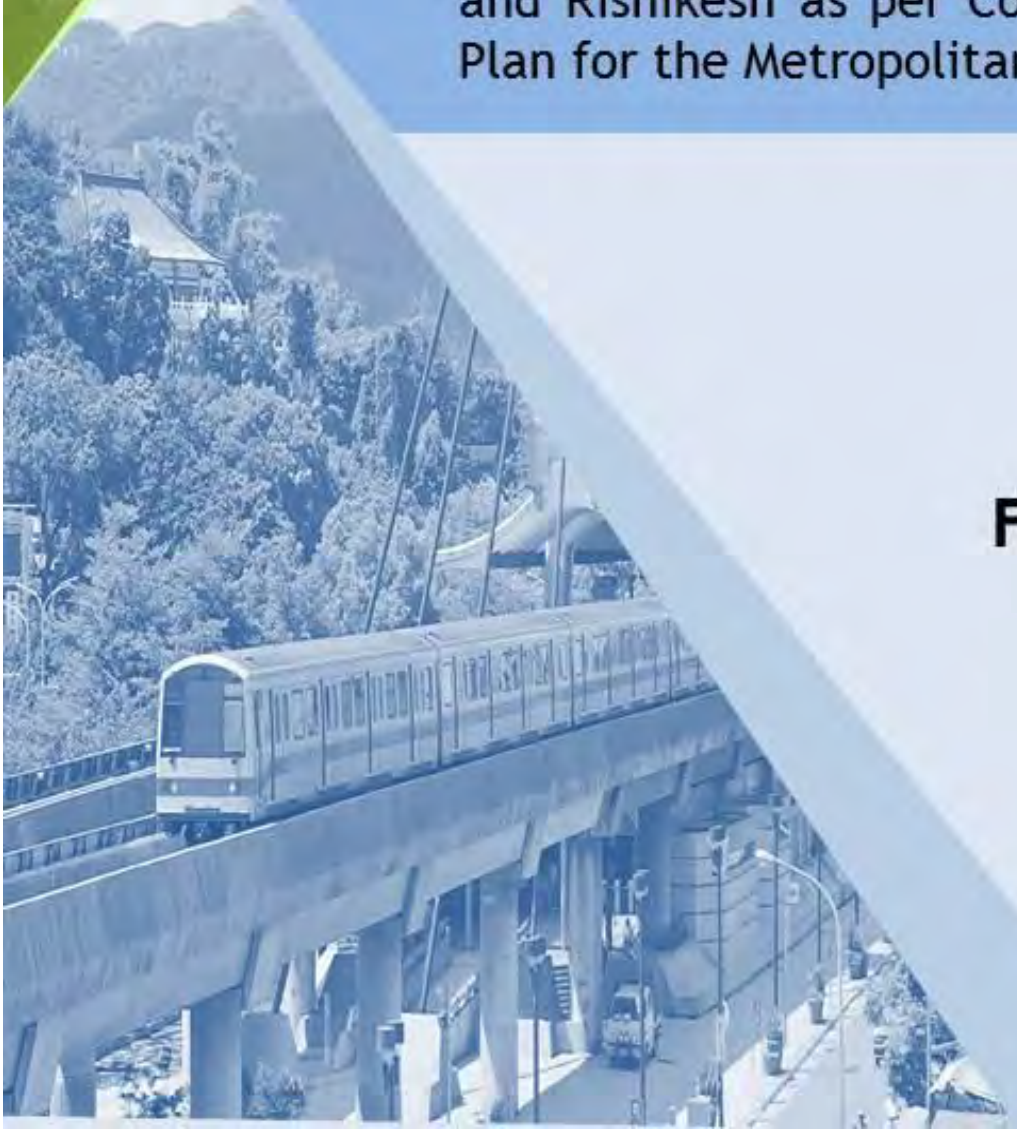
Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited

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

(REVISED)

July 2019

Urban Mass Transit Company Limited

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Quality Management

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LIST OF ABBREVIATIONS

AA	Alternatives Analysis
BRT	Bus Rapid Transit
CMP	Comprehensive Mobility Plan
DPR	Detailed Project Report
GoI	Government of India
GoUK	Government of Uttarakhand
IPT	Intermediate Para Transit/Intermediate Public Transit
ITES	Information Technology Enabled Services
LRT	Light Rail Transit
MOHUA	Ministry of Housing & Urban Affairs
MoUD	Ministry of Urban Development
MRTS	Mass Rapid Transit System
NH	National Highways
NMV	Non - Motorized Vehicles
NUTP	National Urban Transport Policy
PPH	Persons per hectare
PPHPD	Passengers Per Hour Per Direction
PPP	Public Private Partnership
PRT	Personal Rapid Transit
PWD	Public Works Department
RTO	Regional Transport Office
SADA	Doon Valley Special Area Development Authority
SH	State Highways
UKMRCL	Uttarakhand Metro Rail Urban Infrastructure & Building Construction Corporation
ULBs	Urban Local Bodies
UMTC	Urban Mass Transit Company
VGF	Viability Gap Funding

DISCLAIMER

This document has been prepared for 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 for UKMRCL** and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of UMTC being obtained. UMTC accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify UMTC for all loss or damage resulting there from. UMTC accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

CHAPTER 1

NEED FOR STUDY

1. NEED FOR STUDY

1.1 BACKGROUND

The country is witnessing rapid urban development due to the boost in the infrastructure development sector due to various ongoing urban development schemes, promoting growth and development all over the country. This rapid urbanization with lack of a comprehensive planning has led to transport problems such as congestion, increase in traffic accidents and pollution to the environment. Although the state and local government have been making efforts to improve urban transport, problems have been exacerbated to a large extent by the rapidly increasing number of private vehicles.

Uttarakhand Metropolitan Area, like all other cities in India, is experiencing increased dependency on private motor vehicles for personal trips, leading to increased vehicular congestion and emissions. As per the recent CMP study, the present travel demand in the area is 27.7 lakhs trips per day which are estimated to be about 43.9 lakhs trips per day in 2048. The previous transport studies including the CMP also indicate inadequate transportation infrastructure, lack of organized public transportation services and hence increasing private vehicles especially two wheelers, at present. The situation would get worse in the future with increased demand due to the investments in secondary sectors and tourism industry.

Uttarakhand Metro Rail Urban Infrastructure & Building Construction Corporation Limited (UKMRCL) is in the stage of planning a mass transit system in Dehradun city and a corridor connecting the complete Metropolitan Area with focus on Dehradun, Rishikesh and Haridwar. As a part of this, UKMRCL has awarded Urban Mass Transit Company Limited (UMTC) to conduct Alternatives Analysis Study for first order transit corridors: North-South (N-S) and East-West (E-W) corridor in Dehradun city, Corridor connecting Dehradun-Rishikesh-Haridwar and Second order transit corridors in Dehradun, Rishikesh and Haridwar cities.

The new Metro Policy 2017 underlines several pre-requisites to be full filled in order to submit a valid and acceptable Metro Rail Project Proposal to the Ministry of Housing and Urban Affairs (MoHUA). These are:

a) Preparation of Comprehensive Mobility Plan (CMP)/up-dating of an existing CMP
b) Preparation of Alternatives Analysis Report
c) Preparation of Detailed Project Report including detailed economic analysis

The Comprehensive Mobility Plan for Uttarakhand Metropolitan Area was submitted to UKMRCL in October 2018 which is under consideration for approval by the State Government. An Alternatives Analysis Report needs to be prepared to select the transit corridor and transit mode before the preparation of detailed project report.

The Draft Report for the Alternatives Analysis was submitted on 28th December 2018 to UKMRCL, following which the Stakeholder's Consultation was held on 7th January 2019. This document is prepared as final report of Alternatives Analysis Study after incorporating the suggestions received from the Client and the Stakeholders.

1.2 GUIDELINES FOR ALTERNATIVES ANALYSIS

The Alternatives Analysis study has been done for both first order and second order transit corridors as proposed in CMP study. For first order transit corridor, Alternatives Analysis will be done to select most suitable and appropriate mass rapid transit mode along the suitable corridor connecting North-South and East-West corridor in Dehradun city and Corridor connecting Dehradun, Rishikesh and Haridwar.

For second order corridors, Alternatives Analysis is performed to select most suitable transit mode in suitable corridors in Dehradun, Rishikesh and Haridwar Cities.

The analysis will be performed considering following key objectives:

a) Ensure that reasonable transportation alternatives are considered
b) Evaluate major impacts due to the project
c) Consider opinion of stakeholders
d) Select the locally preferred alternative

1.3 OVERVIEW OF STUDY AREA

Uttarakhand Metropolitan Area which comprises cities like Dehradun, Rishikesh and Haridwar, is one of the major attraction centers of the state. Dehradun is the interim capital of the state and also an educational hub; Rishikesh is considered as the "*Yoga Capital of the World"* and Haridwar is regarded as one of the seven holiest places to Hindus. Apart from being the major tourist attractions, the cities are also expanding due to high investment in secondary sectors. These cities are located at the south west corner of the state.

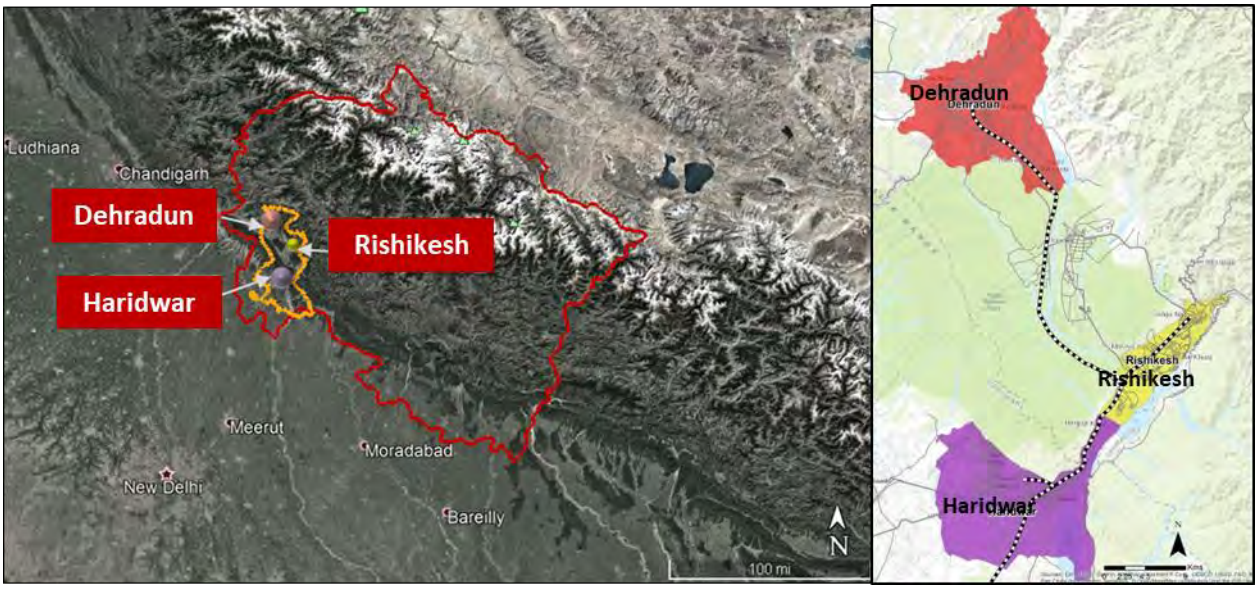


Figure 1-1: Location of Uttarakhand Metropolitan area and Major Cities within it

Dehradun, the interim capital city of Uttarakhand is located in the Garhwal region; it lays 236 kms north of India's capital New Delhi and 168 kms from Chandigarh. It mainly lies in Doon Valley and is at a varying height from 410 m in Clement Town to above 700 m at Malsi which is 15 km from the city. However, the average elevation is 450 m above sea level. It has been a premier educational and institutional center for

a long time. Dehradun became the administrative capital of the new state Uttarakhand only in 2003 and this sudden change in status to a capital city boosted its growth.

Rishikesh, the Yoga capital of India, is approximately 43 km southeast of state capital Dehradun and 25 km north of the city of Haridwar. Rishikesh is the starting point for travelling to the four Chota Char Dham pilgrimage places — Badrinath, Kedarnath, Gangotri, and Yamunotri. Along with the religious importance, the city is also known for its Ashrams flourishing due to the serene environment. The tourists visiting Rishikesh generally stay for longer duration compared to the other cities for the same reason. One of the key influentials of growth in Rishikesh apart from the tourism industry was the establishment of Indian Drugs and Pharmaceuticals Ltd.

Haridwar is situated along Delhi-Niti Pass (DN Road) which starts from Delhi and passes through Meerut, Muzzafarnagar, Roorkee, Haridwar and goes till India-Tibet Boundary. The town of Haridwar grew between the Shivalik Mountain Range in the North and Northeast and Ganga River in the South. Haridwar is located at a distance of 225 kms Northeast from Delhi, 52 kms from Dehradun and 494 kms from Lucknow. It is the second most populous cities of Uttarakhand after the capital city of Dehradun.

(a) (b) (c)

Figure 1-2: Cities in Study Area - (a) Dehradun-Clock Tower, (b) Rishikesh, (c) Haridwar - Har ki Pauri

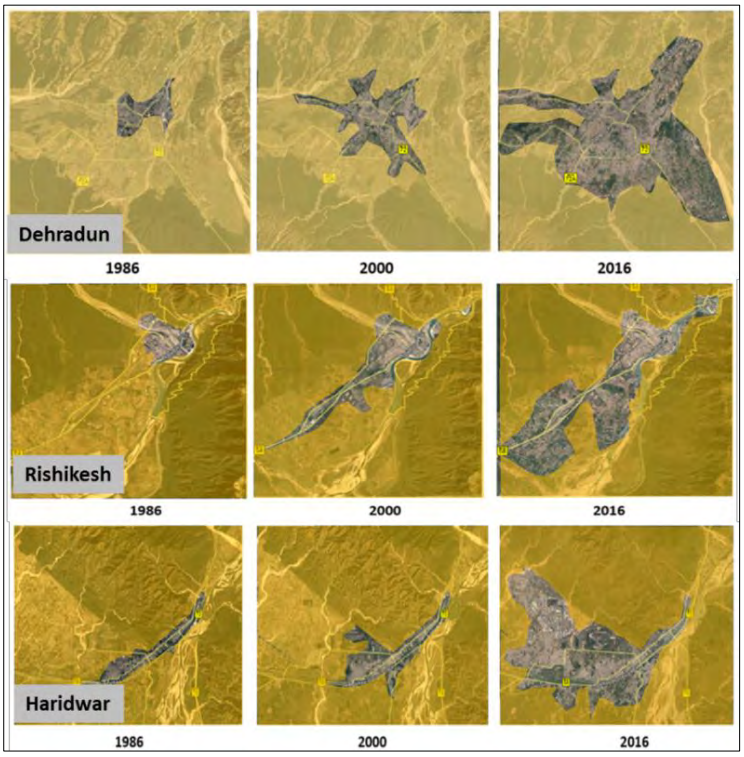


Figure 1-3: Growth of Dehradun, Rishikesh and Haridwar in last 3 decades

The Characteristic feature of land utilization pattern of the Metropolitan Area covering Dehradun – Haridwar – Rishikesh city is the predominance of hills basically the Himalayan range and water body which is River Ganga flowing through the region. The three major cities falling under the metropolitan area are the Municipal Corporations of Dehradun with a population of 5.7 lakhs, Haridwar with a population of 2.3 lakhs and Rishikesh with a population of 70 thousand as per 2011 census. The cities have developed in organic manner with the increasing population leading to higher densification in core area and newer developments in the periphery causing expansion of cities.

The growth directions and expansion of the cities in the past 3 decades are given in Figure 1-3.

CMP for Uttarakhand Metropolitan Area, in order to improve mobility pattern of the region, has identified various corridors for dedicated public transport system. Out of which a few corridors are suggested for first order transit corridor which have high demand, suitable to provide Mass Rapid Transit modes. The proposals for first order transit option are given in the Table 1-1.

Table 1-1: First Order Transit Corridors

Corridors	Transit Order	Length (km)	PHPDT (2048)	Ridership (2048)
Dehradun				
N-S: Khandoli to ISBT	First	9.6	6408	149479
N-S: Along Canal road	First	12.7	7559	150172
N-S: Along Mussoorie Road till Pacific Mall	First	12.8	7484	143914
E-W: Forest Research Institute (FRI) to Vidhan Sabha/Rispana	First	10	7563	183562
E-W: FRI to Raipur	First	13.8	5212	162665
Corridor Connecting Dehradun – Haridwar - Rishikesh				
Haridwar to Rishikesh	First	33	4455	89115
Dehradun to Rishikesh	First	45	3372	67446
Dehradun to Haridwar	First	59	5867	146658

All the first order transit corridors are under consideration for Alternatives analysis. It is observed that the first order transit corridors in Haridwar and Rishikesh city form the part of the corridor connecting Dehradun-Rishikesh- Haridwar. Thus, the Alternatives analysis for the first order transit corridors will be performed for three corridors: -

1. **Corridor 1**: North south Corridor in Dehradun city
2. **Corridor 2**: East West Corridor in Dehradun city
3. **Corridor 3**: Corridor connecting Dehradun-Rishikesh-Haridwar

The CMP has also proposed corridors which have demand lesser than what is required to provide a mass rapid transit mode but high enough to require an organized transit option. The second order transit corridors are given in Table 1.2:

Table 1-2: Second Order Transit Corridors

Corridors	Transit Order	Length (km)
Dehradun		
Banjarawala - Kargi - Gularghati (existing)	Second	35
Bhagwantpur - Supply Bus Stop (proposed)	Second	4.5
Clement Town – ISBT (proposed)	Second	2.9
Dehradun - Doiwala (existing)	Second	4.7
Dehradun - Raipur - Maldevta (existing)	Second	21.3
DL Road - Defence Colony (existing)	Second	17.2
ISBT - Parade Ground - Sahastrdhara (existing)	Second	8.9
Kolaghad - Vidhansabha (existing)	Second	10
MDDA - Dalanwala - Dathmandir (existing)	Second	4.1
Parade Ground - Prem Nagar - Parbal (existing)	Second	17.1
Parade Ground - Pelio Mankasind - Naya Gaav (existing)	Second	30.4
Prashant Colony - Bus Stand Raipur (proposed)	Second	2.3
Prem Nagar - Gularghati (existing)	Second	22.7
Premnagar - Raipur (existing)	Second	18.9
Premnagar - Chowkicholas (existing)	Second	9.7
Purkalgaon - Mothrovala (existing)	Second	18.4
Rajpur - Clement Town (existing)	Second	26
Seemadhar - Nalapani (existing)	Second	9.6
Thana Cantt - Ballupur - ISBT - Rispanapul - Subhash Road Parade Ground (existing)	Second	23.1
Haridwar		
Haridwar Railway Station - SIDCUL Area	Second	20.7
Haripur Kalan – Indian Overseas Bank in Sarai, Jwalapur	Second	17.6
Rishikesh		
ISBT -Railway Station-Raiwala station	Second	11.54

All the second order transit corridors are under consideration for the Alternative analysis.

1.4 LIMITATION OF THE STUDY

The study is based on the primary survey data collected for the CMP Study along with all necessary secondary data and information. No separate primary data collection has been carried out for the Alternatives Analysis study.

1.5 REGIONAL GOALS AND OBJECTIVES

1.5.1 COMPREHENSIVE MOBILITY PLAN FOR UTTARAKHAND METROPOLITAN AREA

The Comprehensive Mobility Plan was prepared for Uttarakhand Metropolitan area including the areas of Dehradun, Rishikesh, Haridwar and Roorkee covering an area of 2108.21 sqkm. The vision of the CMP was

"to attain a People Centric Urban Transport System through an integrated, efficient, livable and sustainable transport system for providing safe and convenient mobility to people of all abilities and goods". To realize this vision, the following goals were formulated:

- Develop public transit system in conformity with the land use that is accessible, efficient and effective
- Ensure safety and mobility of Pedestrian and cyclist by designing streets and areas that make a more desirable, livable city for residents and visitors and support the public transport system
- Develop traffic and transport solutions that are economically and financially viable and environmentally sustainable for efficient and effective movement of people and goods
- Assess the Parking need & suggest alternate solution that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles

Detailed plans were developed for Land use and Transport strategy, Road Network Development Strategy, Public Transport Strategy, Non-Motorized Transport Strategy, Traffic Engineering and Management Strategy, Demand Management Strategy, Technological Strategy.

1.5.2 DEVELOPMENT PLAN

1.5.2.1 DEHRADUN MASTER PLAN

Dehradun Mussoorie Development Area was notified under the provision of UP Urban Planning and Development Act 1973 in October 1984. This included the urban areas of Dehradun and Mussoorie and 185 revenue villages. Then the Dehradun- Mussoorie Development Authority was constituted for planning and development of the area.

Two Master Plans have been prepared for Dehradun. The first Master Plan was for 1982-2001 which came into effect in 1982. The Second master plan was for the horizon 2005- 2025. The total planning area covered is approximately 358.67 sqkm. The projected population is of 15.30 lakhs by 2025. The Master plan 2005-2025 also identified areas where deviation in land use is observed against 2001 Master Plan. The major growth envisioned by MDDA is around the Haridwar Bypass, where MDDA gave a proposal for "Greater Doon" measuring about 450 Hectares.

In terms of Transport, the major proposals included road widening, new roads, and development of bus and truck terminals. The proposed land use for 2025 included 1517.80 hectare of land under traffic and transportation accounting to 4.23% of the total master plan area.

1.5.2.2 RISHIKESH MASTER PLAN

Rishikesh Master Plan was prepared for the year 2001 which was later extended to 2011. The planning area is spread 35 kms in length starting from Haripur Kalan in South west, passing through Raiwala, Shyampur, Veerbhadra, Rishikesh town and ending with Muni ki Reti in North east. The total population projected for 2011 was 1.8 lakhs and the area proposed for this was 29.5 sqkm. The area proposed for transport was 342.5 hectares which account to 11.57% of the total master plan area. The major transport proposals were road widening.

1.5.2.3 HARIDWAR MASTER PLAN

The revised Master Plan 2025 of Haridwar covers an area of 201.19 sq. km. It consists of Haridwar Municipal Corporation jurisdiction areas, outgrowths, industrial townships, census towns and nearby villages. For planning purpose, the whole area is divided into 8 planning units. The projected population for the year 2025 is 7.35 lakhs.

The master plan proposed 1034.22 hectare of land under traffic and transportation which is 5.14% of the total area proposed. The transport proposals included road widening, a new bypass, bus and truck terminals.

1.5.3 CITY DEVELOPMENT PLAN

1.5.3.1 DEHRADUN CDP

City Development Plan (CDP) of Dehradun was prepared as part of the initiative of Government of Uttarakhand to access funds under the JNNURM. It focuses on the municipal area of Dehradun. The objective of CDP was to provide a perspective and pathway for future development for 25 years until 2036. The CDP conceptualized the vision for Dehradun City as a "well maintained, clean, green, environment-friendly city with a character of its own defined by scenic beauty, intellectual capital, eco - friendly tourism through sustained economic growth for all of its citizens". It also gave a transport sector vision – "Economic activities shall be commensurate with excellence and supported by efficient roads and public transport for all citizens". The following strategies were identified to meet the vision -

- Ensure free flow of traffic through junction improvement, signalization, and traffic control and management measures
- To provide alternate routes, parallel roads, link roads, slip roads, ROBs for decongesting the traffic on the major traffic corridors in the city
- To provide high capacity mass transport system
- To improve conditions for all road users – and particularly for pedestrians

Based on the strategies, various projects like junction improvement, traffic management measures, flyovers, new road, increasing bus fleet, etc. were proposed.

1.5.3.2 HARIDWAR CDP

The CDP for Haridwar was revised under the Capacity Building for urban development Project (CBUD), an initiative by the Ministry of Urban development (Now Ministry of Urban Affairs and Housing) supported by World Bank. Thus the CDP was prepared for the horizon period 2015-2041 and the study area was taken as Haridwar Urban Agglomeration.

The vision of the city was framed as "the holy city of Haridwar aspires to be a city of Hope, Faith and Spirituality". CDP also gave sector wise vision. For transport sector the vision framed was "to make city a transportation node for the region with efficient road network and safe, reliable public transport system". To achieve this vision, the development goals were set as:

- Maximize the share of public transport and minimize traffic

- Minimize road accidents and improve the pedestrian related infrastructure
- Improve parking facilities across the city

The various transport projects were intelligent traffic management plans, junction improvements, road widening, pedestrian facilities, developing bus shelters etc.

1.5.4 SADA MASTER PLAN

Doon Valley Special Area includes areas such as Vikasnagar, Sahaspur, Raipur, Doiwala, Jaunpur Chamba, Narendra Nagar. SADA was established to preserve the ecological sensitive zone of the area and to promote balance development in the area.

1.5.5 SMART CITY PLAN

Dehradun Smart City Proposal envisions transforming Dehradun into an "eCity – For all" with focus on Environmental sustainability and economic vibrancy by leveraging its engaged citizens and infusing technology for proactive governance. The projects proposed are categorized in short, medium and long term. Projects like retrofitting of city buses, replacement of vikrams, junction and walkways improvements, road widening, FOBS and regional transit corridor were considered.

1.6 NEED FOR THE STUDY

As suggested in the New Metro Policy 2017, the system needs to be selected based on an Alternatives Analysis. In this regard, the purpose of this assignment is to perform the Alternatives Analysis for North-South, East-West corridors in Dehradun city and the corridor connecting Dehradun-Rishikesh-Haridwar identified in CMP and hence to suggest the most appropriate system and corridor for the proposal. This assignment will also perform an Alternatives Analysis for the second order transit corridors as mentioned in the

Table 1-2.

The present demand of 27.7 lakhs trips per day in Uttarakhand Metropolitan area and the inadequate transport infrastructure have worsened the transport situation of the city. The lack of organized public transportation has made travel a cumbersome experience for the citizens. With rapid urbanization, growing secondary and tourism industry, this demand will have steep rise which will add stress to the already strained infrastructure.

As mentioned in the previous section, CMP suggested certain corridors for Mass Public Transit Systems for helping to develop a comprehensive transportation system solution. The linkage between the cities in the Uttarakhand Metropolitan Area – Dehradun, Rishikesh and Haridwar is strong and hence there is a need for a rapid transit system connecting these cities. As transportation is an interlinked system, the mass transit system corridors alone will not ensure a seamless travel experience for user nor will be profitable for the operator. To complement the first order transit system, it is imperative to provide a second order transit system. This will connect the areas not in the influence zone of first order transit to and also act as a feeder to it.

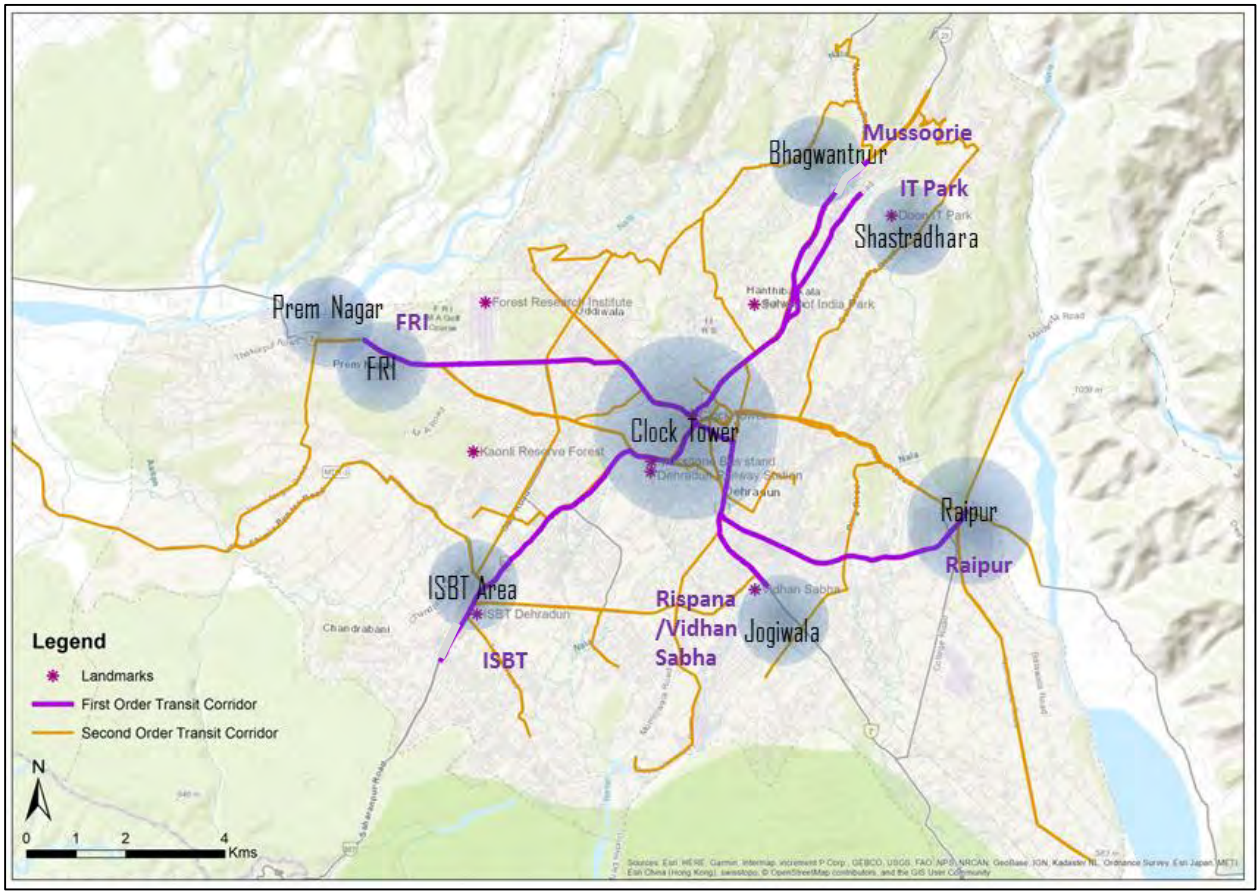


Figure 1-4: Public Transport Improvement Strategies for Dehradun City given in CMP study

The city center is a major attraction zone as it is the major commercial area in the city, locate Dehradun Railway Station and Mussoorie Bus stand. IT Park at Sahastradhara road is an important employment center which is located at North East of the city. New development is coming up in the South and South West direction. ISBT, a major regional connection zone is located at South. Forest Research Institute (FRI) is located in the west. All these centers have a high demand to the city center and thus there is a need for a mass rapid transit system for seamless travel experience connecting these points.

The linkage between Dehradun, Rishikesh, and Haridwar, witnesses high traffic demand and due to absence of adequate service available, has high share of private vehicles commuting in between the three cities. In order to discourage the high share of private vehicles and to provide smooth connectivity between these cities, it is necessary to connect them through a mass rapid transit mode.

In case of Haridwar and Rishikesh, there is a single major radial having the highest demand which runs along the city. The proposed corridor connecting the cities Dehradun-Rishikesh-Haridwar is along this radial and thus this itself shall be serving the internal demand of the cities

The second order transit corridors in Haridwar connect city center to new emerging areas like SIDCUL and Kankhal. In Rishikesh, the second order transit corridor connects Rishikesh city to Pashulok connecting the areas Gumaniwala, Dudhu Pani, THDC Colony, Natraj Chowk, Ashutosh Nagar.

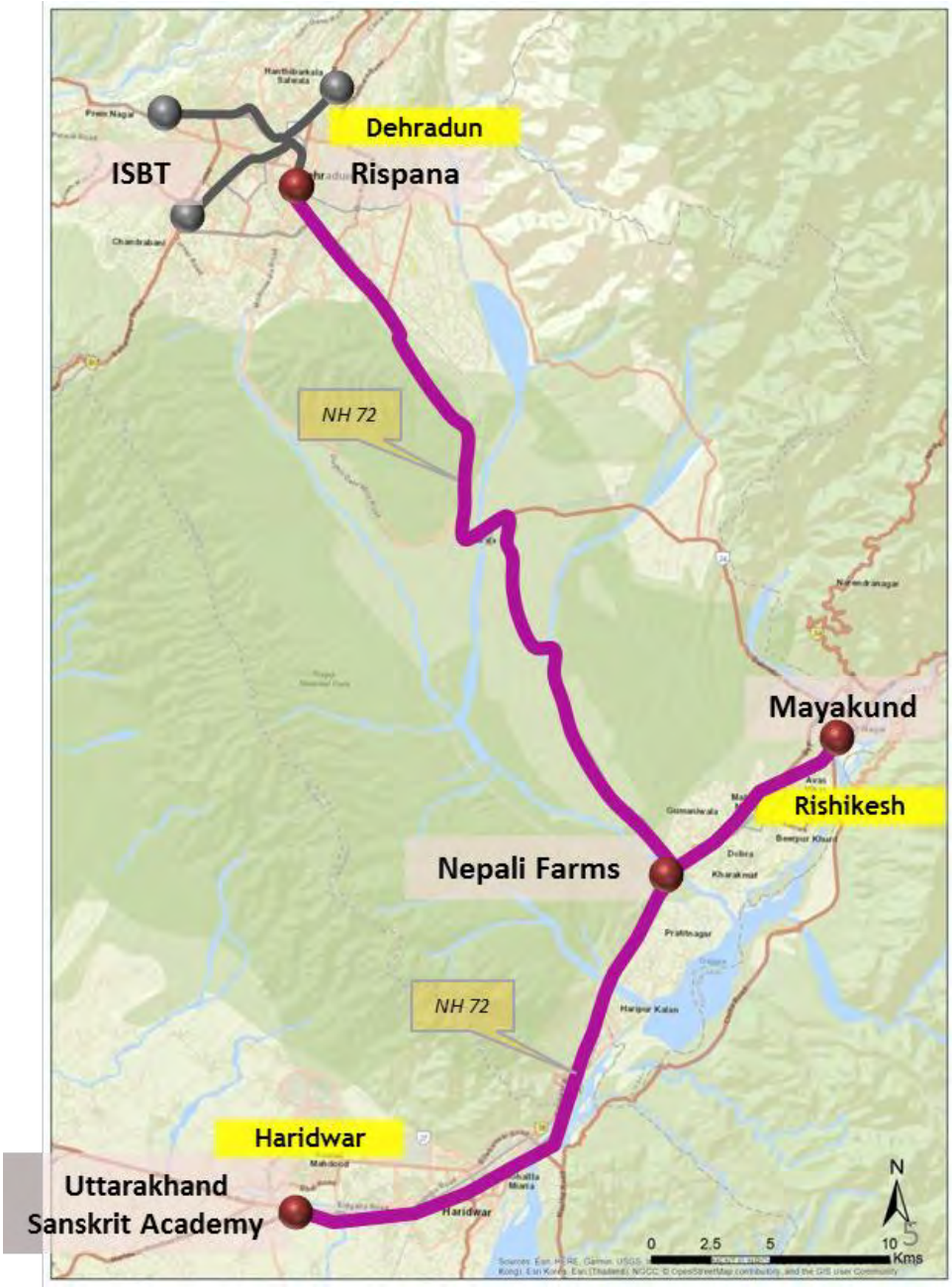


Figure 1-5: Public Transport Improvement Strategy proposed in CMP study connecting Dehradun – Rishikesh – Haridwar

CHAPTER 2

EXISTING SITUATION OF STUDY AREA

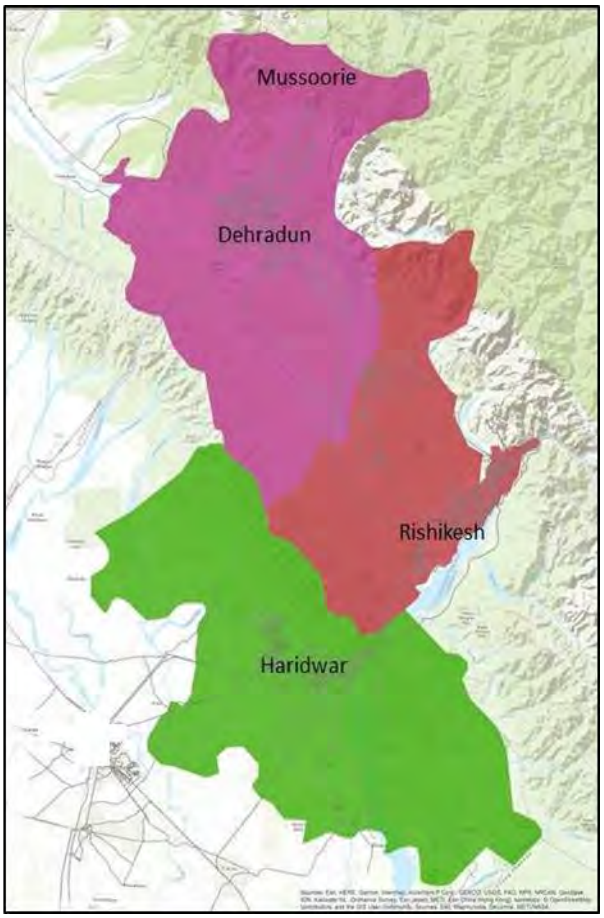
2. EXISTING SITUATION OF STUDY AREA

This section discusses about the study area and existing transport characteristics with a brief description of existing roadway network, transit services, mobility corridors, zoning and land use patterns along with key transport characteristics of the region.

Study Area Description

The Study Area for Alternative Analysis includes the area within 3 districts of Uttarakhand:

Sl. no	Metropolitan area
1	Area covering **District Haridwar** including areas covering Municipal Corporation of Shivalik Nagar, Haridwar Municipal Corporation, Roorkee Municipal Corporation
2	Entire Area covering **District of Dehradun** including Municipal corporation of Dehradun, Doiwala, Rishikesh and rest of the area falling under District of Dehradun
3	Area under **District Tehri Garhwal** covering Narendra Nagar covering Muni-Ki-Reti, Dalwala area



Traffic Analysis Zones

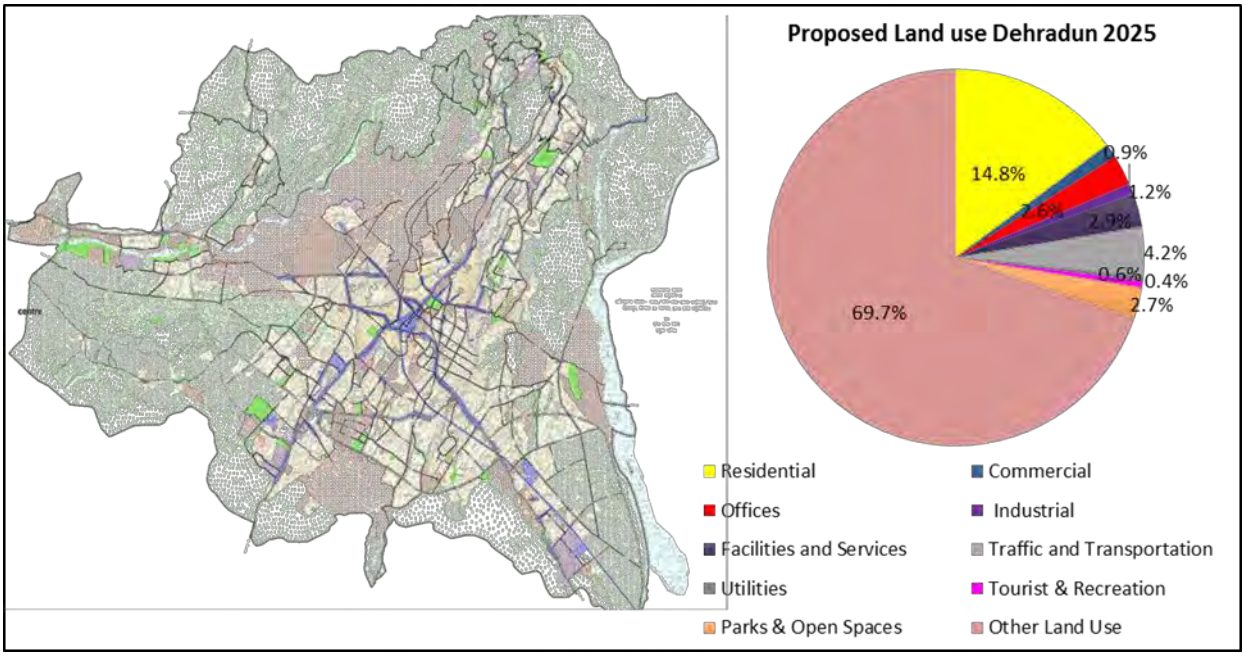
Traffic analysis Zones are smaller sub divided areas within the study area for the purpose of analysis and development of travel demand model. For analysis, the CMP study area is sub divided into 248 traffic analysis zones in which 235 are internal TAZ and 13 are external TAZ's.

2.1 EXISTING LAND USE

The characteristic feature of Metropolitan Area covering Dehradun – Haridwar – Rishikesh city is that the land utilization pattern is predominance of hills basically with the Himalayan range and water body, i.e., River Ganga flowing through the region. However, each city with a different character, vary in the Land use pattern.

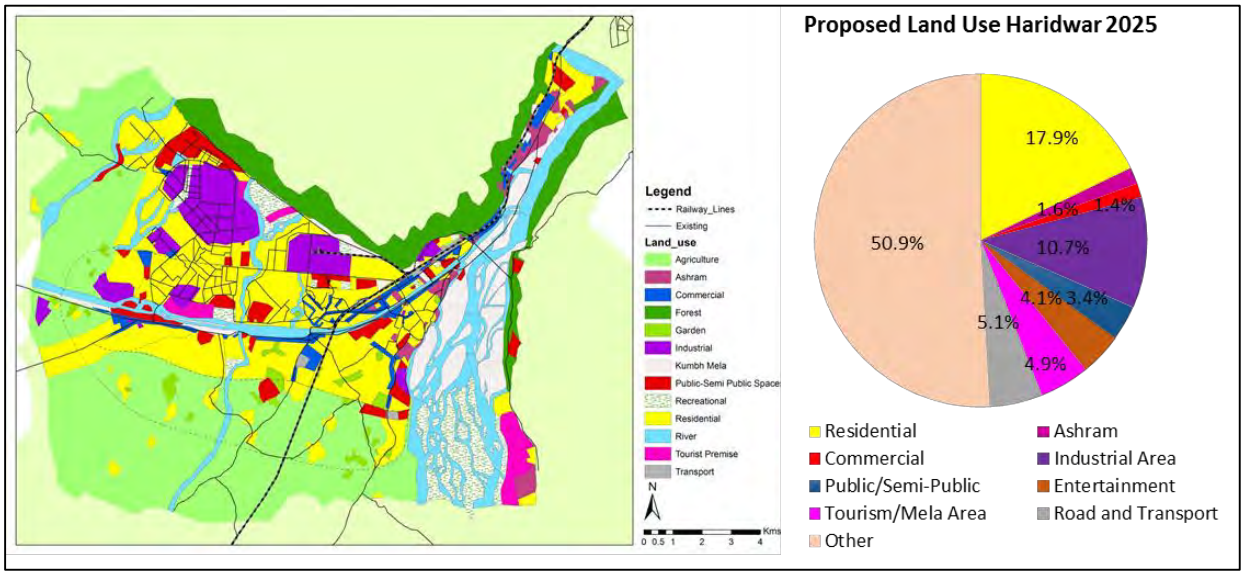
Dehradun:

The total Planning area covered under master plan of Dehradun is approximately 358.67 sqkm. The projected population as per the Master Plan 2025 is 15.30 lakhs by 2025.



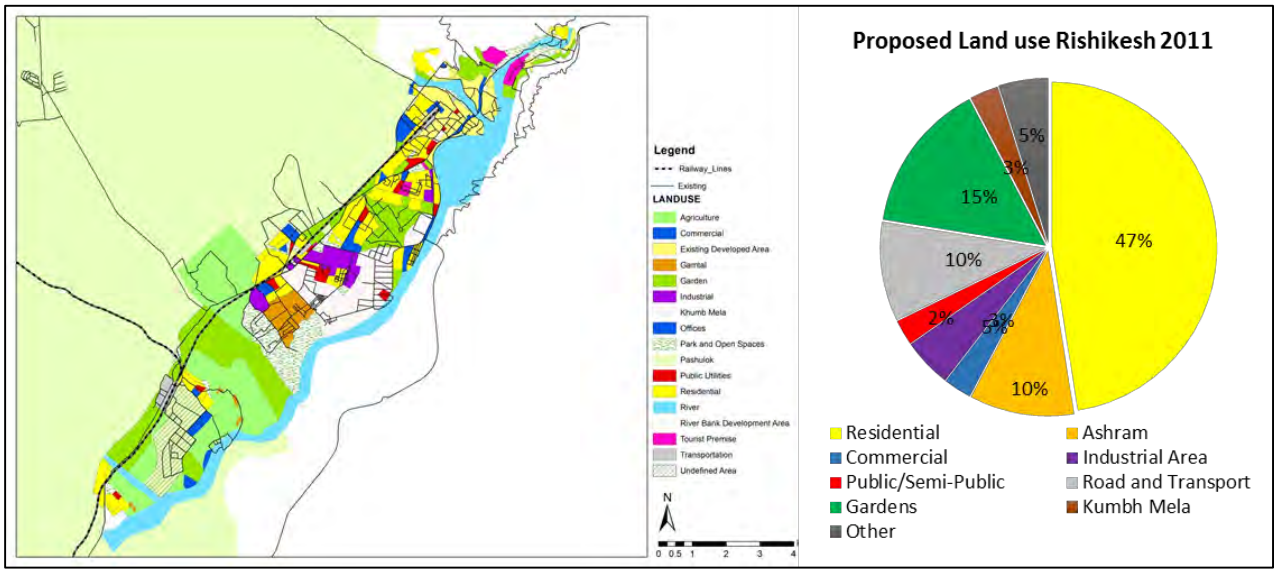
Haridwar:

The Master Plan 2025 prepared by Haridwar Development Authority covers an area of 20,119 ha of land. Haridwar is dominated by mixed commodity commercial areas, with the CBD being highly congested.



Rishikesh:

One of the major driving forces of the economy in these cities is the tourism industry. All around the year these cities have floating population which adds stress to the already strained transport infrastructure.



2.2 URBAN TRANSPORT PROBLEMS AND ISSUES WITHIN METROPOLITAN AREA

Figure 2-1 shows the urban transport issues in the study area based on the existing situation analysis:

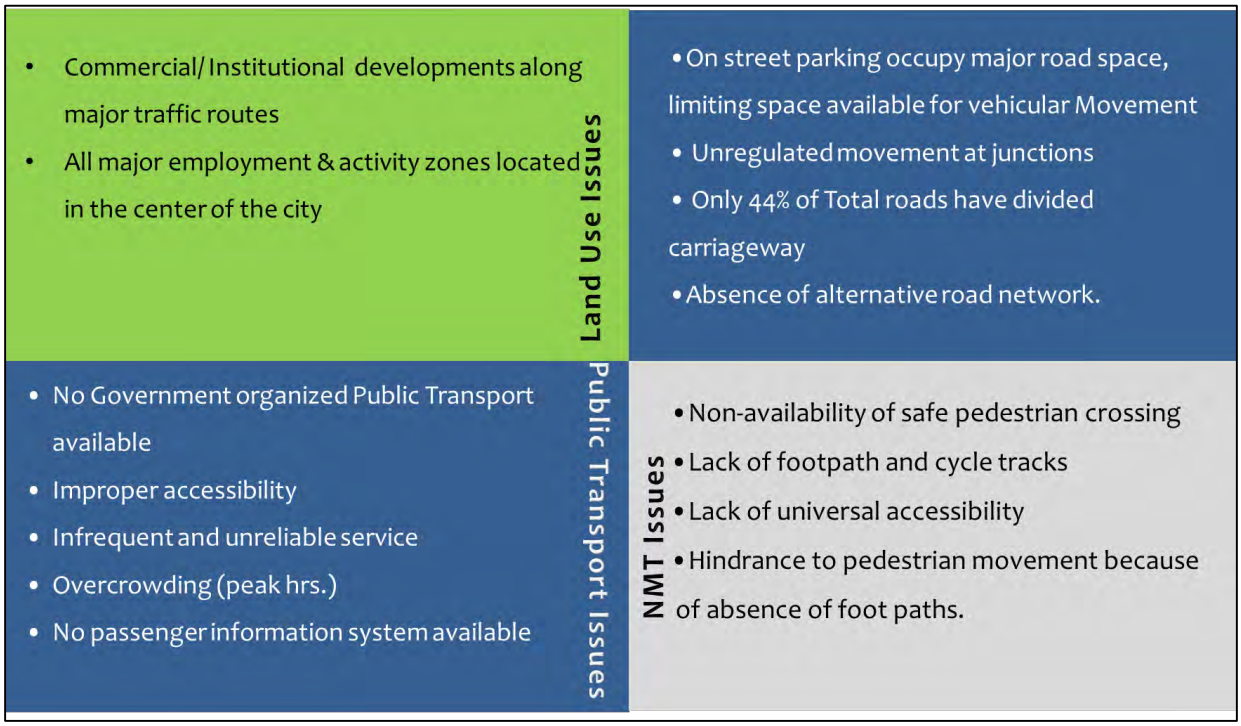


Figure 2-1: Urban Transport issues and challenges in the Uttarakhand Metropolitan area

2.3 MOBILITY STRATEGIES

Table 2-1 below depicts the mobility strategies adopted for Metropolitan Area covering Dehradun-Haridwar-Rishikesh.

Table 2-1: CMP Proposals for Uttarakhand Metropolitan Area

Comprehensive Mobility Plan Proposal for Uttarakhand Metropolitan Area (2018-2048)	
Land Use Transport Integration Plan	Promote Multi Nodal Concept in Dehradun, Haridwar and Rishikesh with major activity nodes to have local transport plan
	Promote Transit Oriented Development (TOD) along the main Mobility Corridor Network
	Identifying new nodes for development with mixed use land use
Network Development Plan	Development of New Links
	Development of Bypass roads
	Widening of Roads
	Development of Grade Separators
Integrated Public Transport Plan	Development of Mass transit corridor connecting the Cities of Dehradun, Rishikesh and Haridwar
	Development of Higher and medium capacity Mobility corridor within the cities of Dehradun, Rishikesh, Haridwar
	Development of a feeder system for last mile connectivity
	Augmentation of existing city bus service
	Development of Multi modal Integration Hubs
Non-Motorised Transport Plan	Development of Footpaths
	Development of Bicycle friendly streets
Freight Mobility Improvement Plan	Development of Truck Terminals and Corridors
Traffic Engineering and Management Measures	Improvement of the major junctions in Dehradun, Haridwar, Rishikesh
	Signage and Markings
Technological Strategy	Installation of smart traffic signals
Parking Strategy	Enforcement of parking regulation and restriction specifically On Street Parking

2.3.1 COMPREHENSIVE MOBILITY PLAN

2.3.1.1 LAND USE TRANSPORT PLAN

Spatial distribution of land use activities determines the urban transport characteristics. By influencing the spatial structure of locations in the urban environment, land use planning can contribute to reduced travel kilometers and support a high transit share. Mixed Use development establishes a compact city and helps keep walking and cycling as attractive modes of transport.

While an old city initially develops as a compact city, however in order to ensure there is balanced development, a multi nodal transit concept need to be promoted, by promoting new nodes to be developed in form of mixed used development.

Transit Oriented Development

The corridor with high passenger movement is designated as the mobility corridors. To maximize the passenger throughput, these corridors should be developed on the concepts of transit oriented development. Mixed use development that is cognizant of the low income users of the transit system is important. It is necessary to create urban and sub-urban environments where NMT and public transit are the favorable transportation options by ensuring seamless integration between different transport modes; this shall further safeguard community and development enhancing a community with increased accessibility.

Development of Tourist Centre

Tourist center should be developed considering the character of the place. It should cater to both the floating and residential population. It should be well accessible, environmentally sound and have well developed infrastructure. In order to ensure the sense of safety and security, information systems should be provided.

(a) Dehradun

In order to decongest the CBD area, the concept of multi nodal needs to be implemented. With various smaller nodes need to be developed in the other parts of the city, key activities may be shifted to these smaller nodes, with trips destined to the inner city area may be redistributed to other parts of the city based on the shifting of the key activities area thereby decongesting the inner city zone.

Ghanta Ghar, the central nuclei of Dehradun, while Rajpur Road, Cannaught Place, Niranjanpur Mandi, Paltan Bazar, Indira Nagar, Saharanpur Road, Prince Chowk, Arhat Bazar, Ashley Hall, IT Park, Selaqui Area etc. may be developed as the minor nodes around Dehradun City. In order to decongest the core city area and for efficient and equitable distribution of transport demand throughout the city, it is imperative to develop sub-city centres in different parts of the city. Further, since all administrative offices, Police Headquarters, Hospitals, colleges etc. are based around CBD Area; there is a need to shift these activity hubs in other parts of the city to decongest the central Zone area.

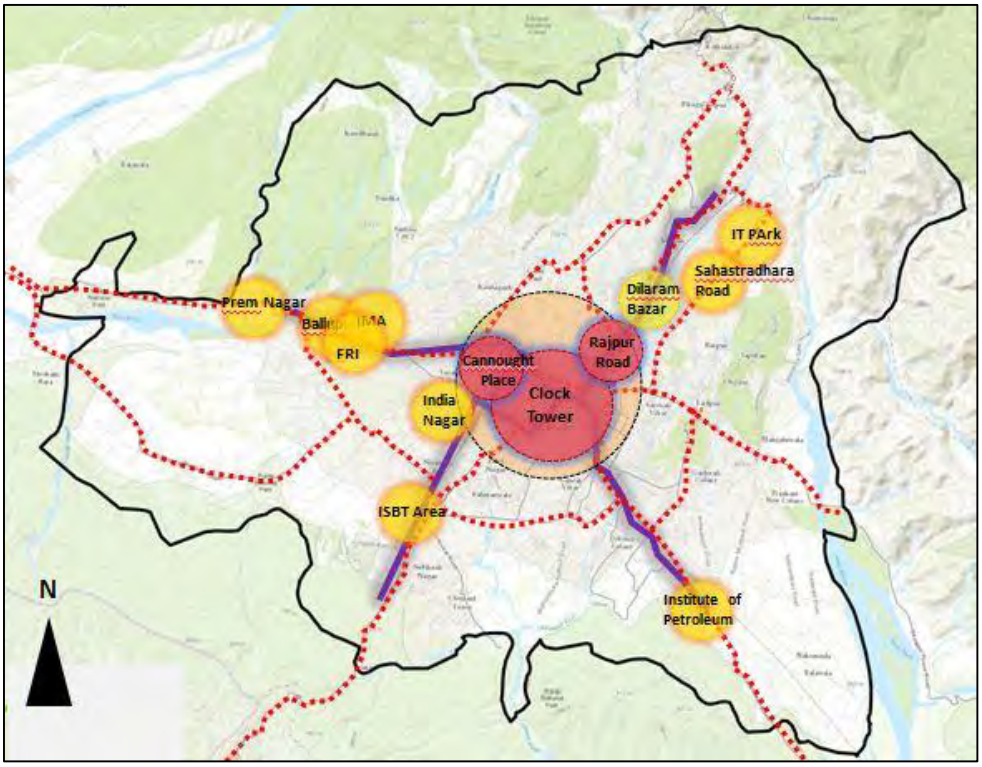


Figure 2-2: : Multi modal concept for Dehradun city

As the Land use for Dehradun area proposed under Dehradun Master Plan, need to be implemented, there is a need to develop these small nodes with complete transport infrastructure. The spread of activities in Dehradun shows a concentric model of development. Major Economic Nodes in Dehradun & the commercial area of the city mainly lies in the core area of the city. It includes Chakrata Road, Rajpur Road. The industrial zones are located in the Western part of the Dehradun city near Sahastradhara Road, Mohobewala, Selanqui, Langha Road etc.

The development of a multi nodal transit concept will allow the city to grow in all the directions. Ghanta Ghar shall continue to be the city centre. However, the administrative centres and developments coming up within the CBD needs to be shifted to the other areas of the city and any further development near clock tower should be carried out in a controlled manner to develop the small nodes in a uniform manner around the city without congesting the CBD. (refer Figure 2-2).

Based on the existing Master Plan, some of the areas were identified having a potential of being developed as key activity node with mixed use development, with Dehradun witnessing major growth towards Haridwar and Saharanpur Road, it was assessed that area near Badowala, Bharpur, East hope town may be developed for new node development with shifting of activities from CBD area to outer area of the city. At the same time all other nodes should consider a transport development strategy in accordance with the overall vision of the city.

Dehradun has the potential to adopt TOD principles, with possibility of increase in population density by increasing FSI and promoting mixed-use development.

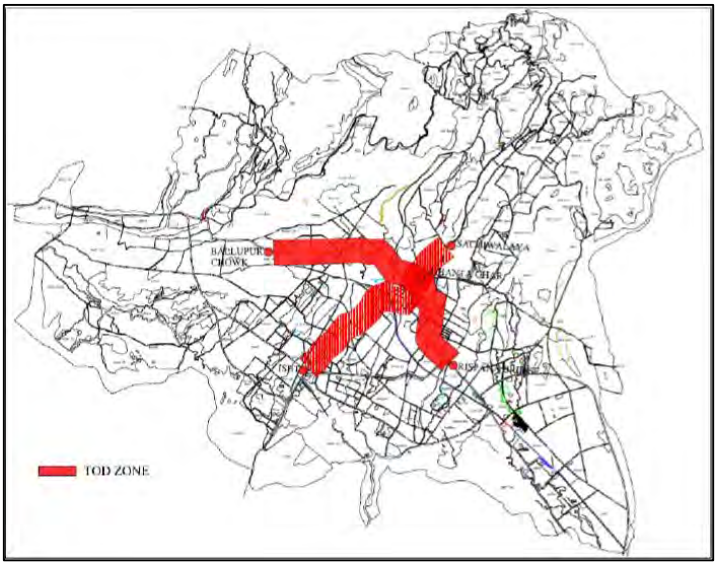


Figure 2-3: Transit Oriented Development along Major Corridors

(b) Haridwar

In case of the City of Haridwar, the city center lies near to the Haridwar Railway station which is the main CBD area. The activity nodes are the Har ki Pauri, SIDCUL area, new market area, Jwalapur, BHEL Township. The city core is a highly congested area which have high share of commercial development along the road and a mix of land use of industries, Ashrams and residential.

Since, the city itself is expanding to new areas owning to growing industrial townships. The northwest part of city is undergoing development with new institutional and industrial estates under proposal and implementation stage. Efforts may be made to decongest the central core of the city with activities shifted to SIDCUL and Bahadrabad area.

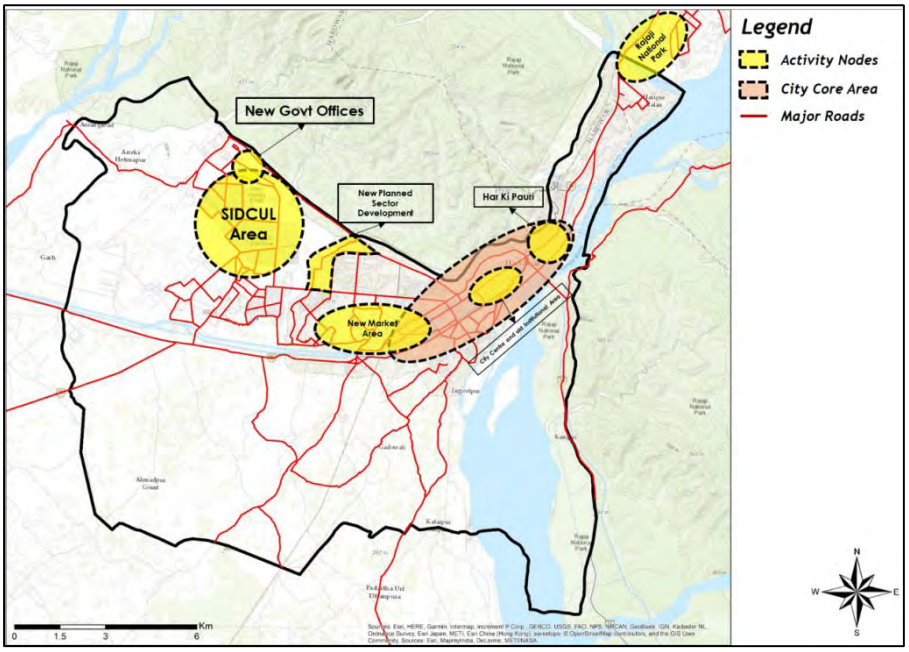


Figure 2-4: Multi modal concept of Haridwar

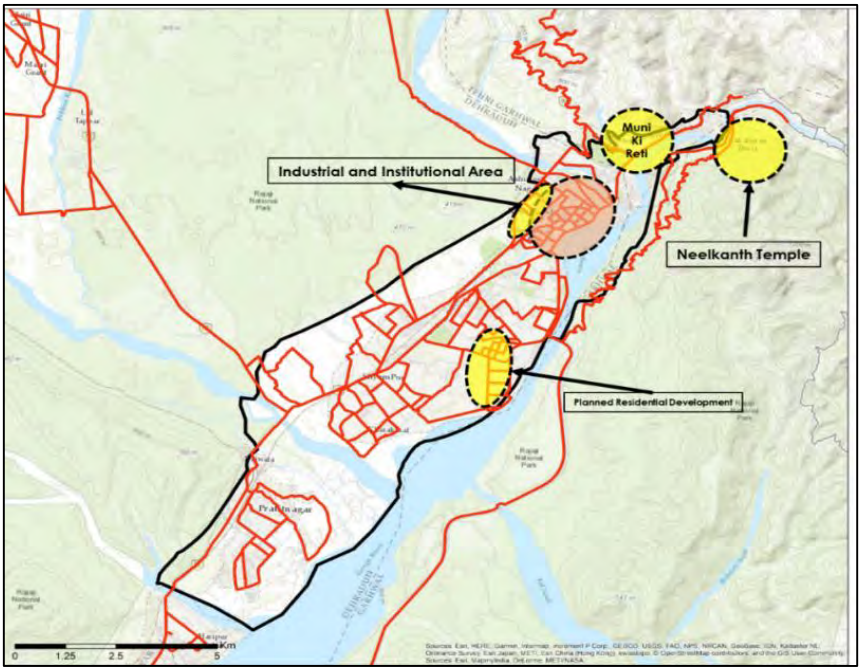


Figure 2-5: Multi modal concept of Rishikesh

(c) Rishikesh

Rishikesh, considered as the gateway to the Chardham places apart from being a religious tourist town with hundreds of serene ashrams attracts people from all over the world for meditation and yoga. Rishikesh has a high potential to be developed as tourist center with focus on Ashrams and Temples. The Muni Ki Reti Area and Swarg Ashram area are proposed to be developed as tourism centers. However, in order to ensure balanced development of city, apart from developing the tourist zones, efforts need to be made to decentralize the activity area, so it may not get over congested since the core area of the city lies near to Railway Station and Bus Terminal, the major commercial land use faces an issue of congestions which needs to be improved.

2.3.1.2 ROAD NETWORK DEVELOPMENT

The cities mentioned have limitations of expansion due to its topographical nature –hilly terrains, valleys and river bound areas. In such a case, the existing road infrastructure gets over saturated. To overcome the challenge, the cities need to develop measures to reduce the congestion within the city core area, separate out through trips, and enhance the mobility and accessibility within the cities.

It is observed from the study of the region that in case of Dehradun, Rishikesh and Haridwar, in order to reach the Key activity or tourist area in each city, a person has to cross from the main CBD area. At present, these cities experiences high external trips which adds to the city traffic clogging the already congested area.

To improve the traffic movement of the city, various proposals apart from short term proposals have been suggested like medium and long term proposals, in order to improve the traffic conditions of the city in the future years with respect to the growing population of the city. These proposals include

widening of existing road, provision of missing links in the network to relieve the overloaded transport network. Such measures would facilitate faster and easier access.

2.3.1.3 PUBLIC TRANSPORT PLAN

The public transport system for the cities in the Metropolitan area should be convenient, efficient, affordable, reliable and integrated. Since no organized public transport services is available currently within Dehradun, Haridwar and Rishikesh, there is a need to provide efficient public transport system which provides connectivity to all end of the city, which apart from adding new infrastructure also involves existing infrastructure improvements like reserving lanes and operational improvements of private buses like optimizing routes and schedules. The improvement in public transport is likely to not only create & maintaining the existing modal share of public transport, but also to create a shift from other modes to public transport.

The proposals under public transport improvement plan are:

- Identification of urban mobility corridors to be developed as Public transit corridor
- Providing last mile connectivity and ensuring multi-modal integration in public transport
- Providing adequate infrastructure facilities for public transport in terms of intermodal mobility hubs, bus stops
- Implementation of ITS to improve the reliability of public transport systems
- Promoting public participation and campaigning mass awareness programs

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 Transit systems** includes bus based system, PRT (Personal Rapid Transit) as well as cable propelled transit, which are medium capacity and are of low speed. Example, city bus service PRT, Cable car etc.
- **Third Order Transit system** includes Aggregator Cabs, e-rickshaws and other IPT modes (Vikram, Chakras, 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.

Along with Public transport, there is a need to provide Multi Modal integration. The approach is 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:

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 fulfill all the needs by using public transport**
- **Provision of Park-and-Ride facility to encourage the use of public transport**

The public transport improvement plan for the cities in the study area are based on the above concepts and are discussed in the following sub sections.

Referring to the study area, while considering the connectivity of the area in between Dehradun, Rishikesh, and Haridwar city, based on the assessment, mobility corridors were identified which are witnessing high traffic demand and should be connected through first order transit system. However, the type of System technology to be provided may be selected after Alternatives analysis study and detailed feasibility study.

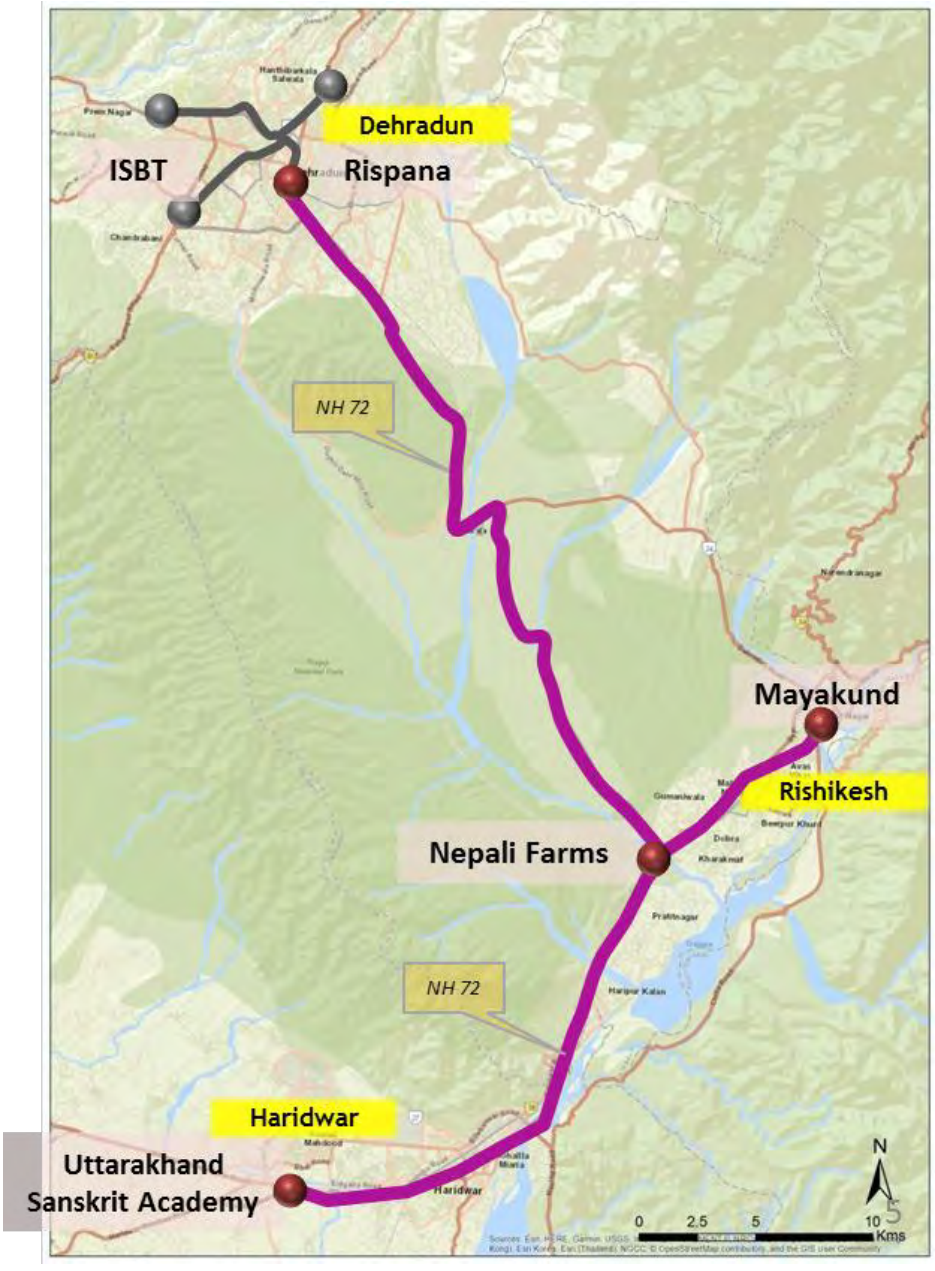


Figure 2-6: Corridor Connecting Dehradun-Rishikesh-Haridwar

The urban transport model developed for Dehradun, Haridwar, and Rishikesh evaluated the PT-Ridership values on all major corridors of the cities for 2048 and are shown in the table below:

Table 2-2: Ridership Assessment of Major Corridors

Options	Alignment	Length(Km)
Connectivity between cities	Haridwar to Rishikesh	33
	Dehradun to Rishikesh	45
	Dehradun to Haridwar	59

Apart from the connectivity between the cities, **City level mobility corridors** were also assessed based on each city internal mobility demand and the same is discussed in detail below:

(a) Dehradun:

Referring to the case of Dehradun, based on the assessed PT-PPHPD demand on the various road corridors of the cities individually, two dedicated public transit corridors are suggested. The technology selection for implementation of public transit should be of First order transit system covering:

- Corridor 1: This Corridor catchment area includes FRI –Ghanta Ghar-Railway Station- Araghar Chowk- Raipur Road- Haridwar Road. The ridership for the same is worked considering the two cases as Case 1 A & Case 1 B, wherein each spur line is considered separately.
- Corridor 2: The corridor's catchment area includes Mussoorie Road –Canal Road-Kandholi-Rajpur Road, Ghanta Ghar- ISBT. The ridership for the same is prepared considering the two cases as Case 2 A & Case 2 B, with each spur line as separate corridor.

The corridor with spur linkage is assessed separately and the same is shown below:

Options	Alignment	Length(Km)
Dehradun		
Case 1-A	NS Khandoli to ISBT	9.6
	EW FRI to Vidhan sabha/Rispana	10
Case 1-B	NS Khandoli to ISBT	9.6
	EW FRI to Raipur	13.8
Case 2 A	NS ISBT to Khandoli till Canal Road	12.7
	EW FRI to Rispana Bridge	10
Case 2 B	NS ISBT to Khandoli till Mussoorie Road	12.8
	EW FRI to Rispana Bridge	10

(b) Haridwar:

In case of Haridwar, the corridor proposed for connectivity of Dehradun – Rishikesh – Haridwar shall be serving the internal city corridor, since the identified corridor serves the main traffic demand of the city area within its influence zone. The public transit corridor proposed shall connect Haridwar via National Highway-72, from Haripur Kalan to Uttarakhand Sanskrit University. MRTS stops are provided on major junctions.

The identified corridors for the First order transit system are given below:

Corridor: This Corridor catchment area includes Haripur Kalan - Motichor-Har-Ki Pauri- Sitapur-Uttarakhand Sanskrit Academy

(d) Rishikesh:

As similar to Haridwar, the First order transit corridor proposed for connectivity of Dehradun - Rishikesh – Haridwar will also serve the intra city trips of Rishikesh city, with majority of city area falling within the catchment area.

The identified corridors for the First Order Transit system are given below:

- **First Order Transit Corridor:** This Corridor catchment area includes Nepali farms-Shyampur- IDPL Colony- Mayakund- Triveni Ghat

Apart from these various projects are detailed out on strategies like NMT improvement plan, Demand Management, freight policy etc.

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

Alternatives Analysis is about finding the best Alternatives for providing a better connectivity to a particular location. The methodology followed for the Alternative analysis of first order and second order corridors connecting Dehradun-Rishikesh- Haridwar cities are discussed in following sub-sections:

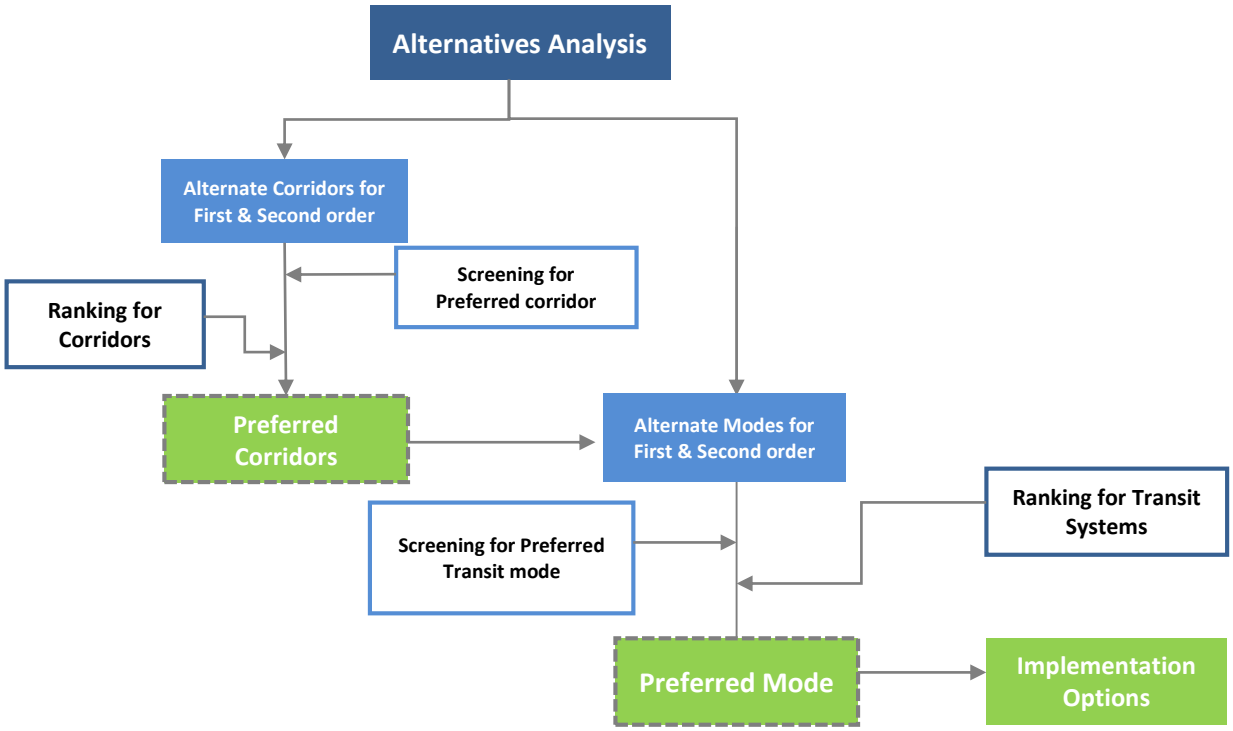


Figure 3-1: Methodology for Alternatives Analysis

3.1 TASK 1: IDENTIFY CORRIDORS FOR ALTERNATIVES ANALYSIS

The first task is to identify probable corridors and systems for the Alternatives analysis. The Alternative corridors considered shall include the corridors mentioned in the CMP as well as any additional probable corridors.

In this study, both first order and second order transit corridors are considered for the Alternatives analysis.

3.2 TASK 2: DEVELOP SCREENING CRITERIA FOR IDENTIFIED OPTIONS

The next task is to develop screening criteria to identify the most reasonable and feasible Alternatives for the options described in Task 1. The screening criteria will include the following parameters:

a) **Mobility Effects**: These criteria relate to travel demand forecasting and facility capacity, presence /absence of different modes, access, connectivity and traffic circulation.
b) **Conceptual Engineering Effect**: These criteria relate to developing all civil engineering aspects of the system.

c) **Financial and Economic Effects**: Identify and quantify the benefits and costs associated with the project to help in identification of the optimum solution along with the economic viability in terms of its likely investment return potential.
d) **Environmental and Social Effects**: Screening Criteria assessing environmental impacts related to land-use and natural environment like water, air etc. The social impact of the Alternatives is evaluated to see potential social costs and benefits.
e) **Cost Effectiveness and Affordability**: The capital and annual costs associated with each of the Alternatives would be evaluated. It also assesses the cost-effectiveness and affordability of the Alternatives
f) **Other Factors**: How each of the Alternatives complies with the local policies and priorities are assessed.

Further, the screening criteria are sub-divided into different levels.

3.3 TASK 3: SCREENING FOR TRANSIT CORRIDOR

This screening is required to identify the most suitable corridor for a transit system. This will be a preliminary screening based on the few parameters as follows:

Screening for Corridor	Right of Way
	Coverage
	Number of Bridges
	Impact on Intermodal connectivity

Same criteria would be considered for screening of first and second order transit corridor Alternatives.

A qualitative comparison is performed for the screening for transit corridor and accordingly, most suitable corridor would be selected. Screening evaluation will look into the Alternatives in terms of following points:

a) Does the Alternative provide planned transportation system improvement?
b) What is the forecasted demand on the corridor?
c) Is the required Right of Way available?

It will quickly and efficiently identify the Alternatives considering all options that most warrant further consideration and evaluation.

Ranking of the Alternatives for Corridors

After all the evaluation criteria have been established, each Alternative corridor needs to be ranked based on values/performance of each of the criteria. As a grading system, a scale of range 1 to 5 may be used, with the negative effects having the least ranking and positive effects, the maximum ranking (1 being an unacceptable option and 5 being the excellent option).

For selection of preferred corridor from the choices after preliminary screening will be based on ranking as follows:

Ranking	1	2	3	4	5
	Unacceptable/Least Suitable	Poor	Fair	Good	Excellent/Most Suitable

Accordingly, a matrix will be prepared based on which preferred Alternative corridor would be selected.

3.4 TASK 4: SCREENING AND EVALUATION FOR PREFERRED TRANSIT SYSTEM (MODE)

Once the preferred corridor is identified, another set of evaluation for selecting the most preferred transit system on the corridor will be done. This second level of screening will compare the most viable Alternatives based on the following parameters.

3.4.1 MOBILITY EFFECT

Travel Demand Forecasting: The primary purpose of this task is to assess the most current version of the City/regional travel demand model (from CMP) for base year data, with available future year networks and land use data, and model documentation. While preparing the travel demand analysis, following tasks need to be completed:

- Identify available transport systems, right of way of roads in city and along the corridor.
- Prepare road and transit networks for each Alternative and a no-project scenario (without project).
- Summarize the travel demand results for existing and all future year Alternatives, including corridor and region-wide travel demand, peak period volumes and congestion levels, and person trips by mode for the corridor and the region.
- Analyze the differences among the Alternatives to provide information to Environmental Assessment.
- Opportunity for intermodal integration at various levels
- Similar analysis to be conducted for the future horizon year to assess how conditions would change over time.

3.4.2 CONCEPTUAL ENGINEERING EFFECT

Further to refine the range of Alternatives to a sufficient level of detail to compare the relative differences between Alternatives, conceptual engineering report must be prepared for all feasible Alternatives, including those specified in the Comprehensive Mobility Plan (CMP) and any other viable/practical "Alternative". The parameters to be considered include:

a) Civil Structures

- Provide preliminary design of bridges, retaining structures and other permanent or temporary structures associated with Alternatives selected for evaluation.
- Develop sufficient detail concerning the structures to allow preparation of preliminary cost estimates.

- Identify the road space to be occupied by civil structure and the project permanently/temporarily

b) Geotechnical

- Develop information concerning adjacent structures impacted by the project, water treatment considerations and information concerning wetlands.
- Perform investigations and analysis necessary to assess aspects of soil and foundations behaviors based on the suitability of each alternative system

c) Station Planning (Bus Stations/Rail Stations etc.)

- Provide preliminary design including geometrics, structural design, shoring and architectural design. Identify the road space to be occupied by station (either underground or elevated) and the project permanently/temporarily.

d) Right-of-ways

- Research and report on the status of current right-of-ways and other properties potentially affected by the project.
- Prepare estimates of the valuation of any property to be permanently acquired or needed for temporary construction easements, as also how the project will have the social effect on the city

e) Impact on inter-modal connectivity

However, in this Study, the evaluation of Alternatives for the Conceptual Engineering Effect is based only on the available secondary data. No fresh data collection is done. Hence, the process will consider the information of the available parameters from the above list for evaluation. The parameters for first order and second order will be selected based on its suitability for the transit options.

3.4.3 ENVIRONMENTAL EFFECT: ENVIRONMENTAL ASSESSMENT

The purpose of the preliminary environmental analysis is to identify environmentally sensitive areas early on, so that these areas can be avoided if possible during design. The preliminary environmental analysis will also assist in determining the level of additional environmental documentation that will be required in subsequent project phases. A screening-level analysis or environmental scan will be conducted to determine the potential environmental impacts of each Alternative identified. However, a detailed assessment would be done at the DPR stage.

3.4.4 SOCIAL EFFECT: SOCIAL ASSESSMENT

Social Assessment includes preliminary screening of the social impacts for each Alternative including Social Impact Mitigation and R&R impacts. A detailed assessment would be done at the DPR stage.

3.4.5 COST EFFECTIVE AND AFFORDABILITY

- **Project cost estimates:** Provide preliminary cost estimates based upon conceptual engineering completed for Alternatives selected for evaluation. Detail items of work, estimates of quantities and costs shall be included at DPR stage.

- Provide estimates of costs for all project elements including right-of-ways, easements, relocations, environmental mitigation, protection of facilities and any other elements affecting project cost.

3.4.6 FINANCIAL AND ECONOMIC EFFECT

- Prepare a preliminary project financial concept plan, which outlines a realistic strategy for implementing the project Alternatives.
- Public and private funding options should be considered in developing the plan.
- To identify and quantify the benefits and costs associated with the project to help in identification of the optimum solution along with the economic viability in terms of its likely investment return potential.

At the end of Comparative Screening, the most preferred Alternative corridor would be selected based on following goals:

a) Meet the purpose and need identified for the project (with more emphasis on intermodal integration and accessibility)
b) Concurrently avoid or minimize environmental and community impacts
c) Allow for effective and feasible project phasing and constructability
d) Provide a cost effective transportation investment

Ranking of the Alternatives for Transit Systems

After all the evaluation criteria have been established, each Alternative mode needs to be ranked based on values/performance of each of the criteria. As a grading system, a scale of range 1 to 5 may be used, with the negative effects having the least ranking and positive effects, the maximum ranking (1 being an unacceptable option and 5 being the excellent option).

For selection of preferred mode from the choices after preliminary screening will be based on ranking as follows:

Ranking	1	2	3	4	5
	Unacceptable/Least Suitable	Poor	Fair	Good	Excellent/Most Suitable

Accordingly, a matrix will be prepared based on which preferred Alternative mode would be selected.

3.5 TASK 5: IMPLEMENTATION OPTIONS FOR THE MOST VIABLE ALTERNATIVE

The implementation options should be identified for best suitable Alternative. If a metro system is identified as the most viable Alternative, then implementation options need to be explored for those projects seeking Central Financial Assistance (CFA) as mentioned in the Metro Rail Policy, 2017. The various options for CFA for these metro projects are as below:

- Public Private Partnership (PPP): Central Government financing to be governed by the Viability Gap Funding (VGF) Scheme of Government of India or any other Guidelines issued by Government of India from time to time.
- Grant by the Central Government: Central Government will consider providing a grant up to 10% of project cost excluding items as mentioned in the Metro Policy 2017, which do not seek project funding as per the VGF Scheme of GoI or under the Equity Sharing Model.
- Equity Sharing Model: Central Government will provide financial support to Metro Rail projects up to 20%of the project cost excluding items as per the Metro Policy 2017.

PPP models should be explored for implementation as per the Metro Rail Policy, 2017. Private participation either for complete provisioning of metro rail project or for some unbundled components will form an essential requirement for all metro rail project proposals seeking Central Financial Assistance. The PPP model options as per the Metro Rail Policy, 2017 that could be taken up for implementation are:

- Construction of new Metro Rail systems through DBFOTs (Design-Build-Finance-Operate-Transfer);
- Award of Concessions for operational services which could include supply of rolling stock;
- Award of Concessions for maintenance and upgrading of infrastructure.

Further, Private Participation in Operation and Maintenance also to be explored for implementation. It is also important to define the exact nature of private participation as per the Metro Rail Policy, 2017. The indicative models of O&M mentioned in the Policy are:

- Cost + Fee Contract
- Gross Cost Contract
- Net Cost Contract

Thus, based on the above available Alternatives, the State Government needs to decide the Metro Project Implementation options

- Whether the project should be implemented on a PPP framework eligible under the VGF Guidelines of Government of India; or
- Whether the project should be implemented on a PPP framework with some component of the project being implemented on PPP model; or
- Whether the project should be implemented on an Equity Sharing Model with some form of PPP for any component of the project, wherever feasible.

CHAPTER 4

DESCRIPTION OF ALTERNATIVES

4. DESCRIPTION OF ALTERNATIVES

4.1 PLANNING CONSIDERATIONS

The Comprehensive Mobility plan for Dehradun-Rishikesh-Haridwar Metropolitan Area has aimed at attaining a "People Centric Urban Transport System" with an integrated, efficient, livable and sustainable transport system by providing safe and convenient mobility to people of all abilities and goods. The connectivity of the North-South & East West Corridor in Dehradun City, Corridor connecting cities of Dehradun-Rishikesh-Haridwar and Second order corridors in Dehradun, Rishikesh and Haridwar shall be established considering following parameters:

a) The ability to meet the vision of CMP
b) Minimum environmental and community impacts
c) Cost Effectiveness of the option
d) Most effective intermodal connectivity option

4.2 DESCRIPTION OF ALTERNATIVES

Considering the expected traffic to be generated in the year 2048 and other planning considerations, a number of alternative mass transport networks were attempted to meet the future transport demand requirement. In this regard, first and second order transit corridors were proposed in CMP. The following corridors are considered for analysis:

FIRST ORDER TRANSIT CORRIDOR:

- North South Corridor in Dehradun city
- East West Corridor in Dehradun city
- Corridor connecting Dehradun-Rishikesh-Haridwar

SECOND ORDER TRANSIT CORRIDOR:

➢ **DEHRADUN -**

CMP suggested continuing with the existing bus routes with additional three extensions to increase the transit coverage. The routes should be rationalized based on the detailed demand assessment and taken up as a separate study to creat a trunk and feeder network.

➢ **HARIDWAR -**

In CMP study, 2 corridors have been proposed as second order transit corridor in Haridwar – Haridwar Railway station to SIDCUL and Haripur Kalan to Indian Overseas bank in Sarai, Jwalapur.

Haripur Kalan to Indian Overseas Bank, Sarai, Jwalapur

Upon further study, it has been assessed that for this corridor, the stretch from Haripur Kalan to Har ki Pauri are overlapping with the first order transit corridor and the proposed transit systems would compete in this stretch rather than complimenting each other. Also, the part of the stretch from Har

ki Pauri to Sitapur pass along the core city area, with least right of way ranging from 8-11 m at few locatios. This is a high demand corridor as it connects railway station, bus stand and commercial areas. The remaining part of the corridor lies south to the canal, in new developing area, with possibility of rght of way development. Thus, given these conditions, the corridor Haripur Kalan to Indian Overseas Bank is curtailed to Har ki Pauri and split further into two corridors – Har ki Pauri to Sitapur and Sitapur to Indian Overseas Bank, Sarai.

Haridwar Railway station to SIDCUL area

Considering the change in the Haripur Kalan to Indian Overseas Bank corridor, this corridor needs to be altered for developing a comprehensive network. Sitapur can be developed a multi modal hub location with proposed transit systems of first order transit corridor, Har ki Pauri to Sitapur and Sitapur to Indian Overseas Bank connecting at this location. Thus, the end point of the corridor is curtailed from Haridwar Railway station to Sitapur.

- **RIHISKESH –**

CMP proposed the stretch ISBT – Railway Station – Raiwala Station. The part of the corridor from Pashulok to Railwala Station overlaps with the first order transit corridor, again with the possibility of competition of the two proposed modes. It is therefore assessed to be curtailed the end point from Railwala station to Pashulok.

The final second order transit corridors considered for further assessment is are –

CITY	CORRIDOR END POINTS
DEHRADUN	1. Banjarawala - Kargi - Gularghati (existing)
	2. Bhagwantpur - Supply Bus Stop (proposed)
	3. Clement Town – ISBT (proposed)
	4. Dehradun - Doiwala (existing)
	5. Dehradun - Raipur - Maldevta (existing)
	6. DL Road - Defence Colony (existing)
	7. ISBT - Parade Ground - Sahastrdhara (existing)
	8. Kolaghad - Vidhansabha (existing)
	9. MDDA - Dalanwala - Dathmandir (existing)
	10. Parade Ground - Prem Nagar - Parbal (existing)
	11. Parade Ground - Pelio Mankasind - Naya Gaav (existing)
	12. Prashant Colony - Bus Stand Raipur (proposed)
	13. Prem Nagar - Gularghati (existing)
	14. Premnagar - Raipur (existing)
	15. Premnagar - Chowkicholas (existing)
	16. Purkalgaon - Mothrovala (existing)
	17. Rajpur - Clement Town (existing)
	18. Seemadhar - Nalapani (existing)
	19. Thana Cantt - Ballupur - ISBT - Rispanapul - Subhash Road Parade Ground (existing)

HARIDWAR	1. Sitapur to SIDCUL
	2. Har ki Pauri to Sitapur
	3. Sitapur to Indian Overseas Bank, Sarai, Jwalapur
RISHIKESH	1. ISBT to Pashulok

4.2.1 FIRST ORDER TRANSIT CORRIDOR - ALTERNATIVE CORRIDORS

The Alternative Corridors for 3 major first order corridors connecting North-South & East-West, and corridor Connecting Dehradun, Rishikesh and Haridwar are discussed in the following sub sections:

4.2.1.1 CORRIDOR 1: NORTH SOUTH CORRIDOR IN DEHRADUN CITY

The North South corridor as proposed in CMP has two bracnches at the north end, one along Mussoorie road and another along Canal road, which has equal weightage in terms of ridership. Premlimiary analysis is carried out to select one of the branches that will be the part of the corridor for futher alternative analysis of the main corridor.

Branching of North South Corridor:

The feasibility of the branch that needs to be implemented will be evaluated based on the engineering effects, area coverage and intermodal connectivity impacts.

Table 4-1: Evaluation Matrix for branching of North south corridor-Dehradun

Corridor 1: Level 3 Screening for Corridor -Branches options-Dehradun - North South Corridor			
S.No	Parameters	**Corridor**	
		A1 : Khandoli to Mussoorie road	**A2: Khandoli to Canal road**
1	**Project Impact-Area Coverage**		
a	Population	117767	118294
b	Employment	46053	48114
2	**Engineering impact**		
a	Right of way Available	20-22m	10-12m
b	Need for Land Acquisition	For Station locations only	For ROW development and station locations
c	Terrain Type	Slightly Hilly	Slightly Hilly
d	Space availability for Depot Facility	yes	Limited cause
e	Details of Major Bridges/Retaining Structures along the corridor	-	-
3	**Effect on Intermodal connectivity**	Yes with proposed cable car system	No
4	**Project Cost (Crs)**	608	589

The scoring has been given based on the suitability of the corridors against the parameters considered. The scoring given is presented in Table 4-2.

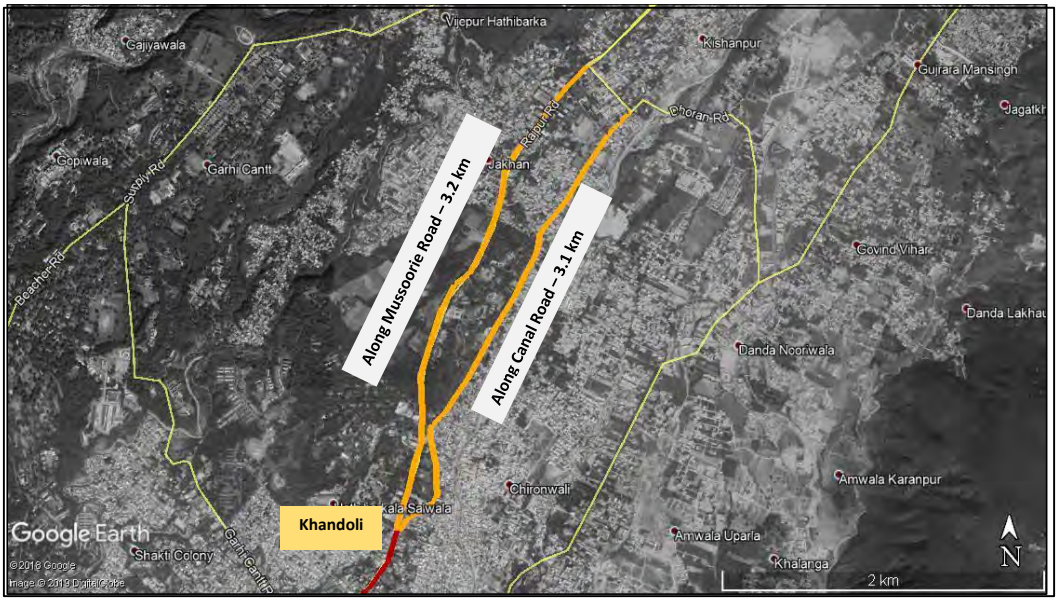


Figure 4-1: Branches along Mussoorie road and Canal Road for North South Corridor

Table 4-2: Scoring for Branches in North south corridor

S.No	Parameters	A1 : Khandoli to Mussoorie road	A2: Khandoli to Canal road
1	**Project Impact-Area Coverage**		
a	Population	1.0	0.8
b	Employment	0.8	1.0
2	**Engineering impact**		
a	Right of way Available	0.7	0.4
b	Need for Land Acquisition	0.4	0.3
c	Terrain Type	0.2	0.2
d	Space availability for Depot Facility	0.7	0.3
e	Details of Major Bridges/Retaining Structures along the corridor	0.2	0.2
3	**Effect on Intermodal connectivity**	0.5	0.2
4	**Project Cost(Crs)**	0.4	0.5
	Total	4.8	3.9

The branch along Mussoorie road obtained highest scoring based on its suitability in the engineering effects. The availability of right of way is higher for this section of corridor. Thus; this branch would be considered as the part of the final corridor for further analysis.

The Alternatives for Corridor 1: North – South Corridor are discussed in following sub sections

Alternative 1 A: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road

The first Alternative under consideration starts from Pacific Mall along the Mussorie road till Khandoli to continue on Rajpur Road and connect Ashley Hall, Parade Ground, and Darshanlal chowk through Subhash Road, Saharanpur, Shewala Kala through Saharanpur Road. The length of the corridor is 12.8 km. The alignment of Alternative 1A is given in Figure 4-2.

The major traffic attraction points along this Alternative are Doon IT Park, Ashley Hall, Gandhi Park, Clock Tower, Darshanlal Chowk, Paltan Bazar, Railway Station, and ISBT.

Advantages:

- This corridor connects all the major commercial area in the city
- It serves high density settlements of Karanpur, Harrawala, Shiv Colony, Sewla Kalan
- Intermodal Connectivity options available at railway station and major bus stations thus ensuring seamless travel experience for the user
- The right of way ranges from 9m to 30m.

Disadvantages:

- As this is the major radial of the city with Railway Station and Inter-state bus terminal, major traffic diversion measures will be required during the construction phase.

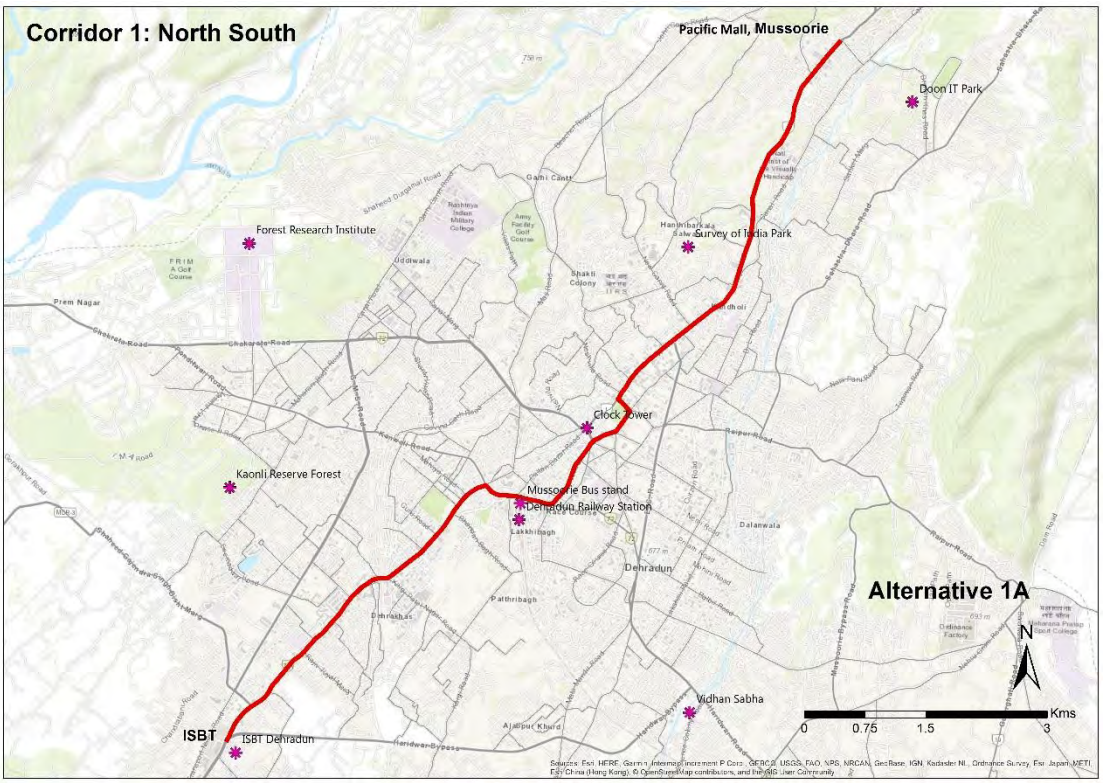


Figure 4-2: Alternative Corridor 1A of Corridor 1- North South

Table 4-3: Population and Employment coverage of Alternative 1A

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Ajabpur	11997	5159
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bharampuri	17159	7378
Bharuwala Grant	6117	1609
Chhukhuwala	7050	3032
Clement Town (CB)	7358	2323
Clock Tower	5943	2555
D.L Road	8076	3473
Dalanwala	30542	13133
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dharampur	9882	4249
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Hathi Barkala	7995	3438
Indira Colony	9405	4044
Indira Nagar	11443	4920
Indrapuri	10772	4632
Indresh Nagar	9163	3940
Jakhan	13173	5664
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	18266	7855
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Majra	14498	6234
Mata Mandir Road	4366	1877
Mehu Wala Mafi (CT)	15665	4947
MKP	6690	2877
Mohit Nagar	8594	3695
Niranjanpur	8772	3772
Patel Nagar	21489	9240

Race Course	15919	6845
Rajpur	11085	4766
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shastradhara	16085	6917
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Turner Road	14511	6240
Vijay Colony	9699	4171
Yamuna Colony	7506	3227
Other villages like Pitthuwala,Shewala Khurd,Chandrwani Khalsa etc	92408	24303

Alternative 1 B: Mussoorie Road to ISBT via Rajpur Road, Govind Garh Road and GMS Road

The alignment starts from Pacific Mall along the Mussorie road till Kandholi, continuing on Rajpur road connecting Ashley Hall, Clock Tower and divert to Chakrata road continuing on Govind Garh road connecting tilak nagar, Dourwala and continues on GMS Road connecting Dronpuri Society, Kanwali and Sewla Kalan. The length of the corridor is 13.7 km. The alignment of Alternative 1B is given in Figure 4-3.The major traffic attractors on this corridor are Doon IT Park, Ashley Hall, Gandhi Park, Clock Tower.

Advantages:

- This corridor connects all the major residential settlements like Vijay park extension, Kanwali, Shivalik Puram etc.
- The right of way ranges from 7m to 30m.

Disadvantages:

- Traffic Diversion would be required at Rajpur Road
- No major intermodal connectivity except ISBT Dehradun

Table 4-4: Population and Employment coverage of Alternative 1B

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bharampuri	17159	7378
Bharuwala Grant	6117	1609
Chhukhuwala	7050	3032
Clement Town (CB)	7358	2323

Clock Tower	5943	2555
D.L Road	8076	3473
Dalanwala	21049	9051
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Hathi Barkala	7995	3438
Indira Colony	9405	4044
Indira Nagar	11443	4920
Indrapuri	10772	4632
Indresh Nagar	9163	3940
Jakhan	13173	5664
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	18266	7855
Kaulagarh	10535	4530
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Majra	14498	6234
Mehu Wala Mafi (CT)	15665	4947
Mkp	6690	2877
Mohit Nagar	8594	3695
Niranjanpur	8772	3772
Patel Nagar	21489	9240
Race Course	15919	6845
Rajpur	11085	4766
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shastradhara	16085	6917
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Turner Road	14511	6240
Vasant Vihar	15219	6544
Vijay Colony	9699	4171
Yamuna Colony	7506	3227
Other villages like Pitthuwala,Shewala Khurd,Chandrwani Khalsa etc	92408	24303

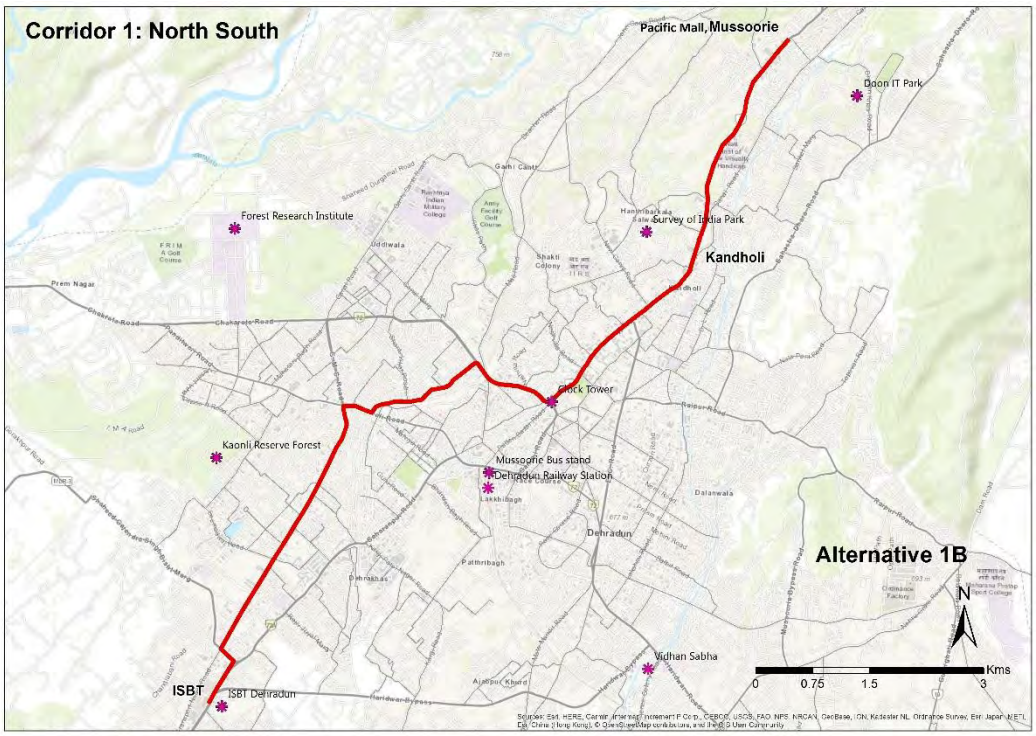


Figure 4-3: Alternative Corridor 1B of Corridor 1- North South

Alternative 1 C: Mussoorie Road to ISBT via Rajpur Road, Saharanpur Road and GMS Road

This alternative starts from Pacific Mall in Mussoorie Road and continues on Rajpur road continuing till Clock tower; the alignment diverts to Saharanpur road and then continues to GMS Road. The length of the corridor is 14.3 km considering both the branches along Mussoorie road and Canal road as a part of the single corridor. The alignment of Alternative 1C is given in Figure 4-4. The major traffic attractors on this corridor are Doon IT Park, Ashley Hall, Gandhi Park, Clock Tower, ISKCON temple.

Advantages:

- This corridor connects all the major residential settlements like Vijay park extension, Kanwali, Shivalik Puram etc.
- The right of way of ranges from 7m to 30 m

Disadvantages:

- Traffic Diversion would be required at Rajpur Road
- No major intermodal connectivity except ISBT Dehradun

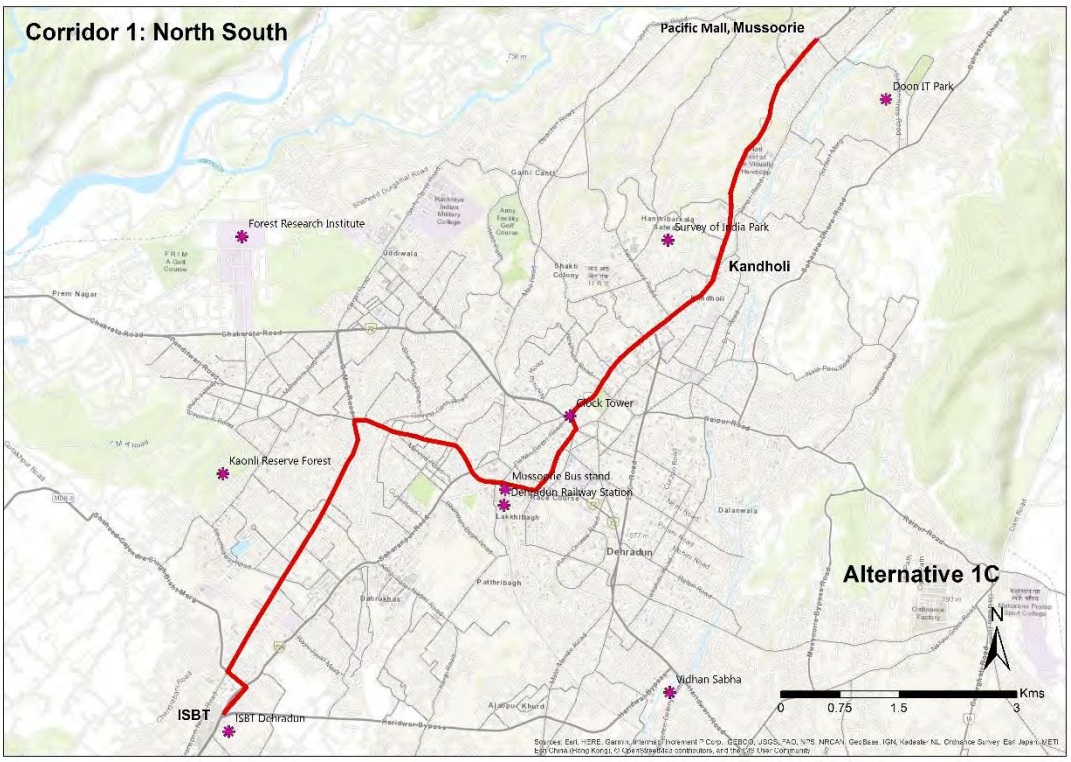


Figure 4-4: Alternative Corridor 1C of Corridor 1- North South

Table 4-5: Population and Employment coverage for Alternative 1 C

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Ajabpur	11997	5159
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bharampuri	17159	7378
Bharuwala Grant	6117	1609
Chhukhuwala	7050	3032
Clement Town (Cb)	7358	2323
Clock Tower	5943	2555
D.L Road	8076	3473
Dalanwala	30542	13133
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dharampur	9882	4249
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Hathi Barkala	7995	3438
Indira Colony	9405	4044

Indira Nagar	11443	4920
Indrapuri	10772	4632
Indresh Nagar	9163	3940
Jakhan	13173	5664
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	18266	7855
Kaulagarh	10535	4530
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Majra	14498	6234
Mata Mandir Road	4366	1877
Mehu Wala Mafi (Ct)	15665	4947
Mkp	6690	2877
Mohit Nagar	8594	3695
Niranjanpur	8772	3772
Patel Nagar	21489	9240
Race Course	15919	6845
Rajpur	11085	4766
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shastradhara	16085	6917
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Turner Road	14511	6240
Vasant Vihar	15219	6544
Vijay Colony	9699	4171
Yamuna Colony	7506	3227
Other villages like Pitthuwala, Shewala Khurd,Chandrwani Khalsa etc	92408	24303

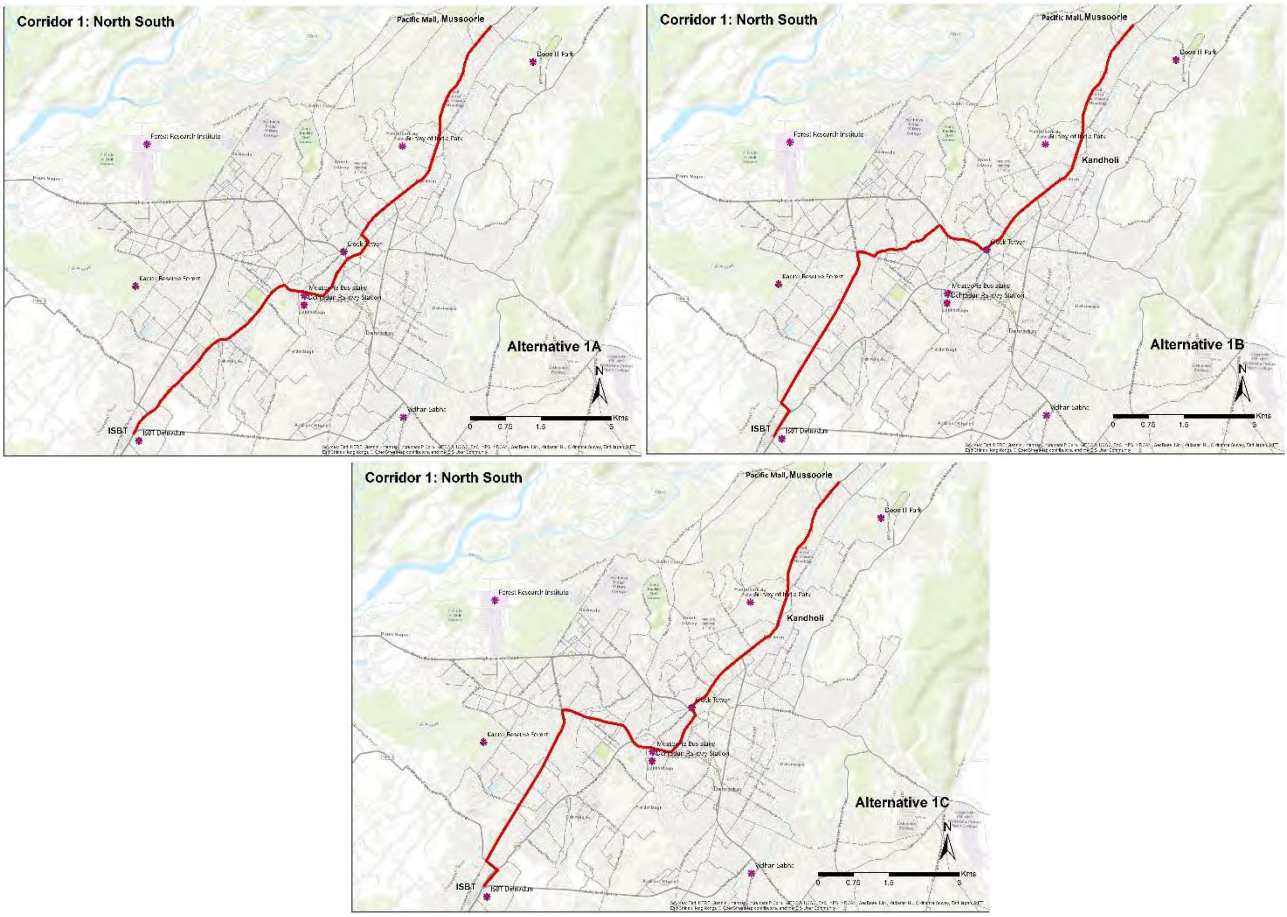


Figure 4-5: Alternative options for Corridor 1- North South

4.2.1.2 CORRIDOR 2: EAST-WEST CORRIDOR IN DEHRADUN CITY

The Alternatives for Corridor 2: East – West corridor are discussed in following sub sections:

Braching of East West Corridor:

Similar to the case of branching in the north south corridor, the branching considered in the east west corridor have equal weightage in terms of ridership and the same as been evaluated based on the parameters discussed below.

Table 4-6: Evaluation Matrix for branching of East West corridor-Dehradun

Corridor 1: Level 3 Screening for Corridor -Branches options-Dehradun - East West Corridor			
S.No	Parameters	Corridor B1: Araghar Chowk to Rispana pul	Corridor B2: Araghar Chowk to Raipur
1	**Project Impact-Area Coverage**		
a	Population	200959	193769
b	Employment	82030	75458
2	**Engineering impact**		
a	Right of way Available	12-15 m	10-12 m

b	Need for Land Acquisition	Yes for Row widening and for 2 station locations	Yes for Row widening and for 5 station locations
c	Terrain Type	Plain	Plain
d	Space availability for Depot Facility	No	Yes
e	Details of Major Bridges/Retaining Structures along the corridor	1	1
3	**Effect on Intermodal connectivity**	Yes with proposed MRTS	Yes with Raipur Bus stand
4	**Project Cost(Crs)**	361	1083

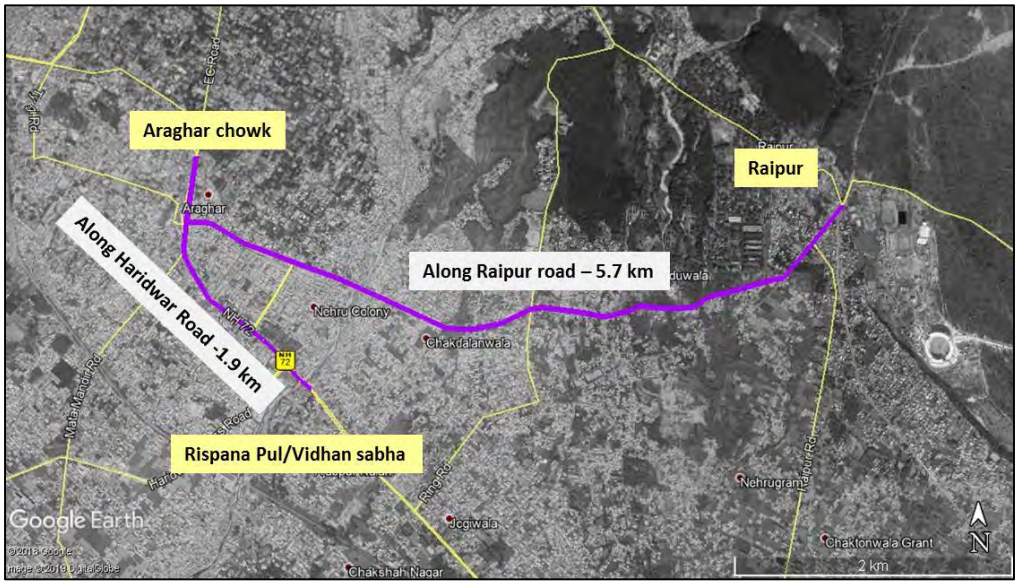


Figure 4-6: Branches along Raipur road and Haridwar Road for East West Corridor

The scoring has been given based on the suitability of the corridors against the parameters considered. The scoring given is presented in Figure 4-6.

Table 4-7: Scoring for branches along East West Corridor

S.No	Parameters	B1: Araghar Chowk to Rispana pul	B2: Araghar Chowk to Raipur
1	**Project Impact-Area Coverage**		
a	Population	1	0.8
b	Employment	1	0.8
2	**Engineering impact**		
a	Right of way Available	0.54	0.405
b	Need for Land Acquisition	0.36	0.18
c	Terrain Type	0.225	0.225
d	Space availability for Depot Facility	0	0.675

e	Details of Major Bridges/Retaining Structures along the corridor	0.18	0.18
3	**Effect on Intermodal connectivity**	0.4	0.3
4	**Project Cost(Crs)**	0.5	0.2
	Total	4.2	3.8

The branch along Haridwar Road till Rispana pul/Vidhan Sabha road obtained highest scoring based on its suitability in the engineering effects and area coverage. This branch of the corridor is preferable because it runs along major radial of the city covering dense area of the city. The average right of way available is also higher as compared to the Raipur branch.

Thus, the branch along the Haridwar Road till Vidhan Sabha/Rispanapul is suitable and considered for the further evaluation of the corridor.

Alternative 2 A: Vidhan Sabha/Rispana Pul to FRI via EC road and Chakrata road

This alignment starts from Vidhan Sabah/Rispana pul at Haridwar Road and continues till Araghar Chowk then diverting on EC Road taking a diversion on cross road and then continue in Chakrata Road till Forest Research Institute. The length of the corridor is 10 km. The alignment of Alternative 2A is given Figure 4-7. The major attractors in this corridor are theVidhan Sabha, EC road, Clock Tower, Paltan Bazar, Doon School, FRI and IMA.

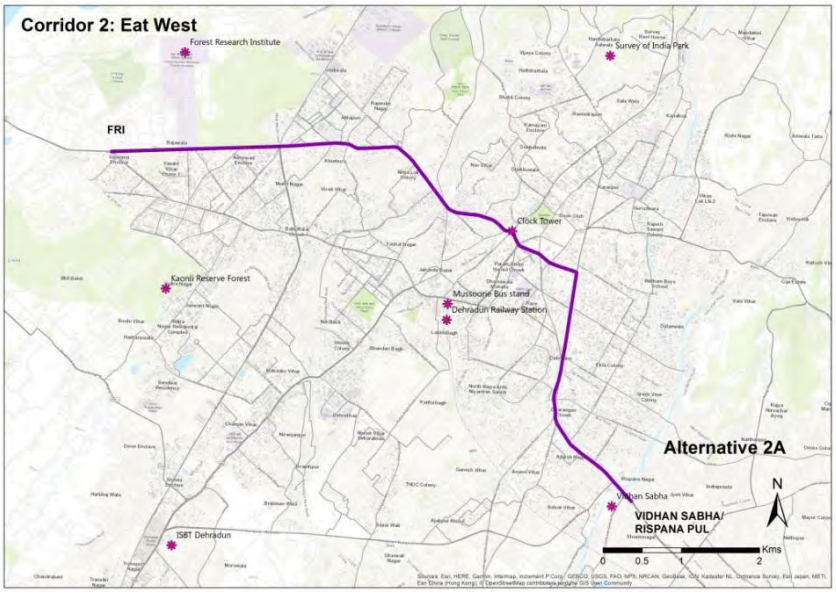


Figure 4-7: Alternative Corridor 2A of Corridor 2 - East West

Advantages:

- This corridor is along one of the major radial in Dehradun which connects the east and west ends of the city
- It connects the residential areas of Ballupur, Suman Nagar, Chukkuwala, Khurbura Mohalla, Dalanwala
- This has an average ROW of 17.80m.

Disadvantages:

- As this is a major radial along the east west direction, major traffic diversion would be required.

Table 4-8: Population and Employment coverage for Alternative 2 A

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Ajabpur	11997	5159
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bhagat Singh Colony	12696	5459
Chhukhuwala	7050	3032
Clock Tower	5943	2555
D.L Road	8076	3473
Dalanwala	30542	13133
Deepnagar	17178	7386
Defence Colony	13975	6009
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dharampur	9882	4249
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Hathi Barkala	7995	3438
Indira Colony	9405	4044
Indira Nagar	11443	4920
Indresh Nagar	9163	3940
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	11122	4782
Kaulagarh	10535	4530
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Mata Mandir Road	14827	6376
Mkp	6690	2877
Mohit Nagar	8594	3695
Natthan Pur (Ct)	16165	5105
Nehru Colony	7946	3417
Patel Nagar	21489	9240

Race Course	15919	6845
Raipur (CT)	24288	7670
Rajeev Nagar	17281	7431
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Vasant Vihar	15219	6544
Vijay Colony	9699	4171
Yamuna Colony	7506	3227
Village TAZ	73322	19284

Alternative 2 B: Raipur to FRI via Jeevanwala-Dehradun Road and Kanwali road

This alignment starts at Vidhan Sabha/Rispana pul along Haridwar Road and ontinues till Araghar Chowk and diverts on Jeevnwala-Dehradun Road and continues on the Chakrata Road. The length of the corridor is 9 km. The alignment of Alternative 2B is given in Figure 4-8. The major attractors in this corridor are Vidhan Sabha, Virmani Market, Railway Station, Mussoorie Bus stand, Paltan Bazar, Balliwala Chowk, FRI and IMA.

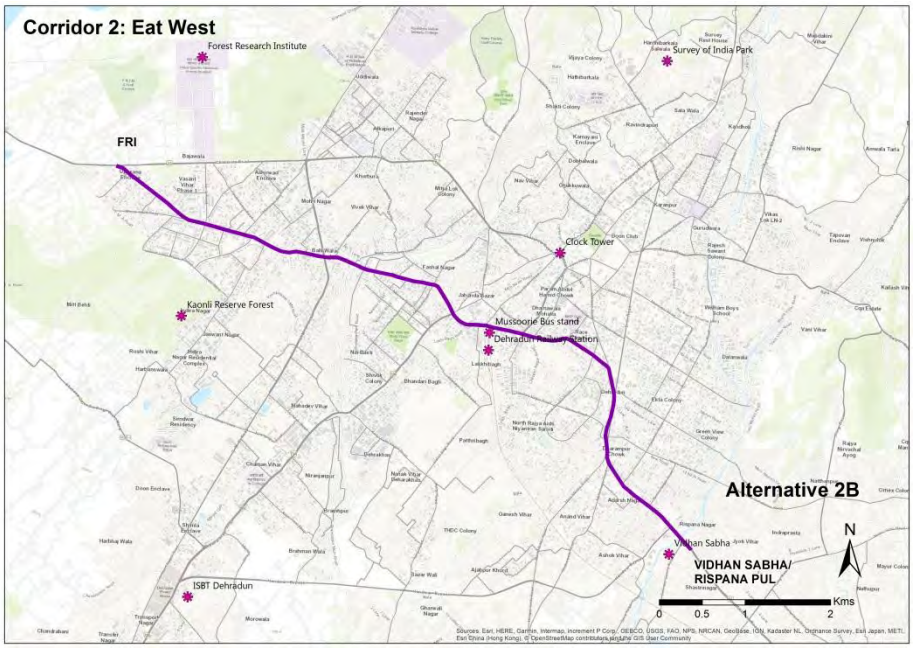


Figure 4-8: Alternative Corridor 2B of Corridor 2 - East West

Advantages:

- It connects the residential areas Shivalik Puram, Gandhi Gram, Khurbura Mohalla, Dalanwala, Jagriti Vihar, Kidduwala

- Intermodal connectivity to Railway station and Mussoorie Bus Stand is possible.

Disadvantages:

- The right of way is constrained. The average RoW of the corridor is 13.50 m.

Table 4-9: Population and Employment coverage of Alternative 2B

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Ajabpur	11997	5159
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bhagat Singh Colony	12696	5459
Bharampuri	17159	7378
Chhukhuwala	7050	3032
Clock Tower	5943	2555
Dalanwala	30542	13133
Deepnagar	17178	7386
Defence Colony	13975	6009
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dharampur	9882	4249
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Indira Colony	9405	4044
Indira Nagar	11443	4920
Indrapuri	10772	4632
Indresh Nagar	9163	3940
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	11122	4782
Kaulagarh	10535	4530
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Mata Mandir Road	14827	6376
Mkp	6690	2877
Mohit Nagar	8594	3695
Natthan Pur (Ct)	16165	5105

Towns/Villages	Population	Employment
	2018	2018
Nehru Colony	7946	3417
Patel Nagar	21489	9240
Race Course	15919	6845
Raipur (CT)	24288	7670
Rajeev Nagar	17281	7431
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Vasant Vihar	15219	6544
Yamuna Colony	7506	3227
Village TAZ	73322	19284

Alternative 2 C: Raipur to FRI via EC road and Chakrata road

This Alternative starts from Vidhan Sabha/Rispana pul along Haridwar Road till Araghar Chowk, diverts to EC Road to continue on Cross Road connecting clock tower again diverting to Gandhi road to connect to railway station and continue on Kanwali Road. The length of the corridor is 10.4 km. The alignment of Alternative 2C is given in Figure 4-9.The major attractors in this corridor are Vidhan Sabha, EC Road, Clock Tower, Railway Station, Mussoorie Bus stand, Paltan Bazar, Balliwala Chowk, FRI and IMA.

Advantages:

- It connects the residential areas Shivalik Puram, Gandhi Gram, Khurbura Mohalla, Chander Nagar, Dalanwala, Jagriti Vihar, Kidduwala
- Intermodal connectivity to Railway station and Mussoorie Bus Stand is possible.

Disadvantages:

- The right of way is constrained. The average RoW of the corridor is 12.80m.

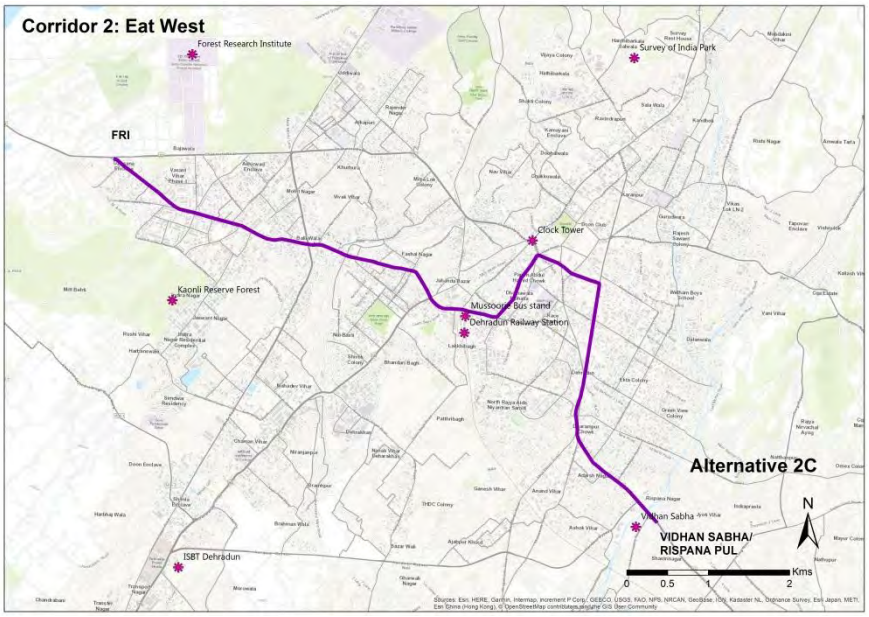


Figure 4-9: Alternative Corridor 2C of Corridor 2 - East West

Table 4-10: Population and Employment coverage of Alternative 2 C

Towns/Villages	Population	Employment
	2018	2018
Adhoiwala	23986	10314
Ajabpur	11997	5159
Aryanagar	9865	4242
Bakralwala	7784	3347
Ballupur	9629	4140
Bhagat Singh Colony	12696	5459
Bharampuri	17159	7378
Chhukhuwala	7050	3032
Clock Tower	5943	2555
D.L Road	8076	3473
Dalanwala	30542	13133
Deepnagar	17178	7386
Defence Colony	13975	6009
Dehradun (CB)	28011	8845
Dhamawala	5253	2259
Dharampur	9882	4249
Dobhalwala	9589	4123
Dronapuri	11269	4846
Gandhi Gram	11791	5070
Govind Garh	11281	4851
Indira Colony	9405	4044
Indira Nagar	11443	4920
Indrapuri	10772	4632

Towns/Villages	Population	Employment
	2018	2018
Indresh Nagar	9163	3940
Jhanda Mohhala	6796	2922
Kalika Mandir Marg	5292	2276
Kanwali	11475	4934
Karanpur	7816	3361
Kargi	11122	4782
Kaulagarh	10535	4530
Khurbura	9777	4204
Krishan Nagar	10174	4375
Lakhibaug	8461	3638
Mata Mandir Road	14827	6376
Mkp	6690	2877
Mohit Nagar	8594	3695
Natthan Pur (CT)	16165	5105
Nehru Colony	7946	3417
Patel Nagar	21489	9240
Race Course	15919	6845
Raipur (CT)	24288	7670
Rajeev Nagar	17281	7431
Reetha Mandi	8358	3594
Rest Camp	12251	5268
Rispana	8102	3484
Shivaji Marg	11396	4900
Shri Dev Suman Nagar	9994	4297
Tilak Road	9683	4164
Vasant Vihar	15219	6544
Vijay Colony	9699	4171
Yamuna Colony	7506	3227
Village	73322	19284

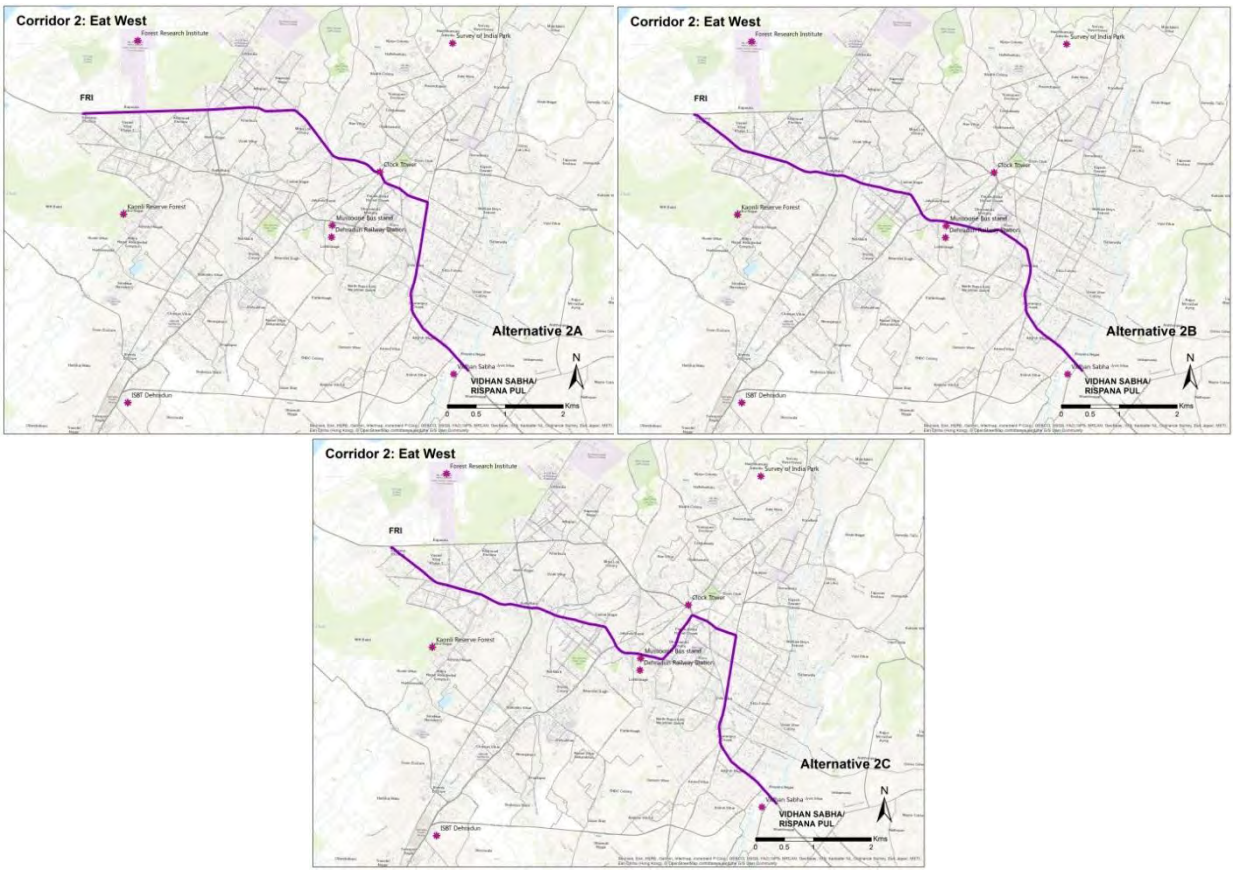


Figure 4-10: Alternative options for Corridor 2- East West

4.2.1.3 CORRIDOR 3: CONNECTING DEHRADUN, RISHIKESH AND HARIDWAR

The Alternatives for Corridor 3: Connecting Dehradun, Rishikesh and Haridwar are discussed in following sub sections

Alternative 3A: Rispana at Dehradun to Bahardarabad at Haridwar via NH 72

This Alternative starts from Rispana on Haridwar road in Dehradun where the East West corridor proposed in Dehradun ends. The alignment continues on NH 72 and connects Rishikesh at Nepali Farms and continues on NH 72 till Uttarakhand Sansakrit Academy at Bahardarabad in Haridwar. At Nepali Farms in Rishikesh, another branch continues along the NH 72 to connect Rishikesh City Centre. The alignment of Alternative 3A is given in Figure 4-11. The overall corridor length is 67.8 km. The major attractors along this corridor are Vidhan Sabha, Doiwala, Pashulok, IDPL, Rishikesh City, Hark ki Pauri, Haridwar City, Bahadarabad.

Figure 4-11: Alternative Corridor 3A of Corridor 3- Connecting Dehradun – Rishikesh - Haridwar

Advantages:

- This alignment passes through the NH 72, which is the shortest distance between Dehradun and Rishikesh
- Intermodal connectivity to Haridwar and Rishikesh Railway stations are possible.
- Corridors can also be phased as the alignment passes through a major radial along the Rishikesh city which will have higher social impact.

Disadvantages:

- As this is a National Highway, the construction phase would affect the mixed lane traffic even the commuters who are travelling beyond Dehradun and Haridwar.

Table 4-11: Population and Employment coverage of Alternative 3A

Town/Village Name	Area	Population	Employment
	Sqkm	2018	2018
Kharak mafi (CT)	3.20	6877	2239
Gumaniwala (CT)	1.86	5014	1633
Virbhadra IDPL (ITS)	2.55	3712	1209
Rishikesh (CT)	5.40	6794	2212
Rishikesh (MB)	0.67	10535	3430
Gumaniwala (CT)	1.14	3069	999

Town/Village Name	Area	Population	Employment
	Sqkm	2018	2018
Rishikesh (CT)	2.02	2545	829
Rishikesh (MB)	1.16	18226	5935
Hardwar (MB + OG)	16.88	244831	77314
Deepnagar	7.21	15879	6828
Dalanwala (North)	1.43	11394	4899
Bhagat Singh Colony	0.57	12696	5459
Dalanwala (East)	0.45	9493	4082
Rajeev Nagar	1.99	17281	7431
Nehru Colony	0.19	7946	3417
Dharampur	0.39	9882	4249
Dalanwala (South)	1.17	9655	4151
Rest Camp	0.72	12251	5268
Race Course (North)	0.74	7605	3270
Race Course South	0.52	8315	3575
Ajabpur	1.04	11997	5159
Mata Mandir Road	0.61	10461	4498
Kargi	2.35	11122	4782
Defence Colony	1.31	13975	6009
Adhoiwala (South)	0.98	15521	6674
Mata Mandir Road	0.25	4366	1877
Deepnagar	0.19	1298	558
Bharat Heavy Electricals Limited Ranipur (ITS)	8.53	29931	13768
Jagjeetpur (CT)	3.25	17488	5246
Bahadarabad (CT)	1.89	11737	3521
Raipur (CT)	3.04	9976	3150
Doiwala (NP)	6.58	10124	3197
Natthan Pur (CT)	4.08	16165	5105
Haripur Kalan (CT)	2.69	12052	3924
Pratitnagar (CT)	1.33	11118	3620
Bharat Heavy Electricals Limited Ranipur (ITS)	4.37	15333	7053
Rishikesh (MB)	0.72	11337	3692
Raipur (CT)	1.64	5394	1704
Raipur (CT)	2.72	8918	2816
Rishikesh (MB)	2.16	33841	11019
Kharak mafi (CT)	1.35	2892	942
Virbhadra IDPL (ITS)	2.69	3928	1279
Other Villages along the corridor	945.95	347829	91479

Alternative 3B: Rispana at Dehradun to Bahardarabad at Haridwar via Rishikesh Road

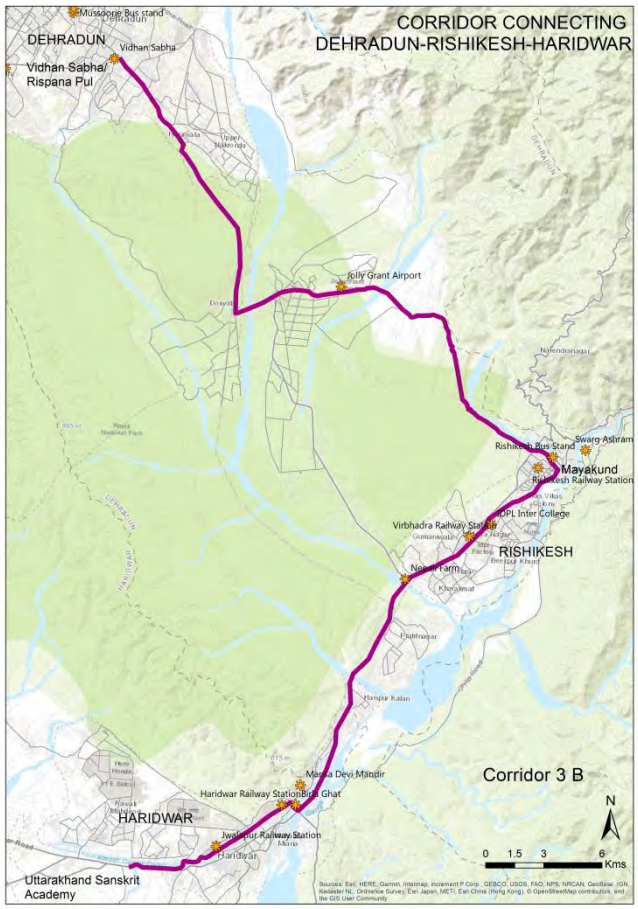


Figure 4-12: Alternative Corridor 3B of Corridor 3- Connecting Dehradun – Rishikesh - Haridwar

This Alternative starts from Rispana on Haridwar road in Dehradun where the East West corridor proposed in Dehradun ends. This alignment continues on NH 72 and from Doiwala diverts to Rishikesh Road to connect Airport and connect Rishikesh at Mayakund. The alignment then continues on NH 72 till Rodi Belwala then diverting on Haridwar Main Road till Jwalapur and again continues on NH 72 till Bahardarabad in Haridwar. The length of the corridor is 71.5km. The alignment of Alternative 3B is given in Figure 4-12.The major attractors along this corridor are Vidhan Sabha, Doiwala, Airport, Pashulok, IDPL, Rishikesh City, Hark ki Pauri, Haridwar City, Bahadarabad.

Advantages:

- Intermodal connectivity to Airport, Haridwar and Rishikesh Railway stations are possible.

Disadvantages:

- The distance for commuters travelling to Dehradun to Haridwar will increase as they will have to travel through Rishikesh too.
- Phasing of the corridor cannot be done as there is no branching.

Table 4-12: Population and Employment coverage of Alternative 3 B

Town/Village Name	Population	Employment
	2018	2018
Kharak Mafi (CT)	6877	2239
Gumaniwala (CT)	5014	1633
Virbhadra IDPL (ITS)	3712	1209
Rishikesh (CT)	6794	2212
Rishikesh (MB)	10535	3430
Gumaniwala (CT)	3069	999
Rishikesh (CT)	2545	829
Rishikesh (MB)	18226	5935
Hardwar (MB + OG)	244831	77314
Deepnagar	15879	6828
Dalanwala (North)	11394	4899
Bhagat Singh Colony	12696	5459
Dalanwala (East)	9493	4082
Rajeev Nagar	17281	7431
Nehru Colony	7946	3417
Dharampur	9882	4249
Dalanwala (South)	9655	4151
Rest Camp	12251	5268
Race Course (North)	7605	3270
Race Course South	8315	3575
Ajabpur	11997	5159
Mata Mandir Road	10461	4498
Kargi	11122	4782
Defence Colony	13975	6009
Adhoiwala (South)	15521	6674
Mata Mandir Road	4366	1877
Deepnagar	1298	558
Bharat Heavy Electricals Limited Ranipur (ITS)	12487	5744
Jagjeetpur (CT)	17488	5246
Bahadarabad (CT)	11737	3521
Raipur (CT)	9976	3150
Doiwala (NP)	10124	3197
Natthan Pur (CT)	16165	5105
Haripur Kalan (CT)	12052	3924
Pratitnagar (CT)	11118	3620
Bharat Heavy Electricals Limited Ranipur (ITS)	15333	7053
Rishikesh (MB)	11337	3692
Raipur (CT)	5394	1704

Town/Village Name	Population	Employment
	2018	2018
Raipur (CT)	8918	2816
Rishikesh (MB)	12495	4069
Kharak mafi (CT)	2892	942
Virbhadra IDPL (ITS)	3928	1279
Other Villages along the corridor	381612	101851

Alternative 3C: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72

This alignment is similar to the first alignment Alternative for the Corridor 3 – Alternative 3A. The deviation is at Haripur Kalan in Haridwar where the alignment diverts to Bhoopatwala-Khadkhadi Road and continues on Haridwar Main road till Jwalapur and again continues on NH 72 till Bahardarabad in Haridwar. The length of the corridor is 67.7 km. The alignment of Alternative 3C is given in Figure 4-13.The major attractors along this corridor are Vidhan Sabha, Doiwala, Pashulok, IDPL, Rishikesh City, Hark ki Pauri, Haridwar City, Bahadarabad.

Figure 4-13: Alternative Corridor 3C of Corridor 3- Connecting Dehradun – Rishikesh – Haridwar

Advantages:

- This alignment passes through the NH 72, which is the shortest distance between Dehradun and Rishikesh
- Intermodal connectivity to Haridwar, Jwalapur and Rishikesh Railway stations are possible.
- Corridors can also be phased as the alignment passes through a major radial along the Rishikesh city which will have higher social impact.

Disadvantages:

- As this is a National Highway, the construction phase would affect the mixed lane traffic even the commuters who are travelling beyond Dehradun and Haridwar.
- The alignment also passes through the major radial along the Haridwar city which is constrained in right of way and would also have higher social impact.

Table 4-13: Population and Employment coverage of Alternative 3 C

Town/Village Name	Population	Employment
	2018	2018
Kharak Mafi (CT)	6877	2239
Gumaniwala (CT)	5014	1633
Virbhadra IDPL (ITS)	3712	1209
Rishikesh (CT)	6794	2212
Rishikesh (MB)	10535	3430
Gumaniwala (CT)	3069	999
Rishikesh (CT)	2545	829
Rishikesh (MB)	18226	5935
Hardwar (MB + OG)	244831	77314
Deepnagar	15879	6828
Dalanwala (North)	11394	4899
Bhagat Singh Colony	12696	5459
Dalanwala (East)	9493	4082
Rajeev Nagar	17281	7431
Nehru Colony	7946	3417
Dharampur	9882	4249
Dalanwala (South)	9655	4151
Rest Camp	12251	5268
Race Course (North)	7605	3270
Race Course South	8315	3575
Ajabpur	11997	5159
Mata Mandir Road	10461	4498
Kargi	11122	4782
Defence Colony	13975	6009
Adhoiwala (South)	15521	6674
Mata Mandir Road	4366	1877

Town/Village Name	Population	Employment
	2018	2018
Deepnagar	1298	558
Bharat Heavy Electricals Limited Ranipur (ITS)	29931	13768
Jagjeetpur (CT)	17488	5246
Bahadarabad (CT)	11737	3521
Raipur (CT)	9976	3150
Doiwala (NP)	10124	3197
Natthan Pur (CT)	16165	5105
Haripur Kalan (CT)	12052	3924
Pratitnagar (CT)	11118	3620
Bharat Heavy Electricals Limited Ranipur (ITS)	15333	7053
Raipur (CT)	5394	1704
Raipur (CT)	8918	2816
Rishikesh (MB)	33841	11019
Kharak mafi (CT)	2892	942
Virbhadra IDPL (ITS)	3928	1279
Other Villages along the corridor	347829	91479

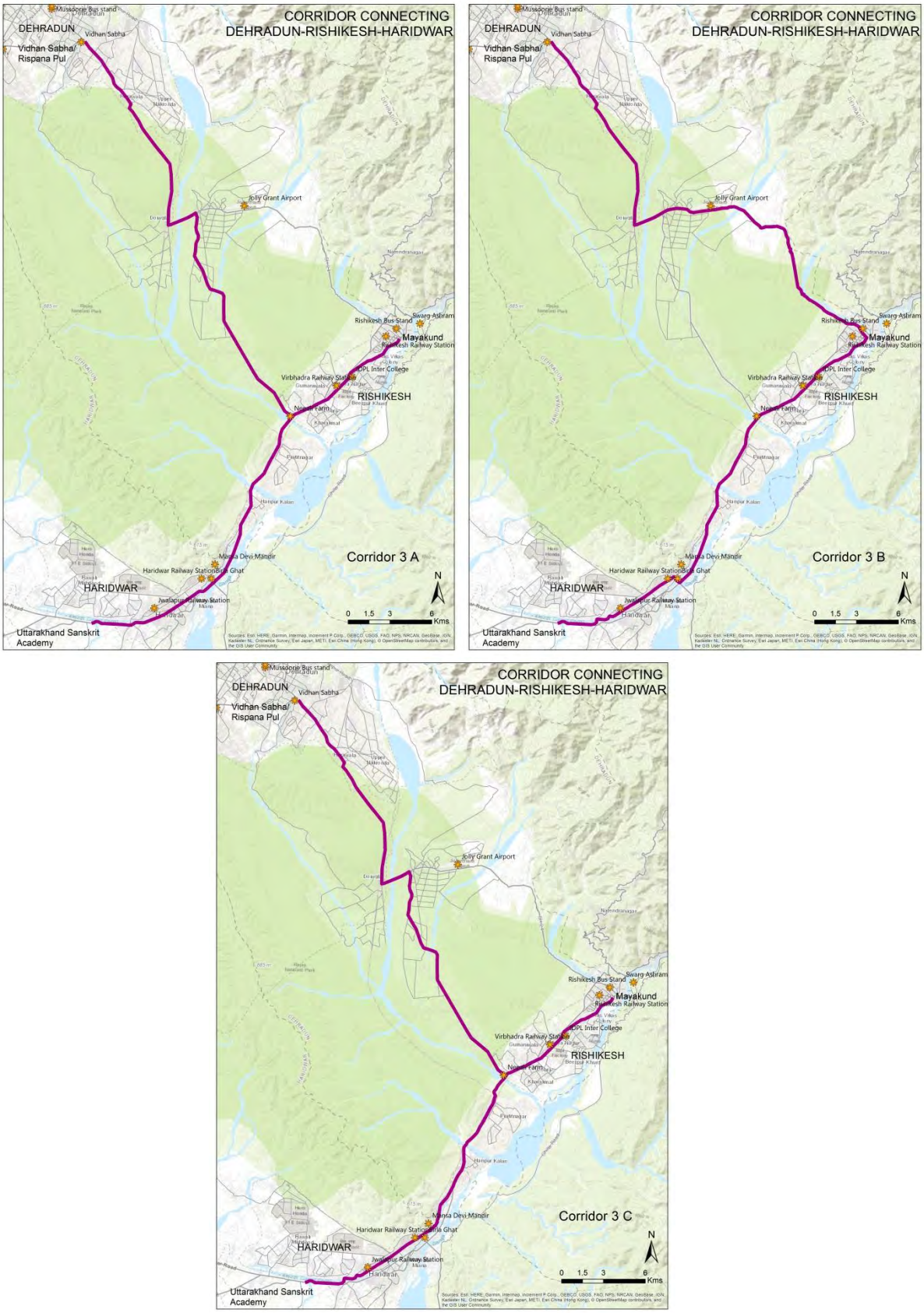


Figure 4-14: Alternative options for Corridor 3 - Connecting Dehradun - Rishikesh - Haridwar

4.2.2 SECOND ORDER TRANSIT CORRIDOR – ALTERNATE CORRIDORS

Second order transit system is provided to enhance the connectivity in the cities. A mass transit corridor in itself cannot be a solution to ensure effective and efficient transportation system, as it has its own limitation in being rigid and having major influence only in close proximity to the corridor. Thus to connect places not in the influence zone of the first order transit and to act as a feeder system, second order transit system are provided. Second order transit corridors in Dehradun, Rishikesh and Haridwar Cities are given below:

4.2.2.1 DEHRADUN CITY

Dehradun is the only city in the study area which has a city bus service though operated by private operators. It is not an organized public transport from the transport department undertakings but the Buses ply on the routes authorize by the RTO. There are 16 intra-city bus routes which have 321 buses plying on them.

CMP suggested to continue with the existing routes with addition of three new routes connecting important residential areas like Dalanwala, Adhoiwala, Dharampur, Race Course, Govind Nagar, Chukkuwala, Dobhalwala, Subash Nagar, Vasant Vihar, Indira Nagar, Smith Nagar, etc that were missing connectivity through transit system.

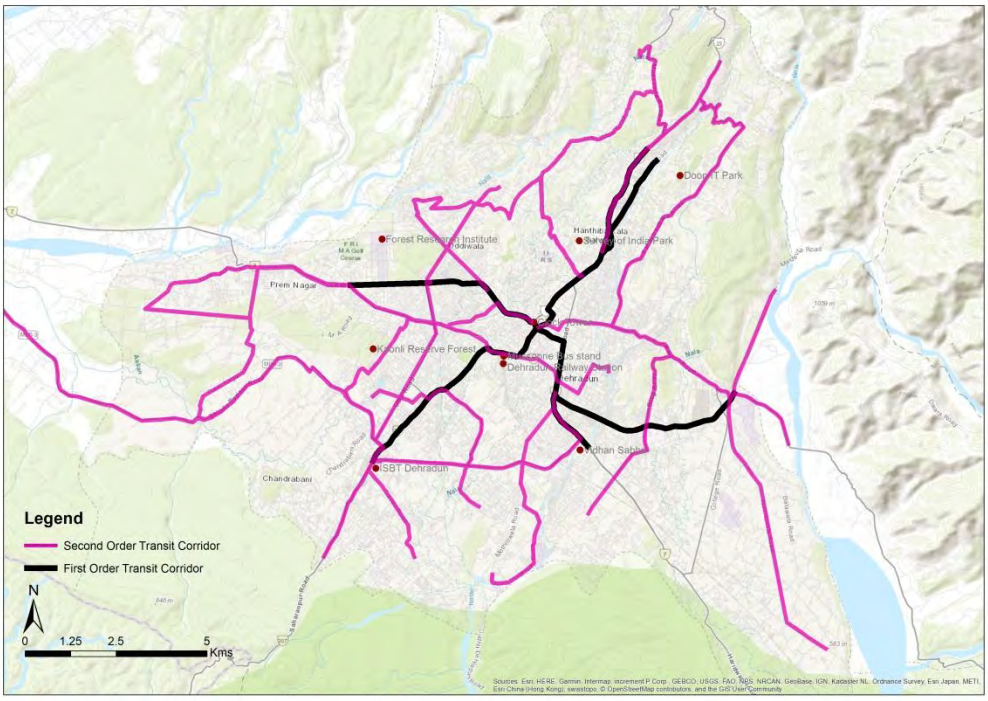


Figure 4-15: Second Order Transit Corridor in Dehradun City

To ensure implementation of an integrated public transport system in Dehradun city, a three tier public transport system is proposed based on the density pattern of the city. The First Order Transit Corridors, which would act as the main public transit corridor while the Second Order Transit Corridors (medium and low density corridors), would complement the First Order Transit Corridors with minimal overlap so as to increase the overall reach of the First Order Transit Corridors and will enhance the population

covered, by access to the public transport system. The Third Order Transit Corridors provide the most important first and last mile connectivity to the First and Second Order by introducing a complementing and effective Intermediate Public Transport System in the city.

These proposed corridors based on density pattern of the city are given in Figure 4-16.

A detailed Route Rationalization study needs to be done to identify the detailed routes for the Second Order, fleet size, operational plan, infrastructure required etc. so as to increase the coverage of the public transport system and to reduce the overlap between the 3 corridors so that the proposed transit systems do not compete with each other and also improve the overall efficiency of the system.

As these second corridors cover the entire region of Dehradun connecting all the major residential areas and commercial areas, covering 190.91 sqkm area and catering to a population of 8.25 lakhs, no other Alternative corridor is suggested.

However, the analysis will be performed for selection of suitable transit modes like Bus, Cable Car and PRT on these corridors.

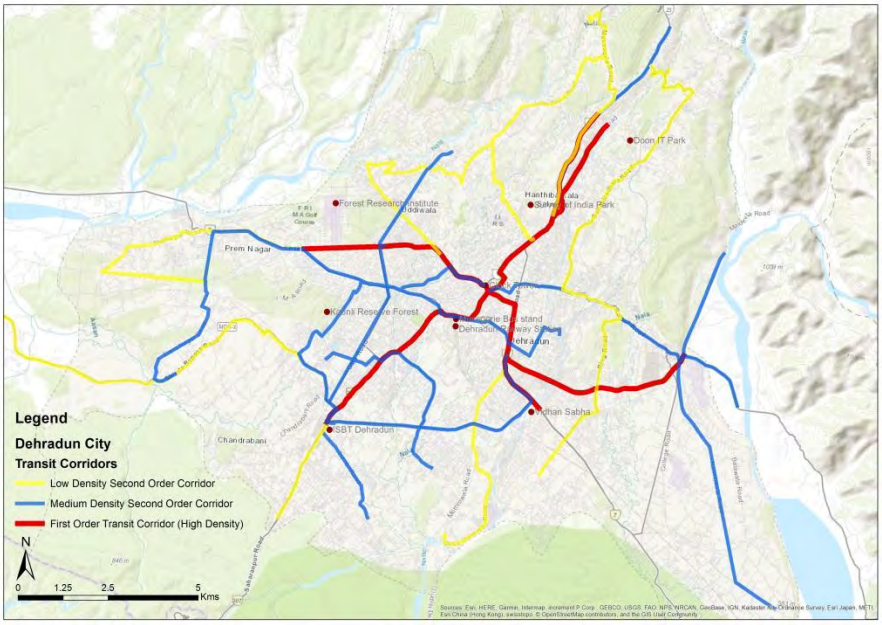


Figure 4-16: Medium and Low Second order transit corridor in Dehradun City

4.2.2.2 RISHIKESH CITY

Second order transit corridor is proposed from ISBT to Pashulok which runs on the parallel road to the first order transit connecting the areas Gumaniwala, Dudhu Pani, THDC Colony, Natraj chowk, Ashutosh Nagar which are not covered by first order transit. This is suggested as the said corridor is already an existing IPT route with high demand. The corridor length is 9.1 km.

This corridor along with the first order transit corridor covers majority of the area of Rishikesh City, following which analysis will be carried out for transit technology to be opted from Alternative modes – Bus, PRT and Cable car.

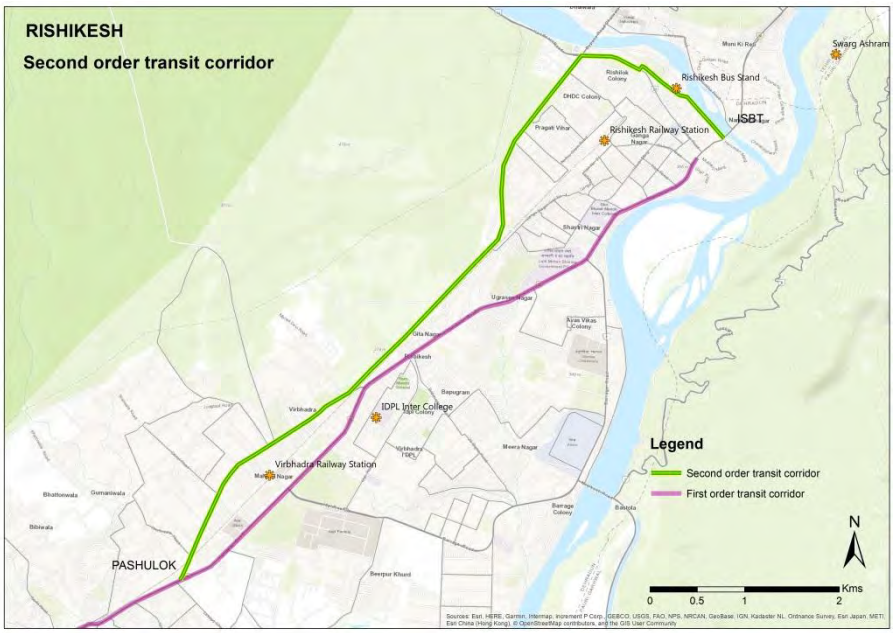


Figure 4-17: Second Order Transit Corridor in Rishikesh City

4.2.2.3 HARIDWAR CITY

There are three second order transit corridors taken for assessment are -

1. Sitapur to SIDCUL
2. Har ki Pauri to Sitapur
3. Sitapur to Indian Overseas Bank, Sarai, Jwalapur

Sitapur to SIDCUL

The Alternatives considered to connect Railway station/Sitapur to SIDCUL are:

Sitapur to SIDCUL area via Madhya Marg and SIDCUL

This Alternative starts from Sitapur on Jwalapur road, moving along the western road of the Jwalapur area and continues on Madhya Marg and passes all around the SIDCUL area and diverts on Sidcul Bypass road till Samrat Prithviraj Chauhan Chowkin Bahadarabad. The corridor length is 18.2 km. The average right of way availability is 17.7 km.

The main attractors in this corridor are BHEL Township, SIDCUL.

This corridor connects the residential areas of Labour Colony, Shivalik Nagar, GM colony, Jwalapur, Rawali Mahdood, RK Puram Colony.

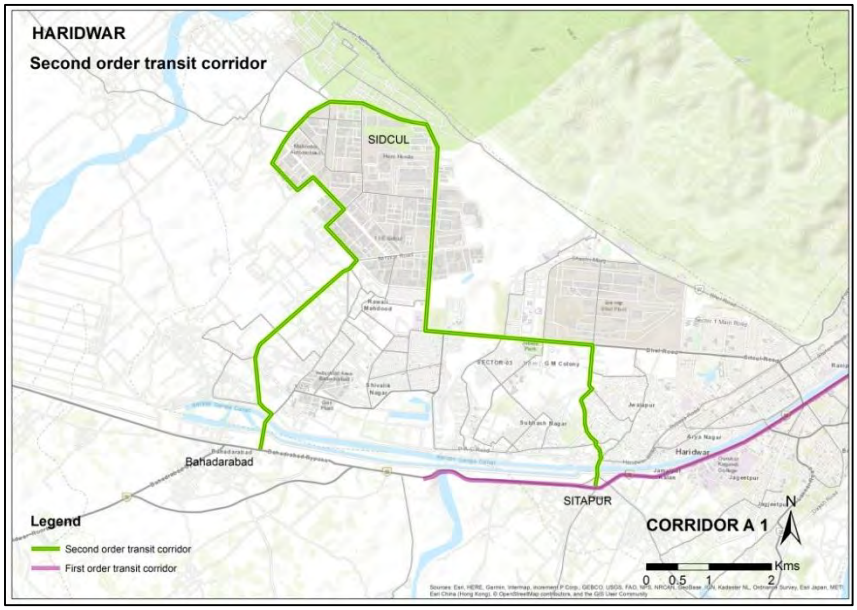


Figure 4-18: Alternative A1 - Second Order Transit Corridor

Sitapur to SIDCUL area via Telephone Exchange Road, Bahadarabad Road and SIDCUL

This Alternative starts from Sitapur on Jwalapur road and continues on Telephone Exchange road, diverting northwards on Bahadarabad road and passes all around the SIDCUL area and diverts on Sidcul Bypass road till Samrat Prithviraj Chauhan Chowkin Bahadarabad. The corridor length is 19.1 km. The average right of way availability is 9.49 km.

The main attractors in this corridor are BHEL Township, SIDCUL.

This corridor connects the residential areas of Ranipur, Shivalik Nagar, Rawali Mahdood, RK Puram Colony.

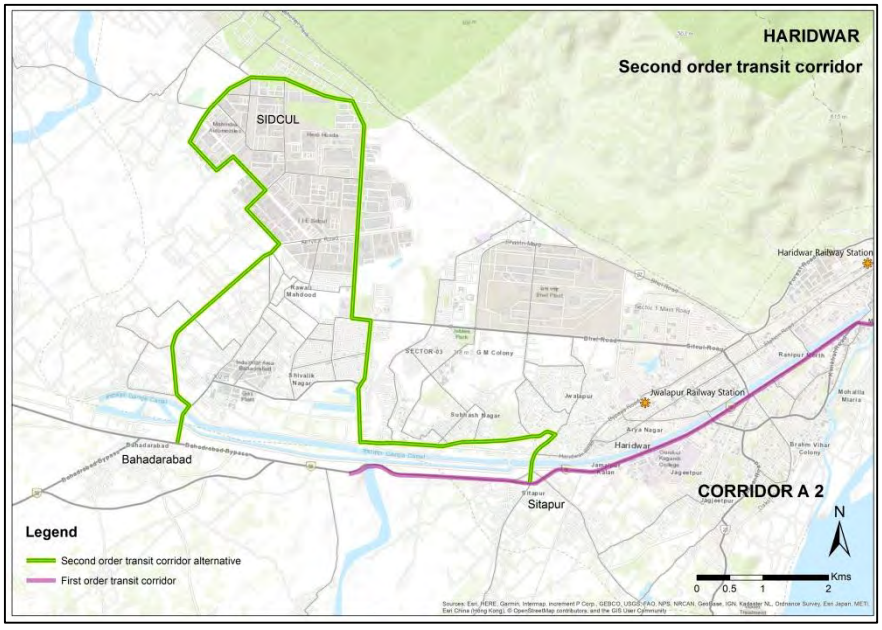


Figure 4-19: Alternative A2 - Second Order Transit Corridor

Sitapur to SIDCUL area via Telephone Exchange road and Sidcul bypass

This Alternative starts from Sitapur on Jwalapur road and continues on Telephone Exchange road and diverts on Sidcul Bypass road till Samrat Prithtviraj Chauhan Chowk in Bahadarabad. The corridor length is 14.9 km. The average right of way availability is 10.4 km.

The main attractors in this corridor are BHEL Township.

This corridor connects the residential areas of Jwalapur, Ranipur, Shivalik Nagar, Rawali Mahdood, RK Puram Colony.

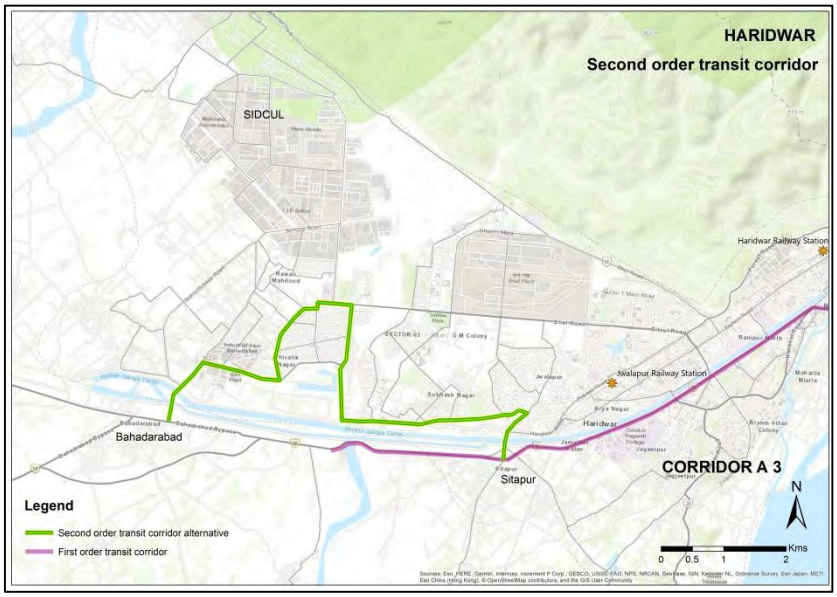


Figure 4-20: Alternative A3 - Second Order Transit Corridor

Sitapur to Bahardarabad via Madhya Marg and Sidcul bypass BHEL Township

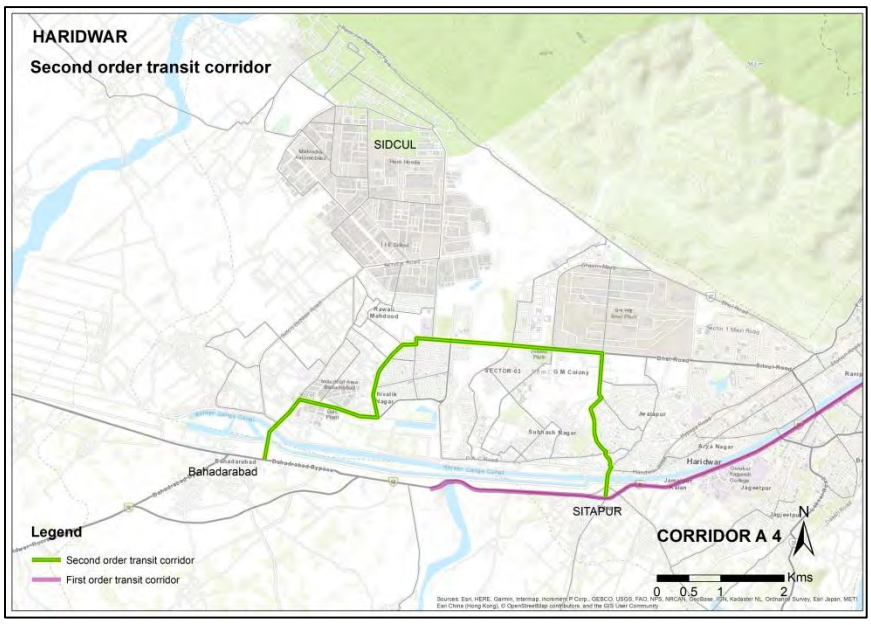


Figure 4-21: Alternative A4 - Second Order Transit Corridor

This Alternative starts starts from Sitapur on Jwalapur road and moving along the western road of the Jwalapur area and continues on Madhya Marg continuing on Sidcul Bypass Road till Samrat Prihtviraj Chauhan Chowk in Bahadarabad. The length of the corridor is 9.5 km and the average right of way available is 13.1m.

The main attractors in this corridor are BHEL Township.

The corridor connects the residential areas of Sector 4, Rosanpuri, Rawali Mahdood, RK Puram colony.

Har Ki Pauri to Sitapur

Har ki Pauri is the major attraction center in the city being an important pilgrimage center, thus a direct connection with the Railway station will improve the chaos at the corridor. The Alternatives considered to connect Sitapur to Har ki Pauri are:

Sitapur to Har Ki Pauri via Haridwar Main road and Upper Bazar Road

This Alternative connects Sitapur to Har ki Pauri via Haridwar Main road and Upper Bazar road. The alignment connects Haridwar Railway station also. The corridor is 7.8 km in length. The average right of way available is 6.7 m. This corridor runs along the main commercial area of the city.

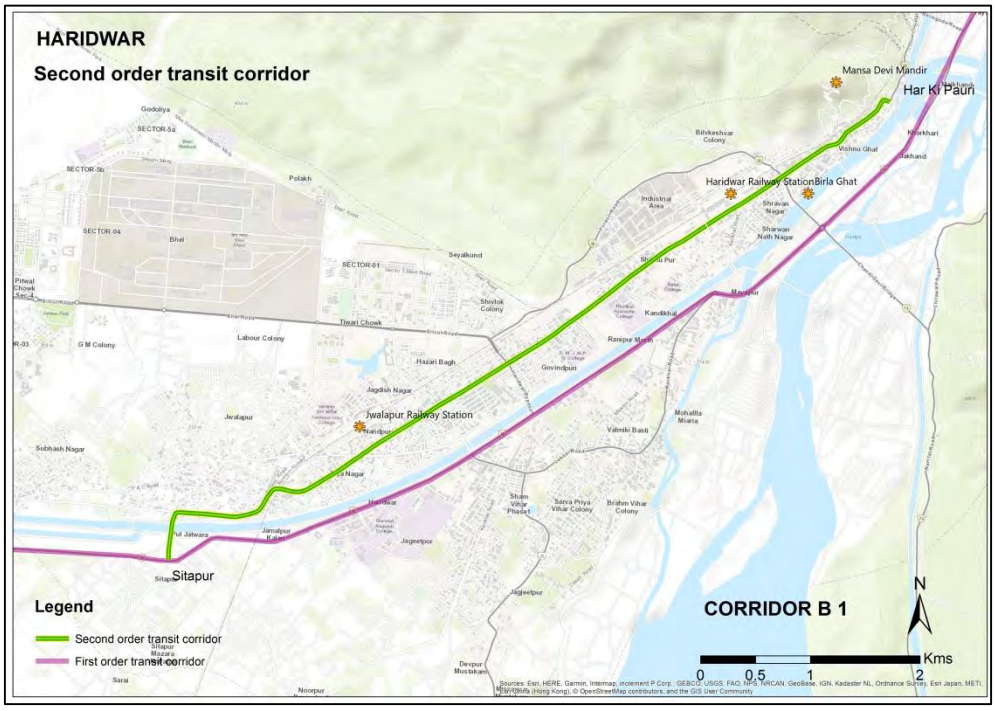


Figure 4-22: Alternative B1 - Second Order Transit Corridor

Sitapur to Har Ki Pauri via Bypass Road and Haridwar Main road

This Alternative connects Sitapur to Har ki Pauri via Haridwar Main road diverting on Bypass road and continuing on Upper Bazar road till Har ki Pauri. The corridor length is 8.6 km with average right of way available as 8 m.

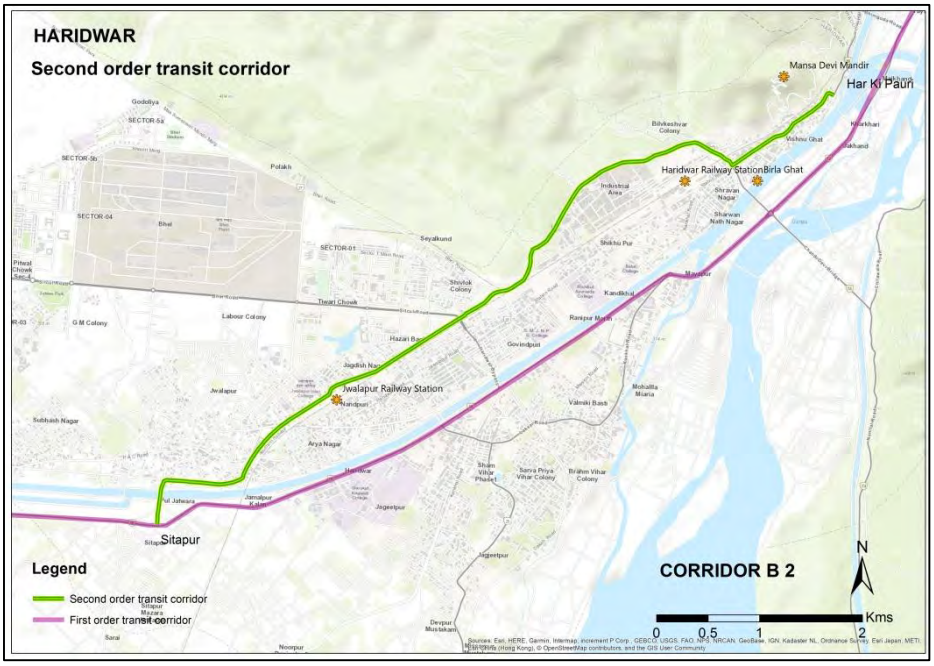


Figure 4-23: Alternative B2 - Second Order Transit Corridor

Sitapur to Sarai

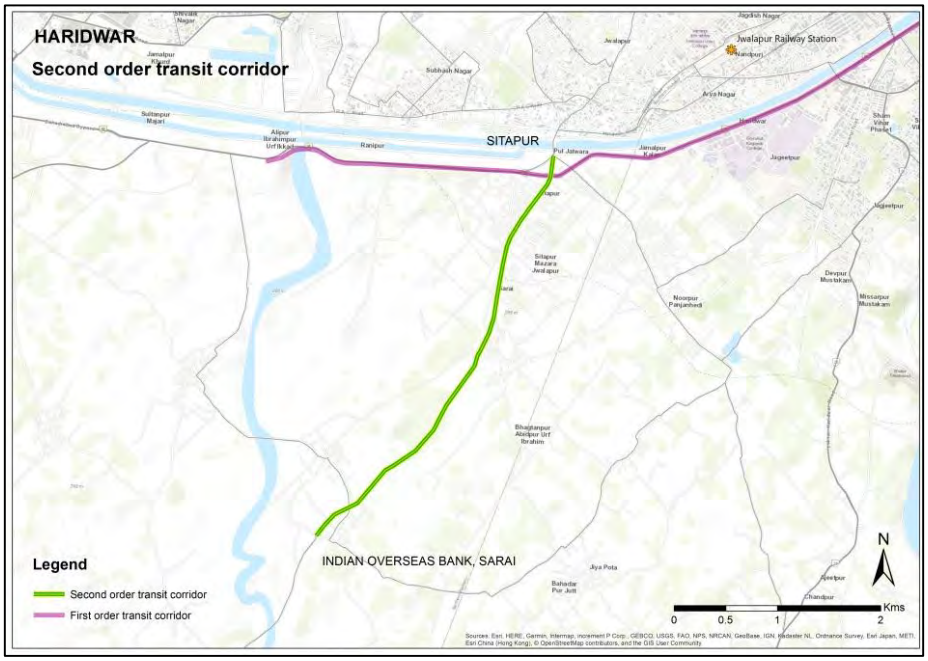


Figure 4-24: Alternative C - Second Order Transit Corridor

The first two corridors discussed above enhance the connectivity of the city towards west and east. It is suggested in CMP to connect the city southwards where the new development is taking place. This alignment starts from Sitapur diverting south towards Sarai. This corridor length is 4.5 km with average right of way 8-10m. There is no other feasible Alternative for this corridor that can be considered and the Alternative analysis will be carried out for suitable modes.

4.2.3 ALTERNATIVE MASS TRANSIT OPTIONS

Mass Rapid Transit (MRT) is collective urban passenger service that operates at high levels of customer performance, especially with regard to travel times and passenger carrying capacity. Mass rapid transit can achieve reduced travel times through the provision of widely accessible networks, higher speed vehicles, exclusive right of way infrastructure, efficient fare collection systems, and faster boarding and alighting techniques. The various mass transit options around the globe include:

- Heavy Rail Transit – Metro
- Medium Metro
- Elevated Light Rail Transit/Light Metro
- At grade Light Rail Transit
- Monorail
- Personal Rapid Transit
- Bus Rapid Transit (BRTS)
- Cable Car/Ropeway
- City Bus

The selection of a particular mass transit system for a city is always a challenging task. Some of the criteria on which the selection of the system can be made include:

- Future travel demand
- Cost of construction
- Available right-of-way
- Integration with other modes of transport
- Accessibility and mobility to the stations
- Environmental and social impact
- Comfort
- Reliability
- Flexibility
- Implementation complexities

A brief description of each of the mass transit options is given in following sub-sections.

Rail Based System

4.2.3.1 METRO SYSTEMS

Metro System is a grade separated dedicated system for high peak traffic densities. Metro utilizes high capacity electric trains with acceleration and braking rates. It represents the highest performance transit mode with the lowest operating cost per space-km. Its implementation requires very high investment and extensive construction. However, metro system has longer life span and exerts a strong, permanent impact on mobility of population, urban form and character. Growth of cities, increasing demand for travel and the growing need for high performance transit that is independent of frequently congested urban streets have resulted in construction of metros in large number of cities in recent decades. Many

Indian cities like Delhi, Mumbai, Bangalore, Kolkata, Hyderabad, Kochi have incorporated metro systems in both elevated and underground capacities.

- Maximum speed:80-90km/h
- Average speed 40-45km/h, depending on station spacing
- Capacity 15 000-80 000 passengers/direction/hour
- Minimum curve radius 100m
- Axle load 15-16 tonnes

Figure 4-25: Delhi Metro

Delhi metro is the largest metro system in India. Some of the key features are:

- Delhi Metro Rail Corporation Limited handles the construction and operation of Delhi Metro
- Operation began on 25th December 2002 with first corridor between Shahdara and Tiz Hazari
- Operational network length 317 km with 231 stations (December 2018)
- 280 train sets of four, six and eight coaches
- Ridership 27 lakhs (2018)

4.2.3.2 ELEVATED LIGHT RAIL TRANSIT/ LIGHT METRO

Light Rail Transit is a form of urban rail public transportation that has generally low capacity and lower speed than heavy rail and metro systems, but higher capacity and speed than traditional tram systems. Light Metro is essentially high-floor Light Rail provided with dedicated Right of way throughout the system. This enables its full speed potential of 80km/h to be exploited, without contending for right-of-way. It can thus offer average speeds similar to metro, namely around 40- 45km/h. Operation is usually automatic (driverless). The high-floor design allows level entry from matched platforms, to minimize station dwell time. This yields the following advantages over heavy metro:

- Axle load is lower, so structures are lighter,
- Vehicle profiles are smaller, so structures, particularly tunnels, are smaller
- Curves are tighter and grades are steeper, which allows greater use of less expensive guide ways
- Stations are smaller and less expensive
- Vehicles cost less

Gurgaon Rapid Metro is one such example of a Light Metro. Other examples are Vancouver (Canada), Barcelona metro (Spain), Kuala Lumpur (Malaysia), and Dockland Light Rail (London).Some of the Key features are:

- Light Metro/Elevated Light Rail Transit acting as a feeder to the Delhi Metro, operation commenced in November 2013
- 12 km and 11 Stations
- 12 Trains
- Ballast-less track & Flange lubrication system minimizes vibration, noise and air pollution
- Length of the vehicle: 21-22 m
- Carrying Capacity: 300 passengers per car
- First 100% Private owned Rail based project in India

Yet another example is the **Light Rail Transit in Singapore** which is a series of localized automated guide way transit systems acting as feeder services to the heavy rail Mass rapid Transit system which forms the core of Singapore's rail transport services.

- Operational from November 1999
- System Length 28.8 km
- 3 lines with 42 stations
- LRT lines use fully automated and driverless rubber tired rolling stock
- Constructed by Land Transport authority with operating concessions handed to SMRT Light Rail and SBS Transit

Figure 4-26: Elevated LRT- Rapid Metro in Gurgaon

Figure 4-27: LRT system in Singapore

4.2.3.3 AT-GRADE LIGHT RAIL TRANSIT (LRT)

Light Rail Transit is modern street cars running on rails at grade with sharp curves. Light rail transit lines are more segregated from street traffic than the tramways nonetheless they are akin to road vehicles and pedestrians and thus operate at much lower speed than heavy rail. They are quiet, and offer a comfortable ride. State-of-the-art LRVs feature low floors, 300-350mm above rail, over 60-100% of their floor area.

- Maximum speed 70-90km/h, depending on station spacing
- Capacity 6000-25 000 passengers/direction/hour
- Minimum curve radius 25m
- Axle load 8-10 tonnes

At grade LRT in the form of heritage old tramways are operational only in Kolkata in India. LRT has been adopted in 436 cities (includes 39 under construction and 30 under planning). Some of the countries are; Algeria, Argentina, Armenia, Australia, Brazil, China, Colombia, Denmark, Finland, France, India, Indonesia, Iran, Iraq, Israel, Italy, Japan, Korea South, Morocco, Netherlands, New Zealand, Norway, Panama, Romania, Russian Federation, Saudi Arabia, South Africa, Spain, Switzerland, Taiwan, Turkey, United Arab Emirates, United Kingdom, United States, Viet Nam. Another example is the **LRT at Rabbat, Morrocco**. The Key Features of Rabbat LRT are:

- 2 lines out of 5 in total (According to the director's plan)
- Exclusive right-of-way represents 70% of the network
- A 17 km long infrastructure
- 17 Electric al power-stations
- 4 terminus
- 1 maintenance center
- 31 stations
- 19 double trains of 63 meters long and 6 single trains of 32 m, width: 2,65m
- 8 100 passengers/h/way

Figure 4-28: At grade LRT at Rabbat Morocco

4.2.3.4 MONORAIL

Monorail is a single rail serving as track for passenger or freight vehicles. Monorail trains operate on grade separated dedicated corridors with sharp curves of up to 70 m radius. This is a rubber tyred based rolling stock, electrically propelled on concrete beams known as guide-ways. Their aerial structures consisting of columns and guiding beams are however smaller and less imposing on the surrounding than aerial structures of other modes. The system is suitable in narrow corridors as it requires minimum Right of Way. This is prevalent in several countries for traffic conditions of <10000 PPHPD.

Monorails are more conducive to single lines than to network. However, their technical characteristics present operational complexities. A serious disadvantage of monorails is the nature of their guide ways and beams. Unlike rail systems, monorail beams cannot cross each other and their switches are slow and take a large area. Another disadvantage is that they have much larger profile than rail and other guided modes, so that they are not conducive of tunnel operations. The disadvantages of monorail include lower average speed; lower carrying capacities however with comparable cost of construction with traditional metro systems.

In addition to their operational complexity and dependence on aerial alignments, monorails require investment much higher than LRT requires. The factors favoring their applications include their exotic/novelty image, the need to follow horizontally and vertically curved alignments, and the need for minimum visual intrusion of aerial guide ways along urban arterials.

Mumbai Monorail is an example of monorail in India.

- Operational Length: Wadala–Chembur Length: 8.93 km Stations: 7 (Elevated)
- Project Cost Rs.2460 + taxes
- Daily Ridership Estimated:1.5 to 3 Lakh
- Journey Time 45 mins
- Passenger carrying capacity: 564 passengers
- Average speed 31kmph
- Maximum Speed 80kmph

Figure 4-29: Mumbai Monorail

Tokyo has monorail system officially known as Tokyo Monorail Haneda Airport Line. Some Key Features are:

- Operational from September 1964and operated by Tokyo Monorail Co. Ltd
- System Length – 17.8km
- 1 line with 11 stations
- Average speed 45kmph
- 3 different types of train services: Haneda Express (non-stop run between Hamamatsucho and Haneda Airport in 13 minutes), Rapid and Local Services

Figure 4-30: Tokyo Monorail

4.2.3.5 PERSONAL RAPID TRANSIT

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 guide ways. PRT is a type of automated guide way transit (AGT), a class of system which also includes larger vehicles all the way to small subway systems. In terms of routing, it tends towards personal public transport systems.

PRT vehicles are sized for individual or small group travel, typically carrying no more than three to six passengers per vehicle. Guide ways are arranged in a network topology; with all stations located on sidings, and with frequent merge/diverge points. 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).

Numerous PRT systems have been proposed. As of November 2016, only a handful of PRT systems are operational: Morgantown Personal Rapid Transit (the oldest and most extensive), in Morgantown, West Virginia, has been in continuous operation since 1975. PRT system is also operating in Heathrow Airport, UK and in Masdar, UAE.

Figure 4-31: PRT system operating in Heathrow Airport, London

Road Based System

4.2.3.6 BUS RAPID TRANSIT SYSTEM (BRTS)

A Bus Rapid Transit System is a bus based mass transit system that delivers metro like facility on road providing fast, comfortable and cost effective urban mobility. It operates mostly on an exclusive right of way/bus way or sometimes on a shared lane too. Bus ways are physically demarcated bus lanes along the main carriageway with a segregated corridor for movement of buses only. At the intersections, the buses may be given priority over other modes through a signaling system. Advantages of BRTS are given in Table 4-14.

Table 4-14: Advantages of BRT against Normal Bus Services

Parameters	BRT	Existing City Bus Features	Advantages of BRTS
Running Ways	Dedicated Bus lanes and Grade Separation	Mixed Traffic	Increased speed and reduced travel time
Stations and stops	Exclusive bus stations	Road side bus stops	More comfort and facilities
Service Design	Frequent services, integrated services and timed transfers	Traditional service designs	Less Waiting time and increased reliability
Fare Collection	Off board, Smart Cards	On Board Ticketing	More efficient, improved usability
Technology	Automated Vehicle Location, PIS, Signal Preferences	Limited Technological Applications	Increased Reliability. More efficient

The key features of a BRTS are:

1) Physical Infrastructure

- Segregated bus ways
- Safe, Convenient stations with easy pedestrian access
- Level boarding and alighting
- Mobility hubs/transfer stations Integrated network of routes and corridors
- Public Space enhancements
- Universal Accessibility

2) Operations

- Frequent and rapid service
- Ample capacity Rapid boarding and alighting
- Pre-board fare collection and fare verification
- Fare Integration between multiple systems
- Reformed business and administrative structures for the operators

Key Features of a BRTS

3) Technology

- Low Emission, Low noise Vehicle technologies
- Automatic fare collection
- System management through control centers and use of intelligent transport systems
- Signal priority or grade separation at intersections

4) Marketing and Customer Services

- Distinctive identity for the system
- Customer services and amenities
- Clear and real time information availability

BRTS systems can be designed to suit the existing Right of way characteristics of the corridor. Two design ways of BRTS are elevated and at-grade. Some of the examples of operational BRTS are:

Ahmedabad BRTS is an at grade BRTS system. Some Key Features of the system are:

- Ahmedabad Janmarg Ltd is registered under the Companies Act, 1956 and is 100% subsidiary of AMC.
- Total Project cost approved for 89 km is Rs.984 Crore (Approx. Rs. 12 Crore per km)
- First Full-fledged BRT system of India
- Commercial operation started from 14th October 2009
- System has grown from 12 km. to 125 km (including 89 km of dedicated corridor) (2018)
- 157 Bus stations operational
- Avg. daily ridership increased from 18,000 pax/day (October 2009) to 1,50,000 pax/day (October, 2016)
- Avg. daily collection increased from Rs.73693/day (October, 2009, with 20 buses) to Rs.19,24,678/day (October, 2016, with 250 buses)

Figure 4-32: Ahmedabad BRTS: Janmarg

Sao Paulo BRTS is an elevated BRTS system. Some key features of the system are:

Figure 4-33: Elevated BRTS in Sao Paulo

- Expresso Tiradentes is an exclusive, elevated bus lane from the centre of São Paulo to Cidade Tiradentes (Tiradentes City) in the east of the city
- Length of 45 km and consists of two corridors
- It is operated with a fleet of 87 buses on weekdays for the baselines and 21 on the service lines. In total, six lines use the system, which operates with articulated vehicles and accessible bi-articulated, with air conditioning, wi-fi and USB socket.
- Ridership of 3,25,000 passengers per day

4.2.3.7 CITY BUS SERVICES

City Bus service is road based system which is most flexible mode of public transportation system. The Buses can be of different sizes – Standard, Midi and Mini Buses which can be used according to the demand and urban form of the city. The major infrastructure requirements are for bus shelters, depots, workshops and office space. The service type can differ from ordinary buses to AC buses. There can be difference in fuel technology – diesel, CNG and electric buses. City Bus services are easy to implement as it operates with mixed lane and routes are flexible. Mostly all the cities in India have city bus services which are run by the State transport undertakings or local government or private bus operators. For

example: City Bus Services in Trivandrum provided by both state Transport undertaking – Kerala State Road Transport Corporation and Private Bus operators, City bus services in Ahmedabad provided by Ahmedabad Municipal Corporation, city bus service in Bangalore is provided by independent city corporation for city – Bangalore Metropolitan Transport Corporation.

(a (b (c

Figure 4-34: City Bus Services - a) KSRTC Services in Trivandrum, b) AMTS Bus Services in Ahmedabad, c) BMTC Buses in Bangalore

Aerial Based System

4.2.3.8 CABLE CAR/ROPEWAY

Cable propelled transit (CPT) is a transportation technology that moves people in motor-less, engine less vehicles that is propelled by steel cables. The two main cable car transit configurations include Top-Supported systems (vehicles/cabins supported from above) and Bottom–Supported systems (vehicles/cabins supported from below via track). It is most suitable in areas with hilly terrain and is also widely used as Public Transport System in Latin Amercican cities such as La Paz, Medellin, Caracas and San Agustin.

There are six major top-supported Cable car transit system available at present, as listed and a comparison of these based on critical parameters are given below:

- Mono-cable Detachable Gondola
- Bi-cable Detachable Gondola
- Tri-cable Detachable Gondola or 3S
- Funitel
- Aerial Tram
- Pulsed Gondola

San Agustin, Caracas, Venezuela is a city which has implemented the cable car transit system - **San Agustin Metro Cable.** Key features of the system are:

- Fully integrated with the Urban Rail Metro System
- 1.8km in length with 5 stations and uses gandolas that hold 8 passengers each
- Total capacity of the system allows 1200 PPHPD
- Out of the 5 station, 2 are located in the valley connected directly with the existing public transport system and 3 are along the mountain ridge
- The operations commenced in 2010 and 52 cabins are in operation

- The average speed is 12 kmph

Figure 4-35: San Agustin Metro Cable

This study is done for first order and second order transit corridors, the alternatives for which have been explained in previous sections. First order transit corridors have higher demand and thus require mass rapid transit systems. Second order transit corridors have lesser demand which have been proposed to connect the areas which are not under the influence of first order transit corridor and to act as feeder to MRTS.

- For first order transit corridors, the MRT systems considered are Metro systems, LRT system and BRT system. For Second order transit corridors, the systems considered are city bus service, cable car/ropeway system and personal rapid transit (PRT) system.

Comparison of various transit systems is presented in Table 4.11 and Table 4-16.

Table 4-15: Comparison of Transit Systems considered for First Order Transit Corridors

Transit Systems/ components	At grade BRTS	Elevated BRTS	At Grade Light Metro/Light Rail	Elevated Light Metro/Light Rail	Elevated Medium Metro	Heavy Metro
FINANCIAL PARAMETERS						
Annual O&M Cost per Km (Cr)	2.25	2.5	4	5	5.5	6
Capital Cost per Km (Cr)	15-20(Diesel) 25-50(Electric)	55-75(Diesel) 90-100(Electric)	85-100	180-210	250-350	350-550
Construction	1.5-2 years	2-3 years	2-3 years	3-5 years	3-5 years	3-5 years
TRAFFIC PARAMETERS						
Capacity (PPHPD)	6,000 - 10,000	6,000 -25,000	6,000-25,000	6,000-35,000	25,000-45,000	25,000-45,000
Average Speed	20-25	25-40	25-25	30-40	30-40	30-40
Total Capacity (Pass.)	60 Standard 110 Art. 170 Bi-art.	60 Standard 110 Art.,170 Bi-art.	100-150 per Car	150-250 per Car	250-300 per Car	250-300 per Car

Transit Systems/ components	At grade BRTS	Elevated BRTS	At Grade Light Metro/Light Rail	Elevated Light Metro/Light Rail	Elevated Medium Metro	Heavy Metro
ENGINEERING PARAMETERS						
Physical Segregation	Segregated RoW	Excl. right of way	At grade	Exclusive Grade Separated	Exclusive Grade Separated	Exclusive Grade Separated
Right of Way	18-24 m	12m	18-22 m	11-12m	12-15m	12-15m
Stn. Spacing	500 – 1000	500 – 1000	700-1000	700 – 1000	800-2000	800 – 2000
Fuel Type	Diesel, CNG, Electric	Diesel, CNG, Electric	Overhead traction/Electric	Third rail/Over Head	Third rail/Over Head	Third rail/Over Head
Axle Load(Tonnes)	-	10-11	10-11	10-11	15-17	15-17
Minimum Curve Radius (m)	12-20	12-20	25	25	100	100
Source	PCMC BRTS	Amritsar BRTS	LRT projects in Lyon, Bordeaux	DPR for Trivandrum, Kozhikode, Vizag metro	DMRC DPRs	DMRC DPRs

Table 4-16: Comparison of Transit Systems considered for Second Order Transit Corridors

Parameters	City Bus	PRT	Cable Car
Physical Segregation	At grade	At grade/Elevated	Elevated
Power Supply/Fuel	Diesel/CNG/Hybrid	Battery Operated	Electricity
Station spacing (m)	500-700	500	700-1500
Platform height	Low/medium/high	Low	Low
Avg. Vehicle capacity	60-120	4-6	8-15
Avg. Opr. Speed (km/hr)	20-30	30	15-20
Ridership (PPHPD)	3000	7200	3000-5000
Capital cost (crores/km)	6-15	55-60	90-100 (Highly dependent on Topography)
Annual O&M Cost per Km (Cr)	2.2	3.47	3.6

CHAPTER 5

SCREENING OF ALTERNATIVES FOR CORRIDORS – FIRST ORDER TRANSIT CORRIDORS

5. SCREENING OF ALTERNATIVES FOR CORRIDORS – *FIRST ORDER TRANSIT CORRIDORS*

5.1 SCREENING PARAMETERS

The screening will be 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 5-1.

Table 5-1: Screening Parameters for selection of corridor and transit system

Screening Level	Criteria
Screening for Corridor	Right of way
	Coverage
	Number of Bridges
	Impact on Intermodal Connectivity
Screening for Transit System	**Mobility /Travel Demand**
	Capacity of the System
	Right of way available against Right of way required
	Viability against projected PPHPD
	Future Capacity Augmentation
	Engineering and Design Characteristics
	Geotechnical Characteristics
	Utility Shifting Required
	Impact on intermodal connectivity/Easiness of transfer
	Time for Implementation
	Safety and comfort of the system
	Environmental and Social Impacts
	Environmental Impact
	Social Impact/R&R
	Cost Estimate Financial Analysis
	Project Cost Estimate
	Rolling Stock Cost
	Operation and Maintenance Cost

5.2 SCREENING FOR ALTERNATIVE CORRIDORS

5.2.1 EVALUATION PARAMETERS OF VARIOUS ALTERNATIVE CORRIDORS

a) Right of Way

The right of way available for the development of a mass transit option determines the key characteristics of the system. The minimum width required for the development of any mass transit is 12m. 12m is required for a monorail whereas any other mass transit system requires a RoW more than 18m. The existing right of way width for the Alternative corridors is given in Table 5-2.

Table 5-2: Existing RoW along the Alternatives of Corridor 1-North South

Alternatives	Existing RoW	Remarks
Alternative 1 A: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road		
ISBT to Shimla Bypass junction	20-24m	
Shimla Bypass Junction Sabzi Mandi Chowk	24-28m	
Sabzi Mandi Chowk – Bandari Bagh Road	18-20m	
Bandari Bagh Road- Railway station	12-15 m	Needs to be Widened
Railway station – Darshan Lala chowk	18-20m	
Darshan Lala chowk – Ashley Hall	18-20m	
Ashley Hall – Bhel Chowk	18-20m	
Bhel Chowk – Garhi Cantt road	24-28m	
Garhi Cantt road - Khandoli	18-20 m	
Khandoli - Mussorie	20-22m	
Alternative 1 B: Mussoorie Road to ISBT via Rajpur Road, Govind Garh Road and GMS Road		
ISBT to Shimla Bypass junction	20-24m	
Shimla Bypass junction to Chakki Tola	12-15 m	Needs to be Widened
Chakki Tola to Balliwala	24-28m	
Balliwala to Bindal Rao	20-24m	
Bindal Rao to Govind garh road end	7-10m	Needs to be Widened
Govind garh road end to bindal tiraha	18-20m	
bindal tiraha to clock tower	24-28m	
Clock Tower – Ashley Hall	28-30m	
Ashley Hall – Bhel Chowk	18-20m	
Bhel Chowk – Garhi Cantt road	24-28m	
Garhi Cantt road - Khandoli	18-20 m	
Khandoli - Mussorie road	20-22m	
Alternative 1 C: Mussoorie Road to ISBT via Rajpur Road, Saharanpur Road and GMS Road		
ISBT to Shimla Bypass junction	20-24m	
Shimla Bypass junction to Chakki Tola	12-15 m	
Chakki Tola to Balliwala	24-28m	
Balliwala to Bindal Rao	20-24m	
Bindal Rao to Saharanpur chowk	7-10m	Needs to be Widened
Saharanpur Chowk to Railway Station	12-15m	Needs to be Widened
Railway station – Darshan Lala chowk	18-20m	
Darshan Lala chowk – Ashley Hall	28-30m	
Ashley Hall – Bhel Chowk	18-20m	
Bhel Chowk – Garhi Cantt road	24-28m	
Garhi Cantt road - Khandoli	18-20 m	

Alternatives	Existing RoW	Remarks
Khandoli - Mussorie	20-22m	

It can be inferred from the table that all the Alternatives have ROW between the range 7m to 30m. The Alternatives 1B and 1C have ROW has low as 7 m in some sections.

Table 5-3: Existing RoW along the Alternatives of Corridor 2- East West

Alternatives	Existing RoW	Remarks
Alternative 2 A: Raipur to FRI via EC road and Chakrata road		
FRI – Kishan nagar Chowk	24-28m	
Kishan nagar Chowk – Bindal tiraha	18-20 m	
bindal tiraha to clock tower	24-28m	
clock tower to Darshan Lal Chowk	28-30m	
Darshan lal Chowk to Cross Road	7-10m	Needs to be Widened
Cross Road to Araghar chowk	15-18m	
Araghar Chowk to Nehru colony Chowk	10-12 m	Needs to be Widened
Nehru colony Chowk to Vidhan Sabha/Rispana pul	15-18m	
Alternative 2 B: Raipur to FRI via Jeevnwala-Dehradun Road and Kanwali road		
FRI to Lovely Market	15-18 m	
Lovely Market to Indira Nagar colony Road	18-20m	
Indira Nagar colony Road to Balliwala	7-10m	Needs to be Widened
Balliwala to Bindal Rao	20-24m	
Bindal Rao to Saharanpur chowk	7-10m	Needs to be Widened
Saharanpur Chowk to Railway Station	12-15m	Needs to be Widened
Railway Station to Prince Chowk	18-20m	
Prince Chowk to regional Passport Office	7-10m	Needs to be Widened
Regional Passport Office to Araghar Chowk	10-12m	Needs to be Widened
Araghar Chowk to Nehru colony Chowk	10-12m	Needs to be Widened
Nehru colony Chowk to Vidhan Sabha/Rispana pul	15-18m	
Alternative 2 C: Raipur to FRI via EC road and Chakrata road		
FRI to Lovely Market	15-18 m	
Lovely Market to Indira Nagar colony Road	18-20m	
Indira Nagar colony Road to Balliwala	7-10m	Needs to be Widened
Balliwala to Bindal Rao	20-24m	
Bindal Rao to Saharanpur chowk	7-10m	Needs to be Widened
Saharanpur Chowk to Railway Station	12-15m	Needs to be Widened
Railway Station to Prince Chowk	18-20m	
Prince Chowk – Darshan Lala chowk	18-20m	
Darshan lal Chowk to Cross Road	7-10m	Needs to be Widened
Cross Road to Araghar chowk	15-18m	
Araghar Chowk to Nehru colony Chowk	10-12m	Needs to be Widened
Nehru colony Chowk to Vidhan Sabha/Rispana pul	15-18m	

It can be observed form the above table that the ROW of the Alternatives varies from 7 m to 30m. A lot of variations in the Alternatives are observed in 2A and 2B.

Table 5-4: Existing RoW along the Alternatives of Corridor 3- corridor connecting Dehradun – Rishikesh - Haridwar

Alternatives	Existing RoW	Remarks
Alternative 3A: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72		
Vidhan Sabha/ Rispana to Mokhampur	13-16m	
Mokhampur to Harrawala	7-10m	Needs to be Widened
Harrawala to Devshreepuram	13-16m	
Devshreepuram to Doiwala	8-11m	Needs to be Widened
Doiwala to Global Institute of Advance Studies	8-11m	Needs to be Widened
Global Institute of Advance Studies to Fun Valley, Lal Tappar	8-11m	Needs to be Widened
Fun Valley, Lal Tappar to Nepali Farms	24-26m	
Nepali Farms to Regenta Orkos, Haridwar	15-18m	
Regenta Orkos, Haridwar to Golden Tulip, Haridwar	24-30m	
Golden Tulip, Haridwar to Ashram Baba Jodh Sachiyar	36-42m	
Ashram Baba Jodh Sachiyar to Dhobi Ghat Parking Area	8-11m	Needs to be Widened
Dhobi Ghat Parking Area to Mata Chandi Devi Chauraha	18-21m	
Mata Chandi Devi Chauraha to New Keshav Ashram	10-40m	Needs to be Widened
New Keshav Ashram to Shankaracharya Chowk	12-15m	
Shankaracharya Chowk to Divine Enterprises Haridwar	30-40 m	
Divine Enterprises Haridwar to AP motors	8-12 m	
AP motors to Hindustan Motors	34- 40m	
Hindustan Motors to Uttarakhand Sanskrit Academy	18-22m	
Nepali Farms to India Post, Shyampur, Rishikesh	18-20m	
India Post, Shyampur, Rishikesh to Outset's WildLife Safari - Rajaji National Park & Tiger Reserve	8-12m	Needs to be Widened
Outset's WildLife Safari - Rajaji National Park & Tiger Reserve to Shyampur Hat Bazar	12-15m	
Shyampur Hat Bazar to Shyampur Police Chowki	18-21m	
Shyampur Police Chowki to IDPL second Gate	22-24m	
IDPL Second Gate to Madhuban Ashram	20-22m	
Madhuban Ashram to Koyal Grand	20-24m	
Koyal Grand to Gangotri Automobiles	18-21m	
Gangotri Automobiles to Mayakund	12-15m	Needs to be Widened
Alternative 3B: Rispana at Dehradun to Baharadarabad at Haridwar via Rishikesh Road		
Vidhan Sabha/ Rispana to Mokhampur	13-16m	
Mokhampur to Harrawala	7-10m	Needs to be Widened
Harrawala to Devshreepuram	13-16m	
Devshreepuram to Doiwala	8-11m	Needs to be Widened
Doiwala to Airport Road	8-11m	Needs to be Widened
Airport Road to Natraj Circle	8-11m	Needs to be Widened
Natraj Circle to ISBT Chowk, Rishikesh	22-26m	

Alternatives	Existing RoW	Remarks
ISBT Chowk, Rishikesh to Rishikesh Police Station	15-18m	
Rishikesh Police Station to Triveni Ghat Chowk	6-9m	Needs to be Widened
Triveni Ghat Chowk to Gangotri Automobiles	12-15m	
Gangotri Automobiles to Koyal Grand	18-21m	
Koyal Grand to Madhuban Ashram	20-24m	
Madhuban Ashram to IDPL Second Gate	20-22m	
IDPL Second Gate to Shyampur Police chowki	20-24m	
Shyampur Police Chowki to Shyampur Haat Bazar	18-22m	
Shyampur Haat Bazar to Outset's WildLife Safari - Rajaji National Park & Tiger Reserve	12-15m	
Outset's WildLife Safari - Rajaji National Park & Tiger Reserve to India Post, Shyampur, Rishikesh	9-12m	Needs to be Widened
India Post, Shyampur to Nepali Farms	18-20m	
Nepali Farms to Regenta Orkos, Haridwar	15-18m	
Regenta Orkos, Haridwar to Golden Tulip, Haridwar	24-30m	
Golden Tulip, Haridwar to Ashram Baba Jodh Sachiyar	36-42m	
Ashram Baba Jodh Sachiyar to Dhobi Ghat Parking Area	9-12m	Needs to be Widened
Dhobi Ghat Parking Area to Mata Chandi Devi Chauraha	18-22m	
Mata Chandi Devi Chauraha to Bhagwan Valmiki Chowk	8-11m	Needs to be Widened
Bhagwan Valmiki Chowk to Chandra Charya Chowk	18-22m	
Chandra Charya Chowk to Arya Nagar Chowk	24-28m	
Arya Nagar Chowk to Kotwali Jwalapur	15-18m	
Kotwali Jwalapur to Jwalapur Bus Stop	18-22m	
Jwalapur Bus Stop to Hindustan Motors, Jwalapur Main Rd	15-18m	
Hindustan Motors, Jwalapur Main Rd to Uttarakhand Sanskrit Academy	18-22m	
Alternative 3C: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72		
Vidhan Sabha/ Rispana to Mokhampur	13-16m	
Mokhampur to Harrawala	7-10m	Needs to be Widened
Harrawala to Devshreepuram	13-16m	
Devshreepuram to Doiwala	8-11m	Needs to be Widened
Doiwala to Nepali Farm	8-11m	Needs to be Widened
Nepali Farms to Regenta Orkos, Haridwar	15-18m	
Regenta Orkos, Haridwar to Golden Tulip, Haridwar	24-28m	
Golden Tulip, Haridwar to Ashram Baba Jodh Sachiyar	36-42m	
Ashram Baba Jodh Sachiyar to Bahgwan Balmiki Chowk	9-12m	Needs to be Widened
Bhagwan Valmiki Chowk to Chandra Charya Chowk	18-22m	
Chandra Charya Chowk to Arya Nagar Chowk	8-11m	Needs to be Widened
Arya Nagar Chowk to Kotwali Jwlapur	18-21m	
Kotwali Jwalapur to Jwalapur Bus Stop	15-18m	
Jwalapur Bus Stop to Hindustan Motors, Jwalapur Main Rd	18-22m	
Hindustan Motors, Jwalapur Main Rd to Uttarakhand Sanskrit	15-18m	

Alternatives	Existing RoW	Remarks
Academy		
Nepali Farms to India Post, Shyampur, Rishikesh	18-20m	
India Post, Shyampur, Rishikesh to Outset's WildLife Safari - Rajaji National Park & Tiger Reserve	9-12m	Needs to be Widened
Outset's WildLife Safari - Rajaji National Park & Tiger Reserve to Shyampur Hat Bazar	12-15m	
Shyampur Hat Bazar to Shyampur Police Chowki	18-21m	
Shyampur Police Chowki to IDPL second Gate	20-24m	
IDPL Second Gate to Madhuban Ashram	20-22m	
Madhuban Ashram to Koyal Grand	20-23m	
Koyal Grand to Gangotri Automobiles	18-21m	
Gangotri Automobiles to Vishal Bhojanalaya	12-15m	Needs to be Widened

It can be observed form the above table that the ROW of the Alternatives varies from 7 m to 42m. As per existing ROW it is observed that there are not many variations in all the Alternatives.

b) Coverage

Coverage is estimated in terms of population and employment of the adjoining traffic analysis zones. Total Population and employment catered by the Alternatives is presented in the Table 5-5, Table 5-6and Table 5-7.

Table 5-5: Coverage of Alternatives of Corridor 1- North South

Alternative	2018		2028		2038		2048	
	Pop	Emp	Pop	Emp	Pop	Emp	Pop	Emp
Alternative 1 A: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road	679660	269971	804683	319677	942643	376250	1273085	422804
Alternative 1 B: Mussoorie Road to ISBT via Rajpur Road, Govind Garh Road and GMS Road	669676	265678	792836	314583	928532	370182	1255366	416919
Alternative 1 C: Mussoorie Road to ISBT via Rajpur Road, Saharanpur Road and GMS Road	705414	281046	835242	332818	979042	391901	1318791	437983

It can be inferred from the table that Alternative 1C has the highest coverage in terms of Population and employment followed by Alternative 1A.

Table 5-6: Coverage of Alternatives of Corridor 2- East West

Alternative	2018		2028		2038		2048	
	Pop	Emp	Pop	Emp	Pop	Emp	Pop	Emp
Alternative 2 A: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	663981	265447	787824	314886	927701	372044	1272286	422539
Alternative 2 B: Vidhan Sabha/Rispana pul to FRI via Jeevnwala-Dehradun Road and Kanwali road	666141	266376	790387	315989	930754	373357	1276120	423812
Alternative 2 C: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	683916	274020	811480	325058	955877	384160	1307666	434289

It can be inferred from the table that Alternative 2C has the highest coverage in terms of Population and employment followed by Alternative 2B.

Table 5-7: Coverage of Alternatives of Corridor 3- corridor connecting Dehradun – Rishikesh - Haridwar

Alternative	2018		2028		2038		2048	
	Pop	Emp	Pop	Emp	Pop	Emp	Pop	Emp
Alternative 3A: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via NH 72	1039114	338571	1213668	394993	1373472	449021	1792823	595413
Alternative 3B: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via Rishikesh Road	1070879	346926	1251983	405070	1416193	460257	1800711	598033
Alternative 3C: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via NH 72	1039114	338571	1213668	394993	1373472	449021	1792823	595413

It can be inferred from the table that Alternative 3A and Alternative 3C has the highest coverage in terms of Population and employment followed by Alternative 3B.

c) Details of Major Bridges/Retaining Structures along the corridor

The detail of the major bridges/retaining structures along the corridors for the Alternatives have been presented in the Table 5-8,Table 5-9 and Table 5-10 below:

Table 5-8: Major Bridges/Retaining structures along the corridor for all Alternatives in Corridor 1- North South

Alternative	S.no	Type	Location
Alternative 1 A: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road	1	River	Lal pul
	2	Nala	Drain near Dehradun Chest Centre
	3	Flyover	ISBT Flyover
Alternative 1 B: Mussoorie Road to ISBT via Rajpur Road, Govind Garh Road and GMS Road	1	Flyover	Balliwala Chowk
	2	River	Bindal Rao near Best IT world
	3	Building Structure at junction	Clock Tower
Alternative 1 C: Mussoorie Road to ISBT via Rajpur Road, Saharanpur Road and GMS Road	1	River	Bindal Rao near Masjid Huda
	2	Nala	Drain near HP service centre

It can be inferred from the table that in Alternative 1C and 1B, only two number of bridges are crossed. In Alternative 1A, there are 3 structures including flyover and bridges which lie in the alignment.

Table 5-9: Major Bridges/Retaining structures along the corridor for all Alternatives in Corridor 2- East West

Alternatives	Sl.no	Type	Location
Alternative 2 A: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	1	Nala	Irrigation canal near IFFCO, Chakrata road
	2	Flyover	Flyover at Ballupur Chowk - 700 m length
	3	Nala	drain till Kishan Nagar Chowk
	4	River	Bindaal Rao
	5	Building Structure at junction	Clock Tower
	6	River	Rispana Bridge
Alternative 2 B: Vidhan Sabha/Rispana pul to FRI via Jeevnwala-Dehradun Road and Kanwali road	1	Flyover	Cross Flyover Balliwala Chowk
	2	River	bindal rao
	3	Nala	Drain near Gurunanak Public Library
	4	River	Rispana Bridge
Alternative 2 C: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	1	Flyover	Cross Flyover Balliwala chowk
	2	River	Bindal Rao
	3	Nala	Drain near Gurunanak Public Library
	4	River	Rispana Bridge

It can be inferred from the table that in Alternative 1C and 1B, only two number of bridges are crossed. In Alternative 1A, there are 3 structures including flyover and bridges which lie in the alignment.

Table 5-10: Major Bridges/Retaining structures along the corridor for all Alternatives in Corridor 3- corridor connecting Dehradun – Rishikesh - Haridwar

Alternatives	Sl.no	Type	Location
Alternative 3A: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via NH 72	1	River	Overpass At Haridwar Ambala Highway At Railway Crossing
	2	Nala	Overpass At Lacchiwala
	3	Flyover	Song River
	4	River	River Near Jeevan Wala
	5	Nala	Drain Near Bhalla Farm Road
	6	Railway Crossing	Railway Crossing Near Mahalakshmi Mandir Rishikesh
	7	River	Song River Near Nepali Farm
	8	River	Ganga Near Haripur Kalan
	9	River	Ganga Near Sarvadhan Ghat
	10	River	3 Bridges Location Har Ki Pauri
	11	River	Bridge Near Hanuman Mandir
	12	Railway Crossing	Near Swami Darshanand Institute of Management and Technology Haridwar
	13	Canal	Uttarakhand Sanskrit Acadamy
Alternative 3B: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via Rishikesh Road	1	Overpass	Overpass At Haridwar Ambala Highway At Railway Crossing
	2	Overpass	Overpass At Lacchiwala
	3	River	Song River
	4	River	River Near Rani Pokhari
	5	River	River near Barkot Mafi
	6	Railway Crossing	Railway Crossing Near Mahalakshmi Mandir Rishikesh
	7	River	Song River Near Nepali Farm
	8	River	Ganga Near Haripur Kalan
	9	River	Ganga Near Sarvadhan Ghat
	10	River	3 Bridges Location Har Ki Pauri
	11	River	Bridge Near Hanuman Mandir, Birla Ghat
	12	Railway Crossing	Railway Crossing near Badhan Place
	13	River	Jatwara Bridge
	14	Canal	Uttarakhand Sanskrit Acadamy
Alternative 3C: Rispana at Dehradun to Uttarakhand Sanskrit academy at Haridwar via Haridwar Main road and NH 72	1	Overpass	Overpass At Haridwar Ambala Highway At Railway Crossing
	2	Overpass	Overpass At Lacchiwala
	3	River	Song River
	4	River	Jeevan Wala
	5	Nala	Drain Near Bhalla Farm Road
	6	Railway Crossing	Railway Crossing Near Mahalakshmi Mandir Rishikesh
	7	River	Song River Near Nepali Farm
	8	River	Ganga Near Haripur Kalan

Alternatives	Sl.no	Type	Location
	9	River	Motichur Railway Staion
	10	River	Bridge Near Kharkhari
	11	Railway Crossing	Railway Crossing near Badhan Place
	12	River	Jatwara Bridge
	13	Canal	Uttarakhand Sanskrit Acadamy

It can be inferred from the table that in Alternative 3C and 3B, only 12 number of bridges are crossed. In Alternative 3A, there are 13 structures including flyover and bridges which lie in the alignment. The structures like flyovers, bridges and rail crossings are important parameter which determines the level of difficulty encountered during design or construction stage. Lesser the number of bridges and crossings, easier will be the design and construction of the system.

d) Effect on Intermodal Connectivity

Easy Intermodal connectivity enhances the transfer experiences of the users. Well planned pedestrian facilities in terms of comfortable walkways, access and entry designs along with fare and information integration shall be ensured at the interchange stations. The opportunity for multimodal integration with regional or urban transit mode (proposed and existing) for each of the Alternative corridors is explained in Table 5-11,

Table 5-12 and Table 5-13 below:

Table 5-11: Interchange Options at Corridor 1- North South

Alternatives	Sl .no	Interchange Point	Interchange Modes
Alternative 1 A: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road	1.	ISBT	Bus, IPT, taxi
	2.	Railway Station - Mussorie Bus stand	Indian Railways, bus , taxi, IPT
	3.	Clock Tower	Proposed MRTS, IPT, bus, taxi
	4.	Old Bus stand	Bus, IPT
	5.	Sahastradhara Bus Stand	Bus, IPT
Alternative 1 B: Mussoorie Road to ISBT via Rajpur Road, Govind Garh Road and GMS Road	1.	Clock Tower	Proposed MRTS, IPT, bus, taxi
	2.	Local Bus Stand	Bus, IPT
	3.	ISBT	Bus, IPT
Alternative 1 C: MussoorieRoad to ISBT via Rajpur Road, Saharanpur Road and GMS Road	1.	Railway Station - Mussorie Bus stand	Indian Railways, bus , taxi, IPT
	2.	Old Bus stand	Bus, IPT
	3.	Local Bus Stand	Bus, ipt
	4.	ISBT	Bus, IPT

Table 5-12: Interchange Options at Corridor 2- East West

Alternatives	Sl .no	Interchange Point	Interchange Modes
Alternative 2 A: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	1.	Clock Tower (Proposed)	Proposed MRTS, IPT, bus, taxi
Alternative 2 B: Vidhan Sabha/Rispana pul to FRI via Jeevnwala-Dehradun Road and Kanwali road	1.	Railway Station - Mussorie Bus stand	Indian Railways, bus , taxi, ipt,
Alternative 2 C: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road	1.	Railway Station - Mussorie Bus stand	Indian Railways, bus , taxi, ipt

Table 5-13: Interchange Options at Corridor 3- corridor connecting Dehradun – Rishikesh - Haridwar

Alternatives	Sl .no	Interchange Point	Interchange Modes
Alternative 3A: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72	1.	Sitapur	Proposed MRTS, Proposed second order transit system, IPT, bus, taxi
	2.	Doiwala Railway station	Indian Railway, IPT
	3.	Rishikesh Railway station	Indian Railway, IPT
	4.	Raiwala Railway station	Indian Railway, IPT
Alternative 3B: Rispana at Dehradun to Baharadarabad at Haridwar via Rishikesh Road	1.	Airport	airways, taxi
	2.	Rishikesh bus stand	Bus, IPT
	3.	Doiwala Railway station	Indian Railway, IPT
	4.	Rishikesh Railway station	Indian Railway, IPT
	5.	Raiwala Railway station	Indian Railway, IPT
	6.	Haridwar Railway Station	bus ipt, Indian Railway
	7.	GMOU Bus stand	Bus, IPT
Alternative 3C: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72	1.	Haridwar Railway Station	bus ipt, Indian Railway
	2.	GMOU Bus stand	Bus, IPT
	3.	Doiwala Railway station	Indian Railway, IPT
	4.	Rishikesh Railway station	Indian Railway, IPT
	5.	Raiwala Railway station	Indian Railway, IPT

INFERENCE FROM SCREENING FOR ALTERNATIVE CORRIDORS – FIRST ORDER TRANSIT CORRIDORS

Overall comparison of Alternative corridors is summarized as given below:

Corridor	Alternatives	Length (km)	RoW (m) min	Population (in lakhs)	Employment (in lakhs)	No. of Bridges	No. of Interchanges
Corridor 1: North South	Alt 1 A	12.8	9.9 m	6.8	2.7	3	5
	Alt 1 B	13.7	7.7 m	6.7	2.65	3	3
	Alt 1 C	14.3	7.7 m	7.05	2.81	2	4
Corridor 2: East West	Alt 2 A	10	9 m	6.63	2.65	6	1
	Alt 2 B	9	7.7 m	6.67	2.66	4	1
	Alt 2 C	10.4	7.7 m	6.83	2.74	4	1
Corridor 3	Alt 3 A	67.8	9.8 m	10.39	3.38	13	4
	Alt 3 B	71.5	8.0 m	10.70	3.46	12	7
	Alt 3 C	67.7	9.8 m	10.39	3.38	12	5

The scoring given for each corridor on the parameters is given in Table 5-14, Table 5-15 and Table 5-16.

Table 5-14: Ranking of parameters for screening of alternate corridors- Corridor 1- North South

S.No	Parameters	Weightage	Type	Corridor		
				Alt 1A	Alt1B	Alt 1C
1.a	Area Coverage - Population	10%	Quantitative	4	3	5
1.b	Area Coverage - Employment	10%	Quantitative	4	3	5
2	Right of way (with details of variation in ROW in b/w sections)	30%	Quantitative	5	3	3
3	Details of Major Bridges/Retaining Structures along the corridor	20%	Quantitative	3	3	4
4	Effect on Intermodal connectivity	30%	Qualitative	5	3	3
	Total	**100%**		**4.4**	**3**	**3.6**

Table 5-15: Screening for Corridor options- Corridor 2 – East West

S.No	Parameters	Weightage	Type	Corridor		
				Alt 2A	Alt 2B	Alt 2C
1.a	Area Coverage - Population	10%	Quantitative	4	4	5
1.b	Area Coverage - Employment	10%	Quantitative	4	4	5
2	Right of way (with details of variation in ROW in b/w sections)	30%	Quantitative	5	2	2
3	Details of Major Bridges/Retaining Structures along the corridor	20%	Quantitative	2	3	3
4	Effect on Intermodal connectivity	30%	Qualitative	3	3	3
	Total	**100%**		**3.6**	**2.9**	**3.1**

Table 5-16: Screening for Corridor options- Corridor 3 - corridor connecting Dehradun – Rishikesh - Haridwar

S.No	Parameters	Weightage	Type	Corridor		
				Alt 3A	Alt 3B	Alt 3C
1.a	Area Coverage - Population	10%	Quantitative	4	5	4

1.b	Area Coverage - Employment	10%	Quantitative	4	5	4
2	Right of way (with details of variation in ROW in b/w sections)	30%	Quantitative	5	3	3
3	Details of Major Bridges/Retaining Structures along the corridor	20%	Quantitative	4	2	2
4	Effect on Intermodal connectivity	30%	Qualitative	3	5	4
	Total	**100%**		**4**	**3.8**	**3.7**

For all the three corridors, Alternative 1A, 2A and 3A have received the highest scoring due to the least constraints in right of way and higher locations of intermodal connectivity which will enhance seamless travel experience for the user. The coverage in terms of population and area approximately the same with variation due to difference in length of the corridor, however, still covering all the major points of the city.

- **Thus, the Alternatives 1A, 2A and 3A are preferred for their respective corridors based on high ranking.**
- **For Corridor 1, the preferable corridor is Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road**
- **For Corridor 2, the preferable corridor is Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road**
- **For Corridor 3, Connecting Dehradun - Rishikesh – Haridwar, phasing can be done for sub corridor connecting Dehradun to Rishikesh and Rishikesh to Haridwar. As, it can be seen from the table below, the ridership per km is higher for the linkage connecting Haridwar to Rishikesh, and thus Corridor connecting Rishikesh to Haridwar should be implemented first followed by Dehradun to Rishikesh which will also connect Dehradun to Haridwar with one interchange point at Nepali Farms in Rishikesh.**

Alignment	Daily Ridership 2048	Length (km)	Ridership/km	Phasing Proposed	
Haridwar to Rishikesh	89115	33	2700	Phase 1	Detailed Phasing Plan to be worked out in the DPR based on the technical and economic viability
Dehradun to Rishikesh	67446	45	1499	Phase 2	
Dehradun to Haridwar	146658	59	2485		

5.3 DESCRIPTION OF PREFERRED CORRIDOR

The details of the right of way and key connecting points of the corridor such as residential, commercial and semipublic is given below:

5.3.1 RIGHT OF WAY DETAILS

The right of way details of the corridors has been given below:

S. No	Corridors	ROWs
Corridor 1: Mussoorie Road to ISBT via Rajpur Road and Saharanpur Road		
1.	ISBT to Shimla Bypass junction	20-24m
2.	Shimla Bypass Junction Sabzi Mandi Chowk	24-28m
3.	Sabzi Mandi Chowk – Bandari Bagh Road	18-20m
4.	Bandari Bagh Road- Railway station	12-15 m
5.	Railway station – Darshan Lala chowk	18-20m
6.	Darshan Lala chowk – Ashley Hall	18-20m
7.	Ashley Hall – Bhel Chowk	18-20m
8.	Bhel Chowk – Garhi Cantt road	24-28m
9.	Garhi Cantt road - Khandoli	18-20 m
10.	Khandoli - Mussorie	20-22m
Corridor 2: Vidhan Sabha/Rispana pul to FRI via EC road and Chakrata road		
1.	FRI – Kishan nagar Chowk	24-28m
2.	Kishan nagar Chowk – Bindal tiraha	18-20 m
3.	bindal tiraha to clock tower	24-28m
4.	clock tower to Darshan Lal Chowk	28-30m
5.	Darshan lal Chowk to Cross Road	7-10m
6.	Cross Road to Araghar chowk	15-18m
7.	Araghar Chowk to Nehru colony Chowk	10-12m
8.	Nehru colony Chowk to Vidhan Sabha	15-18m
Corridor 3: Rispana at Dehradun to Uttarakhand Sanskrit Academy at Haridwar via NH 72		
1.	Vidhan Sabha/ Rispana to Mokhampur	13-16m
2.	Mokhampur to Harrawala	7-10m
3.	Harrawala to Devshreepuram	13-16m
4.	Devshreepuram to Doiwala	8-11m
5.	Doiwala to Global Institute of Advance Studies	8-11m
6.	Global Institute of Advance Studies to Fun Valley, Lal Tappar	8-11m
7.	Fun Valley, Lal Tappar to Nepali Farms	24-26m
8.	Nepali Farms to Regenta Orkos, Haridwar	15-18m
9.	Regenta Orkos, Haridwar to Golden Tulip, Haridwar	24-30m
10.	Golden Tulip, Haridwar to Ashram Baba Jodh Sachiyar	36-42m
11.	Ashram Baba Jodh Sachiyar to Dhobi Ghat Parking Area	8-11m
12.	Dhobi Ghat Parking Area to Mata Chandi Devi Chauraha	18-21m
13.	Mata Chandi Devi Chauraha to New Keshav Ashram	10-40m
14.	New Keshav Ashram to Shankaracharya Chowk	12-15m
15.	Shankaracharya Chowk to Divine Enterprises Haridwar	30-40 m

S. No	Corridors	ROWs
16.	Divine Enterprises Haridwar to AP motors	8-12 m
17.	AP motors to Hindustan Motors	34- 40m
18.	Hindustan Motors to Uttarakhand Sanskrit Academy	18-22m
19.	Nepali Farms to India Post, Shyampur, Rishikesh	18-20m
20.	India Post, Shyampur, Rishikesh to Outset's WildLife Safari - Rajaji National Park & Tiger Reserve	8-12m
21.	Outset's WildLife Safari - Rajaji National Park & Tiger Reserve to Shyampur Hat Bazar	12-15m
22.	Shyampur Hat Bazar to Shyampur Police Chowki	18-21m
23.	Shyampur Police Chowki to IDPL second Gate	22-24m
24.	IDPL Second Gate to Madhuban Ashram	20-22m
25.	Madhuban Ashram to Koyal Grand	20-24m
26.	Koyal Grand to Gangotri Automobiles	18-21m
27.	Gangotri Automobiles to Mayakund	12-15m

5.3.2 PROPOSED STATIONS AND LAND USE CHARACTERISTICS

Corridor 1: North south corridor: Mussoorie to ISBT via Rajpur Road and Saharanpur Road

The stations for the transit system are proposed in all major points in the corridor for example ISBT Dehradun, Sewala Kurd, Lal Chowk, Chamanpuri, Clock Tower, Gandhi Park, Sachivalaya, Khandoli etc.

All these proposed locations have mixed land use of commercial, residential, industrial or institutional uses. IT Park along canal road is a location with industrial and residential mix land use. Clock tower is commercial and residential mix use.

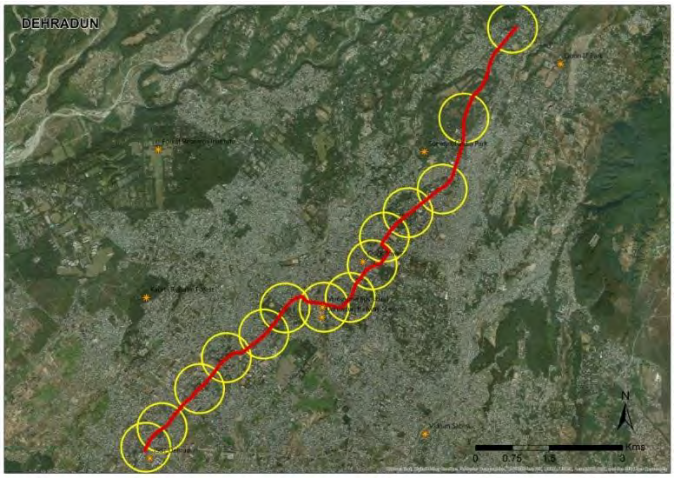


Figure 5-1: Corridor 1: North South Corridor in Dehradun City

Corridor 2: East West Corridor in Dehradun City: Raipur to FRI via EC road and Chakrata road

The stations for the transit system are proposed in all major points in the corridor for example ISBT Dehradun, Sewala Kurd, Lal Chowk, Chamanpuri, Clock Tower, Gandhi Park, Sachivalaya, Khandoli etc. All these proposed locations have mixed land use of commercial, residential, industrial or institutional uses.

IT Park along canal road is a location with industrial and residential mix land use. Clock tower is commercial and residential mix use.

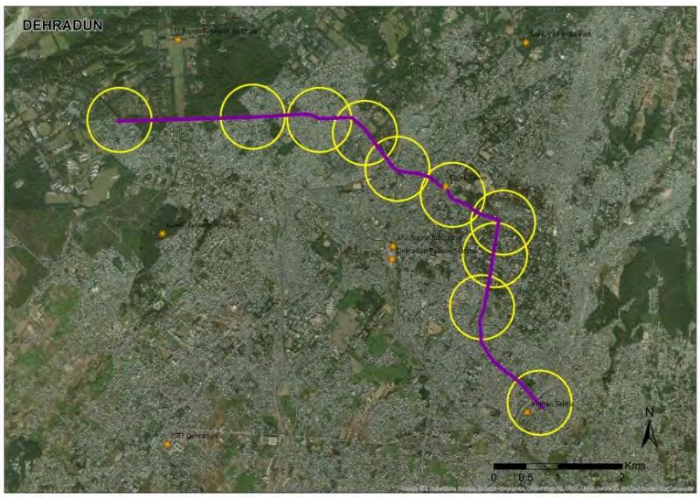


Figure 5-2: Corridor 2: East West corridor in Dehradun City

Corridor 3: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72

The station locations for this corridor are at the point where the major settlements are located for example Balawala, Doiwala, Bhaniawala, Lal Tappad, Chidderwala. Since the part of this corridor connecting Rishikesh to Haridwar and section connecting further to Rishikesh city are also aimed at meeting the internal demand of the city, the station is placed closer at all major attraction points like Nepali farm, Shyampur, IDPL colony, Bapu gram, Rishikesh city centre, Raiwala, Haripur Kalan, Shanitikunj, Har ki Pauri, Jwalapur, Sitapur, Bahadarabad.

Figure 5-3: Corridor 3: Connecting Dehradun-Haridwar-Rishikesh

5.4 SCREENING FOR ALTERNATIVE TRANSIT SYSTEMS (MODES)

This section of the report explains the second level of screening that is performed for the selection of suitable transit system on the preferred corridor.

5.4.1 EVALUATION PARAMETERS OF ALTERNATIVE TRANSIT SYSTEMS

The evaluation parameters for the second level screening is based on

a. Mobility Effects
b. Engineering Effects
c. Social and Environmental
d. Costing and Financial

5.4.1.1 MOBILITY EFFECTS

City Road Network

The National Highways and State Highways make the major radials of the cities in the Metropolitan Area. The existing major roads providing connectivity are NH 72, NH72A, NH 73, NH 74 and NH 94. Apart from this, Rajpur road, Haridwar Bypass Road, Gandhi Road, and Eastern Canal Road in Dehradun, Haridwar Main Road, Madhya Marg, SIDCUL Bypass road in Haridwar, Rishikesh Bypass Road, Dehradun-Rishikesh road in Rishikesh are other major roads providing connectivity within the cities.

Available Transport System

Public transport is non-existent in the Metropolitan area except for Dehradun where mini bus services are provided by private operators on routes issued by the RTO. Uttarakhand Road Transport Corporation run buses provide the interconnectivity among these cities. Dehradun has 573 midi buses operated by private operators which provide intra-city and intercity services. These ply on 16 intra-city routes and 8 other routes connecting city center to other major areas like Gopiwala, Dalanwala, Malawala, Clement Town, Prem Nagar, Badowala. There is no organized public transportation in the city, and hence people are majorly dependent on intermediate public transport which includes shared autos popularly known as Vikrams, individual hire autos and E-rickshaws. These are generally given permits to ply within a range of approximately 15 km from a point. Vikram generally operates on dedicated routes determined by the demand of the passenger.

Travel Demand Model:

This section examines the proposed scenarios in CMP, after revalidation for the preferred corridor with a no-project scenario, which is utilized to develop the strategy for transit development along the corridor.

Business as Usual and Sustainable Urban Transport Scenarios were considered for evaluation in CMP. Before this the base year travel demand model was calibrated to simulate the existing condition and issues of the city.

Base year Travel Demand Model:

The base year scenario represents the present road network and current travel demand of the city. The interaction between traffic analysis zones based on the mode people choose will give fair idea about the travel behavior. This information allows transport agency / stakeholders to comprehend travel patterns and characteristics; measure trends; provide input to travel demand model development, forecasting, and planning for city wide transportation infrastructure needs and monitor progress and changes due to implementation of transportation systems. The trunk network length modeled is 1418 kms.

a) Business as Usual (Do Nothing) Scenario

This scenario represents the future based on the continuation of past trends and is used as the reference point or benchmark for assessing the need for policy interventions. The BaU Scenario extrapolates existing trends and assumes no radical policy interventions for sustainable development and emission mitigations. Future transport demand is based on the preference of different socio economic groups in the base year

Scenario describe the future year (2028 and 2038) and future demand with minimum investments done on public transportation sector, this will help in analyzing the efficacy of the existing network, and how it performs under given traffic demand. The problems (congestion and congested network, increased travel time etc.) can be identified and possible solutions/ interventions can be proposed to mitigate the same. Some of the major shifts are from the modes like car, two wheelers and informal IPTs.

Table 5-17: Mode Split obtained in BAU Scenario for 2048

Trips in City	2038 (BAU)
	Mode Share
Private vehicles	54%
Intermediate Public Transport	14%
Public Transport	14%
Walk & Non-Motorised Transport	18%
Total	**100%**

b) Sustainable Urban Transport Scenario

A Sustainable Urban Transport Scenario (Transit Oriented Development Scenario) is a compact high density mixed use development that is planned along public transit stations (or corridors) which provide housing, employment, entertainment and civic functions within the walking distance. In this scenario, it is assumed that a population density of 400 persons per hectare will be achieved in the zones along transit corridors by the year 2038.

Sustainable Urban Transport Scenario comprises of transport network incorporating committed projects along with major proposed projects as follows:

- Major Roads Proposed
- Proposed Links to complete the road Network

- Missing Links
- Integrated public transport network
- Integrated fare in all transit modes

Due to aforementioned interventions on land use and transport scenarios, the city is expected to have a favorable shift to the public transport in terms of mode choice due to improved infrastructure, availability of public transport and increased cost of using personalized vehicles. The mode choice for the SUT scenario is as follows.

Table 5-18: Mode Split obtained in SUT Scenario for 2048

Trips in City	2038 (SUT)
	Mode Share
Private vehicles	35%
Intermediate Public Transport	5%
Public Transport	39%
Walk & Non-Motorised Transport	20%
Total	**100%**

Based on the SUT scenario the estimated ridership for a dedicated public transport System is discussed in table below:

Table 5-19: Ridership of dedicated public transport system corridor

Corridors	Transit Order	Length (kms)	PHPDT 2048	Ridership 2048
Dehradun				
N-S: Khandoli to ISBT	First	9.6	6408	149479
N-S: Along canal road	First	12.7	7559	150172
N-S: Along Mussoorie Road till Pacific Mall	First	12.8	7484	143914
E-W: FRI to Vidhan Sabha/Rispana	First	10	7563	183562
E-W: FRI Raipur	First	13.8	5212	162665
Corridor Connecting Dehradun – Haridwar - Rishikesh				
Haridwar to Rishikesh	First	33	4455	89115
Dehradun to Rishikesh	First	45	3372	67446
Dehradun to Haridwar	First	59	5867	146658

Following above, the target to be achieved for sustainable solutions in the horizon year, with reduction in emission levels is as follows:

Table 5-20: Target Goals for Sustainable Solutions

Name of the Impact	Existing (2018)	BAU (2048)	Achieved in SUT (2048)
Non-Motorized Trips (%)	19	17	20%
Private Transport (PVT) Trips (%)	53%	54%	35%

Name of the Impact	Existing (2018)	BAU (2048)	Achieved in SUT (2048)
Public Transport Trips (%)	18%	14%	39%
Local Emissions (Tonnes/day)	14.5	17.3	5.1
GHG Emissions (Tonnes/day)	501.5	870.9	261.0

Assessment on various aspects for environmental analysis is discussed under section 5.4.1.3 of this report.

Opportunity for Intermodal Integration

Corridor 1: North South Corridor: Mussoorie to ISBT via Rajpur Road and Saharanpur Road

Intermodal hubs can be developed at ISBT, Dehradun Railway station, Clock Tower, Old Bus stand. The intermodal Hub at ISBT will connect regional bus, city bus, IPT. The Dehradun railway station can be developed as a major intermodal hub with integration of Indian railways, Bus, IPT. At clock tower, the major interchange will be with the proposed transit system in east west corridor. City bus service can be integrated at Old Bus Stand.

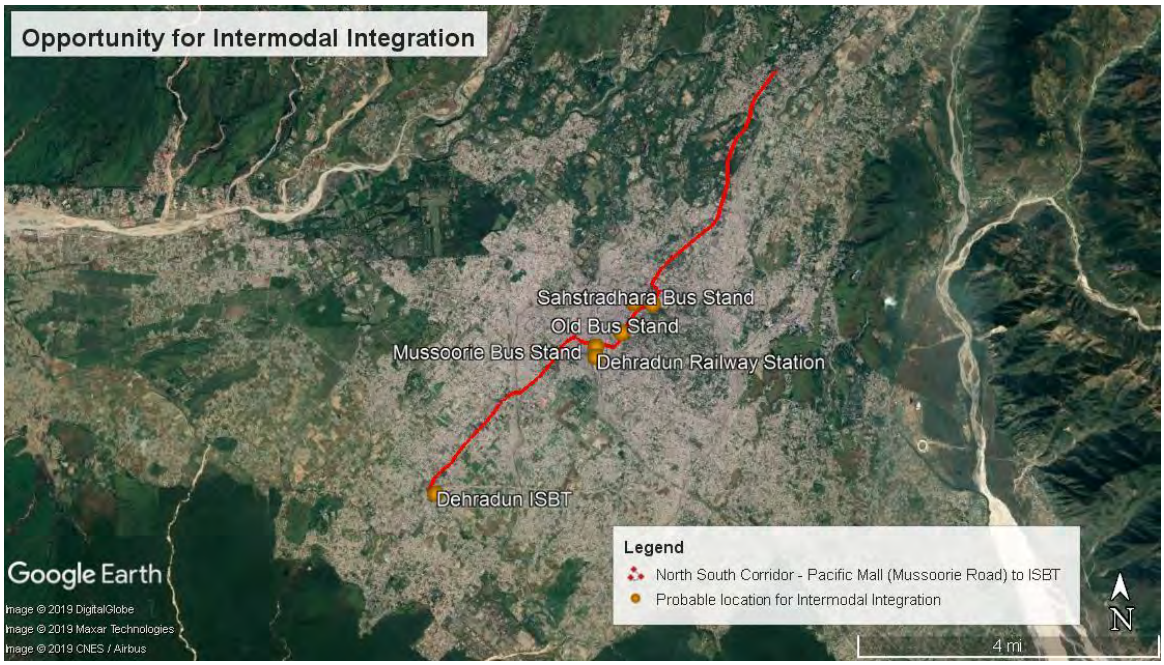


Figure 5-4: Possible locations for Intermodal hub – North South Corridor

Corridor 2: East West Corridor: Raipur to FRI via EC road and Chakrata road

Intermodal hub can be developed at Clock Tower with the proposed transit system on North south corridor and Raipur Bus Stand with Bus. An interchange can also be developed at Rispana connecting with the proposed corridor 3 connecting Dehradun-Rishikesh-Haridwar.

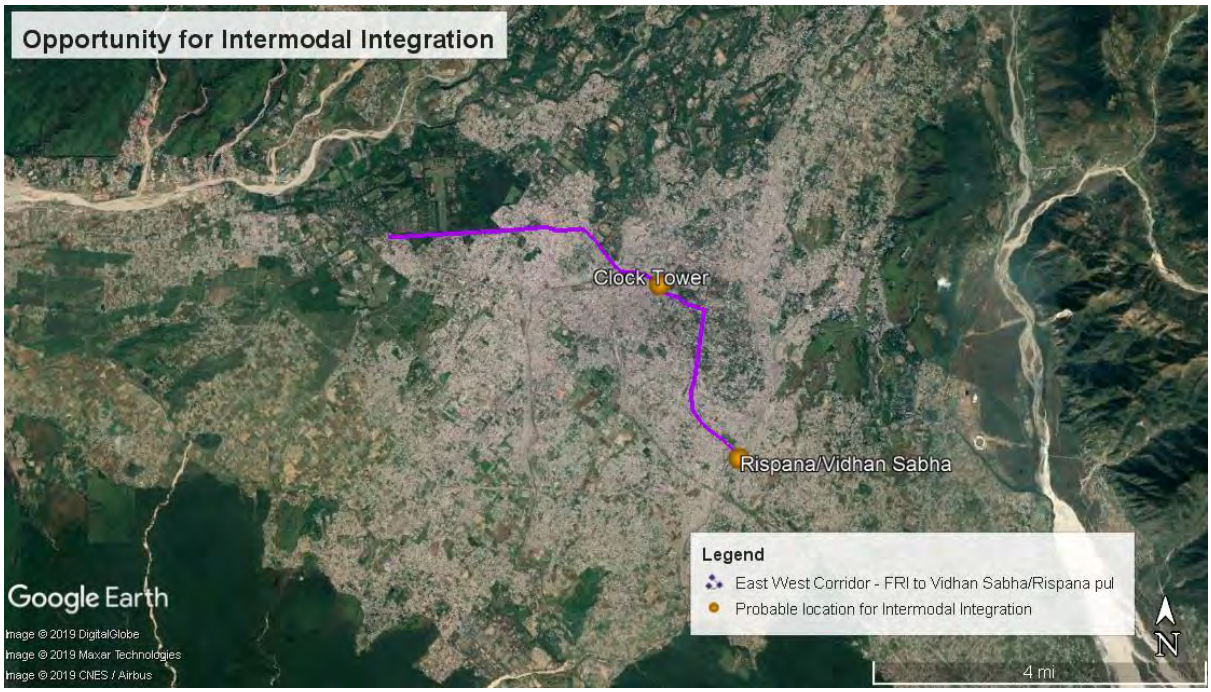


Figure 5-5: Possible locations for Intermodal hub - East West Corridor

Corridor 3: Rispana at Dehradun to Baharadarabad at Haridwar via NH 72 and Haridwar Main road

Intermodal hubs can be developed at Doiwala Railway station, Rishikesh Railway station and Raiwala station integrating with Indian Railways. In case of Haridwar and Rishikesh, in addition to Indian railways the integration will also be with the buses. For Haridwar, the Haridwar Railway station and bus stands should be well integrated with the first order transit system. Sitapur at Haridwar is another location where intermodal hub can be developed.

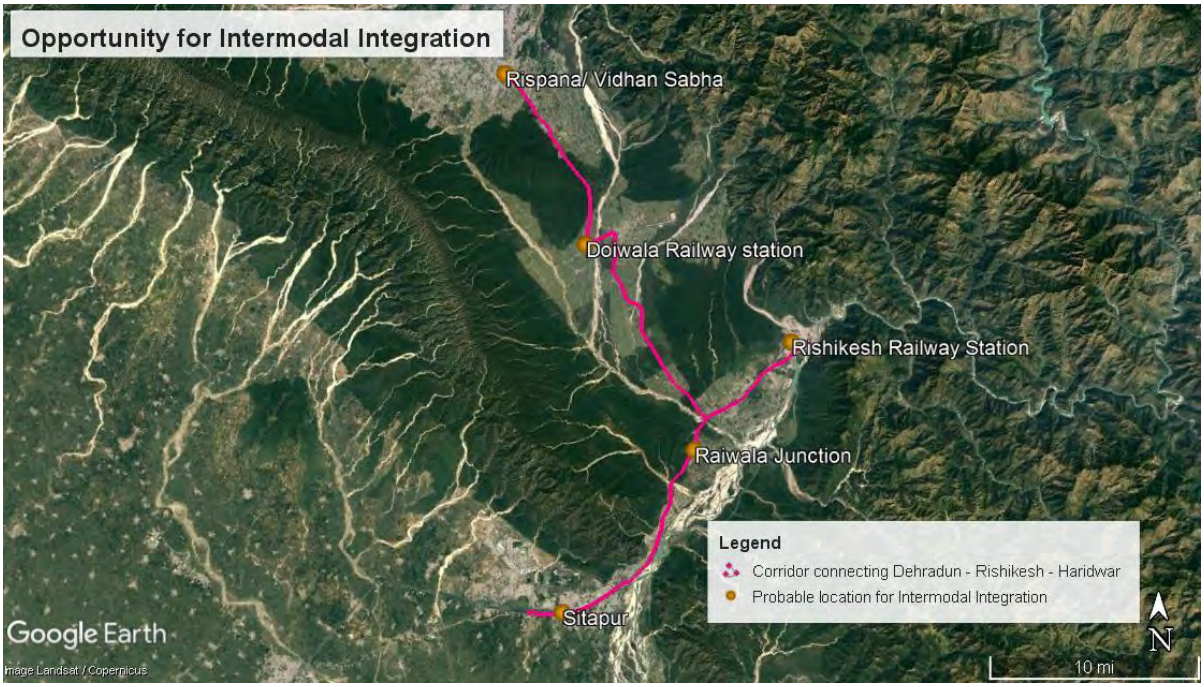


Figure 5-6: Possible locations for Intermodal hub –Corridor connecting Dehradun-Rishikesh-Haridwar

Need for Monitoring & Evaluation Assessment:

A separate Monitoring & evaluation (M&E) assessment is required to be carried out at periodic intervals which include all urban mobility study exercises.

The basic monitoring can be with regard to the status of implementation of the Urban Mobility Plan in terms of time frames proposed and achieved. M&E can include the following modules.

- Public transport proposals including first & Second order transit system
- Intermediate public transport plan (IPT) improvement /Third order transit system
- Road network development plan
- Pedestrian and NMT facilities improvement plan

Monitoring these plans is helpful to understand the pace of urban mobility project implementation and also to assess the impact they are having in improving the air & overall quality of city transport system

5.4.1.2 CONCEPTUAL ENGINEERING EFFECTS

Geotechnical Characteristics

General Geology:

Uttarakhand Metropolitan area can be divided into three zones – Siwaliks, 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 quartzites. 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.

Gangetic Alluvial Plains - The region south of the piedmont plains occupied by Gangetic Alluvial Plains, forms major part of the Bhagwanpur block. Lithologically, the alluvium is formed of unconsolidated to semi-consolidated deposits of sand, silt, clay and kankar.

Seismicity:

Based on the seismic hazard map of India updated in 2002 by the Bureau of Indian Standards (BIS) as per IS 1893 (Part 1)- 2002, the Uttarakhand Metropolitan Area with cities of Dehradun, Rishikesh and Haridwar fall in Earthquake Zone IV considered highly vulnerable to earthquake.

Figure 5-7: Seismic Map of Uttarakhand

Details of Soil & Rock strata for Dehradun - Haridwar – Rishikesh

Details of Soil & Rock Strata was assessed based on geotechnical Study, under which Boreholes were drilled at different locations in the entire study area in proximity to the proposed alignment for detailed investigations. Based on the study covering Field investigations and laboratory tests, it was found that soil strata are non-expansive in nature, containing no organic matter and harmful salts. All the borehole consists of silty sands approximately up to 10.50 meter. However, after this depth and up to till the depth of investigation, boulder Strata (cobbles, pebbles, gravel deposits mixed with fine and course sands) has been met with.

Ground Water Table

During the boring operations for field investigations, water table were encountered and recorded as per IS 6935-1973.

The details of the water level at different locations are given in Table 5-21.

Table 5-21: Details of water table level

Borehole No.	Locations	Water Table (m)
BH-1	GurukulKangri	16.5
BH-2	SankritBhawan	15
BH-3	H.P. Petrol Pump	20
BH-4	Jwalapur Bus stop	Not found
BH-5	Near Sharda Nagar	Not found

BH-6	FCI Godown	Not found
BH-7	Near Hotel Le Central	Not found
BH-8	Near Haridwar railway station	10
BH-9	Near Gujarat Bala Bhavan	6
BH-10	Near Deendayal parking Lot	9
BH-11	Near Hiranwara	6
BH-12	Near Water tank Haridwar	6
BH-13	Motichoor Haridwar	13.5
BH-14	Near Kirti complex	3
BH-15	Shri Nar Singh Temple	10
BH-16	West of Raja ji National Park	Not found
BH-17	Near Raiwala	Not found
BH-18	Near Raiwala 9650	Not found
BH-19	Uttarkhand Grahwal divine	Not found
BH-20	Near Sri Kedarnath Marbles	6
BH-21	Temple Near substation 9538	6
BH-22	Near Lord Shiva HD wallpapers	3
BH-23	Near IDPL colony	4.8
BH-24	Near Manav Chetna Kendra	6
BH-25	Lalit Mohan Sharma PG school	6.5
BH-26	Near SBM inter college	6
BH-27	Near Gaur tour and travels	12
BH-28	Rishi Timber	Not Found
BH-29	IDPL Depot	6
BH-30	Near Raiwala Underpass	15
BH-1	Near Geetanjli garden	10.5
BH-2	Near HP Petrol pump	14
BH-3	Near Shiva Marvel Shop	Not met
BH-4	Near AjabpurKhurd	21
BH-5	Near Kanishq Hospital	Not found
BH-6	Near Kamla Business Centre	Not found
BH-7	Near Uttarakhand Gramin Bank	Not found
BH-8	Near Mahaveer Traders	5.2
BH-9	Near GTM	6.3
BH-10	Near Sub Station Mohakampur	Not found
BH-11	Near Kali mata temple	Not found
BH-12	Near Way to Laxmi Sidh Temple	Not found
BH-13	Near CIMSR Station	12
BH-14	Near Quality Controll Lab	Not found
BH-15	Forest area	Not found
BH-16	Forest area	Not found
BH-17	Forest area	Not found
BH-18	Forest area	Not found

BH-19	Near Old Underpass of Lachhiwala	Not found
BH-20	Near Primary School Lachhiwala	Not found
BH-21	Near Kotwali	Not found
BH-22	Near Pathway	Not found
BH-23	On NH 475 mtr	Not found
BH-24	Near Shere Panjab Dhaba	Not found
BH-25	Near Jeevan wala Dehradun Road	Not found
BH-26	150 Ahead from Sidhi Wali Enterprises	Not found
BH-27	150 mtr Ahead from Pal Traders	Not found
BH-28	Near Hotel delight Restaurant	Not found
BH-29	Near Panjabi Dhaba	Not found
BH-30	Near mochiko Factory	Not found
BH-31	Near Sai Baba Temple	Not found
BH-32	In Reserve Forest	Not found
BH-33	In Reserve Forest	Not found
BH-34	In Reserve Forest	Not found
BH-35	Near Rajkiya inter college Chhiderwala	Not found
BH-36	Near Rawat Genral Store	3.5
BH-37	Near Green valley Restaurant	4.2
BH-38	In Reserve Forest	9.5
BH-39	In Reserve Forest	4.5
BH-40	Nepali Farm	6.5

Based on the study it was observed that all boreholes consist of silty sands approx. 10.50 m and beyond this depth and up to till the depth of investigation, boulder Strata (cobbles, pebbles, gravel deposits mixed with fine and course sands) has been met with. Considering the nature of soil, type of proposed structures and expected loads on foundations, the recommended type of foundations is Pile Foundation. However, further detailed investigation and assessment may be carried out at DPR Stage.

Design and Geometric Characteristics

The geometric characteristics refer to the ability of the technology to handle the geometric constraints, general system parameters and preliminary ridership requirements of this study corridor. Major design and geometric as well as technological characteristics of the transit systems are discussed in the following sections:

Heavy and Medium Metro System

The metro system will be of standard gauge, 1435mm, which is generally adopted for metro railways worldwide. The general rail level is 12.5 m above road and is governed by a ground clearance of 5.50 m. This in turn determines the level of the entire station structure on the elevated section. In order to keep the land acquisition to minimum, alignment shall be planned generally in middle of the road and a two-level elevated station.

The station is generally located on the road median with total length of the station 81m. All the stations are two-level stations. The concourse is divided into two parts at either end of the station, with staircases leading from either side of the road. Passenger facilities like ticketing, information, etc. as well as operational areas are provided at the concourse level. Typically, the concourse is divided into public and non-public zones. The non-public zone or the restricted zone contains station operational areas such as Station Control Room, UPS & Battery Room, Signaling Room, Security Room, Staff Toilets, etc. The public zone is further divided into paid and unpaid areas.

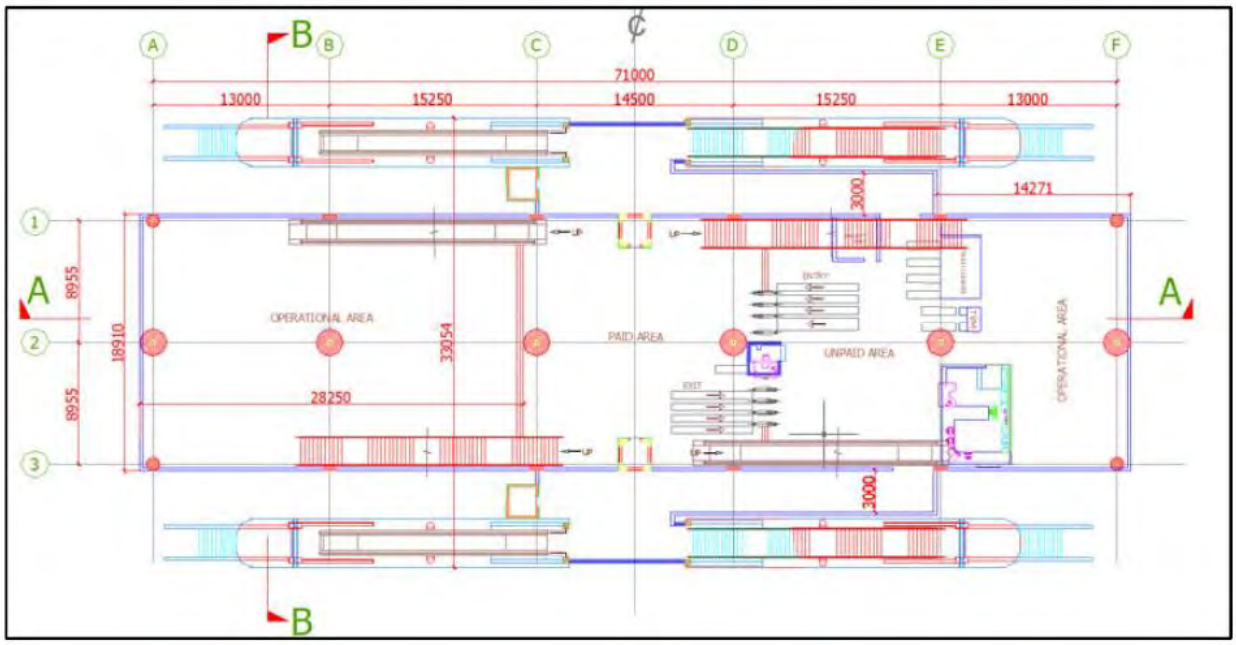


Figure 5-8: General Plan for Metro Station

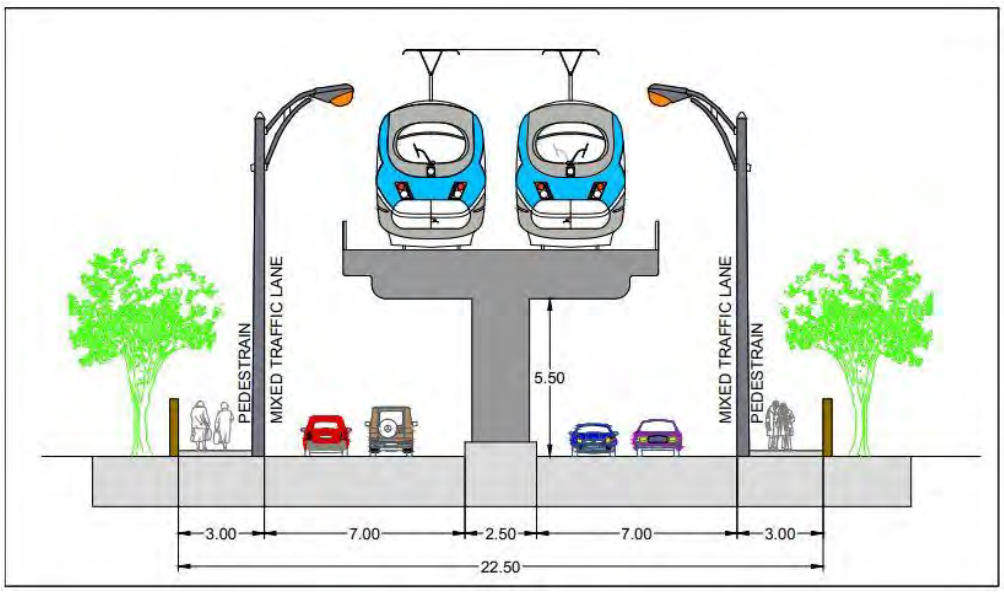


Figure 5-9: Typical section of a metro corridor

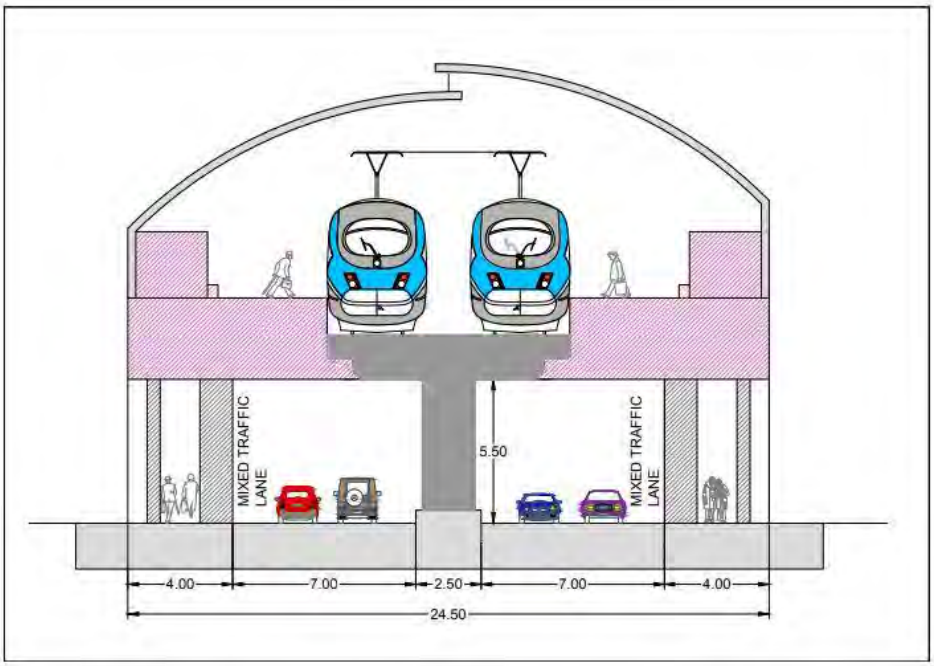


Figure 5-10: Typical Section of Metro corridor at Station location

Heavy and Medium Metro are high capacity public transit system which with high capital investment and it is suitable for capacity above 25,000 PPHPD. As in case of Dehradun, the expected PPHPD is falls in the range 5000 to 8000 only, thus the Heavy and Medium Metro systems are not suitable for this project and are not considered in detailed evaluation in the upcoming sections.

Light Metro/Elevated Light Rail transit

Light Metro/Elevated Light Rail Transit is rail based system that can range in function from lighter capacity “modern/advanced tramways” (single/double train sets) mostly running at grade up to medium/high capacity “heavy LRT/light metro/StadtBahn” (train sets single to quadruple or more: 30->100m) mostly running segregated. Elevated Light rail Transit is considered particularly for the corridor preferred.

Elevated LRT runs on raised track supported by steel or concrete structures. The elevated guide-ways are typically 5-6 m above grade. These can reach more than 10 m above grade to bypass existing roads and bridges. The guide way columns are typically spaced 30 m apart along the right of way. The advantage to elevated LRT over conventional light rail is that less right of way is required because track is elevated. Elevated LRTS is known for being more efficient and has higher carrying capacity than monorail. Modern Light Rail has in recent decades made a comeback in Europe, Australia, and Americas and in recent years even in Asia.

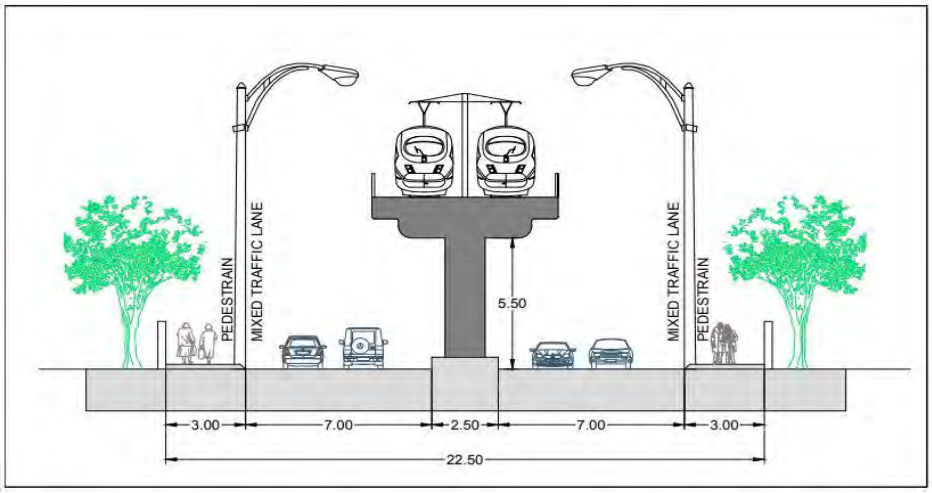


Figure 5-11: Typical Section of Elevated LRT

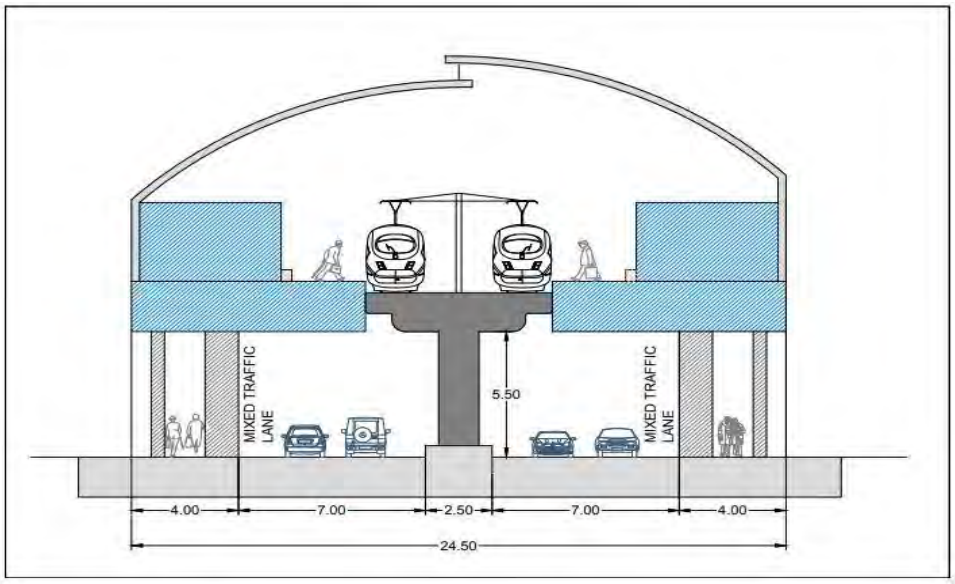


Figure 5-12: Typical section of Elevated LRT at station location

At grade Light Rail Transit System

Light Rail evolved from what were formerly trams, and in many instances still runs on former tram tracks. However, contemporary light rail vehicles (LRVs) are technologically advanced; they contribute substantially to a city's transport task, and are attractively styled. They can mingle intimately with pedestrians and motorists, where their presence represents an in-your-face marketing opportunity. On segregated right-of-way, they can make rapid progress. They are quiet, and offer a comfortable ride. State-of-the-art LRVs feature low floors, 300-350mm above rail, over 60-100% of their floor area. They are convenient for shoppers with parcels and parents with children.

When LRT is at-grade i.e. at road level within a dedicated corridor width of 3.3m on each side of the median of the road requiring a total ROW for LRT of about 6- 8.2m of the road between stations. Additional road space is required at stations. Stations are provided with access control through turnstiles. Stations may be located as near to the road junctions as feasible so that the entry and exit of passengers from the stations is through the existing zebra crossings. However, some stations may have to be

provided at mid-sections with new signaled Zebra crossings. The stations can be staggered stations with 2 m width, to minimize the requirement for land acquisition. Typical cross sections of an at-grade LRT are given in the figures below:

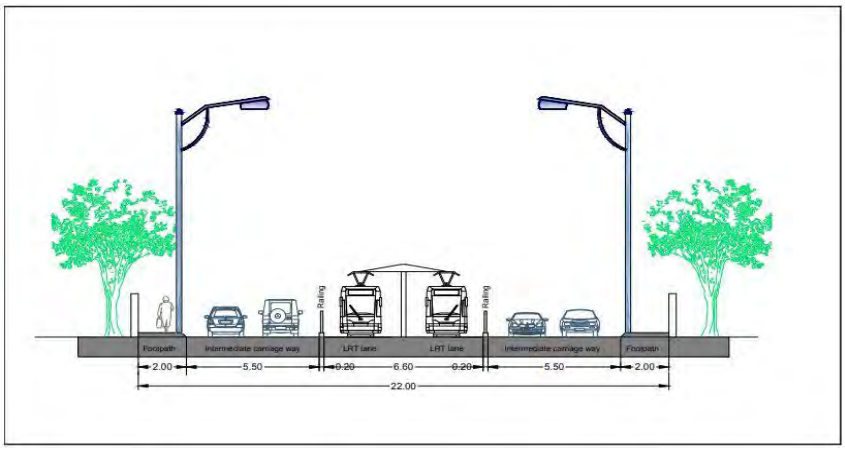


Figure 5-13: Typical cross section of At grade LRT

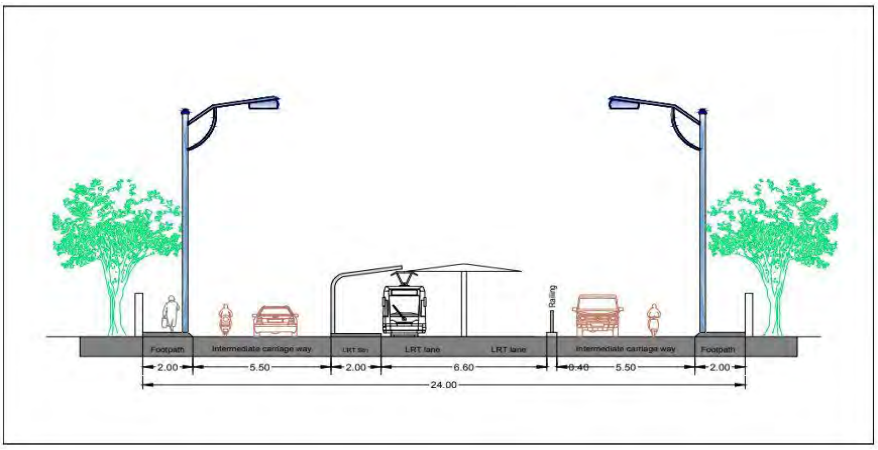


Figure 5-14: Typical Cross section of At grade LRT at station location

Monorail

The Monorail is a sleek, elevated transit system which can be built to efficiently serve areas where metro rail cannot penetrate. As it requires a very narrow right of way, and can navigate such areas which Metro Rail cannot, it can comfortably be built in an area dominated by high-rises and sharp turns.

Monorail and elevated LRT are similar in that they operate on elevated guide ways but monorail operates on guide way requiring only one beam (normally concrete) and mono rail cars have rubber tires. The beam typically measures around three feet in width. Two-way system requires two beams separated 5 m apart. The beams consume very less space compared to a metro and quite easy to install. The station area needs 21-22 m including the lifting devices like stairs, elevators or escalators.

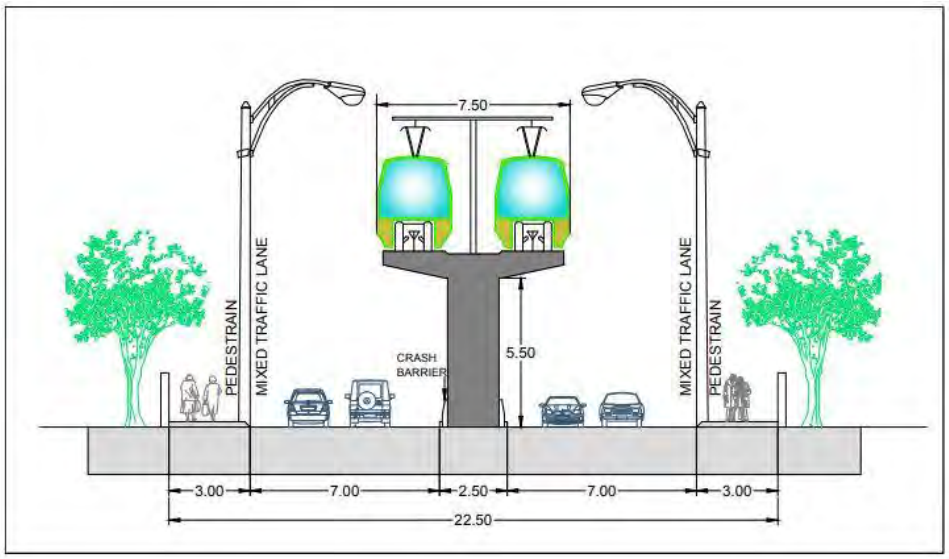


Figure 5-15: Typical Cross section of Monorail

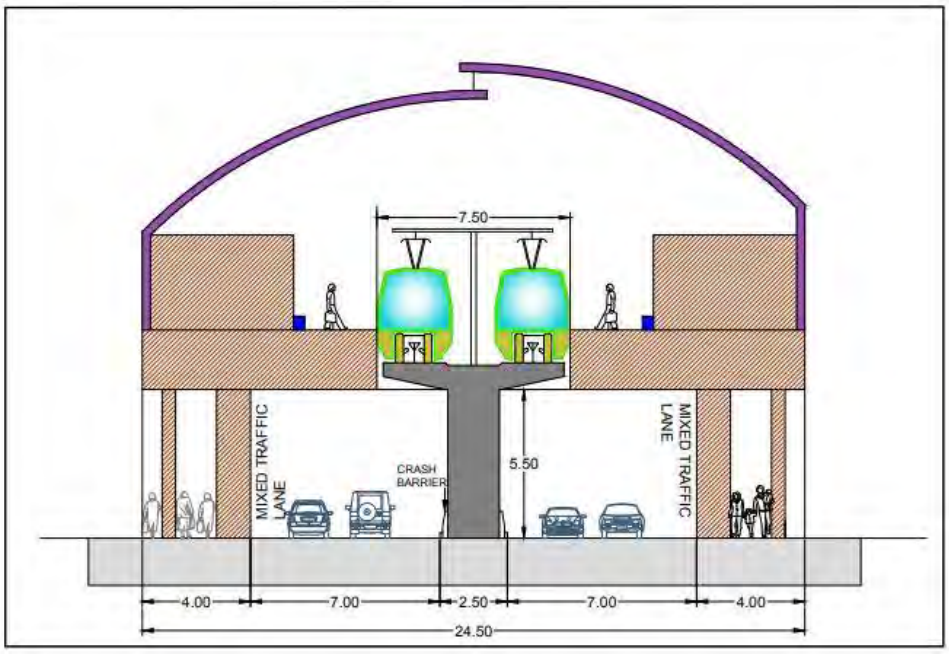


Figure 5-16: Typical Cross section of Monorail at station location

Internationally Monorail systems are not widely used due to various factors like:

- Monorail vehicles are not compatible with any other type of rail infrastructure, which makes through services onto mainline tracks impossible.
- Monorail tracks do not easily accommodate at-grade intersections.
- Monorail infrastructure and vehicles are often made by separate manufacturers using different specifications beam size and rolling stock.
- Proprietary system with only limited manufacturers around the world and variations in the technology used is commonly seen in the system.

Further, considering the case of Mumbai, the implementation of Monorail system has not been successful and the public agencies are finding it difficult to get a suitable company to provide the spare parts and additional rolling stock matching to the specifications of the existing rolling stock company. In addition, the cost difference between light metro and the monorail system implemented in Mumbai makes monorail less viable. Taking all these factors into account, Monorail is not considered in detailed evaluation in the upcoming sections.

Elevated Bus Rapid Transit

The next Alternative mode under consideration is an elevated BRTS system. An elevated road shall be constructed exclusively for the bus transit. The elevated BRT corridor will have two bus lanes of 7.5 m width total. The piers supporting the elevated corridor will have a diameter of 2-3 m and the clear height for at-grade traffic as 5-6m.

For elevated BRT corridor stretches accommodating BRT stations, the total cross sectional width of the elevated structure shall be 12.4m. BRT stations are provided along the median of the elevated corridor access to which is through elevators along medians.

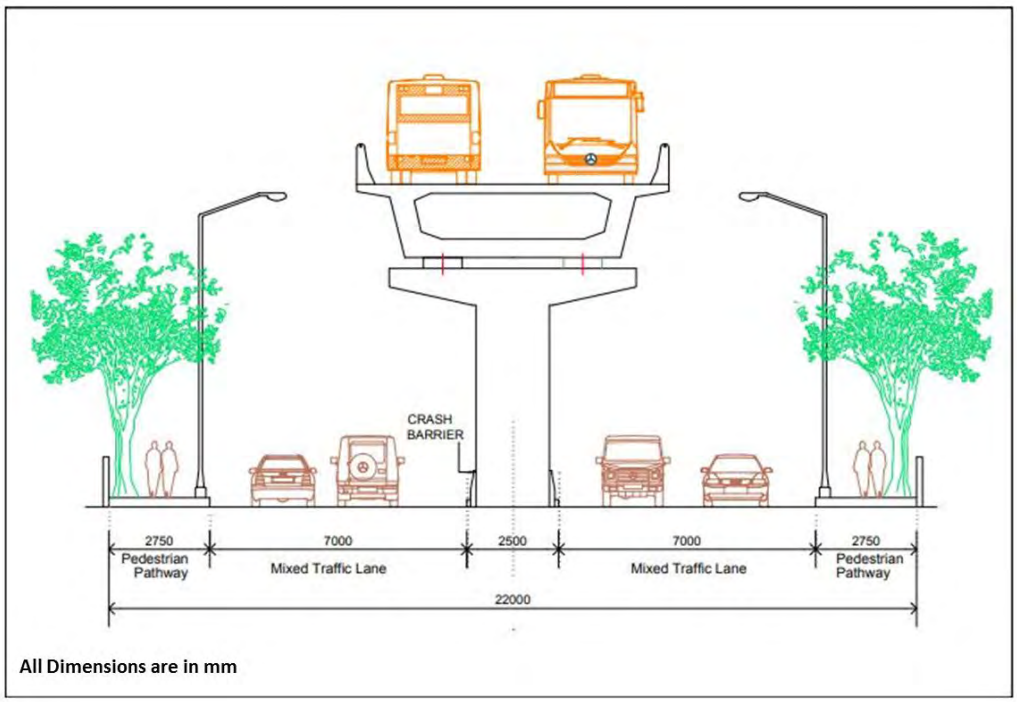


Figure 5-17: Typical Cross section of Elevated BRT

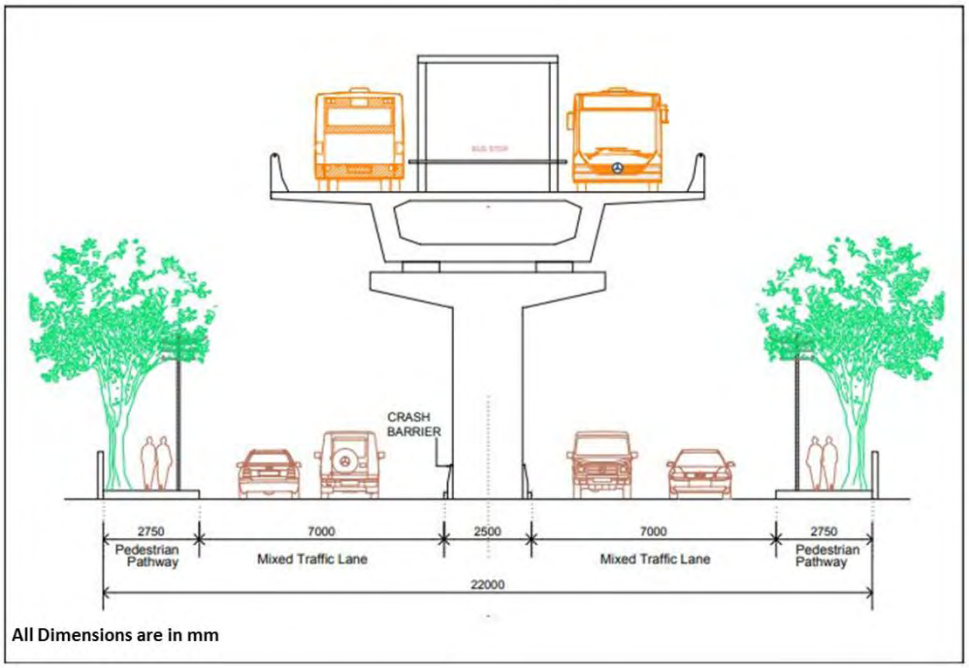


Figure 5-18: Typical Cross section of Elevated BRT at station location

At Grade Bus Rapid Transit

At grade Bus Rapid Transit is the widely used transit mode using bus systems. The system requires a width of 6-7m along the median for the bus movement. The stations can be designed with respect to the floor height of the buses. Median Bus Stations of 4 m width are considered. Other design innovations can also be adopted during the detailed project report stage to minimize the land acquisition. The typical cross sections of an at-grade BRTS with station and without station are shown below:

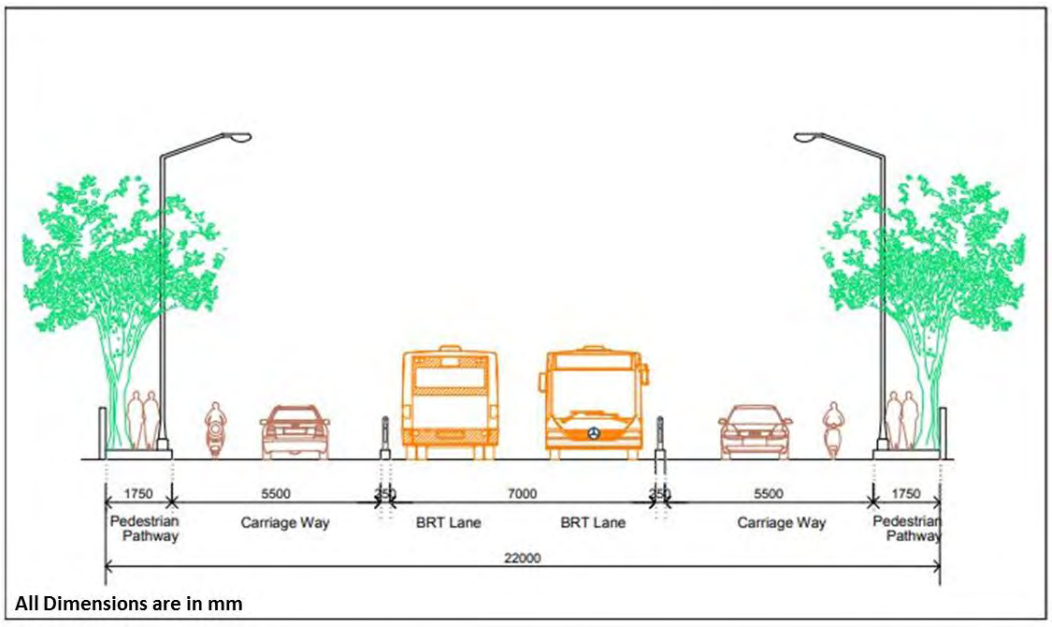


Figure 5-19: Typical Cross section of At grade BRT

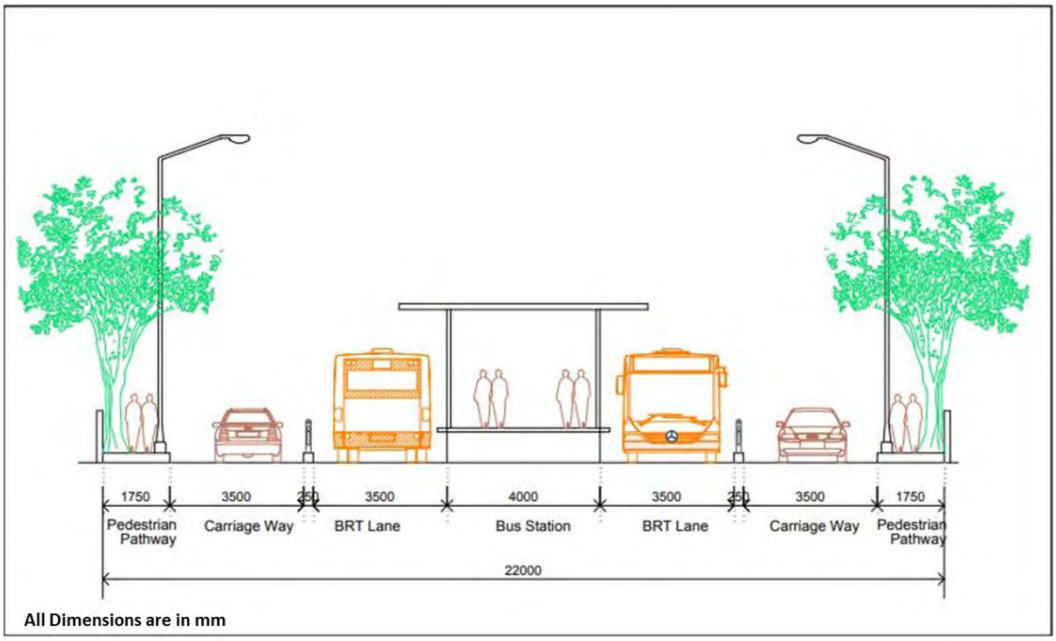


Figure 5-20: Typical Cross section of At grade BRT at station location

COMPARISON OF DESIGN CHARACTERISTICS:

A comparison of the design characteristics of each of the transit mode is given in Table 5-22.

Table 5-22: Comparison on Design characteristics of the transit systems

Parameter	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
Span of the Viaduct (m)	6-7	6.6	7.5	7
Span at the stations	20-22	9.6	12.5	11
Carriageway for Private Vehicles including Footpath(m)	18-19	15	18-19	15 (excluding footpath)
Width of Carriageway at stations(m)	12-14	12-14	15-19	12-14

Land Assessment

All Alternative corridors require a span of 6-7 m. The existing ROW of the roads is generally narrow up at cross road, Kidduwala Road in East west Corridor and near railway station in North South Corridor. The mass transit corridor has to be planned with a view to cause minimum disturbance to the existing property. Even then, at critical and unavoidable locations some land and properties are required.

Table 5-23: Land to be acquired for Corridor 1 -North South corridor

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
Additional land required at Stations in sqm	10737	14935	6954	14935

Table 5-24: Land to be acquired for Corridor 2 - East West corridor

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
Additional land required at Stations in sqm	14650	30354	15616	30354

Table 5-25: Land to be acquired for Corridor 3 – Connecting Dehradun –Rishikesh- Haridwar

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
Additional land required at Stations in sqm	32387	30801	29216	30801

Operational Characteristics

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

- Selecting the most optimum frequency of services to meet sectional capacity requirement during peak hours on most of the sections
- A short train consists of 3 coaches with high frequency service.

Accordingly, considering peak hour traffic demand (PPHPD) for 2038, shows the operational characteristics of the Alternative modes for Corridor 1- North South, Corridor 3- East west and Corridor 3- Connecting Dehradun-Rishikesh-Haridwar are given in the Table 5-26, Table 5-27 and Table 5-28 respectively.

Table 5-26: Operational Characteristics of the systems in Corridor 1- North South corridor

	Light Metro/Elevated LRT	At-grade LRT/Light Metro	Elevated BRTS	At grade BRTS
Length (km)	12.8			
Speed (km/hr)	40	25	30	25
Headway (min)	4.5	4	0.45	0.45
PPHPD (2048)	7484			
Carrying Capacity	600	500	60	60
Total travel time(min)	54	71	61	71
Rolling Stock Required	13	20	231	252

Table 5-27: Operational Characteristics of the systems in Corridor 2- East West corridor

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
Length (km)	10			
Speed (km/hr)	40	25	30	25
Headway (min)	6.5	5	0.5	0.5
PPHPD (2048)	6400			
Carrying Capacity	600	500	60	60

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
Total travel time(min)	39	53	45	53
Rolling Stock Required	8	14	208	225

Table 5-28: Operational Characteristics of the systems in Corridor 3: Connecting Dehradun-Rishikesh-Haridwar

	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
Length (km)	68.29			
Speed (km/hr)	40	25	30	25
Headway (min)	7	6	0.6	0.6
PPHPD (2048)	5867			
Carrying Capacity	600	500	60	60
Total travel time(min)	208	330	276	330
Rolling Stock Required	29	56	540	628

Existing Utilities

The proposed alignments are passing along major arterial roads of the city road network and the main highway connecting the cities of Dehradun-Rishikesh-Haridwar, which are serving Institutional, Commercial and residential areas. Large numbers of sub-surface and over-head utility services like; Sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. are existing along the proposed alignment. The Table 5-29 below gives the possible utilities that would require shifting.

Table 5-29: Possible Utilities below and above the surface which require shifting

SN	Organization/Department	Utility Services
1	State Water Authority	Sewerage and drainage conduits. Water mains, their service lines, including hydrants and fountains etc., water treatment plants, pumping station etc.
2	State Electricity Board	Power cables and their appurtenances, pole Mounted transformers, power cables of 33 & 11KVs.HT Lines, their pylons, sub-station, etc.
3	Phone Cables	Telecommunication cables, junction boxes, telephone posts, O.H. Lines etc.

The utilities need to be shifted irrespective of the type of the system proposed, as the existing road will be widened to incorporate any transit system and hence, the cost of utility shifting will remain same. However, the utility shifting required for any at-grade system will be comparatively lower compared to an elevated system. Further, Detailed Utility Shifting Plans will be prepared at the Detailed Project Stage.

5.4.1.3 ENVRONMENTAL ASSESSMENT

The need of environmental assessment at this stage is to identify the potential impact of the project and to evaluate their impact. The environment includes water, land, air, ecology, noise, each of which is

discussed in following sub-sections. A detailed ESIA Study need to be conducted for the project at the Detailed Project Report Stage.

Land Environment

Uttarakhand Metropolitan area lies in the Garhwal Region of the State. It is sub montane region and has the common climatic characteristics of mountains and plains. The Sub-montane region of the Garhwal Himalayas has specific climatic characteristics, which are dominated by high temperature and humidity. Dehradun mainly lies in Doon Valley and is at a varying height from 410 m in Clement Town to above 700 m at Malsi which is 15 km from the city. Rishikesh has an average elevation of 372 m. The town of Haridwar grew between the Shivalik Mountain Range in the North and Northeast and Ganga River in the South. Climate ranges from sub-tropical in the southern foothills average temperatures of about 30 ^{o}C and inter temperature of about 18 ^{o}C. The state of Uttarakhand is among the most seismically active parts of India. The study area region falls in Zone IV where the maximum intensity expected could reach MSK VIII.

Water Environment

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the needs of the project in its various stages of the project cycle and also to assess the impact of the project on water environment. The greater Himalayan zone serves as the barrier for monsoon winds which cause good rainfall. This region is a massive water store for the abundance of perennial rivers, flowing southwards. So the entire region is well drained by the perennial rivers. The general water level variation falls in the range 5-15m bgl (*Ground Water Brochure, District Dehradun, Uttarakhand 2011*). 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 (*Ministry of Water Resources Central Ground Water Board, 2009*).

Air Environment

The data from the Uttarakhand pollution control board shows that for Dehradun, Rishikesh and Haridwar, the concentration of particulate matter 10 (P.M10) are higher than the stand concentration allowed.

One of the major causes of air pollution is vehicular pollution. The reasons being:

- High emission from two and three wheelers
- Adulteration of fuel
- Violation of emission norms
- Lack of vehicle maintenance
- Large number of old vehicles in use
- Erratic traffic behavior
- Older engine technologies
- Inadequate road space preventing better mobility of traffic
- Poor maintenance of roads
- Inadequate traffic management
- Increase in population of vehicles

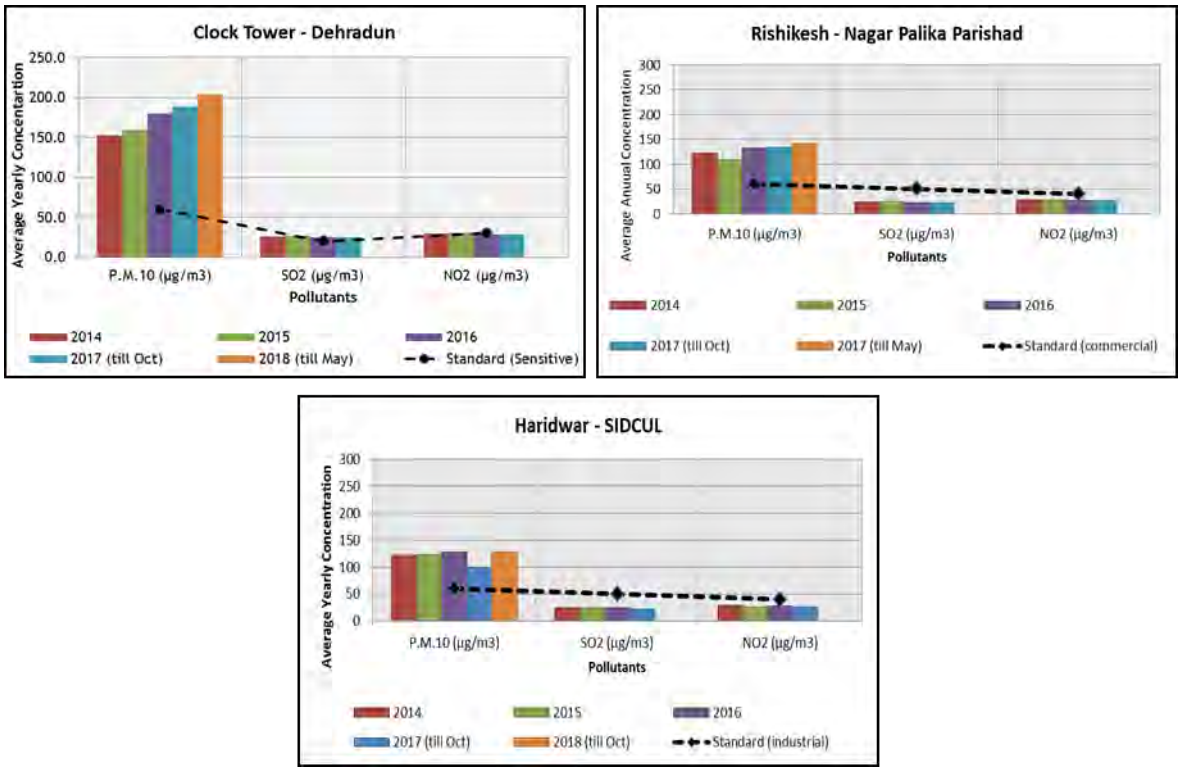


Figure 5-21: Air Quality at Dehradun, Rishikesh and Haridwar

Ecology

An ecological study of the project area is essential to understand the impact due to project development activities on flora and fauna within the area. The project site is located in city area as well as regional area and it is free of any wildlife fauna at the city area. On site construction activities will result in loss of trees though.

An inventory of trees likely to be affected based on only the viaduct width and station area of preferred corridor has been prepared and summarized in the table below.

Table 5-30 : Inventory of Trees

Station From	Station To	Trees
Corridor : NS coridor - ISBT to Pacific Mall (Mussoorie Road)		
Pacific Mall, Mussoorie Road	Kandholi Depot	12
Kandholi Depot	Kandholi	2
Kandholi	Sachivalaya	6
Sachivalaya	Gandhi Park	6
Gandhi Park	Ganta Ghar	64
Ganta Ghar	Dehradun Court	0
Dehradun Court	Dehradun Railway Station	0
Dehradun Railway Station	Saharanpur Chowk	0
Saharanpur Chowk	Mata Wala Bagh	0
Mata Wala Bagh	Near guru road	2
Near guru road	Lal pul	0

Lal pul	ITI	0
ITI	Sewla Kalan	0
Sewla Kalan	ISBT	0
Corridor : EW coridor - FRI to Vidhan Sabha/Rispana pul		
FRI	Ballupur Chowk	36
Ballupur Chowk	IMA Blood Bank	8
IMA Blood Bank	Doon School	4
Doon School	Malhotra Bazar	2
Malhotra Bazar	Ghanta Ghar	0
Ghanta Ghar	CCMC	18
CCMC	Araghar Chowk	10
Araghar Chowk	Dharampur Chowk	2
Dharampur Chowk	Vidhan Sabha	18
Corridor : Connecting Dehradun - Rishikesh - Haridwar		
Vidhan Sabha	Jogiwala	6
Jogiwala	Mokhampur	2
Mokhampur	Balawala	0
Balawala	Harrawala	2
Harrawala	CIMSR	3
CIMSR	Doiwala	32
Doiwala	Bhaniwala	8
Bhaniwala	Lal tapped	2
Lal tapped	Chidderwala	2
Chidderwala	Nepali Farm	3
Rishikesh	Bapu Gram	7
Bapu Gram	IDPL Colony	13
IDPL Colony	Bibiwala	0
Bibiwala	Shyampur	5
Shyampur	Nepali Farm	7
Nepali Farm	Raiwala	93
Raiwala	Haripur Kalan	35
Haripur Kalan	Shantikunj	1
Shantikunj	Doodhadhari	0
Doodhadhari	Har ki Pauri	45
Har ki Pauri	Laltaro Bridge	44
Laltaro Bridge	Shankaracharya Chowk	18
Shankaracharya Chowk	Bus Stand Mayapur	4
Bus Stand Mayapur	Gulab Park	4
Gulab Park	UkPSC	0
UkPSC	Jwalapur	17
Jwalapur	Sitapur	24
Sitapur	Bhumanand Hospital	10
Bhumanand Hospital	Uttarakhand Sanskrit Academy	0

The environmental impacts caused due to the development of the project can be categorized as primary impacts which are induced directly by the projects and secondary impacts which are induced due to associated investments or changing social patterns. Table 5-31 shows an abstract of the Environmental Impacts

Table 5-31: Environmental Impacts during the various stages of construction (preliminary analysis)

Project Activity	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At Grade BRTS
Site preparation	Yes	Yes	Yes	Yes
Traffic Diversion	Yes	Yes	Yes	Yes
Site Excavation and Foundation Work	Yes	No heavy foundation required	Yes	No heavy foundation required
Material Storage and Transportation	Yes	Yes	Yes	Yes
Use of construction equipment	Yes	No heavy equipment required	Yes	No heavy equipment required

The positive environmental impacts are listed below:

- Employment Opportunities
- Benefits to Economy
- Quick Service and Safety
- Reduction in number of vehicles
- Reduction in Fuel consumption
- Less Air pollution
- Carbon Credits

Appropriate environmental pollution mitigation measures shall be adopted during the construction stage for the environmental effects. A detailed ESIA shall be conducted to review the detailed project report along with stakeholder consultation to identify the impacts in details and hence to suggest appropriate mitigation measures. The qualitative comparison of environmental impacts for each transit mode is given in Table 5-32.

Table 5-32: Comparison on Environmental Impact for transit modes

Project Activity	Light Metro/Elevated LRT	At-grade LRT/Light Metro	Elevated BRTS	At grade BRTS
Site preparation	Yes	Yes	Yes	Yes
Traffic Diversion	Yes	Yes	Yes	Yes
Site Excavation and Foundation Work	Yes	No heavy foundation required	Yes	No heavy foundation required
Material Storage and Transportation	Yes	Yes	Yes	Yes
Use of construction equipment	Yes	No heavy equipment required	Yes	No heavy equipment required

5.4.1.4 SOCIAL IMPACT ASSESSMENT

The Social Impact Assessment (SIA) includes preliminary Resettlement Action Plan (RAP) which is based on the principle that the population affected by the project will be assisted to improve their living standards.

The acquisition of land for the project shall displace people from their home, livelihood base, and business base. In order to keep minimum acquisition of private land and government properties, the project shall be planned in such a way that mostly it runs along the median of existing roads. However, for station entry/exist, traffic integration, maintenance depot and construction depots, some acquisition may be required. For the proposed corridor, change of land use will not be created because of the system, as the existing land use pattern is predominantly commercial and public semi-public.

- The proposed corridor will involve acquisition of maximum 14935sqm for at grade LRT and BRTS and minimum of 6954 sqm for Elevated BRTS for Corridor 1: North South corridor.
- The proposed corridor will involve acquisition of maximum 30354sqm for at grade LRT and BRTS and minimum of 14560 sqm for Elevated LRT for Corridor 2: East West corridor.
- The proposed corridor will involve acquisition of maximum 32387sqm for elevated LRT and minimum of 29216 sqm for Elevated BRTS for Corridor 3: connecting Dehradun-Rishikesh-Haridwar

A detailed social impact assessment Study needs to be carried out at the Detailed Project report Stage along with the Rehabilitation and resettlement Plan.

5.4.1.5 COST AND FINANCIAL ANALYSIS

The preliminary cost estimates for the Alternative modes based on the conceptual engineering design is discussed in this section. Detail items of work, estimates of quantities and costs shall be included at DPR Stage.

Cost Estimation for the Alternative modes for Corridor 1- North South, Corridor 2- East West and Corridor 3- Connecting Dehradun-Rishikesh-Haridwar are discussed below:

Table 5-33: Unit cost of Cost Estimate Components

S.No	Parameters	Unit	Light Metro/Elevated LRT	At-grade LRT/Light Metro	Elevated BRTS	At grade BRTS
1	Civil Works &P Way	Cr/km	35	30	25	5
2	Cost of Stations	Cr/Station	25	5	5	0.45
3	Traction & Power supply, Signalling System/ ITMS, AFC, Automatic Doors	Cr/km	26	8	1.6	0.3
4	Rolling Stock	Cr/Train	30	30	2	2
5	Depot & OCC	LS	200	170	25	25
6	Intermodal	LS	100			

S.No	Parameters	Unit	Light Metro/Elevated LRT	At-grade LRT/Light Metro	Elevated BRTS	At grade BRTS
	Connectivity					
7	Utility Shifting	Cr	2.2	1.8	2.2	1.8
8	RoW up gradation	Cr	3			
9	AFC	per station	3.36	3.36	3.36	3.36
10	Escalator	per station	4.3	-	4.3	-

(Sources: from various DPRs of Metro Rail and BRTS Systems)

Table 5-34: Abstract Cost Estimate for each transit mode for Corridor 1: North South

S.No	Parameters	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
1	Length (km)	12.8	12.8	12.8	12.8
2	Depot (Nos)	1	1	1	1
3	Rolling Stock (Nos)	13	20	231	252
4	No of Stations (Nos)	15	15	15	15
5	Elevated Section, including track (Crores)(Rs)	448	384	320	64
6	Cost of Stations (Crores)(Rs)	375	75	75	6.75
7	Traction & Power supply, Signalling System (Crores)(Rs)	332.8	102.4	20.48	3.84
8	Rolling Stock (Crores)(Rs)	398	609	462	505
9	Depot & OCC (Crores)(Rs)	200	170	25	25
10	Intermodal Connectivity (Crores)(Rs)	100	100	100	100
11	Utility Shifting (Crores)(Rs)	28.16	23.04	28.16	23.04
12	RoW up gradation (Crores) (Rs)	51.2	51.2	51.2	51.2
13	AFC & Escalator	114.9	50.4	114.9	50.4
14	Miscellaneous	300	200	100	100
	Total (Crores) (Rs)	**2348**	**1766**	**1297**	**929**

Table 5-35: Abstract Cost Estimate for each transit mode for Corridor 2: East West

S.No	Parameters	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
1	Length (km)	10	10	10	10
2	Depot (Nos)	1	1	1	1
3	Rolling Stock (Nos)	8	14	208	225
4	No of Stations (Nos)	15	15	15	15
5	Elevated Section, including track (Crores)(Rs)	350	300	250	50

6	Cost of Stations (Crores)(Rs)	375	75	75	6.75
7	Traction & Power supply, Signalling System (Crores)(Rs)	260	80	16	3
8	Rolling Stock (Crores)(Rs)	249	424	416	449
9	Depot & OCC (Crores)(Rs)	200	170	25	25
10	Intermodal Connectivity (Crores)(Rs)	100	100	100	100
11	Utility Shifting (Crores)(Rs)	22	18	22	18
12	RoW up gradation (Crores) (Rs)	40	40	40	40
13	AFC & Escalator	114.9	50.4	114.9	50.4
14	Miscellaneous	300	200	100	100
	Total (Crores) (Rs)	**2011**	**1457**	**1159**	**842**

Table 5-36: Abstract Cost Estimate for each transit mode for Corridor 3: Connecting Dehradun-Rishikesh-Haridwar

S.No	Parameters	Light Metro/Elevated LRT	At-grade LRT	Elevated BRTS	At grade BRTS
1	Length (km)	67.8	67.8	67.8	67.8
2	Depot (Nos)	1	1	1	1
3	Rolling Stock (Nos)	29	56	540	628
4	No of Stations (Nos)	30	30	30	30
5	Elevated Section, including track (Crores)(Rs)	2373	2034	1695	339
6	Cost of Stations (Crores)(Rs)	750	150	150	14
7	Traction & Power supply, Signalling System (Crores)(Rs)	1763	542	108	20
8	Rolling Stock (Crores)(Rs)	874	1689	1080	1256
9	Depot & OCC (Crores)(Rs)	200	170	25	25
10	Intermodal Connectivity (Crores)(Rs)	300	300	300	300
11	Utility Shifting (Crores)(Rs)	149	122	149	122
12	RoW up gradation (Crores) (Rs)	271	271	271	271
13	AFC & Escalator	229.8	100.8	229.8	100.8
14	Miscellaneous	300	200	100	100
	Total (Crores) (Rs)	**7210**	**5579**	**4108**	**2548**

(Sources: **from various DPRs of Metro Rail and BRTS Systems)**

As observed in the Table 5-34, Table 5-35 and Table 5-36 the capital cost for implementing a MRTS system in Dehradun is also as follows:

Transit system	Corridor 1: NS	Corridor 2: EW	Corridor 3
Light Metro/Elevated LRT	2348	2011	7210
At grade LRT	1766	1457	5579
Elevated BRT	1297	1159	4108
At grade BRT	929	842	2548

Construction Phasing and financial plan for each of the mode for Corridor 1- North South, Corridor 2- East West and Corridor 3- Connecting Dehradun-Rishikesh-Haridwar will be as given in Table 5-37, Table 5-38 and Table 5-39

Table 5-37: Construction and Financing Plan for Corridor 1- NS Corridor

	Construction Period	Beginning of construction	2020-21	2021-22	2022-23	2023-24
Light Metro/Elevated LRT	4--5 Years	**2020**	25%	40%	20%	15%
At grade LRT	2--3 Years		50%	50%		
Elevated BRT	2--4 Years		50%	50%		
At grade BRT	1--3 Years		50%	50%		

Table 5-38: Construction and Financing Plan for Corridor 2- EW Corridor

	Construction Period	Beginning of construction	2020-21	2021-22	2022-23	2023-24
Light Metro/Elevated LRT	4--5 Years	**2020**	25%	40%	20%	15%
At grade LRT	2--3 Years		50%	50%		
Elevated BRT	2--4 Years		50%	50%		
At grade BRT	1--3 Years		50%	50%		

Table 5-39: Construction and Financing Plan for Corridor 3 – Connecting Dehradun –Rishikesh – Haridwar

	Construction Period	Beginning of construction	2020-21	2021-22	2022-23	2023-24
Light Metro/Elevated LRT	4--5 Years	**2020**	25%	40%	20%	15%
At grade LRT	2--3 Years		50%	50%		
Elevated BRT	3--4 Years		50%	50%		
At grade BRT	2--3 Years		50%	50%		

However, detailed financial plan for the preferred mode shall be worked out as part of the detailed project report.

The implementation of the projects can be either through public funded model or PPP model.

In public funded model, the entire project - planning, designing, constructions, operations & maintenance, is handled by the government. For the implementation of the project and subsequent operations & maintenance, a special purpose vehicle (SPV) is set up with either joint venture of central and state government or under the state government alone. In case of SPV formed under 50:50 central and state government, both the governments provide 20% equity each. The remaining funds, 60% of the project cost, are arranged through bilateral or multilateral agencies providing soft loans.

While Private funded model has various options which can be explored, like PPP model for implementation includes options like limited private participation in AFCS & allied activities or private

participation in operations & maintenance or full private funded model. The MRT project can be implemented with either limited involvement from private sector in AFCS and allied activities like development of non-motorized transport and feeder services or with greater participation with involvement in rolling stock, operations and maintenance of the system. The private operator can pay upfront premium or ask for Viability Gap Funding (VGF) in both cases. Design Build Fiancé Operate and Transfer (DBFOT) is yet another type of implementation model where a single private partner overlooks the entire project from planning, construction to operations stage. This model requires support of the government through capital or VGF funding.

Components to be outsourced under PPP	Light Metro/Elevated LRT	- Automatic fare Collection(AFC) - Non-Motorised Transport (NMT) &Public Bicycle Sharing(PBS) - Feeder Buses - Station Development - Operation &Maintenance (O&M)
	At Grade LRT	- NMT &PBS - Feeder Buses - O&M
	Elevated BRT	- NMT &PBS - Feeder Buses - O&M of buses
	At Grade BRT	- NMT &PBS - Feeder Buses - O&M of buses

However, detailed PPP funding options can be assessed at the DPR Stage of the Project. The comparison of the Advantages and disadvantages of each type of funding model are discussed at section 10.2 of the report for implementation. Further the financial model to opted will be selected based on detailed financial Plan prepared at the Detailed Project Report Stage.

Considering the past experiences, no Mass transit projects are financially viable at the initial stage but are essential because of their economic benefits to the society.

Some of the economic benefits of the project are:

- Savings on account of prevention of pollution with introduction of Mass Rapid Transit System (MRTS)
- Savings on reduced accident on account of lesser vehicle on road due to the shift to MRTS.
- Saving in capital cost of reduced number of buses due to MRTS
- Saving in operating cost of private vehicles and buses due to shifting of passengers to MRTS
- Savings in operating costs of all private vehicles and buses due to de-congestion including those that would continue to use the existing transport network even after MRTS is introduced
- Savings in time of commuters using the MRT system because of faster speed of MRTS
- Savings in time of those passengers continuing on existing modes, because of reduced congestion on roads.

The detailed EIRR for the preferred mode will be performed in the detailed project report Stage. For a viable Project, EIRR should be at least 14%, however, the variation in capital cost of the Project directly affect the EIRR of the Project. The same shall be prepared at the detailed project report Stage.

CHAPTER 6

SCREENING AND EVALUATION BASED ON GRADING CRITERIA FOR TRANSIT SYSTEMS - FIRST ORDER TRANSIT CORRIDOR

6. SCREENING AND EVALUATION BASED ON GRADING CRITERIA FOR TRANSIT SYSTEMS – *FIRST ORDER TRANSIT CORRIDOR*

6.1 EVALUATION BASED ON SCORING CRITERIA

Weightage for ranking is decided based on the following goals:

a. The ability to meet the vision of CMP
b. Minimum environmental and community impacts
c. Cost Effectiveness of the option
d. Most effective intermodal connectivity option
e. Effective and feasible project phasing and constructability

The ranking will be done in a scale of 1 to 5, 1 being least suitable and 5 being most suitable.

The demand on the transit corridor is not very high, thus medium and high metro systems would not be a viable transit option. Monorail system has not been successful in Indian scenarios and it is vendor based technology thus increasing the risk factors associated with the implementation of the system.

Hence, for detailed Analysis, Heavy Metro system, Medium Metro and Monorail system are not considered as viable transit system options for this study area. The mass transit systems considered for alternative analysis are:

1. Light Metro/Elevated LRT (Rail based)
2. At Grade LRT (Rail based)
3. Elevated BRT (Road based)
4. At Grade BRT (Road based)

6.2 SCREENING RESULTS

6.2.1 MOBILITY EFFECTS

The mobility parameters under consideration are:

Table 6-1: Mobility Parameters

Parameters	Description
Max PPHPD of System	The maximum loading that the system will be able to cater to.
RoW available after construction of each system	The right of way of the existing/proposed carriageway after implementation of any system
Area occupied by stations	Area occupied by stations when compared to the RoW available
Average operating speed	The average speed the system can attain

Parameters	Description
Opportunity of Intermodal integration	If the system is able to cater to higher traffic demands in future
Travel Time for same OD pair	The travel time between the same OD pair for different system
Headway (min)	The time for waiting for a passenger
Viability with respect to PPHPD	The viability of the system against projected traffic demand

The basis for the ranking for each of the mode for mobility effects is given in Table 6-2.

Table 6-2: Mobility Effects of the system

Sl No	Parameters		Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At grade BRT
1	Quantitative	Capacity of System	6,000-35,000	6,000-25,000	6,000 - 25,000	6,000 - 10,000
2	Quantitative	RoW available against RoW required for the system	18-19	15	18-19	15
3	Quantitative	Area occupied by stations against RoW available	12-14	12-14	15-19	12-14
4	Qualitative	Viability against PPHPD	High	High	Low	Low

The scoring for mobility effects is given in the Table 6-3, Table 6-4 and Table 6-5.

Table 6-3: Scoring for Mobility effects for Corridor 1-NS

Sl. no	Parameters	Weight-age	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
1	Max PPHPD of System	4%	3	3	2	2
2	RoW available after construction of each system	6%	4	3	2	3
3	Area occupied by stations	4%	3	4	5	5
4	Average operating speed	3%	5	3	4	3
5	Opportunity of Intermodal integration	6%	5	2	3	2
6	Travel Time for same OD pair	6%	5	3	2	1
7	Headway (min)	7%	5	4	1	1
8	Viability with respect to PPHPD	4%	2	2	2	4
Total		40%	**1.61**	**1.23**	**0.96**	**0.94**

Table 6-4: Scoring for Mobility effects for Corridor 2- EW

Sl. no	Parameters	Weight-age	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
1	Max PPHPD of System	4%	3	3	2	2

Sl. no	Parameters	Weight-age	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
2	RoW available after construction of each system	6%	4	3	2	3
3	Area occupied by stations	4%	3	4	5	5
4	Average operating speed	3%	5	3	4	3
5	Opportunity of Intermodal integration	6%	5	3	3	3
6	Travel Time for same OD pair	6%	5	3	1	1
7	Headway (min)	7%	5	4	1	1
8	Viability with respect to PPHPD	4%	1	1	1	3
Total		40%	**1.59**	**1.25**	**0.86**	**0.98**

Table 6-5: Scoring for Mobility effects for Corridor 3

Sl. no	Parameters	Weight-age	Light Metro/Elevated LRT	At-grade LRT	Elevated BRT	At Grade BRT
1	Max PPHPD of System	4%	3	3	2	2
2	RoW available after construction of each system	6%	4	3	2	3
3	Area occupied by stations	4%	3	4	5	5
4	Average operating speed	3%	5	3	4	3
5	Opportunity of Intermodal integration	6%	5	2	3	2
6	Travel Time for same OD pair	6%	4	3	2	1
7	Headway (min)	7%	5	4	1	1
8	Viability with respect to PPHPD	4%	2	2	2	3
Total		40%	**1.57**	**1.23**	**0.96**	**0.92**

6.2.2 CONCEPTUAL ENGINEERING EFFECTS

The conceptual engineering parameters under consideration are:

Parameters	Description
Utility Shifting Required	- The amount of utility shifting required.
Ease of construction	- How easily the construction activity be carried out, use of heavy equipment etc.
Time for Implementation	- Time in years required for the implementation of the project
Safety	- Safety in terms of proven technology, user and pedestrian safety and overall comfort in using the system
Comfort	- The comfort offered by the system in terms of accessing the system, riding and connectivity options
Design Characteristics	- The design specification of the system which determine the technology to be used and impact on the surrounding
Land Acquisition	- The land to be acquired to implement the system

The basis for the ranking for each of the mode is given in table below:

Sl No	Parameters	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Utility Shifting Required	Will require for viaduct and stations	Will be lower as no heavy foundation is required	Will require for viaduct and stations	Will be lower as no heavy foundation is required
2	Impact on Intermodal Connectivity/Easiness of Transfer	Rail based system, at different level	Rail based system, at ground level	Road based system, at different level	Road based system, at ground level
3	Time for Implementation (Years)	4-5	2-3	2-4	1-3
4	Safety and Comfort	Established in India -Comfortable	Established World wide - Comfortable, Pedestrian Crossing difficulty	Under Implementation in India	Established Technology in India Pedestrian Crossing difficulty

The scoring for conceptual engineering effects is given in Table 6-6, Table 6-7 and Table 6-8:

Table 6-6: Scoring for conceptual engineering effects for Corridor 1 - NS corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Utility Shifting Required	2%	1	1	3	5
2	Ease of construction	1%	3	5	3	5
3	Time for Implementation	1%	3	4	4	5
4	Safety	4%	5	3	5	3
5	Comfort	3%	5	5	3	3
	Design Characteristics					
6a	Span of Viaduct	2%	2	3	3	3
6b	Span at the stations	2%	1	4	3	3
7	LA for station	5%	5	2	5	2
Total		20%	**0.74**	**0.62**	**0.79**	**0.63**

Table 6-7: Scoring for conceptual engineering effects for Corridor 2 - EW corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Utility Shifting Required	2%	1	1	3	5
2	Ease of construction	1%	3	5	3	5

3	Time for Implementation	1%	3	4	4	5
4	Safety	4%	5	3	5	3
5	Comfort	3%	5	5	3	3
	Design Characteristics					
6a	Span of Viaduct	2%	2	3	3	3
6b	Span at the stations	2%	1	4	3	3
7	LA for station	5%	4	3	4	3
Total		20%	**0.69**	**0.67**	**0.74**	**0.68**

Table 6-8: Scoring for conceptual engineering effects for Corridor 3

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Utility Shifting Required	2%	1	1	3	5
2	Ease of construction	1%	3	5	3	5
3	Time for Implementation	1%	3	4	4	5
4	Safety	4%	5	3	5	3
5	Comfort	3%	5	3	5	3
	Design Characteristics					
6a	Span of Viaduct	2%	2	3	3	3
6b	Span at the stations	2%	1	4	3	3
7	LA for station	5%	4	5	4	5
Total		20%	**0.69**	**0.71**	**0.8**	**0.78**

6.2.3 ENVIRONMENTAL AND SOCIAL EFFECTS

The environmental and social effects under consideration are:

Parameters	Description
Level of Persons Affected	- Amount of social impact in terms of project affected parties and change in land use
Reduction in road accidents	- Reduction in accidents due to the introduction of the system
Environmental impact Construction Phase	- Magnitude of environmental impact during, preparatory phase, construction phase and operational phase

The basis of scoring will be:

Sl No	Parameters	Light Metro/ Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Level of Persons Affected	As per the land acquisition required			
2	Reduction in road accidents	The reduction of accidents due to the introduction of the system			
3	Environmental impact Construction Phase	As per the Table 5-31 which discusses the impact of various system on environment			

The scorings for environmental and social effects are given in Table 6-9, Table 6-10 and Table 6-11.

Table 6-9: Scoring for environmental and social effects for Corridor 1- NS corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Level of Persons Affected	5%	2	1	2	1
2	Reduction in road accidents	5%	5	5	4	4
3	Environmental impact Construction Phase	5%	1	2	1	2
	Total	15%	**0.4**	**0.4**	**0.35**	**0.35**

Table 6-10: Scoring for environmental and social effects for Corridor 2 –EW corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Level of Persons Affected	5%	2	1	2	1
2	Reduction in road accidents	5%	5	5	4	4
3	Environmental impact Construction Phase	5%	1	2	1	2
	Total	15%	**0.4**	**0.4**	**0.35**	**0.35**

Table 6-11: Scoring for environmental and social effects for Corridor 3

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Level of Persons Affected	5%	3	1	3	1
2	Reduction in road accidents	5%	5	5	4	4
3	Environmental impact Construction Phase	5%	1	2	1	2
	Total	15%	**0.45**	**0.4**	**0.40**	**0.35**

6.2.4 COSTING AND FINANCIAL ANALYSIS

The parameters under consideration are:

Parameters	Description
Project Cost Estimate	- Block Cost Estimate for the project
Rolling Stock Cost	- The cost and number of vehicles required
Operation and Maintenance	- The operation and maintenance cost of the system

The scoring will be based on:

Sl No		Parameters	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	**Quantitative**	Project Cost Estimate	Total Cost of Project without Land Acquisition			
2	**Quantitative**	Rolling stock Required	Total Amount to be invested in the procurement of the rolling stock required			
3	**Quantitative**	Operation and Maintenance Cost	Annual expenditure on operation and maintenance of each system evaluated			

Table 6-12: Scoring for Cost and Financial analysis for Corridor 1- NS Corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Project Cost Estimate	10%	2	3	4	5
2	Rolling stock Required	5%	5	4	2	2
3	Operation and Maintenance Cost	10%	3	3	5	5
		25%	**0.75**	**0.8**	**1**	**1.1**

Table 6-13: Scoring for Cost and Financial analysis for Corridor 2-EW Corridor

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Project Cost Estimate	10%	2	3	4	5
2	Rolling stock Required	5%	5	4	2	2
3	Operation and Maintenance Cost	10%	3	3	5	5
		25%	**0.75**	**0.8**	**1**	**1.1**

Table 6-14: Scoring for Cost and Financial analysis for Corridor 3

Sl No	Parameters	Weightage	Light Metro/Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Project Cost Estimate	10%	2	3	4	5
2	Rolling stock Required	5%	3	4	2	1

3	Operation and Maintenance Cost	10%	3	3	5	5
		25%	**0.65**	**0.8**	**1**	**1.05**

6.3 ALTERNATIVES EVALUATION

The summary of the scoring is as follows:

Corridor 1- North South Corridor:

SI No	Parameters	Weightage	Light Metro/ Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Scoring for Mobility Effects	40%	1.61	1.23	0.96	0.94
2	Scoring for Conceptual Engineering Effects	20%	0.74	0.62	0.79	0.63
3	Scoring for Environmental and Social Effects	15%	0.40	0.40	0.35	0.35
4	Scoring for Cost Financial Analysis	25%	0.75	0.80	1.00	1.10
	Total	100%	**3.50**	**3.05**	**3.10**	**3.02**

From the table, it is observed that Light metro/Elevated LRT has received the highest ranking as it is analyzed as suitable in mobility and engineering effects. The cost of the project for LRT is greater than BRTS system. BRTS would be difficult to implement in the city with the headway obtained in operational characteristics in early chapters and with the limited right of way availability.

Corridor 2-East West Corridor:

SI No	Parameters	Weightage	Light Metro/ Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Scoring for Mobility Effects	40%	1.59	1.25	0.86	0.98
2	Scoring for Conceptual Engineering Effects	20%	0.69	0.67	0.74	0.68
3	Scoring for Environmental and Social Effects	15%	0.40	0.40	0.35	0.35
4	Scoring for Cost Financial Analysis	25%	0.75	0.8	1	1.10
	Total	100%	**3.43**	**3.12**	**2.95**	**3.11**

From the table, it is observed that Light metro/Elevated LRT has received the highest ranking as it analyzed as suitable in mobility and engineering effects. The cost of the project is greater than BRTS system. BRTS would be difficult to implement in the city with the headway obtained in operational characteristics in early chapters and with the limited right of way availability.

Corridor 3: Connecting Dehradun- Rishikesh and Haridwar

Sl No	Parameters	Weightage	Light Metro/ Elevated LRT	At grade LRT	Elevated BRT	At grade BRT
1	Scoring for Mobility Effects	40%	1.57	1.23	0.96	0.92
2	Scoring for Conceptual Engineering Effects	20%	0.69	0.71	0.8	0.78
3	Scoring for Environmental and Social Effects	15%	0.45	0.40	0.40	0.35
4	Scoring for Cost Financial Analysis	25%	0.65	0.80	1.00	1.05
	Total		**3.36**	**3.14**	**3.16**	**3.10**

From the table, it is observed that Light metro/Elevated LRT has received the highest ranking as it analyzed as suitable in mobility and engineering effects. The cost of the project is greater than BRTS system. BRTS would be difficult to implement especially in these corridors with the limited right of way availability. As this corridor is approximately 70 km long, a bus based system would not provide a comfortable travel experience to the users.

CHAPTER 7

SCREENING OF THE ALTERNATIVES FOR CORRIDORS – SECOND ORDER TRANSIT CORRIDORS

7. SCREENING OF THE ALTERNATIVES FOR CORRIDORS – *SECOND ORDER TRANSIT CORRIDORS*

The screening will be 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 7-1. The parameters for Second Order Transit corridor has some parameters from the ones selected for the first order transit corridor while few are based on the suitability to the local conditions of the corridors.

Table 7-1: Screening Parameters for selection of corridor and transit system

Screening Level	Criteria
Screening for Corridor	Right of way
	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

7.1 SCREENING FOR ALTERNATIVE CORRIDORS

As mentioned in section 4.2.2 of Chapter 4, the proposed second order transit corridor in Dehradun and Rishikesh city cover the entire area and no other suitable Alternatives can be suggested. Same is the case of the corridor connecting Sitapur to Sarai in Haridwar city.

The sections below discuss the two corridors in Haridwar city for which the Alternatives have been worked out. These are Sitapur to SIDCUL and Sitapur to Har Ki Pauri.

7.1.1 EVALUATION PARAMETERS OF VARIOUS ALTERNATIVE CORRIDORS

a) Right of Way

The right of way available for the development of a transit option is one of the key characteristics that determine the system. The existing right of way widths for the Alternative corridors are given in Table 7-2 and Table 7-3.

Table 7-2: Existing RoW along the Alternatives of Sitapur to SIDCUL corridor

Alternatives	Existing RoW (m)	Remarks
Alternative A1: Sitapur to SIDCUL via Madhya Marg and SIDCUL		
SBI mandi samiti, Sitapur to Fruits chowk Bazar	10	
Fruits chowk Bazar to Shiv ice factory	5	Needs to be Widened
Shiv ice factory to PNB bank	12	
PNB bank to Madhya Marg Intersection	10	
Madhya Marg Intersection to CISF Colony Chowk	18	
CISF Colony Chowk to Sector 8A Chowk	36	
Sector 8A Chowk to IMC Warehouse	24	
IMC Warehouse to Shesha Travels, IIE	26	
Shesha Travels to Excel Pack Pvt Limited	12	
Excel Pack Pvt Limited to Kaane Packaging Private Ltd	12	
Kaane Packaging Private LTD to Intersection near Cello Plastic Products	36	
Intersection near Cello Pastic Products to Cico Technologies Ltd ,Haridwar	12	
Cico Technologies Ltd ,Haridwar to Pioneer Indsutries	12	
Pioneer Industries to Pallvika Nursery Sidcul Rd	10	
Pallvika Nursery Sidcul Rd to Samrat Prithvi Raj Chauhan Chauk	22	
Alternative A2: Sitapur to Bahardarabad via Telephone Exchange Road, Bahadarabad Road and SIDCUL		
SBI mandi samiti, Sitapur to Fruits chowk Bazar	10	
Fruits chowk Bazar to Shiv ice factory	5	Needs to be Widened
Shiv Ice Factory to Maa Jagdambaa Trading Company	9	
Maa Jagdambaa Trading Company to Kalasheel Ortho & Accidental Care Hospital	10	
Kalasheel Ortho & Accidental Care Hospital to CISF Colony Chowk	36	
Sector 8A Chowk to IMC Warehouse	24	
IMC Warehouse to Shesha Travels, IIE	26	
Shesha Travels to Excel Pack Pvt Limited	12	
Excel Pack Pvt Limited to Kaane Packaging Private Ltd	12	
Kaane Packaging Private LTD to Intersection near Cello Pastic Products	36	
Intersection near Cello Pastic Products to Cico Technologies Ltd ,Haridwar	12	
Cico Technologies Ltd ,Haridwar to Pioneer Indsutries	12	
Pioneer Industries to Pallvika Nursery Sidcul Rd	10	
Pallvika Nursery Sidcul Rd to Samrat Prithvi Raj Chauhan Chauk	22	
Alternative A3: Sitapur to SIDCUL area via Telephone Exchange road and Sidcul bypass		
SBI mandi samiti, Sitapur to Fruits chowk Bazar	10	

Alternatives	Existing RoW (m)	Remarks
Fruits chowk Bazar to Shiv ice factory	5	Needs to be Widened
Shiv Ice Factory to Maa Jagdambaa Trading Company	9	
Maa Jagdambaa Trading Company to Kalasheel Ortho & Accidental Care Hospital	10	
Kalasheel Ortho & Accidental Care Hospital to CISF Colony Chowk	36	
CISF Colony Chowk to Shri Venkateshwara Jewellers	14	
Shri Venkateshwara Jewellers to Hotel Flora	8	Needs to be Widened
Hotel Flora to Sherawali Temple Industrial Area, Haridwar	8	Needs to be Widened
Sherawali Temple Industrial Area, Haridwar to Pallvika Nursery Sidcul Rd	7	Needs to be Widened
Pallvika Nursery Sidcul Rd to Samrat Prithvi Raj Chauhan Chauk	22	
Alternative A4 : Sitapur to Bahardarabad via Madhya Marg and Sidcul bypass BHEL Township		
SBI mandi samiti, Sitapur to Fruits chowk Bazar	10	
Fruits chowk Bazar to Shiv ice factory	5	Needs to be Widened
Shiv ice factory to PNB bank	12	
PNB bank to Madhya Marg Intersection	10	
Madhya Marg Intersection to CISF Colony Chowk	18	
CISF Colony Chowk to Shri Venkateshwara Jewellers	14	
Shri Venkateshwara Jewellers to Hotel Flora	8	Needs to be Widened
Hotel Flora to Sherawali Temple Industrial Area, Haridwar	8	Needs to be Widened
Sherawali Temple Industrial Area, Haridwar to Pallvika Nursery Sidcul Rd	7	Needs to be Widened
Pallvika Nursery Sidcul Rd to Samrat Prithvi Raj Chauhan Chauk	22	

It is observed that apart from Alternative A1, the other Alternatives have very narrow ROW at certain sections which make them inadequate for operations of second order transit systems.

Table 7-3: Existing RoW along the Alternatives of Sitapur to Har Ki Pauri corridor

Alternatives	Existing RoW	Remarks
Alternative B1: Sitapur to Har ki Pauri via Railway station covering Haridwar Main road and Upper Bazar Road		
Sitapur to Kotwali Jwalapur	10	
Kotwali Jwalapur to Arya Nagar chowk	15	
Arya Nagar Chowk to Chandracharya Chowk	22	
Chandracharya Chowk to Railway Station	20	
Railway Station to Balmiki Chowk	18	
Balmiki Chowk to Post Office Haridwar	12	
Post Office Haridwar to Hotel Mayur	8	Needs to be Widened
Hotel Mayur to Shri Shankaracharya Satsang Bhawan	8	Needs to be Widened
Shri Shankaracharya Satsang Bhawan to Har Ki Pauri	8	Needs to be Widened
Alternative B2: Sitapur to Har ki Pauri via Railway station covering Haridwar Main road and Bypass road		
Sitapur to Kotwali Jwalapur	10	
Kotwali Jwalapur to Jwalapur Railway station	15	
Jwalapur Railway station to Balmiki Chowk	10	

Alternatives	Existing RoW	Remarks
Balmiki Chowk to Post Office Haridwar	12	
Post Office Haridwar to Hotel Mayur	8	Needs to be Widened
Hotel Mayur to Shri Shankaracharya Satsang Bhawan	8	Needs to be Widened
Shri Shankaracharya Satsang Bhawan to Har Ki Pauri	8	Needs to be Widened

Alternative B2 has very narrow RoW for any kind of transport system. As such B1 is the preferred corridor in terms of ROW.

b) Coverage

Coverage is estimated in terms of population and employment of the adjoining traffic analysis zones.

Total Population and employment catered by the Alternatives is presented in Table 7-4 and Table 7-5.

Table 7-4: Coverage of Alternatives of Sitapur to SIDCUL corridor

Alternatives	2018		2028		2038			2048
	Pop	Emp	Pop	Emp	Pop	Emp	Pop	Emp
Sitapur to SIDCUL via Madhya Marg and SIDCUL	264310	85945	307088	99585	345155	112257	435415	144606
Sitapur to Bahardarabad via Telephone Exchange Road, Bahadarabad Road and SIDCUL	266591	79572	311183	93733	350897	106889	443046	140461
Sitapur to SIDCUL area via Telephone Exchange road and Sidcul bypass	203389	676692	233370	77563	262541	87506	281968	93644
Sitapur to Bahardarabad via Madhya Marg and Sidcul bypass BHEL Township	216180	71410	249517	82276	280519	92753	420079	139512

It can be inferred from the table that Alternative A2 has the highest coverage in terms of Population and employment followed by AlternativeA3.

Table 7-5: Coverage of Alternatives of Sitapur to Har Ki Pauri corridor

Alternatives	2018		2028		2038		2048	
	Pop	Emp	Pop	Emp	Pop	Emp	Pop	Emp
Alternative B1: Sitapur to Har ki Pauri via Railway station covering Haridwar Main road and Upper Bazar Road	278661	893323	314343	100718	352169	112965	534224	177421
Alternative B2: Sitapur to Har ki Pauri via Railway	252432	81643	282951	91532	317158	102720	419350	139270

station covering Haridwar Main road and Moti Bazar road								

It can be inferred from the table that Alternative 2C has the highest t coverage in terms of Population and employment followed by Alternative 2B.

c) Details of Major Bridges/Retaining Structures along the corridor

The detail of the major bridges/retaining structures along the corridors for the Alternatives have been presented in the Table 7-6.

Table 7-6: Major Bridges/Retaining structures along the corridor for all Alternatives in Sitapur to SIDCUL corridor

Alternatives	Sl.no	Type	Location
Alternative A1: Sitapur to SIDCUL via Madhya Marg and SIDCUL	1	RIver	Jatwara Bridge
	2	River	Bridge at Madhya Marg, Near BHEL
	3	River	Bridge near Samrat Prithivi Raj Chowk over Canal
Alternative A2: Sitapur to Bahardarabad via Telephone Exchange Road, Bahadarabad Road and SIDCUL	1	RIver	Jatwara Bridge
	2	River	Bridge over tributary at New Shivalik Nagar
	3	River	Bridge near Samrat Prithivi Raj Chowk over Canal
Alternative A3: Sitapur to SIDCUL area via Telephone Exchange road and Sidcul bypass	1	RIver	Jatwara Bridge
	2	River	Bridge over tributary at New Shivalik Nagar
	3	River	Bridge near Samrat Prithivi Raj Chowk over Canal
Alternative A4: Sitapur to Bahardarabad via Madhya Marg and Sidcul bypass BHEL Township	1	RIver	Jatwara Bridge
	2	River	Bridge at Madhya Marg, Near BHEL
	3	River	Bridge near Samrat Prithivi Raj Chowk over Canal

It can be inferred from the table that all the corridors have three structures which include two railway crossings and one bridge on river.

There is one railway crossing in the alternatve B2 near Balmiki Chowk in the corridor connecting Sitapurto Har Ki Pauri.

The structures like flyovers, bridges and rail crossings are important parameter which determines the level of difficulty encountered during design or construction stage. Lesser the number of bridges and crossings, easier will be the design and construction of the system.

d) Effect on Intermodal Connectivity

Easy Intermodal connectivity enhances the transfer experiences of the users. Well planned pedestrian facilities in terms of comfortable walkways, access and entry designs along with fare and information integration shall be ensured at the interchange stations. The opportunity for multimodal integration with

regional or urban transit mode (proposed and existing) for each of the Alternative corridors is explained in Table 7-7 and Table 7-8 below:

Table 7-7: Interchange Options at Sitapur to SIDCUL corridor

Alternative	Sl .no	Interchange Point
Alternative A1: Sitapur to SIDCUL via Madhya Marg and SIDCUL	1.	Sitapur
	2.	Local Ipt Stop, SIDCUL
	3.	Junction at Pentagon Mall
	4.	Prithivi Raj Chowk
Alternative A2: Sitapur to Bahardarabad via Telephone Exchange Road, Bahadarabad Road and SIDCUL	1.	Sitapur
	2.	Local Ipt Stop, SIDCUL
	3.	Junction at Pentagon Mall
	4.	Prithivi Raj Chowk
Alternative A3: Sitapur to SIDCUL area via Telephone Exchange road and Sidcul bypass	1.	Sitapur
	2.	Prithivi Raj Chowk
Alternative A4: Sitapur to Bahardarabad via Madhya Marg and Sidcul bypass BHEL Township	1.	Sitapur
	2.	Prithivi Raj Chowk

Table 7-8: Interchange Options at Sitapur to Har Ki Pauri corridor

Alternative	Sl .no	Interchange Point
Alternative B1: Sitapur to Har ki Pauri via Railway station covering Haridwar Main road and Upper Bazar Road	1.	Haridwar Railway Station
	2.	Haridwar Bus Terminal
	3.	Har Ki Pauri
	4	Sitapur
Alternative B2: Sitapur to Har ki Pauri via Railway station covering Haridwar Main road and Moti Bazar road	1.	Haridwar Railway Station
	2.	Haridwar Bus Terminal
	3.	Har Ki Pauri
	4	Sitapur

INFERENCE FROM SCREENING FOR ALTERNATIVE CORRIDORS – SECOND ORDER TRANSIT CORRIDORS

Overall comparison of Alternative corridors is summarized in the table given below:

Corridor	Alternative	Length (km)	RoW (m) minimum	Population	Employment	No. of Bridges	No. of Interchanges
Sitapur to	Alt A1	18.2	10	466822	142176	3	4
	Alt A2	19.1	5	539912	171406	3	4

SIDCUL corridor	Alt A3	10.4	5	527194	165556	3	2
	Alt A4	9.5	7	358493	113792	3	2
Sitapur to Har Ki Pauri corridor	Alt B1	7.78	6	114330	34212	-	4
	Alt B2	8.6	8	114330	34212	1	2

The scoring for the parameters for each Alternative corridor has been given in the Table 7-9 and Table 7-10.

Table 7-9: Screening for Alternatives of Corridor connecting Sitapur to SIDCUL in Haridwar

S.No	Parameters	Weigh tage	Units		Corridors			
				Type	Alt A1	Alt A2	Alt A3	AltA4
1.a	Area Coverage : Population	15%	No	Quanti tative	4	5	5	3
1.b	Area Coverage : Employment	15%	No	Quanti tative	4	5	5	3
2	Right of way	30%	mtr	Quanti tative	5	2	2	3
3	Details of Major Bridges/Retaining Structures along the corridor	10%	no	Quanti tative	3	3	3	3
4	Effect on Intermodal connectivity	30%		Qualit ative	4	4	3	3
		100%			**4.2**	**3.6**	**3.3**	**3.0**

Table 7-10: Screening for Alternatives of Corridor connecting Sitapur to Har ki Pauri

S.No	Parameters	Weightage	Units	Type	Alt B1	Alt B2
1.a	Area Coverage : Population	15%	No	Quantitative	5	5
1.b	Area Coverage : Employment	15%	No	Quantitative	5	5
2	Right of way	30%	mtr	Quantitative	3	4
3	Details of Major Bridges/Retaining Structures along the corridor	10%	no	Quantitative	5	3
4	Effect on Intermodal connectivity	30%		Qualitative	5	3
		100%			**4.4**	**3.9**

For the two corridors, Alternative A1 and B1 have received the highest scoring due to the least constraints in right of way and higher locations of intermodal connectivity which will enhance seamless travel experience for the user. The coverage in terms of population and area in corridor connecting Sitapur to SIDCUL is only slightly lesser than other Alternatives being of lesser length but still all the major points of the city has been covered.

Thus the Alternative A1 and B1 are preferred for their respective corridors based on high ranking.

7.2 SCREENING FOR ALTERNATIVE TRANSIT SYSTEMS (MODES)

This section of the report explains the second level of screening that is performed for the selection of suitable transit system on the preferred corridor.

7.2.1 EVALUATION PARAMETERS OF ALTERNATIVE TRANSIT SYSTEMS

The evaluation parameters for the second level screening is based on

e. Mobility Effects
f. Engineering Effects
g. Social and Environmental
h. Costing and Financial

The screening of the Alternative transit system will be conducted for the five corridors, the proposed corridor in Dehradun and Rishikesh each and 3 corridors in Haridwar. These are:

i. Second order transit corridor in Dehradun City
ii. Rishikesh ISBT to Pashulok in Rishikesh City
iii. Sitapur to SIDCUL area via Madhya Marg and SIDCUL in Haridwar city
iv. Sitapur to Har ki Pauri via Haridwar Main road and Upper Bazar Road in Haridwar city
v. Sitapur to Sarai, Jwalapur in Haridwar city

7.2.1.1 MOBILITY EFFECTS

Mobility Effects like the effect on the city road network in Business as usual Scenario and sustainable urban transport scenario has already been discussed in chapter 5 section 5.4.1.1.

Comparison of Mobility Effects Parameters:

A comparison of the mobility parameters of each of the transit mode is given in Table 7-11.

Table 7-11: Comparison on mobility parameters of the transit systems

Parameter	City Bus	PRT	Cable Car
Max Capacity of system (PHPDT)	3000	7200	5000
ROW required for the system (m)	7	3	3
Area occupied by the system (m)	150	2500	2000
Average operating speed	20-30	30	15-20

Opportunity for Intermodal Integration

Sitapur to SIDCUL area via Madhya Marg and SIDCUL

Intermodal hubs can be developed at Sitapur, Junction at Pentagon Mall, Local IPT stop and Prithviraj chowk. Sitapur can be developed as a major multi modal hub with integration of proposed MRT, bus and IPT.

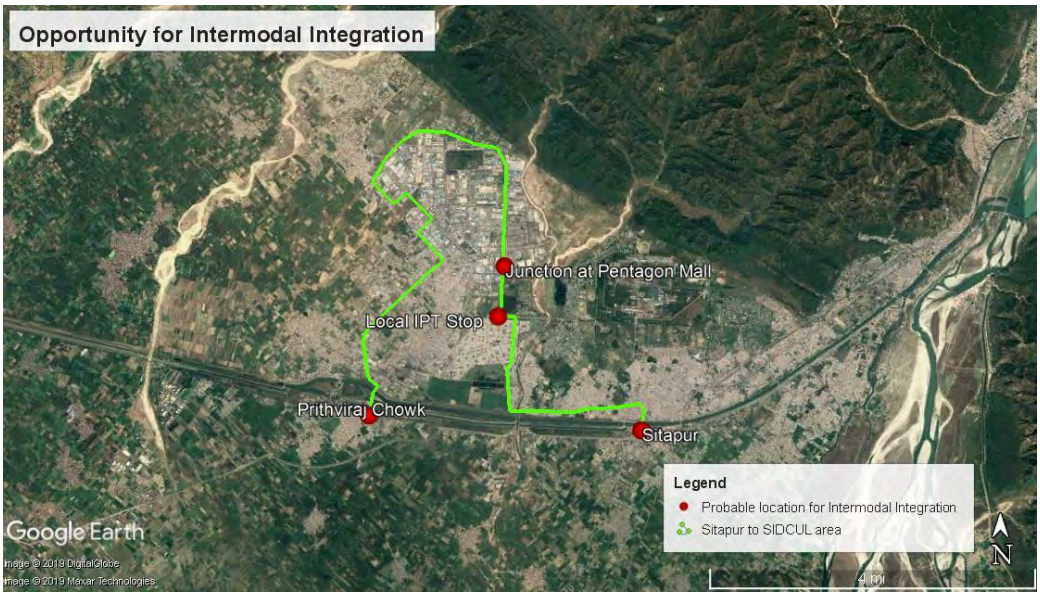


Figure 7-1: Possible locations for Intermodal hub – Sitapur to SIDCUL

Har Ki Pauri to Sitapur via Railway Station covering Haridwar Main road and Upper Bazar Road

Intermodal hub can be developed at Haridwar Railway Station, Sitapur. The Haridwar railway station can be developed as a major intermodal hub with integration of Indian railways, Bus, IPT, and proposed MRTS system.

Figure 7-2: Possible locations for Intermodal hub – Sitapur to Har ki Pauri via Haridwar Main road and Upper Bazar Road

Sitapur to Sarai:

Intermodal hub can be developed at Sitapur.

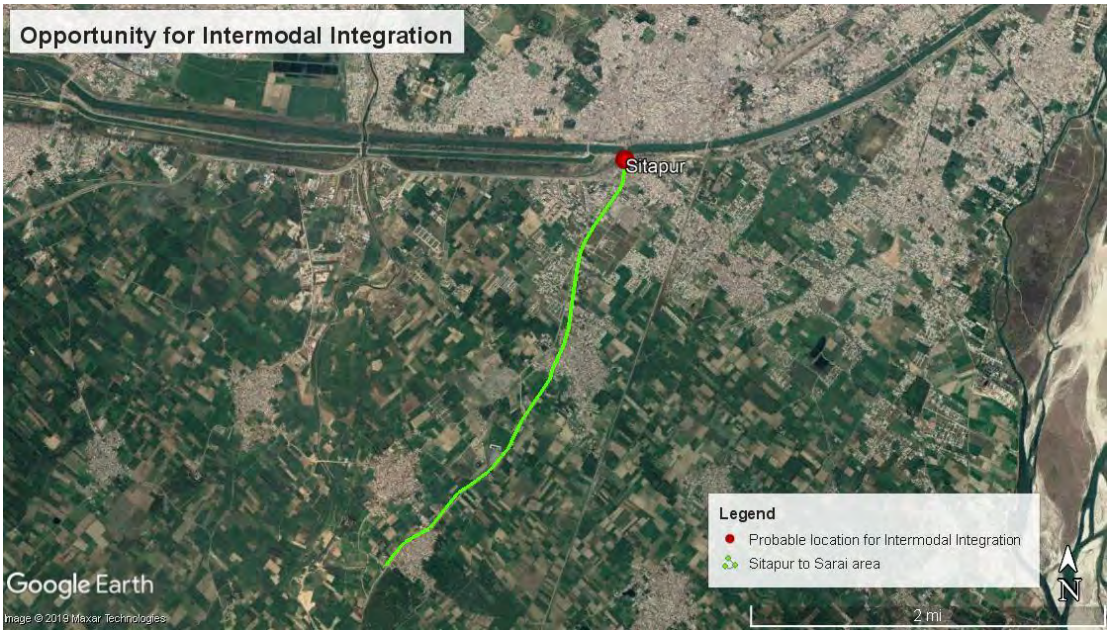


Figure 7-3:Possible locations for Intermodal hub –Sitapur to Sarai

7.2.1.2 CONCEPTUAL ENGINEERING EFFECTS

Design and Geometric Characteristics

The geometric characteristics refer to the ability of the technology to handle the geometric constraints, general system parameters and preliminary ridership requirements of this study corridor. Major design and geometric as well as technological characteristics of the transit systems are discussed in the following sections:

Cable Car Technology

The two main Cable car technology configurations include Top-Supported systems (vehicles/cabins supported from above) and Bottom-Supported systems (vehicles/cabins supported from below via tracks). The cable/rope is the heart of any CCT system. Cables are generally used as a haulage rope or a track rope (Aerial Tramways) or one rope may support both functions. Carriers are defined as the structural and mechanical assemblage in, or on which the passengers of a ropeway system are transported. Cable cars are the best option where there is a need to move people across a significant barrier, such as difficult terrain which is too steep for road or rail networks, existing transport infrastructure such as motorways and in areas of traffic congestion where there is limited space for on-ground transport. They require small physical and environmental footprint and have lower capital and operational costs in comparison to other modes of transit. They are also an iconic addition to a city's skyline. The major benefits include:

- Drastic reduction in emissions
- Average speed comparable to other mass transit modes

- Highly safe mode of transport
- Minimal footprints

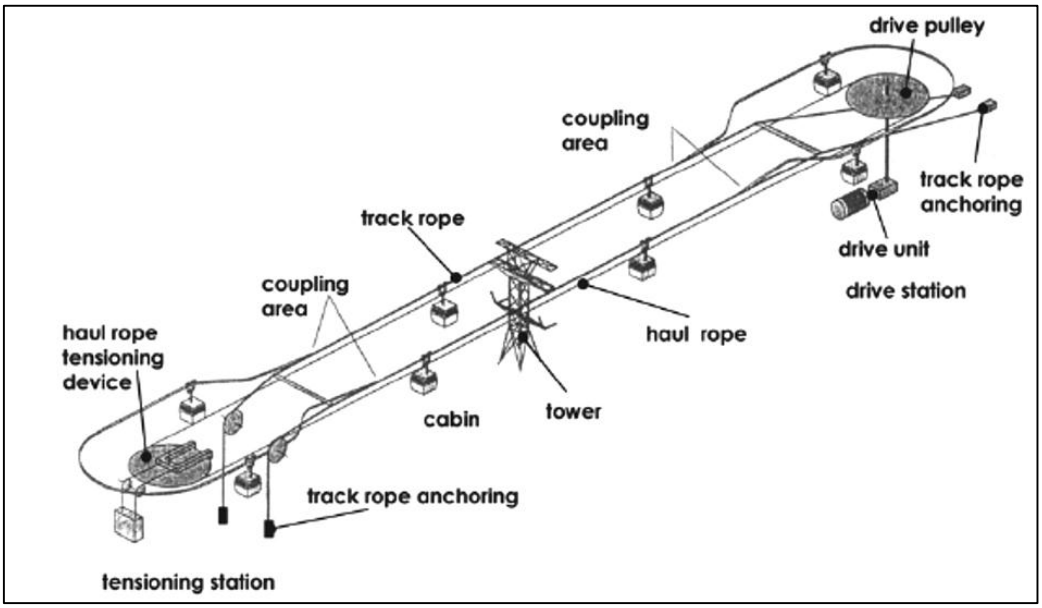


Figure 7-4: Cable Car Technology

Image Source: https://www.nbmcw.com/tech-articles/others-article/38607-aerial-rope-transit-cable-car-for-public-transport.html

Personal Rapid Transit (PRT)

PRT vehicles are sized for individual or small group travel, typically carrying no more than three to six passengers per vehicle. Guide ways are arranged in a network topology, with all stations located on sidings, and with frequent merge/diverge points. This allows for nonstop, point-to-point travel, bypassing all intermediate stations. Comfortable and robust, PRT pods are well-proven, reliable vehicles that are built from off-the shelf automotive industry components and use advanced technology to provide a unique transport solution.

A standard pod features:

- Single-side or double-side electric doors
- Seats facing front and rear to accommodate 4 adults
- Automatic charging points
- Two-way communications between passengers and control team
- Passenger information LCD screen
- Wireless communication system for 2-way data and command exchange between vehicle and central control

Vehicle weight influences the size and cost of a system's guide ways, which are in turn a major part of the capital cost of the system. Larger vehicles are more expensive to produce, require larger and more expensive guide ways, and use more energy to start and stop. Guide ways are an important infrastructure which requires extensive planning. Several types of guide ways have been proposed or implemented including beams similar to monorails, bridge-like trusses supporting internal tracks, and cables embedded in a roadway. Most designs put the vehicle on top of the track, which reduces visual intrusion and cost as

well as easing ground-level installation. An overhead track is necessarily higher, but may also be narrower.

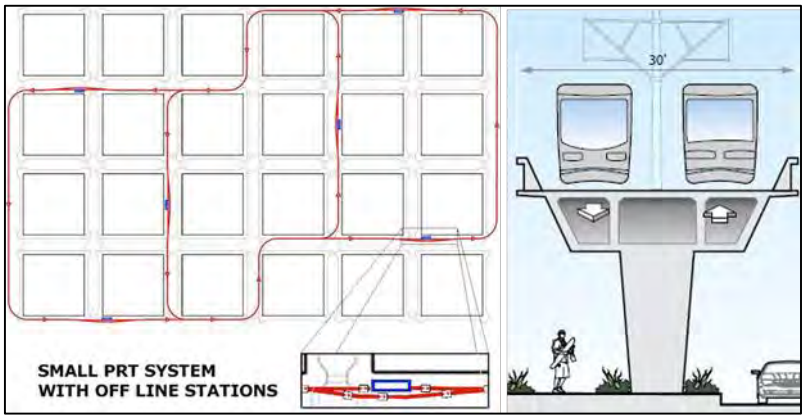


Figure 7-5: PRT System Design

Land Assessment

All Alternative corridors require a span of 6-7 m. The existing ROW of the roads is generally narrow up at cross road, road near railway station in Dehradun. The mass transit corridor has to be planned with a view to cause minimum disturbance to the existing property. Even then, at critical and unavoidable locations some land and properties are required.

Table 7-12: Land to be acquired for second order corridor

	City Bus	PRT	Cable Car
Second order transit corridor in Dehradun City	0	25000 sqm	27000 sqm
Rishikesh ISBT to Pashulok in Rishikesh City	0	10000 sqm	10800 sqm
Sitapur to SIDCUL area via Madhya Marg and SIDCUL	3600 sqm	5000 sqm	4000 sqm
Har Ki Pauri to Sitapur via Railway Station covering Haridwar Main road and Upper Bazar Road	3600 sqm	5000 sqm	4000 sqm
Sitapur to Sarai	0	10000 sqm	10800 sqm

Operational Characteristics

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

- Selecting the most optimum frequency of services to meet sectional capacity requirement during peak hours on most of the sections
- A short train consists of 3 coaches with high frequency service.

The operational characteristics of the system are:

Table 7-13: Operational Characteristics of the transit systems

	City Bus	PRT	Cable Car
Speed (km/hr)	25	30	18
Headway (min)	2.5	0.4	0.4
Carrying Capacity	1440	1440	1440

Existing Utilities

As discussed in the Chapter 5, the proposed alignments are passing along major roads of the city road network which are serving Institutional, Commercial and residential areas. Large numbers of sub-surface and over-head utility services like; Sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. are existing along the proposed alignment. The Table 7-14 below gives the possible utilities that would require shifting.

Table 7-14: Possible Utilities below and above the surface which require shifting

SN	Organization/Department	Utility Services
1	State Water Authority	Sewerage and drainage conduits. Water mains, their service lines, including hydrants and fountains etc., water treatment plants, pumping station etc.
2	State Electricity Board	Power cables and their appurtenances, pole mounted transformers, power cables of 33 & 11KVs.HT Lines, their pylons, sub-station, etc.
3	Phone Cables	Telecommunication cables, junction boxes, telephone posts, O.H. Lines etc.

The utilities need to be shifted irrespective of the type of the system proposed, as the existing road will be widened to incorporate any transit system and hence, the cost of utility shifting will remain same. However, the utility shifting required for any at-grade system will be comparatively lower compared to an elevated system.

7.2.1.3 SOCIAL AND ENVIRONMENTAL EFFECTS

The acquisition of land for the project shall displace people from their home, livelihood base, and business base. In order to keep minimum acquisition of private land and government properties, the project shall be planned in such a way that mostly it runs along the median of existing roads. However, for station entry/exist, traffic integration, maintenance depot and construction depots, some acquisition may be required. The proposed corridors will have maximum acquisition for PRT system as it requires the construction of guide ways and stations and lowest acquisition for city bus service as the buses are in mixed lane itself and the bus stops don't require much infrastructure, though the land has to be acquired for depots of buses. Cable cars have medium impact, as it requires major land requirement only at stations, elsewhere it requires just poles which does not require much land.

City bus services doesn't require much time for implementation it can be readily implemented once the fleets are procured. Being a flexible system; the operations can be changed according to the demand. Cable car system requires 2-3 years for implementation and PRT system the highest time of 3-4 years.

Table 7-15: Social and Environmental Impacts

Parameters	Impacts			
	Type	Bus	PRT	Cable Car
Level of Persons Affected	Qualitative	Very Low	High	Medium
Reduction in road accidents	Quantitative	High	High	High
Construction Phase	Qualitative	0-1 years	3-4 years	2-3 years

7.2.1.4 COST EFFECTS

The preliminary cost estimates for the Alternative modes based on the conceptual engineering design is discussed in this section. Detail items of work, estimates of quantities and costs shall be included at DPR Stage.

Cost Estimation for the Alternative modes for transit order within Dehradun city, Rishikesh ISBT to Pashulok in Rishikesh city, Sitapur to SIDCUL and Sarai and Sitapur to Har ki Pauri are discussed below:

Table 7-16: Cost Estimate for second order corridor in Dehradn City

Sl No		City Bus	PRT	Cable Car
1	Length (km)	168		
2	Speed (km/hr)	18	30	18
3	Headway (min)	2.5	0.4	0.4
4	PPHPD (2038)	1270		
5	Carrying Capacity	60	10	10
6	Total travel time	811	682	514
7	Rolling Stock Required	472	1685	2805
8	O&M per km	2	30	12

Table 7-17: Cost Estimate for Rishikesh ISBT to Pashulok Corridor

Sl No		City Bus	PRT	Cable Car
1	Length (km)	10.9		
2	Speed (km/hr)	18	30	18
3	Headway (min)	2.5	0.4	0.4
4	PPHPD (2038)	1270		
5	Carrying Capacity	60	10	10
6	Total travel time	57	38	38
7	Rolling Stock Required	45	114	87
8	O&M per km	2	30	12

Table 7-18: Cost Estimate for Sitapur to SIDCUL

Sl No		City Bus	PRT	Cable Car
1	Length (km)	18.2		
2	Speed (km/hr)	18	30	18
3	Headway (min)	2.5	0.4	0.4
4	PPHPD (2038)	1270		
5	Carrying Capacity	60	10	10
6	Total travel time	114	73	73
7	Rolling Stock Required	31	182	182
8	O&M per km	2	30	12

Table 7-19: Cost Estimate for Sitapur to Har Ki pauri

Sl No		City Bus	PRT	Cable Car
1	Length (km)	7.78		
2	Speed (km/hr)	18	30	18
3	Headway (min)	2.5	0.4	0.4
4	PPHPD (2038)	1270		
5	Carrying Capacity	60	10	10
6	Total travel time	42	28	28
7	Rolling Stock Required	14	63	63
8	O&M per km	2	30	12

CHAPTER 8

SCREENING AND EVALUATION BASED ON GRADING CRITERIA FOR TRANSIT SYSTEMS – SECOND ORDER TRANSIT CORRIDOR

8. SCREENING AND EVALUATION BASED ON GRADING CRITERIA FOR TRANSIT SYSTEMS – *SECOND ORDER TRANSIT CORRIDOR*

8.1 EVALUATION BASED ON SCORING CRITERIA

Weightage for ranking is decided based on the following goals:

a. The ability to meet the vision of CMP
b. Minimum environmental and community impacts
c. Cost Effectiveness of the option
d. Most effective intermodal connectivity option
e. Effective and feasible project phasing and constructability

The ranking will be done in a scale of 1 to 5, 1 being least suitable and 5 being most suitable.

8.2 SCREENING RESULTS

8.2.1 MOBILITY EFFECTS

The mobility parameters under consideration are given in Table 8-1.

Table 8-1: Mobility Parameters

Parameters	Description
Max Capacity of System	The maximum loading that the system will be able to cater to.
Ease of Construction	The easiness with which the system can be implemented based on the right of way required and available
Level of Congestion	The space cleared off the right of way once the system is implemented
Average operating speed	The average speed the system can operate at.
Opportunity of Intermodal integration	If the system is able to cater to higher traffic demands in future
Headway (min)	The time for waiting for a passenger
Influenced by Topography	Suitability of the system against the terrain

The basis for the ranking for each of the mode is given in

Table 8-2.

Table 8-2: Mobility Effects of the system

Sl No	Parameters	City Bus	PRT	Cable Car

1	Quantitative	Max Capacity of System	3000	7200	5000
2	Qualitative	Ease of Construction	Low	High	High
3	Quantitative	Level of Congestion	Based on V/C ratio : If V/C greater than 1.25 - 2, if V/C greater than 1 -3, if V/C less than 1 - 5)		
4	Qualitative	Average operating speed kmph	25	40	40
5	Qualitative	Opportunity of Intermodal integration	High	Low	Medium
6	Qualitative	Headway (min)	5	-	2
7	Qualitative	Influenced by Topography	High	Low	Very Low

The scoring for mobility effects is given in the Table 8-3, Table 8-4, Table 8-5 and Table 8-6.

Table 8-3: Scoring for Mobility effects for Dehradun city

Sl. no	Parameters	Weight-age	City Bus	PRT	Cable Car
1	Max Capacity of System	7%	5	5	5
2	Ease of Construction	7%	3	5	5
3	Level of Congestion	8%	3	5	5
4	Average operating speed	8%	3	5	4
5	Opportunity of Intermodal integration	6%	5	5	4
6	Headway (min)	6%	3	4	5
7	Influenced by Topography	8%	3	3	5
Total		50%	**1.72**	**2.28**	**2.32**

Table 8-4: Scoring for Mobility effects for Rishikesh city

Sl. no	Parameters	Weight-age	City Bus	PRT	Cable Car
1	Max Capacity of System	7%	5	5	5
2	Ease of Construction	7%	3	5	5
3	Level of Congestion	8%	5	3	3
4	Average operating speed	8%	3	5	4
5	Opportunity of Intermodal integration	6%	5	5	4
6	Headway (min)	6%	3	4	5
7	Influenced by Topography	8%	3	3	5

Total	50%	**1.88**	**2.12**	**2.16**

Table 8-5: Scoring for Mobility effects for Sitapur to SIDCUL and Sarai

Sl. no	Parameters	Weight-age	City Bus	PRT	Cable Car
1	Max Capacity of System	7%	5	5	5
2	Ease of Construction	7%	3	5	5
3	Level of Congestion	8%	5	2	2
4	Average operating speed	8%	3	5	4
5	Opportunity of Intermodal integration	6%	5	5	4
6	Headway (min)	6%	3	4	5
7	Influenced by Topography	8%	3	3	5
Total		50%	**1.88**	**2.04**	**2.08**

Table 8-6: Scoring for Mobility effects for Sitapur to Har ki Pauri

Sl. no	Parameters	Weight-age	City Bus	PRT	Cable Car
1	Max Capacity of System	7%	5	5	5
2	Ease of Construction	7%	3	5	5
3	Level of Congestion	8%	3	5	5
4	Average operating speed	8%	3	5	4
5	Opportunity of Intermodal integration	6%	5	5	4
6	Headway (min)	6%	3	4	5
7	Influenced by Topography	8%	3	3	5
Total		50%	**1.72**	**2.28**	**2.32**

8.2.2 CONCEPTUAL ENGINEERING EFFECTS

The conceptual engineering parameters under consideration are

Parameters	Description
Utility Shifting Required	- The amount of utility shifting required.
Ease of construction	- How easily the construction activity be carried out, use of heavy equipment etc.
Time for Implementation	- Time in years required for the implementation of the project
Safety	- Safety in terms of proven technology, user and pedestrian safety and overall comfort in using the system
Comfort	- The comfort offered by the system in terms of accessing the system, riding and connectivity options

Land Acquisition	- The land to be acquired to implement the system

The basis for the ranking for each of the mode is given in table below:

SI No	Parameters	City Bus	PRT	Cable Car
1	Utility Shifting Required	Low	High	High
2	Ease of construction	High	Medium	Medium
3	Time for Implementation	6 months	1-2 years	1-2 years
4	Safety	Medium	Medium	Medium
5	Comfort	Medium	Medium	Medium
6	Land Acquisition	0	25000	27000

The scoring is given in Table 8-7, Table 8-8,

Table 8-9 and Table 8-10.

Table 8-7: Scoring for conceptual engineering effects for Dehradun city

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Utility Shifting Required	5%	5	1	1
2	Ease of construction	4%	5	3	3
3	Time for Implementation	5%	5	4	4
4	Safety	5%	3	3	3
5	Comfort	4%	3	5	4
6	LA required (Stations and Pillar)	7%	5	3	1
Total		30%	**1.31**	**0.94**	**0.75**

In case of second order corridor in Dehradun, there is one particular corridor which starts from IMA to Railway station via Kaonli road which has constraint of right of way availability and the abutting land use is highly dense compared to other corridors.

Table 8-8: Scoring for conceptual engineering effects for Rishikesh city

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Utility Shifting Required	5%	5	1	1
2	Ease of construction	4%	5	3	3
3	Time for Implementation	5%	5	4	4
4	Safety	5%	3	3	3
5	Comfort	4%	3	5	4

6	LA required (Stations and Pillar)	7%	5	3	1
Total		30%	**1.31**	**0.94**	**0.75**

Table 8-9: Scoring for conceptual engineering effects for Sitapur to SIDCUL and Sarai

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Utility Shifting Required	5%	5	1	1
2	Ease of construction	4%	5	3	3
3	Time for Implementation	5%	5	4	4
4	Safety	5%	3	3	3
5	Comfort	4%	3	5	4
6	LA required (Stations and Pillar)	7%	5	3	1
Total		30%	**1.31**	**0.93**	**0.75**

Table 8-10: Scoring for conceptual engineering effects for Sitapur to Har ki Pauri

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Utility Shifting Required	5%	4	3	3
2	Ease of construction	4%	5	3	3
3	Time for Implementation	5%	5	4	4
4	Safety	5%	3	3	3
5	Comfort	4%	3	5	4
6	LA required (Stations and Pillar)	7%	4	3	2
Total		30%	**1.17**	**1.04**	**0.92**

8.2.3 ENVIRONMENT AND SOCIAL EFFECTS

The environmental and social effects under consideration are:

Parameters	Description
Level of Persons Affected	- Amount of social impact in terms of project affected parties and change in land use
Environmental impact Construction Phase	- Magnitude of environmental impact construction phase based on the years for implementation

The basis of scoring will be:

SI No	Parameters	City Bus	PRT	Cable Car

1	Level of Persons Affected	Very Low	High	Medium
2	Environmental impact Construction Phase	0-1 years	3-4 years	2-3 years

The scoring is for the alternatives for environmental and social effects is given in Table 8-11, Table 8-12, Table 8-13 and Table 8-14.

Table 8-11: Scoring for environmental and social effects for Dehradun city

Sl No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Level of Persons Affected	5%	5	2	3
2	Environmental impact Construction Phase	5%	3	4	4
	Total	10%	0.4	0.3	0.35

Table 8-12: Scoring for environmental and social effects for Rishikesh city

Sl No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Level of Persons Affected	5%	5	2	3
2	Environmental impact Construction Phase	5%	3	4	4
	Total	10%	0.4	0.3	0.35

Table 8-13: Scoring for environmental and social effects for Sitapur to SIDCUL and Sarai

Sl No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Level of Persons Affected	5%	5	2	3
2	Environmental impact Construction Phase	5%	3	4	4
	Total	10%	0.4	0.3	0.35

Table 8-14: Scoring for environmental and social effects for Sitapur to Har ki Pauri

Sl No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Level of Persons Affected	5%	5	2	3
2	Environmental impact Construction Phase	5%	3	4	4
	Total	10%	0.4	0.3	0.35

8.2.4 COSTING AND FINANCIAL ANALYSIS

The parameters under consideration are:

Parameters	Description
Project Cost Estimate	- Block Cost Estimate for the project
Operation and Maintenance	- Operation and maintenance cost of the system

The scoring will be based on:

SI No	Parameters		City Bus	PRT	Cable Car
1	Quantitative	Project Cost Estimate	Based on estimated cost for each transit system on a corridor		
3	Quantitative	Operation and Maintenance Cost	Based on estimated cost for operation and maintenance of the system		

Table 8-15: Scoring for Cost and Financial analysis for Within Dehradun City

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Project Cost Estimate	5%	5	3	2
2	Operation and Maintenance Cost	5%	5	4	3.5
10%			0.5	0.35	0.28

Table 8-16: Scoring for Cost and Financial analysis for Rishikesh

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Project Cost Estimate	5%	5	3	1
2	Operation and Maintenance Cost	5%	5	4	3.5
10%			0.5	0.4	0.23

Table 8-17: Scoring for Cost and Financial analysis for Sitapur to SIDCUL and Sarai

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Project Cost Estimate	5%	5	3	1
2	Operation and Maintenance Cost	5%	5	4	3.5
10%			0.5	0.4	0.23

Table 8-18: Scoring for Cost and Financial analysis for Sitapur to Har ki Pauri

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Project Cost Estimate	5%	5	3	2
2	Operation and Maintenance Cost	5%	5	4	4

10%	0.5	0.4	0.3

8.3 ALTERNATIVES EVALUATION

The summary of the scoring is as follows:

Dehradun City Corridor:

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Scoring for Mobility Effects	50%	1.72	2.28	2.32
2	Scoring for Conceptual Engineering Effects	30%	1.31	0.94	0.75
3	Scoring for Environmental and Social Effects	10%	0.4	0.3	0.35
4	Scoring for Cost Financial Analysis	10%	0.5	0.35	0.275
	Total	**100%**	3.93	3.87	3.70

It can be inferred from the table that city bus service received highest grading due to its easy implementation and higher suitability in engineering effects and financial analysis.

For medium density corridors, it is proposed to provide city bus service and for low density corridors, it proposed to provide either city bus service with mini buses/dedicated IPT system as these have low demand but require an organized transit system.

As mentioned earlier, the corridor which starts from IMA to Railway station via Kaonli road has a constraint of right of way availability and the abutting land use is highly dense compared to other corridors. Providing a city bus service in this route would not make any significant improvement in the traffic flow condition of this section as the road space would still be occupied. Also, it is a medium density corridor; hence IPT system would not be able to sustain the demand. This warrants a need for a low capacity grade separated system.

A preliminary analysis for the viability of either cable car or PRT system is made and based on the preliminary assessment, PRT system seems to be a more suitable option for the corridor. Since PRT columns footprint is lesser, it would be more feasible considering the limited right of way available on the existing road. Also, the cable car would not be a competent mode in the considered corridor with relatively plain features. The assessment of the same is shown in Table 8-19.

Table 8-19: Parameters for IMA to Railway station corridor

IMA to Railway Station via Kaonli road		
Engineering Effects	**PRT**	**Cable Car**
Utility Shifting Required	Medium	High

Ease of construction	Medium	Medium
Time for Implementation	1-2 years	1-2 years
Safety	High	Medium
Comfort	High	Medium

Therefore, it is recommended that a separate detailed feasibility study may be carried out for assessing the viability of PRT System for the suggested corridor.

Rishikesh City Corridor:

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Scoring for Mobility Effects	50%	1.88	2.12	2.16
2	Scoring for Conceptual Engineering Effects	30%	1.31	0.94	0.75
3	Scoring for Environmental and Social Effects	10%	0.4	0.3	0.35
4	Scoring for Cost Financial Analysis	10%	0.5	0.35	0.23
	Total	**100%**	4.09	3.71	3.49

It can be inferred from the table that city bus service received highest grading due to its easy implementation and higher suitability in mobility effects. This is followed by cable car system

Haridwar City Corridors

Sitapur to SIDCUL and Sarai

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Scoring for Mobility Effects	50%	1.88	2.04	2.08
2	Scoring for Conceptual Engineering Effects	30%	1.31	0.94	0.75
3	Scoring for Environmental and Social Effects	10%	0.4	0.3	0.35
4	Scoring for Cost Financial Analysis	10%	0.5	0.35	0.23
	Total	**100%**	4.09	3.63	3.41

It can be inferred from the table that city bus service received highest grading due to its easy implementation and higher suitability in engineering effects.

Sitapur to Har ki Pauri

SI No	Parameters	Weightage	City Bus	PRT	Cable Car
1	Scoring for Mobility Effects	50%	1.72	2.28	2.32

2	Scoring for Conceptual Engineering Effects	30%	1.17	1.04	0.92
3	Scoring for Environmental and Social Effects	10%	0.4	0.3	0.35
4	Scoring for Cost Financial Analysis	10%	0.5	0.35	0.3
	Total	**100%**	3.79	3.97	3.89

It can be inferred from the table that PRT system received the highest grading due to its suitability in mobility effects.

CHAPTER 9

CONCLUSIONS

9. CONCLUSIONS

9.1 CORRIDOR ANALYSIS

First Order Transit Corridor:

For the First Order Transit Corridor, Alternative 1A, 2A and 3A have been found preferable for Corridor 1- North South Corridor, Corridor 2- East-West Corridor of Dehradun city and Corridor 3- connecting Dehradun-Haridwar, Rishikesh respectively. These corridors were preferred as it has least ROW constraints with high potential for intermodal connectivity. Population and employment covered are approximately the same as compared to other options considered.

Second Order Transit Corridor:

For second order transit corridors in Haridwar city which required Alternative corridor assessment, Alternative A1, B1 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.

9.2 TRANSIT SYSTEM ANALYSIS

First Order Transit Corridor

Light Metro system received the highest ranking among the transit system followed by at grade BRTS and elevated BRTS. BRTS would be difficult to implement with 40 seconds headway. Light metro system is found suitable for First order transit corridors as it has been found suitable in all aspects of mobility effects, engineering concepts, with medium level impact on environmental and project cost.

Second Order Transit Corridor

The most suitable transit systems for second order are given below:

- **Dehradun City**: City Bus received the highest ranking due to the ease of implementation as the corridors cover the entire region of Dehradun. However based on the corridors:
  - For medium density corridors, it is proposed to provide city bus service and for low density corridors, it is proposed to provide either city bus service with mini buses/dedicated IPT system as these have low demand but require an organized transit system.
  - The corridor connecting IMA and Dehradun Railway Station through Shree Enclave – Pandit Warj - Kaonli Road - Balliwala chowk - Saharanpur Chowk is proposed to have a grade separated system, PRT system, which can be easily implemented in limited right of way
- **Rishikesh City**: City Bus Services received highest ranking for ease of construction which will also have least environmental impact
- **Sitapur station to SIDCUL and Sarai:** City Bus service received the highest ranking due to easy implementation and least environmental impact.
- **Sitapur to Har ki Pauri via railway station**: PRT system received highest ranking due to suitability in mobility effects.

9.3 FINAL RECOMMEDATIONS FOR THE TRANSIT CORRIDORS

Thus, the following systems are proposed for the corridors based on the alternative analysis conducted as given in Table 9-1.

Table 9-1: Systems proposed for the Alternative Corridor

Proposed Corridors	Suitable Alignment	Transit System Order		Proposed Transit System
North South Corridor in Dehradun city	Alternative 1A : Pacific Mall (Mussoorie Road) to ISBT via Mussorie road, Rajpur Road and Saharanpur Road	First		Light Metro/ Elevated LRT
East West Corridor in Dehradun City	Alternative 2A : Rispana Pul/Vidhan Sabha to FRI via EC road and Chakrata road	First		Light Metro/ Elevated LRT
Corridor connecting Dehradun Rishikesh and Haridwar	Alternative 3A : Rispana at Dehradun to Uttarakhand Sanskrit Academy at Haridwar via NH 72	First		Light Metro/ Elevated LRT
Dehradun (Within City)	Pan City	Second order	Medium	City Bus Service
			Low	City Bus Service/ Dedicated IPT
			IMA to Dehradun Railway Station	PRT system
Rishikesh (Within City)	Pashulok to Rishikesh ISBT via Bypass Road	Second		City Bus Service
Haridwar – SIDCUL and Sarai	Haridwar : Sitapur to SIDCUL Haridwar: Sitapur to Sarai	Second		City Bus Service
Haridwar- Har Ki Pauri	Haridwar: Sitapur to Har ki Pauri	Second		PRT System

CHAPTER 10

IMPLEMENTATION OPTIONS FOR SUITABLE ALTERNATIVES

10. IMPLEMENTATION OPTIONS FOR SUITABLE ALTERNATIVES

The financing and implementing options depend on the selection of the dedicated agency created to implement the project. UKMRCL, a venture of Government of Uttarakhand is a Special Purpose Vehicle entrusted with the responsibility of implementation of Uttarakhand Metro Rail Project.

10.1 IMPLEMENTATION OPTIONS FOR FIRST ORDER TRANSIT SYSTEM

Four implementation options that can be considered for the implementation of two Metro Rail corridor in Dehradun city and corridor connecting Dehradun Rishikesh and Haridwar are discussed below:

- Option 1: Public Sector Model: The system will be developed by UKMRCL with grant from Government of Uttarakhand and Government of India up to 40% and Loan from Multi-lateral funding agencies
- Option 2: Implementation with limited Private Participation in AFCS and Allied Activities
- Option 3: Implementation with Private Participation in implementation and O&M except Civil
- Option 4: Design Build Finance Operate and Transfer (DBFOT) Model

Table 10-1: Implementation Options for the preferred Alternative

	Implementation Options				O&M	Revenue	
	Civil	AFCS	Electrical & Rolling Stock	Allied Activities (NMT& Feeder)		UKMRCL	Private
Option 1	UKMRCL	UKMRCL	UKMRCL	UKMRCL	UKMRCL	- Fare Box - Land Value Capture - Non Fare Box	
Option 2	UKMRCL	PPP	UKMRCL	PPP	UKMRCL	- Fare Box - Land Value Capture - Non Fare Box	Premium/VGF
Option 3	UKMRCL	PPP	PPP	PPP	PPP	- Land Value Capture - Non Fare Box	Fare Box Revenue & VGF
Option 4	PPP	PPP	PPP	PPP	PPP	- Land Value Capture - Non Fare Box	Fare Box Revenue & VGF

10.2 PROS AND CONS OF EACH OPTION

10.2.1 OPTION 1: PUBLIC SECTOR MODEL

In this option, UKMRCL is responsible for undertaking construction, operations and maintenance of the system. All construction works including civil construction works, other functions of system including

procurement of rolling stocks, signaling & telecommunication, fare collection system and operations and maintenance to be done by UKMRCL

Advantages:

- Already UKMRCL has been established with expertise in this sector, and hence there will be ease of implementation and procurement
- Savings in the establishment of a new agency
- Availability of low cost funds, through multi-lateral funding agencies
- Government guarantee for operational losses

Disadvantages:

- Constraints on Government funds

Most of the Metro Projects so far in India are implemented through government funding model as public transportation projects are large scale requiring huge capital investments. It is basically a service with more economic benefits to the city than financial benefits to the developer/operator.

The financial models options by public sector practiced in India include –

1) **Formation of a Special Purpose Vehicle (SPV) by the Joint Venture of Central and state Government** – Under this model, a special purpose vehicle is establishes with 50:50 share of both Centre and State government. Both the government contributes to 20% of equity, while the remaining 60% is through soft loans. Bilateral/Multilateral funding agencies such as AFD, KFW, ADB, WB, JICA fund soft loans up to 60% of the project cost. The repayment of the loan is the burden of the State government/SPV for repayment. Delhi metro, Ahmedabad metro, Kochi metro, Bangalore metro are some of the examples which were funded by this model.
2) **Formation of Special Purpose Vehicle (SPV) under state Government** – Under this model, a special purpose vehicle is established by the state government alone and the equity is contributed by the state, while the remaining is through soft loans. Jaipur Metro (10km) is implemented on this model.

As mentioned earlier, public transportation is huge capital investment project and is primarily aimed at providing service to the city. It cannot be denied that mobility is an important factor responsible for the development of economy. The concept of transit oriented development is catching up in India, which envisions development of compact, livable cities with vibrant economy supported by high order transit lines. The increasing land values and potential for real estate development attracts the investment from private sectors for this kind of projects.

Metro projects in India like Hyderabad Metro, Mumbai Metro, Delhi Airport Express link and Gurgaon Rapid Metro are implemented with the involvement of the private sector. The various financial models involving private sector are explained in below options.

10.2.2 OPTION 2: IMPLEMENTATION WITH LIMITED PRIVATE PARTICIPATION IN AFCS& ALLIED ACTIVITIES

This option is a variation of Option 1, in which AFCS and Allied activities like development of Non-Motorized Transport and Feeder Services to ensure Multi-modal integration will be performed by private operator. All other infrastructure will be developed by UKMRCL. The private operator would either pay upfront premium or ask for a VGF for AFCS and allied activities depending on the financial viability of the project.

Advantages:

- Already UKMRCL has been established with expertise in this sector, and hence there will be ease of implementation and procurement
- Savings in the establishment of a new agency
- Availability of low cost funds, through multi-lateral funding agencies
- Government guarantee for operational losses
- Increased coverage of metro, because of the efficiency of the private operator to increase his income

Disadvantages:

- Multiple agencies handling transport systems, hence suitable mechanisms have to be developed to ensure Multi modal Integration
- Constraints on Government Funds as the cost of allied activities will be small compared to overall project cost

10.2.3 OPTION 3: IMPLEMENTATION WITH PRIVATE PARTICIPATION IN ACTIVITIES EXCEPT CIVIL

In this option, the entire project would be executed and managed through two or more entities. The PPP partner shall provide the rolling stock, can develop the electrical and other equipment required for the operations of the system. In this option also, AFCS and Allied Infrastructure can be through same or different PPP Partner. However, O&M PPP partner shall be ensured viability gap funding to reduce his revenue risk. With the financing risk being reduced, the project would attract more number of investors. This could also reduce the borrowings from Multi-Lateral agencies by UKMRCL

Advantages:

- Better risk sharing- Capital intensive, civil works and administrative issues handled by Government
- Private Sector Efficiency in operations
- Better Integration and responsibility during operations
- Availability of low cost funds, through multi-lateral funding agencies
- Government guarantee for operational losses

Disadvantages:

- Requires better coordination between stakeholders
- Risk Management and Sharing between Government and PPP Partner will require critical assessment

10.2.4 OPTION 4: DESIGN BUILD FINANCE OPERATE AND TRANSFER (DBFOT) MODEL

DBFOT is the most common form of PPP Model. In this option, a single private partner will be responsible for the implementation and operation of the project. Hence, the private partner will undertake detailed engineering works, planning and construction, development of allied activities, raise finances, operate, maintain, manage, collect revenue, additional investments for capacity augmentation and replacement. This could bring innovation in construction, design and operations to happen.

However, the project need to be supported by the Government through a capital or viability gap funding to ensure that project will meet the overall aim of connecting people. In this option, all the revenue will be collected by the private operator; however, suitable model could be worked out for Land Value Capturing options

Advantages:

- Involvement of private partner during all stages of project, hence better efficiency
- Reduced risk of construction cost and operation losses

Disadvantages:

- Market may not have sufficient ability to deliver the project
- Issues with administration and land acquisition
- Funding issues due to inherent project characteristics

Some of the examples of the PPP model for MRTS projects in India are:

Hyderabad Metro Rail Project – under VGF Model

The Hyderabad Metro opted for PPP model, where L&T was selected as the concessionaire. The total project cost quoted was Rs 14580 Cr for 72 km MRT corridor. The project received the support of 10% of the project cost (1458 Cr), from the Central government as VGF. The state government extended its support was through land 269 acres for real estate development.

Some of the issues for this project are:

- The entire burden (90%) of project cost except VGF (10%) is on the concessionaire - L&T and shareholding taken by the GoI/State govt.

Mumbai Metro Rail Project – under VGF model

The project cost for Mumbai Metro Rail for a corridor length of 11 km was estimated as Rs 2356 Cr. The bidding was held in 2007, with the project being awarded to Reliance Infra. The financial support given to

the project was 20% of the project cost (Rs 470 Cr) by central government and 7.5% (Rs 180 Cr) of the project cost by the state government as VGF. The ridership projected was about 3.5 lakhs/day for 11 kms and it is found to be operating satisfactorily. The additional support was rendered by the MMRDA which contributed 26% equity in the project and developer 74%.

For having maximum benefits, the Project should be implemented in one phase but considering the financial investment to be made by the state government, the project may be phased for implementation.

10.3 IMPLEMENTATION OPTIONS FOR SECOND ORDER TRANSIT CORRIDOR

10.3.1 CITY BUS SERVICE

The various implementation options for the provision of the city bus service are given in the table below:

Option	Implementation Options				O&M	Revenue	
	Civil	AFCS	Electrical & Rolling Stock	Allied Activities (NMT& Feeder)		UKMRCL	Private
Option 1	UKMRCL	UKMRCL	UKMRCL	UKMRCL	UPSRTC	- Fare Box - Land Value Capture - Non Fare Box	
Option 2	UKMRCL	PPP	UKMRCL	UKMRCL	PPP (Net Cost & Gross Cost)	- Fare Box - Land Value Capture - Non Fare Box	Premium/VGF
Option 3	UKMRCL	PPP	PPP	UKMRCL	PPP (Net Cost & Gross Cost)	- Land Value Capture - Non Fare Box	Fare Box Revenue & VGF
Option 4	PPP	PPP	PPP	PPP	PPP (Net Cost & Gross Cost)	- Land Value Capture - Non Fare Box	Fare Box Revenue & VGF

10.3.2 PERSONAL RAPID TRANSIT SYSTEM (PRT)

The various implementation options for the provision of the PRT system are given in the table below:

Options	Implementation Options				O&M	Revenue	
	Civil	AFCS	Electrical & Rolling Stock	Allied Activities (NMT& Feeder)		UKMRCL	Private
Option 1	UKMRCL	UKMRCL	UKMRCL	UKMRCL	PPP		- Fare Box - Land Value Capture - Non Fare Box

Option 2	UKMRCL	PPP	PPP	UKMRCL	PPP	- Fare Box - Land Value Capture - Non Fare Box	Premium/VGF
Option 3	PPP	PPP	PPP	PPP	PPP	- Land Value Capture - Non Fare Box	Fare Box Revenue & VGF
	(Based on Swiss Challenge Method)						

Personal Rapid Transit System cannot be implemented under Metro Act/Tramway Act; hence there is a need for framing a separate State Act for enabling Automatic People Movers System (APM)/PRT for implementation as public transport mode.

Modes of Private Participation for City Bus Service:

Few of the common Terms used in discussing the main PPP contract models for running city bus service are

- Management contract
- Gross-cost contract
- Net-cost contract, more commonly known as a lease
- Net-cost contract with investment (NCCI), more commonly known as the concession, build-operate transfer (BOT) form or finance-design-build-operate maintain (FDBOM)

Management Contract: The public authority retains ownership and control of all depots and vehicles, retains all revenues, and pays for all capital and recurrent expenditures. The public authority may also be the employer of most or all of the staff members engaged in providing the services. Contractor involvement is confined to the professional management of operations on behalf of the public authority. Normally, these services are provided for a fixed, negotiated period and for an agreed price. The contract term is established to allow sufficient time to achieve the desired operational effectiveness, and it is typically of short duration.

Gross-Cost Contract: The public authority relinquishes control of the vehicles and rolling stock and possibly also control of the depots and other infrastructure (although it may retain ownership or transfer ownership to a separate body). It requires the contractor to operate—and perhaps also to provide—the required rolling stock to specified quality-of-service standards for an agreed price. Under gross-cost contracts, all revenues (from fares and other sources) are transferred to the public authority, and the risks absorbed by the contractor are confined to those associated with the cost of operations.

Net-Cost Contract (Lease): The public authority relinquishes control of the vehicles and rolling stock and possibly also the depots and other infrastructure (although it may retain ownership or transfer ownership to a separate body). It requires the contractor to operate—and perhaps also to provide—the required fleet of vehicles and rolling stock to specified quality-of-service standards for an agreed subsidy or premium. The contractor is normally entitled to all revenue (from fares and other sources) and could bear a number of additional risks. Those risks typically concern disturbances to traffic, fluctuations in revenue, and changes to the regulatory regimes. Negotiated risk-sharing clauses in the contract may, however, limit the contractor r's exposure to those risks. If required, these contracts allow for lease payments to

the grantor for use of facilities or services. These contracts are typically longer term—usually 10 to 14 years.

Net-Cost Contract with Investment (Concession or BOT variants): The Net-Cost Contract with Investment (NCCI) may also commonly be known as a Concession type contract or a form of build-operate-transfer contract with many of its variants such as design-build-operate (DBO) amongst others. In these contracts the public authority contracts with an outside organization (contractor) to provide services to specified quality of-service standards. The developer must, consequently, provide the required inventory of fixed and movable assets from its internal resources or through external financing. The contractor will also retain all revenues and will absorb either all or a contractually agreed portion of traffic and revenue risks, as well as the risks associated with construction. Risk sharing may also extend into the areas of regulatory risk.

(Source: Private Sector Participation in Light Rail-Light Metro Transit Initiatives, PPIAF, World Bank)

10.4 MOST SUITABLE OPTION FOR IMPLEMENTATION

The most suitable option for implementation would be decided based on the financial analysis along with detailed project report as it involves detailed estimations of revenue from fare box, station development, advertisement, land value capture financing and O&M Cost. Also, detailed discussions would be required with the various stakeholders to discuss on the pros and cons of each implementation option.

CHAPTER 11

WAY FORWARD

11. WAY FORWARD

With the approval of the Comprehensive Mobility Plan and Alternative Analysis Study, as a follow up action as per the Metro Rail Policy 2017, UKMRCL would require to prepare the following documents:

- Detailed Project Report for the suitable Public Transit System on the identified corridors as given in Table 9-1 after approval of the State Government
- Detailed Techno Economic feasibility study for PRT system for following routes –
    i. Corridor connecting IMA and Dehradun Railway Station through Shree Enclave – Pandit Warj - Kaonli Road - Balliwala chowk - Saharanpur Chowk in Dehradun
    ii. Corridor connecting Sitapur to Har ki Pauri via Haridwar Railway station in Haridwar
- Detailed Multi Modal Integration Plan for each of the Public Transit System with emphasis on First and Last mile connectivity
- Transit Oriented Development (TOD) Plan including Land Value Capture Study for each of the Public Transit System
- City Bus Route Rationalization study need to be done for Dehradun city identifying the detailed routes, fleet size, operational plan, infrastructure required etc.

APPENDIX 1

Copy of Letter issued by UKMRCL inviting the Stakeholders for the Stakeholder's Consultation and Minutes of the Meetings:

उत्तराखण्ड मेट्रो रेल, शहरी अवस्थापना एवं भवन निर्माण निगम लिमिटेड 19

(उत्तराखण्ड सरकार का उपक्रम)

(CIN: 45309UR 2017 SGC007687) (GSTIN: 05AACCU1650R1Z1)

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

पत्रांकः- 476 /उ0मे0–82/2017–18 दिनांकः 10 .01.2019

सेवा में,

1. प्रोग्राम डायरेक्टर, उत्तराखण्ड आपदा रिकवरी पहल/आपदा निवारण और प्रबंधन केन्द्र, उत्तराखण्ड सचिवालय, देहरादून।
2. मुख्य कार्यकारी अधिकारी, उत्तराखण्ड पर्यटन विकास परिषद्, पं0 दीन दयाल उपाध्याय पर्यटन भवन, ओ0एन0जी0सी0 हैलीपैड, गढ़ी कैंट, देहरादून।
3. मुख्य कार्यकारी अधिकारी, स्मार्ट सिटी लिमिटेड, कार्यालय मसूरी देहरादून विकास प्राधिकरण, ट्रांसपोर्ट नगर, सहारनपुर रोड़, देहरादून।
4. प्रबन्ध निदेशक, उत्तराखण्ड परिवहन निगम, देहरादून।
5. प्रबन्ध निदेशक, राज्य बुनियादी ढांचा और औद्योगिक विकास निगम (SIDCUL), सहस्त्रधारा रोड़, देहरादून।
6. उपाध्यक्ष, मसूरी देहरादून विकास प्राधिकरण, ट्रांसपोर्ट नगर, सहारनपुर रोड़, आई0एस0बी0टी0 के समीप, देहरादून।
7. उपाध्यक्ष, हरिद्वार रूड़की विकास प्राधिकरण, तुलसी चौक मायापुर, हरिद्वार
8. नगर आयुक्त, नगर निगम, देहरादून/हरिद्वार/ रूड़की।
9. निदेशक, शहरी विकास निदेशालय, 31/62, राजपुर रोड़ इन्द्रा मार्केट, देहरादून।
10. प्रबन्ध निदेशक, उत्तराखण्ड वन विकास निगम, डालनवाला, देहरादून।
11. वरिष्ठ पुलिस अधीक्षक, देहरादून/हरिद्वार।
12. निदेशक, राज्य नियोजन विभाग, चतुर्थ तल, विश्वकर्मा भवन, उत्तराखण्ड शासन, 4 सुभाष मार्ग, देहरादून।
13. सचिव, दून घाटी विशेष विकास प्राधिकरण (SADA) 12, प्रीतम रोड, डालनवाला, देहरादून।
14. सदस्य सचिव, उत्तराखण्ड पर्यावरण प्रदूषण नियंत्रण बोर्ड, 29/20 नेमी रोड़, नेमी रोड़, देहरादून।
15. मुख्य अभियन्ता, लोक निर्माण विभाग, यमुना कॉलोनी, देहरादून।
16. मुख्य अभियन्ता, उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण, चतुर्थ तल, राजीव गाँधी बहुद्देश्यीय कॉम्पलेक्स, डिस्पेन्सरी रोड, देहरादून।
17. मुख्य अभियन्ता, उत्तराखण्ड ग्रामीण सड़क विकास अभिकरण, प्रथम तल, पंचायतीराज निदेशालय, सहस्त्रधारा रोड़, समीप आई0टी0 पार्क, देहरादून।
18. मुख्य नगर नियोजक, नगर नियोजन कार्यालय, चतुर्थ तल, राजीव गाँधी बहुउद्देश्यीय कॉम्पलैक्स, डिस्पेन्सरी रोड, देहरादून।
19. क्षेत्रीय अधिकारी, राष्ट्रीय राजमार्ग प्राधिकरण, क्षैत्रीय कार्यालय, 58/37, बलबीर रोड़, दे0दून।
20. क्षेत्रीय परिवहन अधिकारी, (आर0टी0ओ0) राजपुर रोड़, देहरादून/हरिद्वार।
21. अधिशासी अधिकारी, नगर पालिका, ऋषिकेश/डोईवाला।

विषयः– देहरादून–हरिद्वार–ऋषिकेश मेट्रो पॉलिटन क्षेत्र हेतु Alternative Analysis Report (AAR) को अन्तिम रूप दिये जाने हेतु सम्पादित बैठक का कार्यवृत्त प्रेषित किये जाने विषयक।

महोदय,

कृपया उपरोक्त विषयक देहरादून–हरिद्वार–ऋषिकेश मेट्रो पॉलिटन क्षेत्र हेतु Alternative Analysis Report (AAR) को अन्तिम रूप दिये जाने हेतु दिनांक 07.01.2019 को पूर्वान्ह 11:00 बजे, सभागार कक्ष, उत्तराखण्ड आवास एवं नगर विकास प्राधिकरण, चतुर्थ तल, राजीव गाँधी बहुउद्देश्यीय कॉम्पलेक्स, डिस्पेन्सरी रोड़, देहरादून में बैठक आहूत की गयी थी, जिसमें यू0एम0टी0सी0 द्वारा Alternative Analysis Report (AAR) के सम्बन्ध में प्रस्तुतीकरण दिया गया।

प्रस्तुतीकरण के दौरान समस्त उपस्थित Stakeholder से सुझाव देने हेतु अनुरोध किया गया एवं उक्त हेतु दो दिन का समय निर्धारित किया गया ताकि प्राप्त सुझावों को Alternative Analysis Report (AAR) में समाहित किया जा सकें।

उक्त के सन्दर्भ में देहरादून–हरिद्वार–ऋषिकेश मेट्रो पॉलिटन क्षेत्र हेतु Alternative Analysis Report (AAR) को अन्तिम रूप दिये जाने हेतु सम्पादित बैठक दिनांक 07.01.2019 का कार्यवृत्त संलग्न कर सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित किया जा रहा है।

संलग्नकः–उपरोक्तानुसार।

भवदीय

10.01.2019

(अनिल कुमार मलिक)

महाप्रबन्धक (सिविल)

राजीव गाँधी बहुउद्देश्यीय कॉम्पलैक्स, डिस्पेन्सरी रोड, देहरादून, उत्तराखण्ड, 248001

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प्रतिलिपि प्रबन्ध निदेशक, अरबन मास ट्रांसिट कम्पनी लि0, द्वितीय तल, कॉरपोरेट ऑफिस टॉवर, एम्बियन्स आईलैण्ड, एन0एच0–8, गुड़गॉव–122001 को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

संलग्नकः–उपरोक्तानुसार।

10.01.2019

(अनिल कुमार मलिक)

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Minutes of Meeting of Stakeholder Consultation meeting held on Preparation of Alternative 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

Date: 07.01.2019

Venue: UKMRC Office

I. A meeting was organized under the chairmanship of Managing Director, Uttarakhand Metro Rail, Urban Infrastructure & Building Construction Corporation Limited, for the preparation of Alternative Analysis Study for Dehradun- Haridwar- Rishikesh City. List of participants are enclosed as annexure.

II. Chairman welcomed the representatives of various departments, attending the Stakeholder Consultation meeting. He gave the background for the meeting, explaining that UMTC has already submitted the CMP for Uttrakhand Metropolitan Area and the same is under approval from the State Government and that as per the New Metro Policy 2017, after preparation of CMP, an Alternatives Analysis Report needs to be prepared, followed by preparation of DPR for the chosen Mass Transit System, and that all the three Reports need to be submitted to the Central Government after approval from UMTA/State Government. He, then, requested UMTC to make a detailed presentation for the same.

III. UMTC, team made a detailed presentation, giving a brief description about purpose of the Study, the components covered and not covered under the study, Appraisal Framework for Projects under Metro Rail Policy, 2017, the importance of Alternative Analysis, its approach & Methodology, Screening criteria for corridor & Transit System, and the corridors suggested in CMP Report for Mass Transit System, under First Order Category.

IV. Further, UMTC team explained the following components, while making the detailed presentation including:

   I. Details about the Study Area covering Dehradun, Haridwar and Rishikesh City
   II. Corridors considered for the First Order for Alternative Analysis Study as per CMP report and the Alternative options explored for identifying the most suitable corridor
   III. Based on the three basic corridors, as identified under CMP Study for first order transit system, three separate alternatives were evaluated for each basic corridor
   IV. Ranking Methodology for Screening of Corridor and transit technology with parameters considered and the weightage defined for each parameter
   V. While selecting the transit technology options, parameter was evaluated for Heavy and Medium Metro, Light Rail/Light Metro, At grade LRT, At grade and elevated BRTS and Monorail
   VI. Out of all based on the ranking criteria, corridors were selected with the suitable transit technology
   VII. For Second Order Transit System, the Corridors identified based on CMP Study followed by the Alternative options explored for identifying the most suitable corridor,
      - for Haridwar city three basic corridor were studied with different alternative for evaluation,
      - in Dehradun-city bus routes along with additional new routes were evaluated and
      - for Rishikesh one route was studied for second order transit system
   VIII. The ranking methodology opted for selecting the corridor was explained
   IX. Methodology was also discussed for selecting the transit technology for Second order transit System, like City Bus service, Personal Rapid Transit System and Cable Car, with preferred technology for each corridor was recommended.
   X. Implementation options for System
   XI. The Summarized table for the preferred corridor with technology suggested in as mentioned below:

Proposed Corridors	Suitable Alignment	Transit System Order		Proposed Transit System
North South Corridor in Dehradun city	Alternative 1A : Mussoorie Road (Inder Bawa Marg) to ISBT via Rajpur Road and Saharanpur Road	First		Elevated LRT/ Light Metro
East West Corridor in Dehradun City	Alternative 2A : Raipur to FRI via EC road and Chakrata road	First		Elevated LRT/ Light Metro
Corridor connecting Dehradun Rishikesh and Haridwar	Alternative 3A : Rispana at Dehradun to Baharadarabad at Haridwar via NH 72	First		Elevated LRT/ Light Metro
Dehradun (Within City)	Pan City	Second order	Medium	City Bus Service
			Low	City Bus Service/ Dedicated IPT
			IMA to Railway Station	PRT/Cable Car System
Rishikesh (Within City)	Nepali Farm to Triveni Chowk via Bypass Road	Second		City Bus Service
Haridwar- SIDCUL- Jwalapur	Haridwar Railway Station to SIDCUL Haridwar Railway Station to Jwalapur	Second		City Bus Service
Haridwar- Har Ki Pauri	Haridwar Railway Station to Har ki Pauri	Second		PRT/Cable Car System

V. Following the Presentation, the comments and observations were received from the stakeholders are discussed as under:

S.No	Observation Made	Response	Action to be Taken
1	Shri. Bahuguna,DTDO(HQ) from Uttarakhand Tourism Department Board, • Where is the First Order corridor terminating? • Whether the tourist Traffic is taken into consideration, as the city witnesses huge tourist inflow during tourist season. • As the cable car System is planned from Purkul to Library Chowk (Mussorie), is there a possibility of integrating the same with First Order Transit System?	• MD, UKMRC mentioned that Tourist traffic is seasonal in nature and a system cannot be planned based on it. The Corridors are planned for the Local City Commuters, giving due consideration to the average tourist inflow. • The Feasibility of integrating the System with cable car will be looked into at DPR Stage	No Action Required
2	Director, Planning-SIDCUL, was enquiring whether for such a study, the general public needs to be sensitised about the Surveys • The Right of Way considered is quiet less as compared to the right of way notified by the PWD Department	• MD, UKMRC, highlighted that the Traffic Surveys were carried out based on scientific methodology with a considerable sample size covered for getting the information. • UMTC team informed that the Right of way considered is as per actuals, with due consideration to the Right of way given in the Master Plan	• It was suggested that the Right of way considered may be verified based on the notified Right of Way by PWD
3	Officials from Smart City inquired if these proposals are duly informed to the Smart City SPV, as they are in process of implementing the smart	MD, UKMRC, informed that a copy of CMP report has already been sent to all the stakeholders and any future information will be shared with all the concerned stakeholders	No Action required.

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S.No	Observation Made	Response	Action to be Taken
	city projects along the mobility corridors	after getting approval from state government. MD, UKMRC, also emphasised about the need and importance of UMTA and how the implementation of Urban transport in the cities needs to be coordinated and approved by single agency like UMTA	
4	MD,UKMRC enquired which branching is the preferred one for implementation in case of a) Corridor1: from Kandoli to ISBT connecting Mussorie road and canal Road section b) Corridor 2: from FRI to Raipur & Rispana bridge section	UMTC team informed that both the branches have equal weightage and can be implemented after considering the technical operational aspect of the system, which can be covered while preparing the Detailed Project Report	
5	Commissioner, Roorkee, inquired if any MRTS connectivity is planned for Roorkee, stating that instead of connecting it with Bahadarabad, which have limited development, the same can be connected to Roorkee	MD,UKMRC informed that the MRTS system is planned for the corridor where there is high demand and Roorkee after due analysis is found to have very low ridership which cannot be considered for implementation of MRTS System at present. The same may be considered for implementation for Transit system later when there is an increase in Traffic demand	No action required
6	Mr. Jugmohan, (U&TP) MDDA, inquired • if the capacity of various transit system is considered or not, and • At grade BRTS System can serve various levels of PPHPD and same PPHPD cannot be served by different transit System	It was clarified, that Similar PPHPD can be served by different transit technology. However, based on various other parameters such as Mobility, Engineering and Costing aspects, the suitable technology, a particular system can be selected for implementation	No action required
7	Official from Smart City enquired, whether a flyover can be integrated with Metro System, such as in the city of Nagpur Metro corridor along the Highway, which can be implemented in Dehradun	It was informed that such structures can be planned in a scenario where there is high demand which cannot be served by Public transport system alone, like in Jaipur and Delhi(Proposed). Since such a scenario is not existing in Dehradun, at present, similar structures cannot be proposed at this stage.	No action required
8	MD,UKMRC directed consultant to prepare implementation options separately for First Order and second order transit system and also a separate implementation Plan may be prepared for cable car/ PRT System	Consultant agreed to prepare the same	Separate implementation Plan to be included in the Final Report

<table>
<tr><th>S.No</th><th>Observation Made</th><th>Response</th><th>Action to be Taken</th></tr>
<tr><td>9</td><td>Mr. Jugmohan, MDDA, inquired if the consultant has carried out willingness to pay and willing ness to shift Survey</td><td>After preparation of Alternative Analysis report, the willingness to pay and willingness to shift Survey is done, as part of the techno economic feasibility study/ DPR for the suitable Public Transport System</td><td>No action required</td></tr>
<tr><td>10</td><td>• Chief Town Planner enquired about the demand in between Dehradun-Haridwar and Rishikesh City

• MD,UKMRC , directed the consultant to include the phasing plan for implementation of First Order transit system in between the cities</td><td>• Consultant informed that the ridership estimates in between the cities are
<table><tr><th>Alignment</th><th>Daily Ridership 2038</th></tr><tr><td>Haridwar to Rishikesh</td><td>70,405</td></tr><tr><td>Dehradun to Rishikesh</td><td>53,286</td></tr><tr><td>Dehradun to Haridwar</td><td>1,15,867</td></tr></table>
• Consultant agreed to include the same in the final report</td><td>• Phasing Plan for implementation of First Order transit system in between the cities to be included in the final report</td></tr>
<tr><td>11</td><td>Director, Planning-SIDCUL was enquiring that whether the existing traffic for such a study, has considered Volume capacity ratio</td><td>It was informed that while comparing the corridors, level of congestion i.e (V/C) ratio and Ease of construction (Row constraints) have been considered for assessing the traffic on the corridors</td><td>No action required</td></tr>
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VI. It was suggested by MD, UKMRC, that all stakeholders may send their comments within two day time, so the same may be incorporated in the Final Report by UMTC at the earliest.

VII. The Meeting ended with a vote of thanks to all the participants.

10.01.2019

ANIL KUMAR MALIK
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