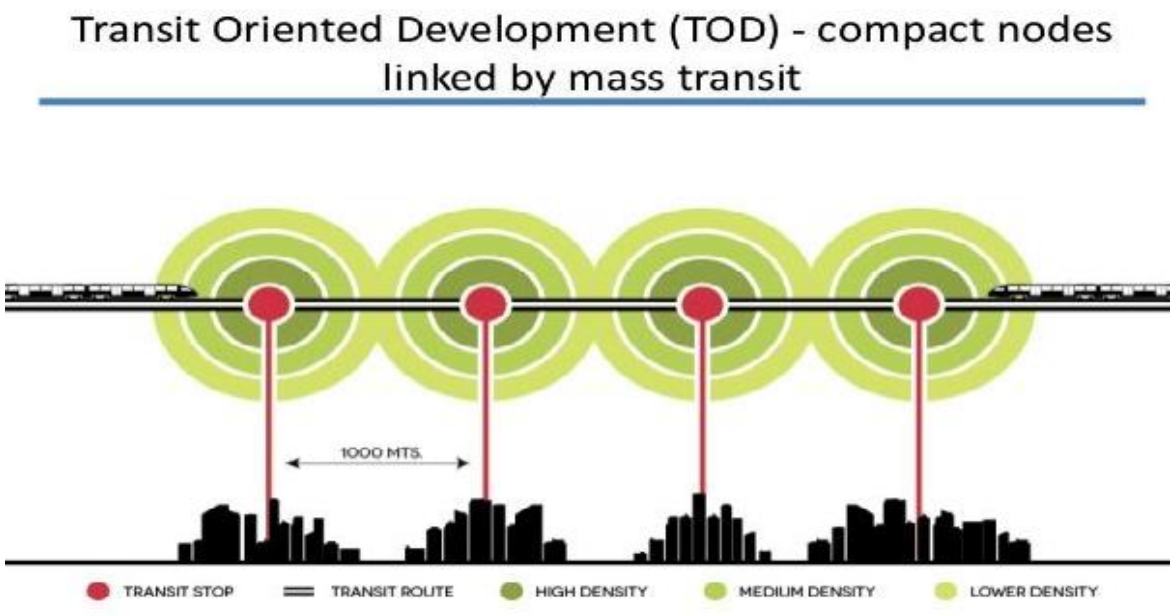


Figure 14-1: Map Showing Study Area (Haridwar)

TOD advocates pedestrian trips to access various facilities such as shopping, entertainment and work. TOD increases the accessibility of the transit stations by creating pedestrian and Non-Motorised Transport (NMT) friendly infrastructure that benefits large number of people, thereby increasing the ridership of the transit facility and improving the economic and financial viability of the system. Since the transit corridor has mixed land-use, where the transit stations are either origin (housing) or destination (work), the corridor experiencing peak hour traffic in both directions would optimize the use of the transit system.

14.3 TOD FOR THE PRT CORRIDORS OF HARIDWAR

It is recommended that PRT corridors to be provided on the under-mentioned four routes:

1. Sitapur - Bharat Mata Temple (14.55 km)
2. City Hospital - Daksh Temple (3.10 km)
3. Valmiki Chowk - Laltaro Bridge (0.69 km)
4. Ganeshpuram - DAV School (2.40 km)

Comparison of all the modes has already been given in The Alternatives Analysis Study Report, Dehradun, Haridwar and Rishikesh, Final Report, January, 2019 prepared by M/s UMTC and in System Selection Chapter. The above corridors qualify for the Personal Rapid Transit System (PRTs) as public transport. It has been recommended that all the corridors be provided with PRT System.

14.4 SCOPE FOR THE TRANSIT ORIENTED DEVELOPMENT & VCF

These corridors have very low population density. Some stretches on these corridors are still to be developed.

Table 14-1 Coverage is Estimated in Terms of Population and Employment of the Adjoining Traffic Analysis Zones

Alternatives	2018		2028		2038	
	Pop.	Emp.	Pop.	Emp.	Pop.	Emp.
Alternative B1: Sitapur to Har-Ki-Pauri via Railway station covering Haridwar Main Road and Upper Bazar Road	89862	26970	102344	30622	114330	34212
Alternative B2: Sitapur to Har-Ki-Pauri via Railway station covering Haridwar Main Road and Moti Bazar Road	89862	26970	102344	30622	114330	34212

Source-The Alternatives Analysis Study Report, Dehradun, Haridwar and Rishikesh as per Comprehensive Mobility Plan for the Metropolitan Area, Final Report, January, 2019 prepared by M/s UMTC

As per Traffic Report of Haridwar PRT System, the PHPDT on these corridors for PRT system in the year 2021 will be 1819 on normal day and 4393 on Mela day.

Table 14-2 Traffic Summary

Year	Corridor	Route Length (km)	Norma Day		Mela Day	
			Daily Ridership (Passengers)	PHPDT	Daily Ridership (Passengers)	PHPDT
2021	Sitapur - Bharat Mata Temple	14.55	54,608	1,819	1,25,059	4,393
2021	City Hospital - Daksh Temple	3.1	16,295	858	33,766	1,812
2021	Valmiki Chowk - Laltaro Bridge	0.69	3,723	191	13,412	690
2021	Ganeshpuram - DAV School	2.4	7,015	366	16,821	905

Source-Traffic Report, Haridwar PRT System

It has also been felt that there is need of grade separated transport system due to roads being very narrow and volume of traffic being higher than the capacity. For these corridors, it is recommended that Uttarakhand Government should bring out a policy for land pooling, re-development of hutments in encroached area and allowing higher FAR on a reasonable cost to the public owning houses or plots along these corridors. This can be done within half a kilometer of the corridor declaring it as influence zone. It will not only help in improving health of the city, but also help in raising the revenue with upfront or recurring. This will however, need a very meticulous planning by appointing Consultants and implementation earnestly. Land acquisition can be done on these corridors by giving the transfer of development rights (TDR) to

the land owning public.

14.5 EXTENT OF TRANSIT ORIENTED DEVELOPMENT (TOD) AND VALUE CAPTURE FINANCING (VCF)

Since the transit corridor has mixed land-use the area along these corridors may be developed as residential and commercial by the agencies willing to take up the construction along the corridors and construction of some station on PPP model. This may not only fetch the cost of station but also the recurring revenue to make the corridor more viable.

Value of the corridors can be captured by urban local bodies by the way of allowing land use change from residential to mixed, allowing higher FAR, charging higher percentage of property tax and allowing re-distribution of weaker section J.J. Colonies in the influence zone.

The part of these revenues to be decided by state government and shall be shared with UKMRC, the company implementing Haridwar PRT project.

14.6 CONCLUSION

It is suggested that all efforts may be made to maximize earning from TOD and Value Capture even by increasing the areas not suggested in this chapter. The Capital raised upfront may be used for construction of the project and recurring earning to be used for Fare Box support.

The financial figures calculated here have however not been taken in evaluating the financial viability for the reason that raising of funds depends upon. Policies/circulars to be notified by State Government.

23

STRUCTURAL and FIRE SAFETY;

Third party audits of soil bearing capacities (from geology and mining unit of industries) and structural designs shall be necessary. The fire consultant shall prepare the plans incorporating the provisions given in NBC 2016 which shall be vetted by the Chief Fire Officer.

Sanctioning of all the projects in TOD influence zone shall be given by high powered screening committee.

10- REQUIRED INTERVENTIONS TO MAKE THE PROJECT VIABLE

- The real-estate market can be erratic and therefore caution should be observed while estimating the revenue from land value capture. Usually circle rates are revised every year with an increment of 10-15%. With the augmentation of metro, the circle rate in the influence zones are expected to increase manifold which may result in the poor response of the affordable real estate projects hence resulting in the failure of TOD concept which is of utmost importance to sustain metro project as well as the optimum utilization of limited developable land. Hence, for influence zones of metro, a policy intervention is required to increase the circle rate maximum by 10-15% per annum. This will not only help in attracting affordable real estate projects but will also help in realizing betterment charges which shall be used for the upkeep of the TOD project.
- To ensure that TOD does not merely become a high density development along the transit, which may result in higher concentration of private vehicles and congestion, it is important that the LDA make sure that all the important aspects of TOD, as given in National TOD policy, are implemented in totality and Influence Zone Plan are revised periodically.
- To boost the densification of TOD corridor, the FAR of other zones (except affordable housing projects) need to be lowered or development charges need to be upgraded.

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8

Chapter -15
Cost Estimates

15.1 Cost Components

15.2 Assumptions

CHAPTER 15
COST ESTIMATES

15.1 COST COMPONENTS

PRT System comprise of the following components:

15.1.1 Infrastructure

(i) Civil and Structural

- Site Work: Clearing the site, Excavation and Back filling
- Concrete and form Work: Piles and concrete foundations for piers of Guideway and Stations
- Steel Works: Reinforcement work for foundation, structural steel work for piers, guideways and stations. Roofing work for stations
- Aluminium and finishing work for stations

(ii) Electrical

- Unit sub-stations, panels
- Wiring and cabling
- Lighting
- Fire alarm system
- Public address
- UPS
- DG Sets
- CCTV
- Elevators, etc.

(iii) Plumbing and Fire Fighting System

- Water supply
- Sewerage and storm water
- Rainwater piping
- Soil, waste and vent piping

- Sanitary fixture
- Pumps, etc.

(iv) HVAC

Stations will not have HVAC, only split/ cassette ACs will be provided in enclosed areas.

(v) Charging Stations

(vi) POD Parking Area, if any

15.1.2 Control System

Control System is proprietary item. Components of control system are:

(i) Central control system

(ii) Data Communication Network

(iii) Software and system design

(iv) Automatic Vehicle Protection System

(v) Berth doors and mechanisms

(vi) Ticketing system

(vii) Security equipment

(viii) POD lifts

(ix) CCTV System

(x) System Design

(xi) System installation, Integration and commissioning

15.1.3 Vehicle (PODs)

PODs shall be an electrical autonomous vehicle and shall also be a proprietary item. Broadly it will have the following components:

(i) Body System

(ii) Chassis System

(iii) Power train System

(iv) Traction Battery System

(v) HVAC System

(vi) Electrical Distribution

(vii) Control System

- Power train Controller
- Vehicle Control Module - D-Space MABx
- DC/DC Convertors
- Radios and Communications
- Door Controller
- Load Cell/Controller
- Antennas/AVP Sensors
- Lasers / Other Sensors
- Tire Pressure Monitoring
- Smoke Detector/Crash Sensors.

In absence of any Bench marking available for cost & since this type of system is also not available in the country, an approximate cost has been tabulated below with assumptions.

Table 15-1 Cost Estimate of PRT System

(June 2021 Price Level)

S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.0	Land				
1.1	Land Cost	Ha.	20.00	2.469	49.38
1.2	R and R Cost	Rkm	1.00	20.74	20.74
1.3	Utility Shifting	Rkm	1.00	20.74	20.74
	Subtotal (1)				90.86
2.0	Civil & Structure Cost				
	Subtotal (2)	km	19.42	20.740	402.81
3.0	MEP cost				
	Subtotal (3)	km	5.65	20.740	117.27
4.0	Charging Station Cost				
	Charging Station	No.	0.16	32.00	4.98
	Subtotal (4)				4.98
5.0	Depot				
	Subtotal (5)	Each	LS	1	55.00
6.0	Control System				
	Subtotal (6)	Each	LS	1	270.97
7.0	Total POD cost (Inclusive of Automatic Parking Cost)				
	Subtotal (7)	no.	0.42	514.000	213.31
8.0	Total of all items except Land				1064.34
9.0	GC@5%				53.22
10.0	Contingencies@3%				31.93
11.0	Total cost of all items including General Charges, and Contingency without land			=	1149.49
12.0	Total cost of all items including General Charges, and Contingency and including Land			=	1240.36
13.0	Taxes			=	179.10
14.0	GROSS TOTAL			=	1419.45

Cost of land temporarily for construction depot for Contractor has not been considered. Part of Depot land proposed at Rishikul (1.73 ha) planned to be utilised temporarily during construction period**.**

Table 15-2 Detail of Taxes and Duties

- **POST GST Regime**

CGST Customs Duty	=	9.495 %
SGST Customs Duty	=	9.495 %
Total Customs Duty	**=**	**24.4900 %**
General IGST	=	12 %
General CGST	=	6 %
General SGST	=	6 %

S. No.	Description	Total cost without Taxes & duties (Cr.)	Foreign Component (%)	Taxes and duties									Total Taxes & Duties (Cr.)
				CUSTOMS DUTY					GST				
				Basic Customs Duty @5.5% (Cr.)	IGST (CGST portion) @9.4635 % (Cr.)	IGST (SGST portion) @9.4635 % (Cr.)	Total Customs Duty (Cr.)	Local Component (%)	GST RATE	CGST (Cr.)	SGST (Cr.)	Total GST (CGST & SGST) (Cr.)	
1	**CIVIL & Structure cost**												
	Total	402.81	20%	4.43	7.65	7.65	19.73	80%	12%	19.33	19.33	38.67	**58.40**
2	**MEP Cost**												
	Total	117.27	20%	1.29	2.23	2.23	5.74	80%	12%	5.63	5.63	11.26	**17.00**
3	**Charging Station**												
	Total	4.98	50%	0.14	0.24	0.24	0.61	50%	12%	0.15	0.15	0.30	**0.91**
4	**Control System**	270.97	80%	11.92	20.58	20.58	53.09	20%	12%	3.25	3.25	6.50	**59.59**
5	**Depot**	55.00	20%	0.61	1.04	1.04	2.69	80%	12%	0.79	0.79	1.58	**4.28**
6	**POD Cost**	213.31	50%	5.87	10.13	10.13	26.12	50%	12%	6.40	6.40	12.80	**38.92**
	Total	**1064.34**		**24.25**	**41.87**	**41.87**	**107.99**			**35.56**	**35.56**	**71.11**	**179.10**
	Total taxes & Duties										**SAY**		**179.10**
Rate of Taxes & Duties on Total cost without taxes & duties													**16.83%**
Total Central GST & Basic Customs duty													101.68
Total State GST													77.42
Total State Taxes & Duties													**179.10**

Note: Railway Crossing near Jwalapur: Way leave charges for railway crossing to be borne by state government.

15.2 ASSUMPTIONS

- Foundation shall be of RCC
- All piers and track shall be made in Structure steel. It will be fabricated off-site
- Pier to pier spacing is 18 m approx.
- Station shall also be done in structure steel to the extent possible and shall be fabricated off site.
- No tunnel has been considered
- POD parking is considered at stations and Depot. No separate building has been considered for POD parking

Total PODs (514 no. in Year 2025) have been taken by considering PHPDT of Mela days especially Poornima days. Normal days PHPDT can be catered by approximately 285 PODs. The price will get adjusted based on the nos. of PODs inducted to meet the demand.

Chapter -16
Financing Options, Fare Structure and Financial Viability

16.1 Introduction

16.2 Costs

16.3 Revenues

16.4 Financial Internal Rate of Return (FIRR)

16.5 Financing Options

16.6 Recommendations

CHAPTER -16
FINANCING OPTIONS, FARE STRUCTURE AND FINANCIAL VIABILITY

16.1 INTRODUCTION

The Haridwar PRT system from Bharat Mata Temple to Sitapur, Prem Nagar to Daksh Temple & Ganeshpuram to DAV School covering approximately 20.74 Km length is proposed to be constructed from November 2022 to October 2025. All the corridors are proposed to be built as Personal Rapid System. The financial viability, with estimated cost at June 2021 price level, along with route length of the PRT system is placed in Table 16.1 as under:

Table 16.1 Cost Details (at June 2021 price level)

Name of Corridor	Distance (KMs)	Estimated cost without Land and taxes (Rs/Crore)	Estimated cost with land cost (Rs/Crore)	Estimated cost with all taxes & land cost (Rs/Crore)
Bharat Mata Temple to Sitapur, Prem Nagar to Daksh Temple &Ganeshpuram to DAV School	**20.74**	**1149**	**1240**	**1419**

16.2 Costs

16.2.1 Investment Cost

It has been assumed that the Government of Uttarakhand will provide the land worth Rs.90.86 crore on estimated cost basis either free of cost or it shall provide Interest Free Subordinate Debt of the equal amount against it. The Interest Free Subordinate Debt is normally repayable in 5 equal instalments after repayment of Multilateral/Overseas Development Assistance Loan. The financial calculations in this chapter have been done with this assumption only.

The estimated capital cost does not include charges towards capital expenditure on security such as cost of weapons, barricades, hand-held devices and door detector machine etc. The new system will be provided with shelter platforms and there is no provision for platform screen doors, AFC gates, X-ray and Baggage Scanner. The ticket validators are likely to be installed inside the platforms with NCMC or other ticketing systems. The recurring cost towards salary and allowances of security personnel has also not been taken in to account in the FIRR calculation since providing required security at stations shall be the responsibility of State Police.

For the purpose of calculating Financial Internal Rate of Return (FIRR), completion cost with taxes has been calculated by taking escalation factor @5% p.a. on all items except land.

The taxes and duties consist of Custom Duty (CD) and Goods & Services Tax (GST). **The project falls in the category of urban infrastructural space and the promoter is assumed to arrange relaxation from the Government for concessional custom duties through project imports and lower GST liability of 12% admissible to other Govt. infrastructure projects.** The effective Customs Duty (CD) rate under project import scheme, post GST, works out to 24.49% {Basic CD @ 5.5%, IGST (CGST & SGST) @ 18%} on the imported portions. The GST rate on supply of indigenously manufactured items and services has been considered @ 12% (CGST & SGST @ 6% each).

It is assumed that the construction work of the line will commence from November 2022 and is expected to be completed by October 2025 with Revenue Opening Date (ROD) as 01.11.2025. The total completion costs duly escalated and shown in the table 16.2 have been taken as the initial investment.

Table 16.2 Year-wise Investment

Rs./Crore

Financial Year	Cost at June 2021 Price Level including Taxes & Land cost	Completion Cost including Taxes &Land cost
2021-22	163.15	169.79
2022-23	561.73	616.20
2023-24	561.73	645.49
2024-25	132.86	161.49
Total	**1419.47**	**1592.98**

16.2.2 Additional Investment

Total investment provided in the FIRR calculation towards requirement of additional POD cars and charging stations duly escalated @5% p.a. is placed in table 16.3 as under:

Table 16.3 Additional Investment towards PODs & Charging Stations

(Rs/Crore)

With Taxes & Duties			
Year	**No. of Cars**	**No. of charging stations**	**Amount**
2032-33	145	-	122
2042-43	170	11	238
Total	**315**	**11**	**360**

16.2.3 Operation & Maintenance (O&M) Costs

The Operation & Maintenance costs can be divided into three major parts: -

(i) Staff costs
(ii) Maintenance cost which includes expenditure towards upkeep and maintenance of the system and consumables
(iii) Energy costs

The PRT system is being developed exclusively for efficient movement of commuters, as such the staff requirement has been assumed @ 30 persons per kilometre. The escalation factor used for staff costs has been assumed at 9% per annum. The running cost of the system on account of repair and maintenance expenses has been calculated considering the requirement of periodical replacement of Battery, Wheel, etc. The average rate of electricity assumed is Rs.5 per unit and the same has been adopted for calculating the electricity cost. The O&M costs (except Staff cost) have been obtained by providing an escalation of 5% per annum. The O&M cost has been calculated on life cycle cost basis. The different elements of O&M cost have been tabulated in Table 16.4 as below:

Table 16.4 Operation and Maintenance Costs

Rs.in Crore

YEAR			Staff	Maintenance Expenses	Energy	Total
2025	-	2026	41.30	9.19	5.80	56.29
2026	-	2027	90.03	19.29	12.17	121.49
2027	-	2028	98.14	20.26	12.78	131.18
2028	-	2029	106.97	21.27	13.42	141.66
2029	-	2030	116.60	22.33	14.09	153.02
2030	-	2031	127.09	23.45	14.79	165.33
2031	-	2032	138.53	24.62	19.84	182.99
2032	-	2033	151.00	25.85	20.84	197.69
2033	-	2034	164.59	27.14	21.88	213.61
2034	-	2035	179.40	28.50	22.97	230.87
2035	-	2036	195.54	29.93	24.12	249.59
2036	-	2037	213.14	31.42	25.33	269.89
2037	-	2038	232.33	32.99	26.59	291.91
2038	-	2039	253.24	34.64	27.92	315.80
2039	-	2040	276.03	36.38	29.32	341.73
2040	-	2041	300.87	38.19	30.78	369.84
2041	-	2042	327.95	40.10	38.61	406.66
2042	-	2043	357.46	42.11	40.54	440.11
2043	-	2044	389.63	44.21	42.57	476.41
2044	-	2045	424.70	46.43	44.70	515.83
2045	-	2046	462.92	48.75	46.93	558.60
2046	-	2047	504.59	51.18	49.28	605.05
2047	-	2048	550.00	53.74	51.75	655.49
2048	-	2049	599.50	56.43	54.33	710.26
2049	-	2050	653.46	59.25	57.05	769.76
2050	-	2051	712.27	62.21	59.90	834.38
2051	-	2052	776.37	65.32	74.09	915.78
TOTAL			**8443.65**	**995.18**	**882.39**	**10321.22**

16.2.4 Depreciation

Depreciation not being a cash outflow, has not been taken in the FIRR calculations.

16.2.5 Replacement Cost

The replacement costs are provided for meeting the cost on account of replacement of equipment due to wear and tear. With the nature of equipments proposed to be used in the system, it is expected that only 25% of system equipments would require replacement after 15 years. Based on this assumption, cost of replacement of these equipments has been provided in the 15th and 16th year of operation in following Table16.5. Similarly, charging stations will require replacement after every 10 years.

Table 16.5 Replacement Cost of System Equipments

Rs. in crore

Year	Replacement Cost
2035-36	12
2040-41	147
2041-42	154
2045-46	19
Total	**332**

16.3 Revenues

The Revenue of PRT system mainly consists of fare box collection and other incomes from rental, advertisement, parking etc.

16.3.1 Fare box

The Fare box collection is the product of projected ridership per day and applicable fare structure based on trip distribution at different distance zones.

16.3.2 Traffic

Haridwar city attracts additional tourists in certain period/days of the year in which Religious Fair (*Mela*) is organised. The ridership of PRT system is expected to increase substantially during these days. Based on the traffic study conducted by M/s ICRA Analytics, the projected ridership in optimistic scenario considering normal days as well as *Mela* days for the corridors is indicated in table 16.6 as below:

Table 16.6 Projected Ridership

Financial Year	Trips per day (Lakhs)
2024-25	1.22
2031-32	1.56
2041-42	2.07
2050-51	2.61

The growth rate for traffic has been assumed as per traffic study.

16.3.3 Trip Distribution

Trip distribution indicates the percentage of commuters which will travel in various distance zones. As the fare for each distance zone is different it has a bearing on the estimated revenue. The trip distribution has been worked out based on the average

lead at ROD level which is shown in Table 16.7 below. **Further, it has been considered that 11% passenger will travel with reservation of full POD.**

Table 16.7 Trip Distribution

Distance in km	Normal Days	Mela Days
0-2	15.20%	24.90%
2-4	13.00%	16.80%
4-6	16.70%	13.90%
6-8	26.00%	19.70%
8-10	14.70%	15.30%
10-14	11.40%	8.10%
>14	3.00%	1.30%
Total	**100.00%**	**100.00%**

16.3.4 Fare Structure

The fare structure for the FY 2025-26 is shown in the table 16.8 below:

Table 16.8 Fare Structure

Distance (Kms)	Rs.
0-2	20
2-4	40
4-6	60
6-8	75
8-10	80
10-14	85
>14	90

The fare structure has been escalated @5% p.a. in succeeding years.

16.3.5 Non-Fare Box Revenue

Non-fare box revenue from property business and advertisement has been considered in addition to the fare box revenues. It is possible to raise resources through leasing of parking rights at stations, advertisement on PODs and tickets, advertisements within stations and parking lots, advertisements on viaducts, columns and other system structures, co-branding rights to corporate, naming rights, film shootings and special events on system premises.

In addition to above, income from Property Development on standalone parcel of Land measuring 10 hectares approx. has been considered to augment revenue. As per discussion, the land parcel is proposed to be allotted near DAV school station which is on river front and is therefore suitable for construction of a Resort/Hotel, etc. The value of the proposed land parcel has been estimated to be Rs.100 crore which the Government of Uttarakhand will provide free of cost. The details of PD income accruing to Project is placed in Table 16.9 below:

Table 16.9 Estimated generation of Rental Income from PD

Rs. in crore

	Construction cost	Earning of Developer	Maintenance Expenditure	Developer's Equity	Developer's Market Debt Loan	Return @16%	Residual rental income to Project
Total (Year 2022-2052)	463	3301	641	138	325	1153	**949**

The detailed cash flow statement for PD activity is placed at Table No. 16.14.

16.4 Financial Internal Rate of Return (FIRR)

16.4.1 The Financial Internal Rate of Return (FIRR) with and without additional PD income for 30 years life cycle business model including construction period works is tabulated in Table 16.9A below:

Table 16.9A FIRR (with additional PD income)

Rs. in crore

Sl.	Financial Year			Completion Cost	Additional Cost	Replacement Cost	Running Exp	Total Cost	Fare Box Revenue	Non-Fare Box incl. PD	Total Revenue	Net Cash Flow
1	2022	-	2023	170	-	-	-	170	-	-		-170
2	2023		2024	616	-	-	-	616	-	-		-616
3	2024	-	2025	645	-	-	-	645	-	-		-645
4	2025	-	2026	161	-	-	56	217	142	-82	60	-158
5	2026	-	2027	-	-	-	121	121	311	-68	243	121
6	2027	-	2028	-	-	-	131	131	339	-51	288	157
7	2028	-	2029	-	-	-	142	142	369	-33	337	195
8	2029	-	2030	-	-	-	153	153	402	-13	389	236
9	2030	-	2031	-	-	-	165	165	440	-16	424	259
10	2031	-	2032	-	-	-	183	299	486	-9	477	294
11	2032	-	2033	-	122	-	198	320	538	-2	536	217
12	2033	-	2034	-	-	-	214	214	581	4	585	372
13	2034	-	2035	-	-	-	231	231	627	11	638	407
14	2035	-	2036	-	-	12	250	262	678	52	730	469
15	2036	-	2037	-	-	-	270	270	733	55	788	518
16	2037	-	2038	-	-	-	292	292	790	57	848	556
17	2038	-	2039	-	-	-	316	316	855	59	914	598
18	2039	-	2040	-	-	-	342	342	924	63	987	645
19	2040	-	2041	-	-	147	370	517	998	67	1,065	548
20	2041	-	2042	-	-	154	407	788	1,077	70	1,147	587
21	2042	-	2043	-	238	-	440	678	1,153	75	1,228	550
22	2043	-	2044	-	-	-	476	476	1,243	79	1,322	846
23	2044	-	2045	-	-	-	516	516	1,338	83	1,421	905
24	2045	-	2046	-	-	19	559	578	1,442	87	1,529	952
25	2046	-	2047	-	-	-	605	605	1,554	91	1,645	1040
26	2047	-	2048	-	-	-	655	655	1,675	95	1,770	1115
27	2048	-	2049	-	-		710	710	1,805	100	1,905	1194
28	2049	-	2050	-	-	-	770	770	1,944	105	2,049	1279
29	2050	-	2051	-	-	-	834	834	2,093	111	2,204	1370
30	2051	-	2052	-	-	-	916	916	2,255	116	2,370	1454
	Total			**1592**	**360**	**332**	**10322**	**12949**	**26792**	**1109**	**27900**	**15294**
												16.16%

Table 16.9B FIRR (without additional PD income)

Sl.	Financial Year			Completion Cost	Additional Cost	Replacement Cost	Running Exp	Total Cost	Fare Box Revenue	Non Fare Box	Total Revenue	Net Cash Flow
1	2022	-	2023	170	-	-	-	170	-	-		-170
2	2023		2024	616	-	-	-	616	-	-		-616
3	2024	-	2025	645	-	-	-	645	-	-		-645
4	2025	-	2026	161	-	-	56	217	142	1	143	-75
5	2026	-	2027	-	-	-	121	121	311	1	312	190
6	2027	-	2028	-	-	-	131	131	339	1	340	209
7	2028	-	2029	-	-	-	142	142	369	1	371	229
8	2029	-	2030	-	-	-	153	153	402	2	404	251
9	2030	-	2031	-	-	-	165	165	440	1	441	276
10	2031	-	2032	-	-	-	183	299	486	2	488	305
11	2032	-	2033	-	122	-	198	320	538	3	541	222
12	2033	-	2034	-	-	-	214	214	581	3	584	371
13	2034	-	2035	-	-	-	231	231	627	4	631	400
14	2035	-	2036	-	-	12	250	262	678	4	682	421
15	2036	-	2037	-	-	-	270	270	733	5	738	468
16	2037	-	2038	-	-	-	292	292	790	5	796	504
17	2038	-	2039	-	-	-	316	316	855	5	860	544
18	2039	-	2040	-	-	-	342	342	924	6	930	588
19	2040	-	2041	-	-	147	370	517	998	6	1,004	487
20	2041	-	2042	-	-	154	407	788	1,077	6	1,083	523
21	2042	-	2043	-	238	-	440	678	1,153	8	1,161	483
22	2043	-	2044	-	-	-	476	476	1,243	8	1,251	775
23	2044	-	2045	-	-	-	516	516	1,338	9	1,347	831
24	2045	-	2046	-	-	19	559	578	1,442	9	1,451	874
25	2046	-	2047	-	-	-	605	605	1,554	10	1,564	959
26	2047	-	2048	-	-	-	655	655	1,675	10	1,685	1,030
27	2048	-	2049	-	-		710	710	1,805	11	1,816	1,105
28	2049	-	2050	-	-	-	770	770	1,944	11	1,955	1,185
29	2050	-	2051	-	-	-	834	834	2,093	12	2,105	1,271
30	2051	-	2052	-	-	-	916	916	2,255	13	2,267	1,351
	Total			**1592**	**360**	**332**	**10322**	**12949**	**26792**	**160**	**26951**	**14345**
												16.85%

16.4.2 The various sensitivities with regard to increase/decrease in capital costs, O&M costs and fare-box revenues are placed in Table 16.10below:

Table 16.10A FIRR SENSITIVITY (with PD income)

Capital Cost			
20% increase in capital cost	**10% increase in capital cost**	**10% decrease in capital cost**	**20% decrease in capital cost**
14.46%	15.26%	17.20%	18.41%
REVENUE			
20% decrease in Fare Box revenue	**10% decrease in Fare Box revenue**	**10% increase in Fare Box revenue**	**20% increase in Fare Box revenue**
12.40%	14.37%	17.81%	19.37%

O&M COSTS	
10% increase in O&M cost	**10% decrease in O&M cost**
15.50%	16.80%

Table 16.10B FIRR SENSITIVITY (without PD income)

Capital Cost			
20% increase in capital cost	**10% increase in capital cost**	**10% decrease in capital cost**	**20% decrease in capital cost**
14.93%	15.83%	18.05%	19.46%
REVENUE			
20% decrease in Fare Box revenue	**10% decrease in Fare Box revenue**	**10% increase in Fare Box revenue**	**20% increase in Fare Box revenue**
12.77%	14.93%	18.62%	20.27%
O&M COSTS			
10% increase in O&M cost		**10% decrease in O&M cost**	
16.14%		17.54%	

Table 16.10C FIRR SENSITIVITY OF PD INCOME

Capital Cost of PD Work			
20% increase in capital cost	**10% increase in capital cost**	**10% decrease in capital cost**	**20% decrease in capital cost**
15.60%	15.91%	16.41%	16.67%
PD REVENUE			
20% decrease in Rental Value	**10% decrease in Rental Value**	**10% increase in Rental Value**	**20% increase in Rental Value**
15.77%	15.96%	16.37%	16.56%

These sensitivities have been carried out independently for each factor.

16.5 Financing Options

16.5.1 Objectives of Funding - The objective of funding rapid transport systems is not necessarily enabling the availability of funds for construction but coupled with the objective of financial closure are other concerns, which are of no less importance: -

- Ensuring low project cost
- Ensuring debt funds at low rates of interest
- Creating self-sustainable system in the long run by
    - Low infrastructure maintenance costs
    - Longer life span
    - Setting fares which minimise dependence on subsidies
- Recovering returns from both direct and indirect beneficiaries

Mass transit systems are characterised by heavy capital investments coupled with long gestation period leading to low financial rates of return although the economic

benefits to the society are immense. Such systems generate externalities, which do not get captured in monetary terms and, therefore, do not flow back to the system. However, experience all over the world reveals that both construction and operations of metro are highly subsidised. Government involvement in the funding of transport systems is a foregone conclusion. Singapore had a 100% capital contribution from the government, Hong Kong 78% for the first three lines and 66% for the later 2 lines. The Phase-I, Phase-II as well as Phase-III of Delhi MRTS project, Chennai, Bengaluru, Lucknow, Nagpur, Pune metros are also funded with a mixture of debt (ODA) and Equity by GOI & concerned State Governments.

16.5.2 ALTERNATIVE MODELS OF FINANCING

The following two models of financing have been evaluated to see the least cost model for financing the project:

(i) Special Purpose Vehicle under the State Government Control (Delhi Metro Rail Corporation (DMRC) /Bangalore Metro Rail Corporation (BMRC)/Chennai Metro Rail Corporation (CMRL)/Mumbai Metro Rail Corporation (MMRC), and

(ii) Design, Finance, Built, Operate & Transfer (DFBOT)

16.5.3 Special Purpose Vehicle (SPV) Model:

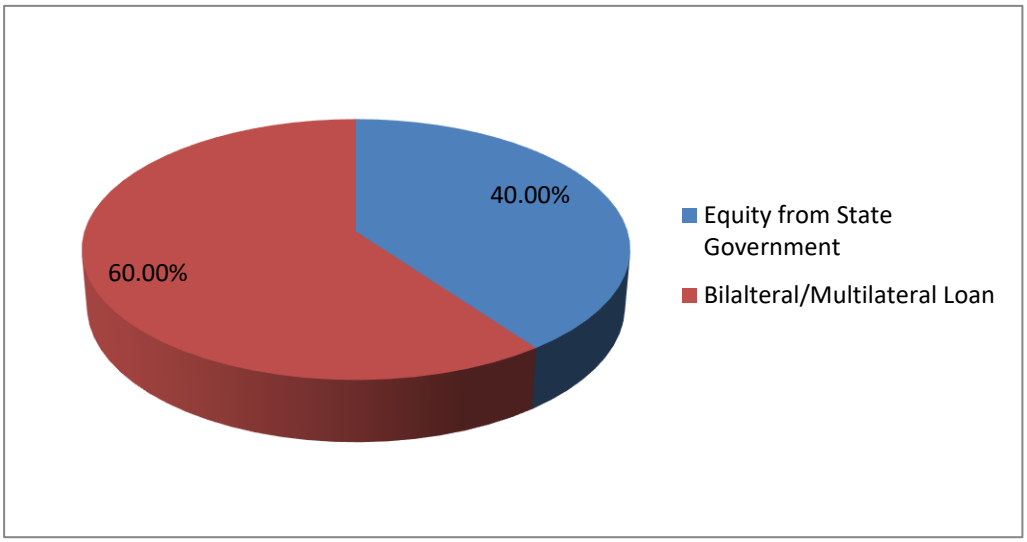
The corridors are standalone and, therefore, forming a separate SPV may be desirable. The Government of Uttarakhand (GoUK) has already formed a SPV in the name of **Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited** for planning and implementation of metro rail or other similar mass rapid transport system in the State of Uttarakhand. The funding pattern under this model (SPV) is placed in table 16.11below: -

Table 16.11 Funding pattern under SPV model

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by GoUk	520	40.00%
ODA loan from Multilateral / Bilateral Agency	780	60.00%
Sub-Total (A)	**1300**	**100.00%**
Land Cost to be borne by GoUk	91	
Central Taxes to be borne by GoUk	115	
State Taxes to be borne by GoUk	87	
Sub-Total (B)	**293**	
Total Cost (A+B)	**1593**	
IDC on Loan (to be borne by the GoUk)	19	
Total Cost including IDC	**1612**	

The funding pattern assumed under SPV model is depicted in the pie chart i.e., Figure 16.1 as under: -

Figure 16.1: Funding pattern under SPV Model



With the above funding pattern and other assumptions, the Financial IRR works out to **16.16% with PD and 16.85% without PD (Refer Table No. 16.15 & 16.17).** Additional Land for PD to be arranged & provided by GoUK.

16.5.2.2 DFBOT Model

In this model, the private firm will be responsible for financing, designing, building, operating and maintaining of the entire project. However, Land is to be provided by GoUK with no cost to the Concessionaire. The financing model shall depend upon selection of a dedicated agency to implement the project. The proposed corridor is a unique one and first of its kind in the country. The alignment will be fully elevated. Apart from equity contribution from the promoters, it is assumed that the funding for the project shall be achieved through market borrowings. The rate of interest on market borrowings is assumed at 10% p.a. and the repayment of the loan will start immediately after the commercial operations and repaid in 10 (ten) years. Accordingly, the funding pattern proposed is placed in table 16.12 as under: -

Table 16.12 Funding pattern under DFBOT

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by Concessionaire	451	30%
Market Borrowings by Concessionaire	1051	70%
Sub-Total (A)	**1502**	**100%**
Land Cost to be borne by GoUk	91	
Sub-Total (B)	**1593**	
IDC on Loan (to be borne by the Concessionaire)	182	
Total Cost including IDC	**1775**	

With the above funding pattern and other assumptions, the Equity IRR for Concessionaire works out to **19.80% with PD and 21.57% without PD (Refer Table No. 16.16 & 16.18).**

16.6. RECOMMENDATIONS

The total fund to be contributed by GoUk is shown in Table 16.13 below under SPV and DBFOT model.

Table 16.13A

Rs.in crore

Particulars	SPV Model	DFBOT Model
GoUk	832	91*
Others	780	1684
Total	**1612**	**1775**

*****Additional Land for PD to be arranged & provided by GoUK in case of PD option.

Since the total contribution of GoUK is lesser under DFBOT Model, therefore, the Project is recommended for implementation under DFBOT model.

For, DBFOT Model, the FIRR & Equity IRR are as follows (Refer Table 16.9A&B,16.16 &16.18):

Table 16.13B

Particulars	FIRR	Equity IRR
With PD	16.16%	19.80%
Without PD	16.85%	21.57%

Since the Financial and Equity IRRs of the Concessionaire with PD is not increasing, rather marginally reducing, so the project is recommended for implementation under DBFOT model without additional PD.

The detailed cash flow statements under various alternatives are placed at Table No. 16.15, 16.16, 16.17 &16.18.

Table 16.14 Cash Flow Statement of PD Income

	Year			Construction cost of the Developer	Upfront Money to SPV	Earning of Developer	Maintenance Expenditure	Developer's Equity	Developer's Market Debt Loan	IDC on Loan	Total Loan of the Developer	Loan repayment	Bal Loan Amount	Interest on Loan @10%	Return @16% + 5% escalation pa	Residual rental income to SPV
1	2022	-	2023	132	0			46	86.30	4.00	90.30		90.30			
2	2023	-	2024	185	0			46	139.22	15.59	154.81		245.11			
3	2024	-	2025	146	0			46	99.86	27.55	127.41		372.52			
4	2025	-	2026			13	1				0	37.3	335	35	22	-83
5	2026	-	2027			26	3				0	37.3	298	32	23	-69
6	2027	-	2028			42	4				0	37.3	261	28	24	-52
7	2028	-	2029			58	6				0	37.3	224	24	25	-34
8	2029	-	2030			76	8				0	37.3	186	20	26	-15
9	2030	-	2031			80	16				0	37.3	149	17	27	-17
10	2031	-	2032			84	17				0	37.3	112	13	28	-11
11	2032	-	2033			88	18				0	37.3	75	9	29	-5
12	2033	-	2034			93	19				0	37.3	37	6	30	1
13	2034	-	2035			97	19				0	37.3		2	32	7
14	2035	-	2036			102	20				0			0	34	48
15	2036	-	2037			107	21				0				36	50
16	2037	-	2038			113	23				0				38	52
17	2038	-	2039			118	24				0				40	54
18	2039	-	2040			124	25				0				42	57
19	2040	-	2041			131	26				0				44	61
20	2041	-	2042			137	27				0				46	64
21	2042	-	2043			144	29				0				48	67
22	2043	-	2044			151	30				0				50	71
23	2044	-	2045			159	32				0				53	74
24	2045	-	2046			167	33				0				56	78
25	2046	-	2047			175	35				0				59	81
26	2047	-	2048			184	37				0				62	85
27	2048	-	2049			193	39				0				65	89
28	2049	-	2050			203	41				0				68	94
29	2050	-	2051			213	43				0				71	99
30	2051	-	2052			223	45				0				75	103
Total				**463**	**0**	**3301**	**641**	**138**	**325**	**47**	**373**	**373**	**0**	**186**	**1153**	**949**

Table no. 16.15: - Cash Flow of SPV Model (with PD)

YEAR		Completion Cost	PPP	Additional Cost	Replacement Cost	Depreciation	Fare Box Revenue	Non Fare Box	PD Income	NFB	Total Revenue	Running Exp	Net Cash Flow	Equity by CG	Equity by SG	SD for Land	SD for State Taxes	SD for Central Taxes	SD for Central Taxes by SG	Cash Availability	Cummulative Cash befor JICA Loan	JICA Loan	Net Cash Available	Cummulative Loan	IDC	Repayment	Balance Loan	Interest	Cash Balance
2022	2023	170	-										-170	-	173.28	30.29	29.18	38.32	-	101.28	101.28	-	101.28	-	-	-	-		101.28
2023	2024	616	-										-616	-	173.28	30.29	29.18	38.32	-	-345.13	-243.86	243.86	-	243.86	2.19	2.19	243.86		-101.28
2024	2025	645	-										-645	-	173.28	30.29	29.18	38.32	-	-374.43	-374.43	374.43	-	618.28	6.78	6.78	618.28		-
2025	2026	161				48	142	1	-83	-82	60	56	-158	-						-157.79	-157.79	161.49	3.70	779.78	9.54	9.54	779.78	5.46	-1.75
2026	2027	-				48	311	1	-69	-68	243	121	121							121.34	125.04	-	125.04	779.78			779.78	10.92	110.42
2027	2028	-				48	339	1	-52	-51	288	131	157							156.94	281.99		281.99	779.78			779.78	10.92	146.03
2028	2029					48	369	1	-34	-33	337	142	195							195.08	477.06	-	477.06	779.78			779.78	10.92	184.16
2029	2030					48	402	2	-15	-13	389	153	236							236.06	713.12	-	713.12	779.78			779.78	10.92	225.14
2030	2031					48	440	1	-17	-16	424	165	259							259.10	972.22	-	972.22	779.78			779.78	10.92	248.18
2031	2032					48	486	2	-11	-9	477	183	294							294.42	1,266.65	-	1,266.65	779.78		-	779.78	10.92	283.51
2032	2033			122		52	538	3	-5	-2	536	198	217							216.80	1,483.45	-	1,483.45	779.78		-	779.78	10.92	205.88
2033	2034					52	581	3	1	4	585	214	372							371.58	1,855.03	-	1,855.03	779.78		12.2	767.58	10.83	348.55
2034	2035					52	627	4	7	11	638	231	407							407.19	2,262.21	-	2,262.21	779.78		30.9	736.67	10.53	365.74
2035	2036				12	52	678	4	48	52	730	250	469							468.84	2,731.05	-	2,731.05	779.78		39.0	697.68	10.04	419.81
2036	2037					52	733	5	50	55	788	270	518							517.72	3,248.77	-	3,248.77	779.78		39.0	658.69	9.49	469.24
2037	2038					52	790	5	52	57	848	292	556							555.74	3,804.51	-	3,804.51	779.78		39.0	619.70	8.95	507.80
2038	2039					52	855	5	54	59	914	316	598							598.29	4,402.79	-	4,402.79	779.78		39.0	580.71	8.40	550.89
2039	2040					52	924	6	57	63	987	342	645							645.49	5,048.28	-	5,048.28	779.78		39.0	541.72	7.86	598.65
2040	2041				147	57	998	6	61	67	1,065	370	548							547.98	5,596.26	-	5,596.26	779.78		39.0	502.74	7.31	501.68
2041	2042				154	61	1,077	6	64	70	1,147	407	587							586.64	6,182.91	-	6,182.91	779.78		39.0	463.75	6.77	540.89
2042	2043			238	-	69	1,153	8	67	75	1,228	440	550							549.63	6,732.54	-	6,732.54	779.78		39.0	424.76	6.22	504.43
2043	2044					69	1,243	8	71	79	1,322	476	846							845.63	7,578.17	-	7,578.17	779.78		39.0	385.77	5.67	800.97
2044	2045					69	1,338	9	74	83	1,421	516	905							905.09	8,483.26	-	8,483.26	779.78		39.0	346.78	5.13	860.97
2045	2046				19	69	1,442	9	78	87	1,529	559	952							951.80	9,435.05	-	9,435.05	779.78		39.0	307.79	4.58	908.23
2046	2047					69	1,554	10	81	91	1,645	605	1,040							1,039.62	10,474.67	-	10,474.67	779.78		39.0	268.80	4.04	996.59
2047	2048					69	1,675	10	85	95	1,770	655	1,115							1,114.93	11,589.60	-	11,589.60	779.78		39.0	229.81	3.49	1,072.45
2048	2049					69	1,805	11	89	100	1,905	710	1,194							1,194.35	12,783.95	-	12,783.95	779.78		39.0	190.83	2.94	1,152.42
2049	2050					69	1,944	11	94	105	2,049	770	1,279							1,279.31	14,063.26	-	14,063.26	779.78		39.0	151.84	2.40	1,237.92
2050	2051					69	2,093	12	99	111	2,204	834	1,370							1,369.71	15,432.97	-	15,432.97	779.78		39.0	112.85	1.85	1,328.87
2051	2052					69	2,255	13	103	116	2,370	916	1,454							1,454.48	16,887.45	-	16,887.45	779.78		39.0	73.86	1.31	1,414.19
Total		**1,593**	**-**	**360**	**332**	**1,563**	**26,792**	**160**	**949**	**1,109**	**27,900**	**10,321**	**15,294**	**-**	**519.85**	**90.86**	**87.53**	**114.96**	**-**	**16,107.68**	**1,53,237.46**	**779.78**	**1,54,017.24**	**21,916.07**	**18.52**	**724.44**	**15,162.67**	**199.69**	**15,981.84**
													16.16%																

Table no. 16.16:- Cash flow of DFBOT Model (with PD)

Financial Year			Completion Cost	VGF	Concessionaire Cost	Additional Cost	Replacement Cost	Fare Box Revenue	Non Fare Box	PD	Total Revenue	Running Exp	Net Cash Flow	Concessionaire Equity	Availability of cash	Cummulative Cash	Cummulative Loan	Loan	IDC	Cummulative Loan Including IDC	Repayment	Bal Loan	Int	Cash Balance
2022	-	2023	169.79	30.29	139.50	-	-	-	-			-	-139.50	139.50	-0.00	-0.00	0.00	0.00	0.00	0.00		0.00		-139.50
2023	-	2024	616.20	30.29	585.91	-	-	-	-			-	-585.91	150.21	-435.70	-435.70	435.70	435.70	21.79	457.49		457.49		-150.21
2024	-	2025	645.49	30.29	615.21	-	-	-	-			-	-615.21	150.21	-465.00	-900.70	900.70	465.00	66.82	989.31		989.31		-150.21
2025		2026	161.49	-	161.49	-	-	142.24	0.74	-83.00	59.99	56.28	-157.79	10.71	-147.08	-1,047.78	1,047.78	150.78	93.84	1,233.93		1,233.93	61.70	-57.99
2026	-	2027	-	-	-	-	-	310.90	0.94	-69.00	242.83	121.50	121.34							1,233.93	123.39	1,110.54	117.22	-119.28
2027	-	2028	-	-	-	-	-	338.97	1.15	-52.00	288.12	131.17	156.94							1,233.93	123.39	987.14	104.88	-71.33
2028	-	2029	-			-	-	369.35	1.38	-34.00	336.73	141.66	195.08							1,233.93	123.39	863.75	92.54	-20.86
2029	-	2030	-			-	-	402.45	1.63	-15.00	389.08	153.02	236.06							1,233.93	123.39	740.36	80.21	32.46
2030	-	2031	-			-	-	440.08	1.35	-17.00	424.43	165.33	259.10							1,233.93	123.39	616.96	67.87	67.84
2031	-	2032	-			-	-	486.22	2.20	-11.00	477.42	182.99	294.42							1,233.93	123.39	493.57	55.53	115.50
2032	-	2033	-			121.70	-	538.12	3.07	-5.00	536.18	197.68	216.80							1,233.93	123.39	370.18	43.19	171.92
2033	-	2034	-			-	-	580.70	3.49	1.00	585.19	213.61	371.58							1,233.93	123.39	246.79	30.85	217.34
2034	-	2035	-			-	-	627.11	3.94	7.00	638.06	230.87	407.19							1,233.93	123.39	123.39	18.51	265.28
2035	-	2036	-			-	11.66	677.65	4.44	48.00	730.09	249.59	468.84							1,233.93	123.39	0.00	6.17	350.94
2036	-	2037	-			-	-	732.64	4.97	50.00	787.61	269.89	517.72							1,233.93		0.00	0.00	517.72
2037	-	2038	-			-	-	790.43	5.22	52.00	847.65	291.91	555.74							1,233.93		0.00	0.00	555.74
2038	-	2039	-			-	-	854.61	5.48	54.00	914.09	315.80	598.29							1,233.93		0.00	0.00	598.29
2039	-	2040	-			-	-	924.46	5.75	57.00	987.21	341.72	645.49							1,233.93		0.00	0.00	645.49
2040	-	2041	-			-	146.83	997.61	6.04	61.00	1,064.65	369.85	547.98							1,233.93		0.00	0.00	694.80
2041	-	2042	-			-	154.17	1,077.13	6.34	64.00	1,147.48	406.66	586.64							1,233.93		0.00	0.00	740.81
2042	-	2043	-			238.05	-	1,152.74	8.06	67.00	1,227.80	440.12	549.63							1,233.93		0.00	0.00	787.69
2043	-	2044	-			-	-	1,242.58	8.47	71.00	1,322.05	476.42	845.63							1,233.93		0.00	0.00	845.63
2044	-	2045	-			-	-	1,338.02	8.89	74.00	1,420.91	515.83	905.09							1,233.93		0.00	0.00	905.09
2045	-	2046	-			-	19.00	1,442.07	9.33	78.00	1,529.40	558.61	951.80							1,233.93		0.00	0.00	970.79
2046	-	2047	-			-	-	1,553.87	9.80	81.00	1,644.67	605.05	1,039.62							1,233.93		0.00	0.00	1,039.62
2047	-	2048	-			-	-	1,675.13	10.29	85.00	1,770.42	655.49	1,114.93							1,233.93		0.00	0.00	1,114.93
2048	-	2049	-			-	-	1,804.81	10.80	89.00	1,904.61	710.26	1,194.35							1,233.93		0.00	0.00	1,194.35
2049	-	2050	-			-	-	1,943.72	11.34	94.00	2,049.07	769.76	1,279.31							1,233.93		0.00	0.00	1,279.31
2050	-	2051	-			-	-	2,093.18	11.91	99.00	2,204.09	834.38	1,369.71							1,233.93		0.00	0.00	1,369.71
2051	-	2052	-			-	-	2,254.76	12.51	103.00	2,370.27	915.79	1,454.48							1,233.93				1,454.48
Total			1,592.98	90.86	1,502.12	359.75	331.65	26,791.57	159.53	949.00	27,900.10	10,321.25	15,385.33	450.63	-1,047.78	-2,384.18	2,384.18	1,051.48	182.45	34,762.90	1,233.93	8,233.41	678.66	15,226.34
																								19.80%

Table no. 16.17: - Cash Flow of SPV Model (without PD)

YEAR		Completion Cost	Additional Cost	Replacement Cost	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow	Equity by SG	SD for Land	SD for State Taxes	SD for Central Taxes	Cash Availability	Cummulative Cash befoer Loan	Loan	Net Cash Available	Cummulative Loan	IDC	Repayment	Balance Loan	Interest	Cash Balance
2022	2023	170							-170	173.28	30.29	29.18	38.32	101.28	101.28	-	101.28	-	-	-	-		101.28
2023	2024	616							-616	173.28	30.29	29.18	38.32	-345.13	-243.86	243.86	-	243.86	2.19	2.19	243.86		-101.28
2024	2025	645							-645	173.28	30.29	29.18	38.32	-374.43	-374.43	374.43	-	618.28	6.78	6.78	618.28		-
2025	2026	161			142	1	143	56	-75					-74.79	-74.79	161.49	86.70	779.78	9.54	9.54	779.78	5.46	81.25
2026	2027	-			311	1	312	121	190					190.34	277.04	-	277.04	779.78			779.78	10.92	179.42
2027	2028	-			339	1	340	131	209					208.94	485.99		485.99	779.78			779.78	10.92	198.03
2028	2029				369	1	371	142	229					229.08	715.06	-	715.06	779.78			779.78	10.92	218.16
2029	2030				402	2	404	153	251					251.06	966.12	-	966.12	779.78			779.78	10.92	240.14
2030	2031				440	1	441	165	276					276.10	1,242.22	-	1,242.22	779.78			779.78	10.92	265.18
2031	2032				486	2	488	183	305					305.42	1,547.65	-	1,547.65	779.78		-	779.78	10.92	294.51
2032	2033		122		538	3	541	198	222					221.80	1,769.45	-	1,769.45	779.78		-	779.78	10.92	210.88
2033	2034				581	3	584	214	371					370.58	2,140.03	-	2,140.03	779.78		-	779.78	10.92	359.66
2034	2035				627	4	631	231	400					400.19	2,540.21	-	2,540.21	779.78		-	779.78	10.92	389.27
2035	2036			12	678	4	682	250	421					420.84	2,961.05	-	2,961.05	779.78		-	779.78	10.92	409.92
2036	2037				733	5	738	270	468					467.72	3,428.77	-	3,428.77	779.78		-	779.78	10.92	456.80
2037	2038				790	5	796	292	504					503.74	3,932.51	-	3,932.51	779.78		-	779.78	10.92	492.82
2038	2039				855	5	860	316	544					544.29	4,476.79	-	4,476.79	779.78		-	779.78	10.92	533.37
2039	2040				924	6	930	342	588					588.49	5,065.28	-	5,065.28	779.78		-	779.78	10.92	577.57
2040	2041			147	998	6	1,004	370	487					486.98	5,552.26	-	5,552.26	779.78		-	779.78	10.92	476.06
2041	2042			154	1,077	6	1,083	407	523					522.64	6,074.91	-	6,074.91	779.78		-	779.78	10.92	511.73
2042	2043		238	-	1,153	8	1,161	440	483					482.63	6,557.54	-	6,557.54	779.78		-	779.78	10.92	471.72
2043	2044				1,243	8	1,251	476	775					774.63	7,332.17	-	7,332.17	779.78		-	779.78	10.92	763.71
2044	2045				1,338	9	1,347	516	831					831.09	8,163.26	-	8,163.26	779.78		-	779.78	10.92	820.17
2045	2046			19	1,442	9	1,451	559	874					873.80	9,037.05	-	9,037.05	779.78		-	779.78	10.92	862.88
2046	2047				1,554	10	1,564	605	959					958.62	9,995.67	-	9,995.67	779.78		-	779.78	10.92	947.70
2047	2048				1,675	10	1,685	655	1,030					1,029.93	11,025.60	-	11,025.60	779.78		-	779.78	10.92	1,019.01
2048	2049				1,805	11	1,816	710	1,105					1,105.35	12,130.95	-	12,130.95	779.78		-	779.78	10.92	1,094.43
2049	2050				1,944	11	1,955	770	1,185					1,185.31	13,316.26	-	13,316.26	779.78		-	779.78	10.92	1,174.39
2050	2051				2,093	12	2,105	834	1,271					1,270.71	14,586.97	-	14,586.97	779.78		-	779.78	10.92	1,259.79
2051	2052				2,255	13	2,267	916	1,351					1,351.48	15,938.45	-	15,938.45	779.78		-	779.78	10.92	1,340.56
Total		**1,593**	**360**	**332**	**26,792**	**160**	**26,951**	**10,321**	**14,345**	**519.85**	**90.86**	**87.53**	**114.96**	**15,158.68**	**1,50,667.46**	**779.78**	**1,51,447.24**	**21,916.07**	**18.52**	**18.52**	**21,916.07**	**289.30**	**15,649.15**
									16.85%														

Table no. 16.18:- Cash flow of DFBOT Model (without PD)

Financial Year	Completion Cost	VGF	Concessionaire Cost	Additional Cost	Replacement Cost	Fare Box Revenue	Non Fare Box	Total Revenue	Running Exp	Net Cash Flow	Concessionaire Equity	Availability of cash	Cummulative Cash	Cummulative Loan	Loan	IDC	Cummulative Loan Including IDC	Repayment	Bal Loan	Int	Cash Balance
2022 - 2023	169.79	30.29	139.50	-	-	-	-		-	-139.50	139.50	-0.00	-0.00	0.00	0.00	0.00	0.00		0.00		-139.50
2023 - 2024	616.20	30.29	585.91	-	-	-	-		-	-585.91	150.21	-435.70	-435.70	435.70	435.70	21.79	457.49		457.49		-150.21
2024 - 2025	645.49	30.29	615.21	-	-	-	-		-	-615.21	150.21	-465.00	-900.70	900.70	465.00	66.82	989.31		989.31		-150.21
2025 2026	161.49	-	161.49	-	-	142.24	0.74	142.99	56.28	-74.79	10.71	-64.08	-964.78	964.78	150.78	93.84	1,233.93		1,233.93	61.70	25.01
2026 - 2027	-	-	-	-	-	310.90	0.94	311.83	121.50	190.34							1,233.93	123.39	1,110.54	117.22	-50.28
2027 - 2028	-	-	-	-	-	338.97	1.15	340.12	131.17	208.94							1,233.93	123.39	987.14	104.88	-19.33
2028 - 2029	-			-	-	369.35	1.38	370.73	141.66	229.08							1,233.93	123.39	863.75	92.54	13.14
2029 - 2030	-			-	-	402.45	1.63	404.08	153.02	251.06							1,233.93	123.39	740.36	80.21	47.46
2030 - 2031	-			-	-	440.08	1.35	441.43	165.33	276.10							1,233.93	123.39	616.96	67.87	84.84
2031 - 2032	-			-	-	486.22	2.20	488.42	182.99	305.42							1,233.93	123.39	493.57	55.53	126.50
2032 - 2033	-			121.70	-	538.12	3.07	541.18	197.68	221.80							1,233.93	123.39	370.18	43.19	176.92
2033 - 2034	-			-	-	580.70	3.49	584.19	213.61	370.58							1,233.93	123.39	246.79	30.85	216.34
2034 - 2035	-			-	-	627.11	3.94	631.06	230.87	400.19							1,233.93	123.39	123.39	18.51	258.28
2035 - 2036	-			-	11.66	677.65	4.44	682.09	249.59	420.84							1,233.93	123.39	0.00	6.17	302.94
2036 - 2037	-			-	-	732.64	4.97	737.61	269.89	467.72							1,233.93		0.00	0.00	467.72
2037 - 2038	-			-	-	790.43	5.22	795.65	291.91	503.74							1,233.93		0.00	0.00	503.74
2038 - 2039	-			-	-	854.61	5.48	860.09	315.80	544.29							1,233.93		0.00	0.00	544.29
2039 - 2040	-			-	-	924.46	5.75	930.21	341.72	588.49							1,233.93		0.00	0.00	588.49
2040 - 2041	-			-	146.83	997.61	6.04	1,003.65	369.85	486.98							1,233.93		0.00	0.00	633.80
2041 - 2042	-			-	154.17	1,077.13	6.34	1,083.48	406.66	522.64							1,233.93		0.00	0.00	676.81
2042 - 2043	-			238.05	-	1,152.74	8.06	1,160.80	440.12	482.63							1,233.93		0.00	0.00	720.69
2043 - 2044	-			-	-	1,242.58	8.47	1,251.05	476.42	774.63							1,233.93		0.00	0.00	774.63
2044 - 2045	-			-	-	1,338.02	8.89	1,346.91	515.83	831.09							1,233.93		0.00	0.00	831.09
2045 - 2046	-			-	19.00	1,442.07	9.33	1,451.40	558.61	873.80							1,233.93		0.00	0.00	892.79
2046 - 2047	-			-	-	1,553.87	9.80	1,563.67	605.05	958.62							1,233.93		0.00	0.00	958.62
2047 - 2048	-			-	-	1,675.13	10.29	1,685.42	655.49	1,029.93							1,233.93		0.00	0.00	1,029.93
2048 - 2049	-			-	-	1,804.81	10.80	1,815.61	710.26	1,105.35							1,233.93		0.00	0.00	1,105.35
2049 - 2050	-			-	-	1,943.72	11.34	1,955.07	769.76	1,185.31							1,233.93		0.00	0.00	1,185.31
2050 - 2051	-			-	-	2,093.18	11.91	2,105.09	834.38	1,270.71							1,233.93		0.00	0.00	1,270.71
2051 - 2052	-			-	-	2,254.76	12.51	2,267.27	915.79	1,351.48							1,233.93				1,351.48
Total	**1,592.98**	**90.86**	**1,502.12**	**359.75**	**331.65**	**26,791.57**	**159.53**	**26,951.10**	**10,321.25**	**14,436.33**	**450.63**	**-964.78**	**-2,301.18**	**2,301.18**	**1,051.48**	**182.45**	**34,762.90**	**1,233.93**	**8,233.41**	**678.66**	**14,277.34**
																					21.57%

Chapter -17
Economic Appraisal

17.1 Introduction to PRT & Economic Appraisal Process

17.2 Values Adopted for Some Important Variables

17.3 Economic Benefit Stream

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CHAPTER 17
ECONOMIC APPRAISAL

17.1 INTRODUCTION TO PRT & ECONOMIC APPRAISAL PROCESS

Personal rapid transit (PRT), also referred to as pod cars, is a public transport mode featuring small automated vehicles operating on a network of specially built guideways. PRT provides a taxi-like service for individual or small group of travellers. It provides as demand responsive feeder and shuttle service connecting major facilities such as shopping, tourist attractions, and centres. The system uses automated electric driven pod cars with capacity of 4 to 6 peoples on a network of narrow segregated guide ways in order to ensure unhindered direct trips between origin and destination. With high vehicle speeds and very small headways, PRT provides fast, individual, on-demand and point-to-point PT with very short waiting times. This system is proposed in the Haridwar city. The system will provide on-demand operations, direct origin to destination stop services, and congestion free transport due to operating on segregated guide-ways and the economics of this system are analysed herein.

Economic benefits are social and environmental benefits which are quantified and then converted into money cost and compared to the cost of construction and maintenance for deriving Economic Internal Rate of Return (EIRR). When actual revenue earned from fare collection, advertisement and property development are discounted against construction and maintenance cost, interest (to be paid) and depreciation cost, Financial Internal rate of Return (FIRR) is obtained. Therefore, EIRR is viewed from socio-economic angle while FIRR is an indicator of pure financial profitability and viability of any project.

Economic appraisal of a project starts from quantification of measurable economic benefits in economic money values, which are basically the savings of resource cost due to introduction of the PRT system. Economic savings are derived from the difference of the cost of the same benefit components under ‘with’ and ‘without’ PRT system.

In transport construction projects, ‘without’ is taken as “base case” and ‘with’ implies ‘alternative case’. In ‘alternative case’ a portion of traffic on the road is diverted to a new system which is estimated first. Then the difference between maintenance & construction cost for ‘base case’ and for ‘alternative case’ which is known as relative road agency cost (RAC) is derived. Difference between road user cost for ‘base case’ and of ‘alternative case’ is also derived which is known as relative road user cost (RUC). Difference between RAC and RUC calculated for each year generates net benefit stream. Economic indicators (EIRR, BC Ratio, NPV) are then obtained.

In PRT projects, same principle is followed but procedure is slightly different. Here, diverted traffic is nothing but the passengers shifted from road based modes to PRT. Travel time saving is the difference between time which would be taking on PRT and road based transports for same distance. Fuel cost saving is the difference between the cost of the fuel burnt on road based modes by the shifted passengers and the energy cost of running the PRT which is a part of the maintenance cost. Thus, the benefits are directly obtained by correlating with them with the passenger km (ridership and average trip length is multiplied to get passenger km). As is done in highway projects, net benefit is obtained by subtracting the cost of the project (incurred for construction (capital) and maintenance (recurring) costs for the PRT system) from the benefits derived from pass km savings in each year. The net benefit value which would be negative during initial years becomes positive as years pass. Internal rate of return and benefit cost ratio are derived from the stream.

The sources from where economic savings occur are identified first. Although there are many kinds of primary, secondary and tertiary benefits, only the quantifiable components can be taken to measure the benefits. These components are quantified by linking with the number of passengers shifted and the passenger km saved by the trips which are shifted from road/ rail based modes to PRT. It may be observed that first three (No. 3-5, given in Table 17.1) are direct benefits due to shifting of trips to PRT, but other secondary benefit components are due to decongestion effect on the road, reduction of emission, accident, saving of fuel and time by remaining road passengers and road maintenance cost.

Cost components are first estimated applying market values then distributed year wise after applying escalation factors. Tax components are also added for arriving at real completion cost. For financial analysis these exercises are necessary, but for economic analysis all additional cost components are to be removed.

Values of Benefit components are mostly economic values except fuel and vehicle maintenance cost which are estimated from market cost. Economic factors as per Appraisal Guidelines for Metro Rail Project Proposals, 2017; which are used for each cost/ benefit component are also given in table 17.1. Overall economic value of benefit components is 97.81% of the actual (financial) estimated value whereas overall economic value of cost components is 86.28% of the actual (financial) estimated cost.

Table 17-1 Cost-Benefit Components due to PRT

S. No.	Cost/ Benefit Components	Economic Factors*
1	Construction Cost	83%
2	Maintenance Cost	87%
3	Annual Time Cost Saved by PRT Passengers	100%
4	Annual Fuel Cost Saved by PRT Passengers	90%

5	Annual Vehicle Operating Cost Saved by PRT Passengers	90%
6	Emission Saving Cost	100%
7	Accident Cost Saving	90%
8	Annual Time Cost Saved by Road Passengers	100%
9	Annual Fuel Cost Saved by Road Passengers	90%
10	Annual Infra Structure Maintenance Cost	87%

** As per Appraisal Guidelines for Metro Rail Project Proposals, 2017*

17.2 VALUES ADOPTED FOR SOME IMPORTANT VARIABLES

Benefit components are converted (by applying appropriate unit cost) to money values (Rs.). Derivation procedures of some of the values used for economic analysis are shown in Table **17.2.**

Table 17-2 Values Adopted for Some Important Variables

S. No.	Important variables	Values
1	Value of travel time is estimated from the weighted average income of the population for base year 2017	Rs. 1.66/min
2	Adopted value of Petrol, Diesel and CNG	Table 17.5
3	Vehicle Operating Cost per km (Derived from Life Cycle Cost of different passenger vehicles)	Table 17.3
4	Emission (gm/km as per CPCB and UK Norms) Saving Cost (adopted for Indian conditions in Rs./tonne).	Table 17.4
5	Fuel prices used (Rs./litre or Rs./kg)	Table 17.5
6	Accident Rate (No of fatal and all accidents per one Cr. km)	Table 17.6
7	Fuel Consumption of vehicles at a given speed is derived from Road User Cost Study Model (CRRI-2010)	Graph 17.1
8	Infra-Structure Maintenance Cost is derived from published values on annual expenditure on roads and traffic and annual vehicle km	Rs. 0.5/ vehicle-km
9	Average Journey Time Saved for average trip length (km) journey after Shifting (Derived from modal split -Table 17.8 and speed and delay survey)	8.2 minutes
10	Average Journey Speed (Speed and delay Survey)	18.93 kmph

Table 17-3 Vehicle Operating Cost (VOC) in Rs. In 2014

Per Vehicle-km	Bus	Four Wheeler (Large)	Four Wheeler (Small)	Two Wheeler	Three Wheeler (Auto)	Mini Bus
Maintenance Cost	5.97	2.47	1.68	0.57	1.25	2.66
Capital Cost	4.81	2.14	1.34	0.18	0.72	3.43
Vehicle Operating Cost (VOC)	10.77	4.61	3.01	0.75	1.97	6.10

Table 17-4 :Vehicle Emission (gm/lit.) as per CPCB (2011-2021) and Treatment Costs

Vehicle	CO	HC	NO_X	PM	SO_2	CO_2
Bus	3.72	0.16	6.53	0.24	0.025	10.68
Two Wheeler-2 Stroke	1.4	1.32	0.08	0.05	0.003	2.85
Two Wheeler-4 Stroke	1.4	0.7	0.3	0.05	0.003	2.45
Minim Bus	2.77	0.83	8.26	0.58	0.02	12.46
Four Wheeler (Small)	2.33	0.15	0.12	0.02	0.003	2.62
Four Wheeler (Large)	0.71	0.05	0.45	0.05	0.003	1.26
Tata Magic	1.24	0.17	0.58	0.17	0.01	2.16
Three Wheeler (Auto)	2.45	0.75	0.12	0.08	0.006	3.41
Treatment Cost (Rs./tonne)	100000					500

Table 17-5 Fuel Prices in Haridwar

Fuel Type	Fuel Prices (As on 09.06.2021)
Petrol (Rs./l)	92.55
Diesel (Rs./l)	85.67
CNG (Rs./kg)	38.18

Table 17-6 Unit Cost of Accident in 2004 and Rate of Accident in Haridwar

Type of Accident	Cost (Rs.) *	Rate per Year (Rs.) **
Fatal accidents	4,37,342	199
All other type of accidents	64,256	294

Source:
** Appraisal Guidelines for MRPs, MoHUA*
*** Comprehensive Mobility Plan for Metropolitan Area focusing Dehradun-Haridwar-Rishikesh*

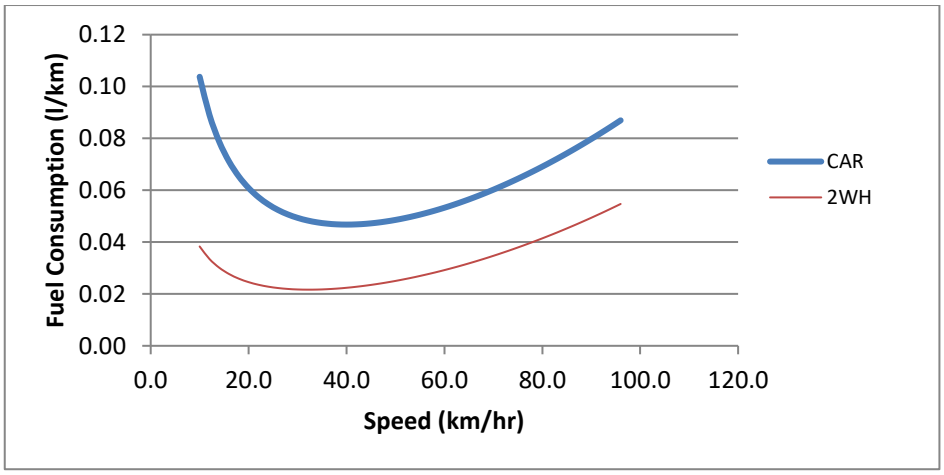

Figure 17-1: Fuel Consumption Curve against Speed for Car and Two-Wheeler

Traffic demand estimates used for economic analysis are given in the Tables below.

Table 17-7 Summary of the Proposed PRT Ridership in Haridwar

Particulars	2025	2031	2041	2051
PRT Trips/day	1,22,230	1,56,387	2,07,433	2,67,310
Average Trip length	3.77	3.81	4.36	4.40
Passenger-km	4,61,282	5,95,834	9,04,408	11,76,164
Passenger-km/km	22,241	28,729	43,607	56,710

Mode share obtained from Household Survey data is shown in table.

Table 17-8 Existing Modal Split in the Study Area

Modes	Modal Split
Bus	5.90%
Cycle Rickshaw	2.40%
Car	21.30%
E-Rickshaw	11.60%
Two Wheeler	38.50%
Shared Auto	20.30%

Source: Household Survey in 2017

17.3 ECONOMIC BENEFIT STREAM

For deriving the values of economic indicators (EIRR, NPV, BCR), cost and benefit stream table is constructed in terms of money value. Socio-Economic Benefits are first quantified and converted in to money cost. All Benefit component values (economic) accrued between the years 2025-2052 are shown in figure 17.2 which shows that benefits are mainly coming from saving of travel time by PRT and road passengers (79.20%), fuel saving cost (7.37%), vehicle maintenance cost (9.85%) and Environmental benefit from emission reduction, accident reduction and road maintenance cost (altogether) is 3.57%.

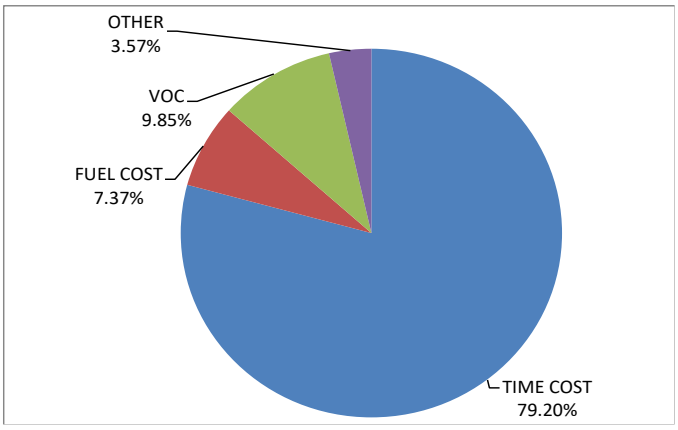

Figure 17-2: Percentage of Benefits

Benefits are obtained directly from the projected passenger-km saved for the horizon years (shown in table 17.6) and the values for other years are interpolated and extrapolated on the basis of projected traffic. Benefit Components Stream for proposed line is shown in Table 17.9

Table 17-9 Component-wise Stream of Economic Benefit Value at Economic Rates

From	To	Annual Travel Time Cost Save by PRT Passenger in Cr. Rs.	Annual Vehicle Operating Cost Save by PRT Passengers in Cr. Rs.	Annual Fuel Cost Save by PRT Passengers in Cr. Rs.	Annual Emission Cost Saving in Cr. Rs.	Annual Accident Cost Saving in Cr. Rs.	Annual Travel Time Cost Save by Road Passenger in Cr. Rs.	Annual Fuel Cost Save by Road Passengers in Cr. Rs.	Annual Infrastructure Cost Saving in Cr. Rs.	Total Benefits in Cr. Rs.
2025	2026	89.6	21.1	20.7	3.2	3.1	12.4	1.2	3.5	154.8
2026	2027	100.3	23.1	21.8	3.5	3.4	13.3	1.2	3.9	170.5
2027	2028	112.3	25.3	23.0	3.8	3.6	14.4	1.2	4.2	187.9
2028	2029	125.8	27.6	24.3	4.1	3.9	15.5	1.3	4.6	207.1
2029	2030	140.9	30.2	25.6	4.5	4.2	16.8	1.3	5.0	228.5
2030	2031	157.7	33.0	27.0	4.9	4.5	18.1	1.3	5.5	252.1
2031	2032	176.6	36.0	28.5	5.3	4.8	19.5	1.4	6.0	278.2
2032	2033	197.4	38.9	29.7	5.7	5.1	21.0	1.4	6.5	305.8
2033	2034	220.6	41.9	31.0	6.2	5.5	22.6	1.5	7.1	336.4
2034	2035	246.5	45.3	32.3	6.7	5.9	24.3	1.5	7.6	370.2
2035	2036	275.5	48.9	33.7	7.3	6.2	26.2	1.5	8.3	407.6
2036	2037	307.9	52.8	35.1	7.9	6.7	28.2	1.6	8.9	449.0
2037	2038	344.1	57.0	36.6	8.6	7.1	30.3	1.6	9.7	494.9
2038	2039	384.5	61.5	38.1	9.3	7.6	32.6	1.7	10.5	545.8
2039	2040	429.8	66.4	39.7	10.1	8.1	35.1	1.7	11.3	602.1
2040	2041	480.3	71.7	41.4	10.9	8.6	37.7	1.8	12.2	664.6
2041	2042	536.8	78.5	43.2	11.9	9.2	40.6	1.8	13.2	735.1
2042	2043	590.1	84.5	44.9	12.8	9.8	43.4	1.9	14.3	801.6
2043	2044	648.7	90.9	46.6	13.9	10.5	46.5	1.9	15.4	874.4
2044	2045	713.1	97.7	48.5	15.0	11.2	49.8	2.0	16.6	953.9
2045	2046	783.9	105.1	50.4	16.2	12.0	53.3	2.1	17.9	1040.9
2046	2047	861.8	113.1	52.4	17.5	12.8	57.1	2.1	19.3	1136.1
2047	2048	947.4	121.6	54.5	19.0	13.7	61.1	2.2	20.9	1240.3
2048	2049	1041.5	130.8	56.6	20.5	14.6	65.4	2.3	22.5	1354.2
2049	2050	1144.9	140.7	58.9	22.2	15.6	70.0	2.4	24.3	1478.9
2050	2051	1258.6	151.4	61.2	24.0	16.6	74.9	2.4	26.2	1615.4
2051	2052	1383.6	162.2	63.6	26.0	17.8	80.2	2.5	28.3	1764.2

17.4 ECONOMIC COST

Total financial cost is the aggregate of construction cost (capital cost) and recurring cost. Construction cost (capital cost) is derived after considering cost of all major component such as Relocation and Rehabilitation (RR), civil construction for guideway, stations and depots, charging stations, rolling stock (Pod), manpower etc. Recurring cost includes energy cost, maintenance cost, and operation cost. These costs are inclusive of central tax and yearly escalation cost applied on fixed cost. Analysis period is taken from 2022-23 to 2051-52 out of which 4 years (2022-23 to 2025-26) are marked as construction period. During the years 2032-33 and 2042-43 additional capital will again be required. Repairing and replacement cost is envisaged in 2035-36, 2040-42 and 2045-46. Operation is expected to start in 2025-26 (4th Year). To obtain economic value of cost, all taxes and escalation factors are removed from the completion cost. Reduction factor for financial cost to economic cost is derived as 86.18%. Cost stream generated for both options are shown in the Table below.

Table 17-10 Financial and Economic Cost stream

Year Start	Year Ending	Financial Cost		Economic Cost	
		Capital Cost	Recurring Cost	Capital Cost	Recurring Cost
		Cr. Rs.	Cr. Rs	Cr. Rs.	Cr. Rs
2022	2023	169.79	0.00	140.93	0.00
2023	2024	616.20	0.00	511.45	0.00
2024	2025	645.49	0.00	535.76	0.00
2025	2026	161.49	56.28	134.04	48.97
2026	2027	0.00	121.50	0.00	105.70
2027	2028	0.00	131.17	0.00	114.12
2028	2029	0.00	141.66	0.00	123.24
2029	2030	0.00	153.02	0.00	133.13
2030	2031	0.00	165.33	0.00	143.84
2031	2032	0.00	182.99	0.00	159.20
2032	2033	121.70	197.68	101.01	171.98
2033	2034	0.00	213.61	0.00	185.84
2034	2035	0.00	230.87	0.00	200.86
2035	2036	11.66	249.59	9.68	217.14
2036	2037	0.00	269.89	0.00	234.81
2037	2038	0.00	291.91	0.00	253.96
2038	2039	0.00	315.80	0.00	274.75
2039	2040	0.00	341.72	0.00	297.30
2040	2041	146.83	369.85	121.87	321.77
2041	2042	154.17	406.66	127.96	353.80
2042	2043	238.05	440.12	197.58	382.90
2043	2044	0.00	476.42	0.00	414.49
2044	2045	0.00	515.83	0.00	448.77
2045	2046	19.00	558.61	15.77	485.99
2046	2047	0.00	605.05	0.00	526.40
2047	2048	0.00	655.49	0.00	570.28
2048	2049	0.00	710.26	0.00	617.93
2049	2050	0.00	769.76	0.00	669.69
2050	2051	0.00	834.38	0.00	725.91
2051	2052	0.00	915.79	0.00	796.74

17.5 ECONOMIC PERFORMANCE INDICATORS

After generating the cost and benefit stream table, values of economic indicators are derived and are given in Table 17.11. Project period is 2022 to 2052. On the basis of economic cost, EIRR is **11.71%,** B/C Ratio is **1.71** and NPV is **Rs. 265 Cr**. As per the ADB Guidelines, a single option project is considered viable when either the ENPV is positive or the EIRR is greater than the minimum required discount rate. For the present study, ENPV is positive (Rs. 265 Cr.) and EIRR is 11.71% vis-à-vis to the minimum required discount rate of 10%, which shows that the project is economically viable.

Table 17-11 Economic Indicator Values (2051-52)

Economic Indicators	Economic Price
Cumulative Cost (Cr. Rs.)	10,876
Cumulative Benefit (Cr. Rs.)	18,651
Benefit Cost (B/C) Ratio	1.71
NPV (Cr. Rs.)	265
EIRR	11.71%

17.6 SENSITIVITY ANALYSIS

Sensitivity of EIRR and B/C ratios was carried out and the output is given in the Table 17.12. 2051-52 is taken for the year of comparison.

Table 17-12 Sensitivity of EIRR

Sensitivity		Economic Parameter		
Traffic	Cost	EIRR	B/C	Cost (Cr. Rs.)
0%	0%	11.71%	1.71	10876
-10%	0%	10.45%	1.59	10876
-15%	0%	9.76%	1.53	10876
0%	10%	9.74%	1.54	12136
0%	15%	8.81%	1.46	12766
-10%	10%	8.41%	1.42	12136
-15%	15%	6.65%	1.30	12766

17.7 QUANTIFIED BENEFITS

Benefits which are shown in previous tables are money value of the benefits. These benefits are estimated first and the converted into money value.

Table 17-13 Estimated Environmental Benefits per Year in Metric Ton (Reduction of Vehicle Gas Emission)

Type of Emission	2025	2031	2041	2051
CO	103	130	176	231
HC	37	47	63	85
NO_X	77	94	130	179
PM	7	8	11	16
SO_2	0.31	0.38	0.51	0.68
CO_2	6,775	8,425	11,283	14,777
Total Emission	**6,999**	**8,705**	**11,664**	**15,287**

From Table 17.14, it may be seen that in 2025, due to shifting, PRT passengers time saving will be 0.6 Cr. hour, fuel saving by PRT passengers will be 6.21 thousand tons. Amount of travel in terms of passenger km reduced due to shifting to PRT Rail is equivalent to reduction of 32,599 vehicles from the road. About 1 fatal accident and 10 other accidents may be avoided. Hence it is expected that there will be some improvement of the overall ambience of the area.

Table 17-14 Estimated Travel Benefits (Reduction of Fuel, Time of Travel, Vehicle on Road etc.)

Benefits in Horizon Years	2025	2031	2041	2051
Annual Time Saved by PRT Passengers in Cr. hr.	0.6	0.9	1.7	2.6
Annual Fuel Saved by PRT Passengers in thousand tonnes.	6.21	8.56	13.33	20.37
Daily vehicles reduced (off the road)	32,599	41,380	56,090	74,096
CO_2 reduced in thousand tonnes	6.78	8.43	11.28	14.78
Other gases reduced in thousand tonnes	0.192	0.239	0.329	0.445
Reduced No. of Fatal Accidents per year	23.60	26.99	31.60	37.46
Reduced No. of Other Accidents per year	34.86	39.88	46.68	55.34
Daily Vehicle-km reduced in thousand km	1.58	2.01	2.71	3.56

Chapter -18
Implementation Plan

18.1 General

18.2 Possible Models for Financing PRT System

18.3 Recommended Financial Model

18.4 Institutional Arrangements

18.5 Implementation Strategy

18.6 Construction Strategy

18.7 High Power Committee

18.8 Legal Cover

CHAPTER 18
IMPLEMENTATION PLAN

18.1 GENERAL

Estimated cost of the project at June 2021 price level is Rs. 1419 Crore inclusive of all taxes & duties and land cost. Completion Cost with all the taxes & duties and land cost is Rs. 1593 Crore (excluding IDC) under SPV model. FIRR with and without PD income for 30 years life cycle business model including construction period works out to be 16.16% and 16.85% respectively.

18.2 POSSIBLE MODELS FOR FINANCING PRT SYSTEM

The financing option shall depend upon selection of the dedicated agency created to implement the project. The prominent models are:

(i) Special Purpose Vehicle under the State Government Control.

(ii) Design, Built, Finance, Operate & Transfer (DBFOT)

18.2.1 Special Purpose Vehicle (SPV) Model

The Government of Uttarakhand (GoUK) has already formed a SPV in the name of Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited for planning and implementation of metro rail or other similar mass rapid transport system in the State of Uttarakhand. This project may also be implemented by M/s UKMRC. The funding pattern under this model (SPV) is placed in the Table below:

Table 18-1 Funding pattern under SPV model

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by GoUk	520	40.00%
ODA loan from Multilateral / Bilateral Agency	780	60.00%
Sub-Total (A)	**1300**	**100.00%**
Land Cost to be borne by GoUk	91	
Central Taxes to be borne by GoUk	115	
State Taxes to be borne by GoUk	87	
Sub-Total (B)	**293**	
Total Cost (A+B)	**1593**	
IDC on Loan (to be borne by the GoUk)	19	
Total Cost including IDC	**1612**	

18.2.2 DFBOT Model

In this model, the private firm will be responsible for financing, designing, building, operating and maintaining of the entire project. The financing model shall depend upon selection of a dedicated agency to implement the project. The proposed corridor is a unique one and first of its kind in the country. The alignment will be fully elevated. Apart from equity contribution from the promoters, it is assumed that the funding for the project shall be achieved through market borrowings. The rate of interest on market borrowings is assumed at 10% p.a. and the repayment of the loan will start immediately after the commercial operations and repaid in 10 (ten) years. Accordingly, the funding pattern proposed is placed in table 18.4 as under:

Table 18-2 Funding pattern under DFBOT

Sources of Funds	Amount (Rs/Crore)	% of contribution
Equity by Concessionaire	451	30%
Market Borrowings by Concessionaire	1051	70%
Sub-Total (A)	**1502**	**100%**
Land Cost to be borne by GoUk	91	
Sub-Total (B)	**1593**	
IDC on Loan (to be borne by the Concessionaire)	182	
Total Cost including IDC	**1775**	

The total fund to be contributed by GoUk is shown in Table 16.13 below under SPV and DBFOT model.

Table 18-3A Fund Contribution

Rs.in crore

Particulars	SPV Model	DFBOT Model
GoUk	832	91*
Others	780	1684
Total	**1612**	**1775**

*Additional Land for PD to be arranged & provided by GoUK in case of PD option.

Since the total contribution of GoUK is lesser under DFBOT Model, therefore, the Project is recommended for implementation under DFBOT model.

18.3 RECOMMENDED FINANCIAL MODEL

For DBFOT Model, With the above funding pattern (Refer Table 18-2) and other assumptions, the FIRR & Equity IRR are as follows (Refer Table 16.9A&B,16.16 &16.18):

Table 18-3B IRR Table

Particulars	FIRR	Equity IRR
With PD	16.16%	19.80%
Without PD	16.85%	21.57%

The project is recommended for implementation under DBFOT model without additional PD as inferred from above table.

18.4 INSTITUTIONAL ARRANGEMENTS

The Government of Uttarakhand (GoUK) has already formed a SPV in the name of Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited for planning and implementation of metro rail or other similar mass rapid transport system in the State of Uttarakhand. The State Govt. of Uttarakhand may approve the implementation of the project through Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited on Government Funding or through Concessionaire on PPP Mode.

18.5 IMPLEMENTATION STRATEGY

When the project is taken up on PPP (DBFOT) mode, Uttarakhand Metro Rail, Urban Infrastructure & Buildings Construction Corporation Limited (UKMRC) may call international bids for the project and a transaction advisory firm may be appointed for evaluation of bids and selection of the concessionaire. M/s UKMRC will be responsible for overall monitoring of the project. M/S UKMRC will assist the concessionaire to obtain permissions from various department of the State Government. M/s UKMRC will also assist concessionaire in the acquisition of land required for the project.

18.6 CONSTRUCTION STRATEGY

18.6.1 Civil and other System Works

Since the project is proposed to be implement in PPP (DBFOT) mode through concessionaire bid packages of the project should be decided by concessionaire in consultation with M/s UKMRC.

18.6.2 Construction Period

The project is planned to be implemented in 3 years from November 2022 to October 2025 and Revenue Opening Date (ROD) has been assumed as 01.11.2025. Project completion date is subject to land required for the project is made available to the agency within 3 months period from date of signing of Concessionaire Agreement.

Table 18-4 Implementation Plan

S. No.	Description	Time Line
1	Date Of Award	01.11.2021
2	Date Of Financial Closure	31.10.2022
3	Construction Start Date	01.11.2022
4	Construction Period	03 Years
5	Estimated Date of Work Completion	31.10.2025
6	Date of Operation	01.11.2025
7	Concession Period	31 Years (Incl. Period for Financial closure and construction)

18.7 HIGH POWER COMMITTEE

During the implementation of the project several problems with regard to acquisition of land, diversion of utilities, shifting of structures falling on the project alignment, rehabilitation of project affected persons, etc. are likely to arise. For expeditious resolution of these problems, an institutional mechanism needs to be set up at the State Government level. Towards this end, it is recommended that a High-Power Committee under the chairmanship of Chief Secretary, Uttarakhand should be set up. Other members of this Committee should be Secretaries of the concerned Departments of the State Government and Heads of civic bodies who will be connected in one way or the other with the implementation of the project. This Committee should meet once a month and sort out all problems brought before it by Concessionaire.

18.8 LEGAL COVER

There is no legislation available for Construction, Operation and Maintenance of PRT System in Uttarakhand. It is learnt that Government of Punjab has enacted legislation in this regard. Government of Uttarakhand may also enact legislation on similar line for Construction, Operation and Maintenance of PRT System in Haridwar (Uttarakhand) in cognisance of international practices.

Chapter -19
Conclusions and Recommendations

19.1 General

19.2 Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR)

CHAPTER 19
CONCLUSION AND RECOMMENDATION

19.1 GENERAL

Public Transit Projects are highly capital intensive on account of the high costs involved. Due to the need to maintain a fare structure within the affordable reach of ordinary citizens, Transit projects are ordinarily not financially viable. However, Haridwar being gateway city Uttarakhand and Yoga Capital of the world thousands of domestic and international tourists visit the city annually. There is no organized, safe, reliable, secure, comfortable and efficient mode of Public Transit available in the city. People are largely depending upon cycle rickshaws, e-rickshaws, autorickshaws and Vikrams for commuting. Which neither cost effective nor comfortable. Considering the economic growth of the city implementation of PRT System on selected four corridors is strongly recommended.

The proposal of the corridors is technically feasible but involves acquisition of land as well as rehabilitation of some shops. This is a socio-economic problem and has to be tackled for execution of the project.

Estimated Cost of the project at June 2021 price level is ₹1,419 Crore with all the taxes & duties and land cost. Whereas, Completion Cost (by Sept 2025) works out to ₹1,593 Crore excluding IDC.

The project has many positive environmental impacts like reduction in traffic congestion, saving in travel time, reduction in noise pollution, lesser fuel consumption, lesser road accidents etc, with a few negative impacts (especially during implementation phase of the project) for which Environmental Management Plan has been suggested.

After examining the various options for execution of the project, it has been recommended that the project should be got executed through a concessionaire on PPP (DFBOT) mode.

The fare structure has been prepared based on primary survey conducted in Haridwar. Subsequently, for the purpose of assessing returns from the project, the fares have been revised each year with an escalation of 5%.

19.2 FINANCIAL INTERNAL RATE OF RETURN (FIRR) AND ECONOMIC INTERNAL RATE OF RETURN (EIRR)

The Financial Internal Rate of Return (FIRR) for the project with central taxes has been assessed as **16.16% and 16.85% with and without PD.**

The Economic Internal Rate of Return (EIRR) at present rate works out to **11.71%.** It seems to be on lower side, as major portion of modal shift passenger in PRT system is from Cycle Rickshaw & E-rickshaw etc and their contribution in economic benefits is very small.

Meanwhile the State Government should freeze all future developments along the proposed corridors to avoid in-fructuous expenditure.

To avoid delays in processing the clearance for the Project, UKMRC Board should approve project on receipt of the DPR and forward the DPR to Government of Uttarakhand, advising to take up the Project on **DFBOT** Model as recommended in Financial Analysis.

22/08/2022
Camlcinl