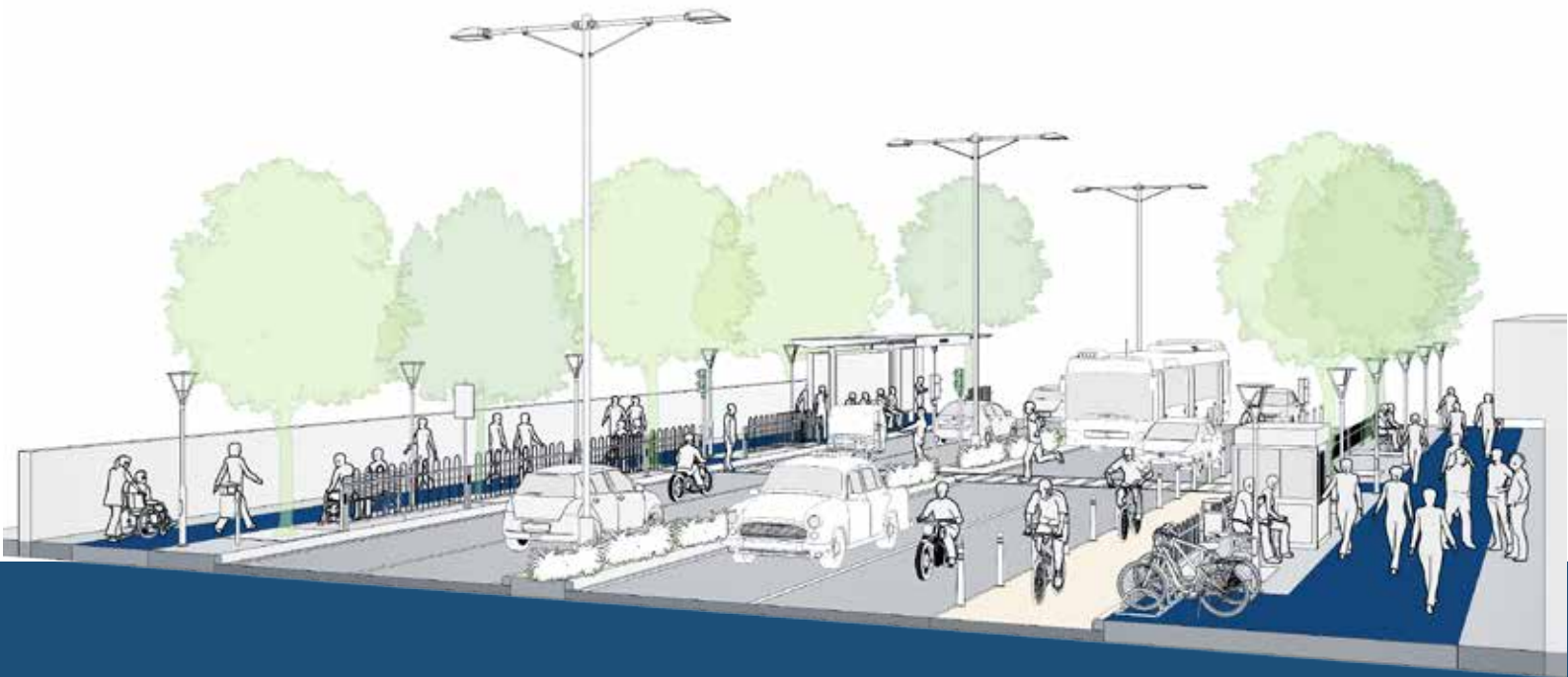




CITY LEVEL PROJECTS

STREET DESIGN GUIDELINES





सत्यमेव जयते

Delhi Urban Art Commission

The Delhi Urban Art Commission was set up by an Act of Parliament in 1973 to “advise the Government of India in the matter of preserving, developing and maintaining the aesthetic quality of urban and environmental design within Delhi and to provide advice and guidance to any local body in respect of any project of building operations or engineering operations or any development proposal which affects or is likely to affect the skyline or the aesthetic quality of the surroundings or any public amenity provided therein”.



सत्यमेव जयते

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Delhi Metro Rail Corporation
Delhi Urban Shelter Improvement Board
BSES Rajdhani Power Limited
BSES Yamuna Power Limited
RWAs and Area Councillors

Preface



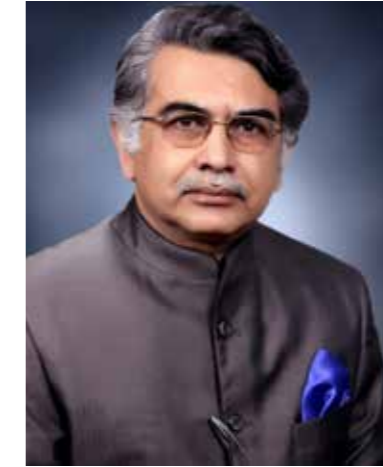
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The city of Delhi, capital of this vast land of diversities, is a city laden with layers of history, a place where civilizations have lived, prospered and perished over centuries. The modern city today, built over and around a rich tapestry of heritage, presents an opportunity at every turn, to allow for co-existence of the past, present and the future. In order to understand this multidimensional urban spectrum and attempt to plan the future, various city level studies have been initiated by the DUAC. I hope that these studies will help the planners of modern day Delhi to carefully articulate urban space, structure, form and environment and sensitively address future requirements.

I convey my thanks to all the Consultants and Members of the Commission who have tirelessly worked on this research project to bring out this document. I also take this opportunity to place on record my sincere appreciation of the efforts of Secretary and other staff of DUAC for providing the necessary administrative support to make this happen.

I fondly hope that the authorities of the local, state and national government take these studies seriously and implement, in right earnest, the suggestions given herein.

December, 2020

Prof. Dr. P.S.N. Rao
Chairman
Delhi Urban Art Commission

Foreword



Streets are like living organisms where every part performs a specific function. Streets connect neighborhoods, landmarks, open spaces and other city zones enabling the users to traverse through the city fabric. Their characteristic varies through scales, context and use.

In Indian cities, streets are often found to be designed with unequal distribution between the motorised and non-motorised zones giving noticeable preference to the motorised zone. Also, a lack of cohesiveness in design creates spaces which become 'No man's land' and thus prone to encroachment.

These guidelines are conceived in order to make our streets 'Complete Streets'. There is an attempt to shift the focus from considerations of vehicular movement to 'Streets for all'. It takes into consideration the needs of users of all age, abilities, modes etc. and enhance the quality of space. Also, the longevity of any infrastructure depends on periodic maintenance and management. Thus, the document strongly recommends the creation of a common database and co-ordination of various agencies and stakeholders.

The document would serve to be a comprehensive guide to city officials; design, planning and associated professionals. It can be paradigm shift towards streets where aspects like Liveability, mobility, safety and equity can be demonstrated by an efficient Street Design. These guidelines need to be read in conjunction with the Design manual for Street Elements and Amenities.

December, 2020

Samir Mathur
Member, DUAC

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4.1 12 M ROW

- Residential streets with Vending in the MUZ
- Residential streets without Vending zone

4.2 18 M ROW

- Commercial streets
- Commercial streets with Cycle track
- Commercial streets with Vending in the MUZ

4.3 20M ROW

- Commercial/ Industrial streets
- Residential streets
- Commercial streets with vending in the MUZ

4.4 24M ROW

- Residential streets
- Residential streets with Cycle Track
- Residential streets with vending in the MUZ
- Commercial/ Industrial streets

4.5 30M ROW

- Commercial/ Industrial streets with overhead Metro line
- Commercial/ Industrial streets with overhead Metro line + Cycle Track
- Commercial/ Industrial streets without overhead Metro line (Arterial Roads)
- Commercial/ Industrial streets with Bus Stops
- Residential streets with Cycle Track
- Residential streets with vending in the MUZ

4.6 45M ROW

- Commercial/ Industrial streets with overhead Metro line
- Commercial/ Industrial streets with overhead Metro line + Bus lanes (at Junctions)
- Commercial/ Industrial streets with overhead Metro line + Bus lanes (at Mid-Block)
- Residential streets with overhead Metro line + Bus lanes (at Mid-Block)

4.7 60M ROW

- Commercial/ Industrial streets with overhead Metro line + Bus lane (at Junctions)
- Commercial/ Industrial streets with overhead Metro line + Bus lanes (at Mid-Block)
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Overview

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I.2 Approach to 'Complete Streets'

I.3 Evolution of Streets of Delhi

1.0 Overview



Streets for all : Pedestrian pathways



Streets for all : Access for Specially-abled



Streets for all : Safe streets

"Complete Streets are streets for everyone. They are designed and operated to enable safe access for all users. People of all ages and abilities are able to safely move along and across streets in a community, regardless of how they are travelling. They allow buses to run on time and make it safe for people to walk to and from train stations." (National Complete Streets Coalition, 2010).

Vision

Develop street design guidelines for Delhi, which ensure the concept of 'Complete streets' by addressing the needs of all users including pedestrians, bicycles, vehicles, transit users, emergency vehicles and goods movement.

Goals

- Prioritize pedestrians over vehicles to ensure safety of the users.
- Ensure the use zones in the street are segregated and conflict free by means of appropriate design elements.
- Provide the designers and policy makers comprehensive listing and principles of street elements and design.
- Identify the agencies involved in street design and highlight their roles and responsibilities.

Objectives

- To understand street functions corresponding to use zones and categorise streets based on surrounding context.
- To collate best practices covering all aspects of efficient and equitable street design to put together in a comprehensive manner.
- To ensure inclusion of all users by providing design elements for each keeping in mind the principles of safety, equity and mobility.
- To suggest street sections portraying equitable distribution of various amenities and utilities.

1.1 Principles



Senior citizens enjoy street activity during Raahgiri, Golf Course Road, Gurugram, NCR

Source : <https://worlddesignguide.com/entry/270244-raahgiri-day>



Pedestrians street, Karol Bagh, New Delhi

Source : <https://www.thehindu.com/news/cities/Delhi/no-vehicles-on-road-karol-bagh-puts-its-best-foot-forward/article27098894.ece>



Lala Lajpath Rai Road near Nehru Place, New Delhi

Source : <https://www.financialexpress.com/auto/car-news/new-parking-rules-for-delhi-and-itll-cost-you-more-all-you-should-know/1718062/>

In the process to achieve 'Complete Streets', we need to shift focus of street from catering exclusively to the movement of vehicles to including all users of the street. The following principles would enable the streets to become Complete streets:

Livability

Complete streets with well-defined footpaths and bicycle routes encourage healthy and active lifestyles. Creative re-purposing of street space helps connect the community by providing attractive public space for residents and visitors to gather.

Mobility

"Complete Street" ensure :

- Safe pedestrian network facilitated with street utilities that make the commute comfortable and enjoyable.
- Catering to the people with disabilities, including people with varying levels of restrictions in mobility, vision, or cognitive abilities.
- A variety of alternative transportation choices beyond the personal automobile.

Safety

Continuous pedestrian networks help reduce conflicts between pedestrians and vehicles. Well-lit streets and walking zones without any obstruction ensure safety and help create an inclusive and disable-friendly walkable environment.

Equity

Streets should be inclusive and safe, regardless of age, ability, income, or chosen travel mode. Incomplete streets adversely impact the specially-abled, aged, children and the low-incomes.

1.2

Approach to 'Complete Streets'

Stage 1

Streets across various parts of the city were studied to analyse the ground conditions, issues, potentials etc. and it was observed that some elements that make 'Complete streets' were missing. Therefore, the vision for a Complete street was envisaged.

Stage 2

Best practices from Street Design Manuals of Indian and International origin were studied to understand the varied street elements and amenities, their integration with each other and placement etc., segregation of streets into various use zones.

Stage 3

Attributes from various Street Design Manuals were compiled and a comparative analysis was conducted to extract the best applicable standards for Delhi.

Stage 4

The manual was conceived with extractions from the relevant best practices and street sections were produced for Streets measuring 12-60 m (as per hierarchy in MPD -2021) highlighting layering in streets as movement networks and utility corridors.

Stage 5

The Roles and responsibilities of various agencies/ organisations involved was analysed and documented with recommendations from DUAC for stakeholder co-ordination for effective implementation of projects.

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1.3 Evolution of Streets of Delhi (Best Practices)



STREETS OF LUTYEN'S DELHI
1911-1945

Salient features :
Dedicated lanes were designed with provision of:

- Cycle track
- NMV lanes
- Kerb details
- MUZ details
- Trees/ landscape was planned to define the character of the streets

COMMONWEALTH GAMES
(Govt. OF Delhi)
2009-2010

Salient features :
Streets in various parts were face lifted, by introduction of:

- Dedicated cycle lanes, by introducing signages and markings on the street
- Colour coded signages for bus and vehicle lanes
- Infrastructure up gradation

IP Marg

Source: <http://oasisdesigns.org/ipmarg.asp>

Source: <https://www.designforuminternational.com/project/ito-fab/>

Salient features :
IP Marg houses offices including the Police Headquarters, PWD, DDA and institutions such as SPA, ITO etc. leading to a huge footfall. The streetscape design focuses on:

- Creating spaces for pedestrians to access the public transit systems such as metro and the BRT
- Providing a footpath cum plaza using stone seaters dotting the whole stretch of the road.
- The green strips along the road and boundary walls are retained and enhanced to form continuous buffers

Delhi - Meerut Expressway
NHAH - Welspun Delhi Meerut Expressway Private Limited

Salient features :
The NHAH, Delhi-Meerut expressway redefined Eastern part of the city, by providing uninterrupted and direct connections. The stretch includes elements and amenities like:

- Pedestrian sidewalks
- Bicycle tracks
- Solar panels
- Vertical gardens

Chandni Chowk Pedestrianization Project
Pradeep Sachdeva Design Associates
(2018- ongoing)

Source: <http://www.thehindu.com/news-nations/new-chandni-chowk-on-arrival-178377>

Source: <https://www.theguardian.com/cities/2019/jul/30/redesigning-delhis-champs-elysees-it-represents-all-thats-complex-about-urban-india>

Salient features :
The stretch from Red Fort to Fatehpuri Masjid, around 1.5 km, is redeveloped as a pedestrian and non-motorised vehicle street.

The proposal intends to :

- Decongest the area by restricting traffic
- Facilitate free pedestrian movement,
- Provide basic facilities, such as drinking water, toilets, police posts
- Enhance greenery around the place while showcasing its rich heritage and culture.

(To service the commercial activity in the area, entry of vehicles is staggered and will be allowed from 9 p.m. to 9 a.m)

Ajmal Khan Road, Karol Bagh, Pedestrianization Project
UTTIPEC+nila.A+DIMTS
2019

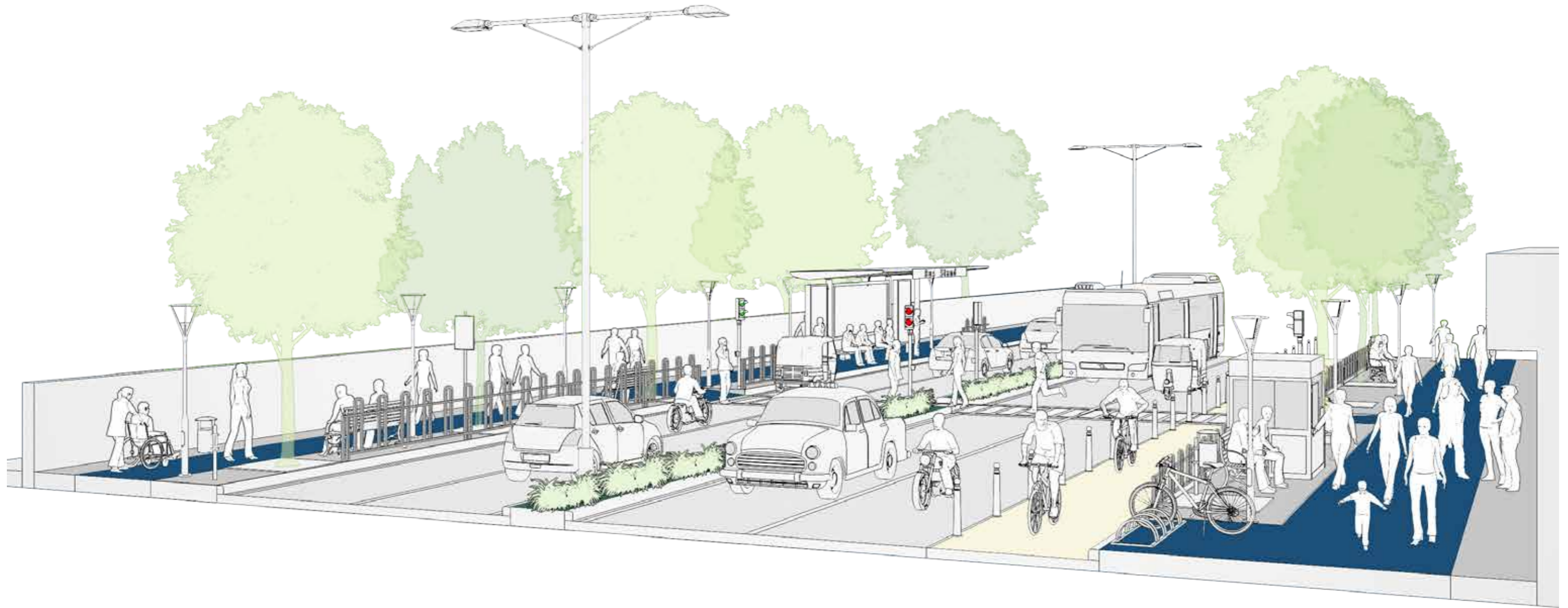
Source: <https://indianexpress.com/article/cities/delhi/only-feet-no-wheels-karol-bagh-stretch-gets-makeover-5705732/>

Source: <https://timesofindia.indiatimes.com/city/delhi/you-have-no-right-to-park-in-market-hc-to-karol-bagh-traders/articleshow/69568832.cms>

Salient features :
Pedestrianization of Ajmal Khan street, 1 km stretch was carried out through 'Tactile Urbanism' method.

The street was transformed by:

- Closing the street for vehicles and creating a pedestrian friendly environment including, signages painted on the street, enforcement of stricter penalties.
- Elements like planting were added to introduce a green layer; pause points were created by installing benches, creating a comfortable and soothing experience for pedestrians.



2.0

Introduction to Streets

- 2.1 Road Hierarchy
- 2.2 Landuse & Density
- 2.3 Zoning of Streets

2.1 Road Hierarchy



Road Hierarchy Map of Delhi,
Source : MPD 2021

Road hierarchy is a function of transport network, street widths and length. The character and design of the street shall be determined, based on the hierarchy of road as it would support functions such as travel, connections and access to destinations.

2.1.1 National Highways : The recommended minimum right of way (ROW) is 90 meters, wherever possible. However, within the city it shall not be less than 60 meters. National highways only have an inter-city role; when they pass through urban areas they become urban arterials.

2.1.2 Arterial Roads : Arterial roads are main roads with or without access control. They form the main frame that provide long distance mobility between various parts of the city. Arterial streets are basically of two types :

- **Primary Roads :** Vehicular routes carrying heavy volumes of traffic generally. The recommended ROW in existing urban areas is 60-80 m and minimum 80 m in proposed urban extension.
- **Secondary Roads :** Vehicular routes carrying heavy volumes of traffic and BRT routes are part of this type of road. The recommended ROW in existing urban area is 45 - 60 m and a minimum of 60 m in proposed urban extensions.

2.1.3 Sub-Arterial : Sub arterial roads provide local connections between neighbourhoods and connect them to arterial roads. They include:

- **Primary Collector**
Connects major arterial roads and inter-residential district collectors. The recommended ROW in existing urban area is 30-40 m and minimum 45 m in the proposed urban extensions.
- **Secondary Collector**
Collects traffic from local streets within a residential district. The recommended ROW in existing urban area is 18 - 24 m and minimum 30 m in proposed urban extensions.

2.1.4. Local Streets : Suggested ROW is 12 - 20 m in existing and proposed urban area. These roads should be made pedestrian and bicycle friendly by using modern traffic calming designs to keep speed within limits and be conducive to walking and non-motorized movement.

2.1.5 Pedestrian & NMV Streets : Pedestrian only streets, 6 m and less, as per MPD 2021, are streets where pedestrian and non-motorized transport are dominant. These streets are particularly appropriate in intensely commercialized areas.

2.2 Landuse & Density



Residential Street in New Panchvati, Delhi

Source :



Commercial street in Chandni Chowk, (before 2018), Old Delhi

Source :



Mixed-Use settlement, Greater Kailash, New Delhi

Source : DUAC



Okhla Industrial Area, New Delhi

Source : RITES Transport Demand Forecast Study, May 2008

Street design shall be shaped by primarily two variables: Land use and Density where "Density is thought to shape pedestrian activity by bringing numerous activities closer together, thus increasing their accessibility from trip origins" (Cervero & Kockelman, 1997; Krizek, 2003). and land use mix which "increases accessibility by increasing the number of available destinations within walking range".

2.2.1 Residential : Urban neighbourhoods support a high demand for multi-modal access, and the streets should provide safe and inviting places for people to walk and bike. In residential areas, pedestrian safety is of primary importance. Driving lanes should be designed to cater to low vehicular speed. The area and its streets should allow direct access for all residents to transit stops, retail centres, religious area, schools, etc.

2.2.2 Commercial : Commercial areas are typical of urban development patterns. However, pedestrian and NMV mobility is often restricted by unmanaged traffic volumes and lack of accommodation for temporal shops and streets vendors. Inadequate pedestrian facilities reduce accessibility to the shops and use of transit services. Street sections should be designed such that equal attention should be paid to both motor vehicles and pedestrians. Strategically placed pedestrian crosswalks and segregated pedestrian zones are important elements of a commercial street.

2.2.3 Mixed-Use : Mixed-use as per Master Plan Delhi 2021 is an area with residential, commercial, and mixed-use components. Streets of this area should be designed to cater to the requirements of both resident and visiting population. Safe pedestrian networks should be provided to improve access and transition between different modes of transport. Transit lanes should be considered for the comfort of passengers, which may also act as an on-street parking zone for visitors. Mixed-use streets that carry regional commuter traffic should be designed for peak-period travel.

2.2.3 Industrial : Most industrial zones are designed and oriented for automobile access and lack pedestrian or bicycle infrastructure. Such designs restrict access to those who use public transportation. Design treatments should focus on creating streets with appropriate travel lane width and internal circulation for pedestrians and bicyclists, as well as connections to nearby bicycle, pedestrian, and transit networks. There should be a number of transit lanes to facilitate loading/unloading of goods, which do not interfere with one another.

2.3

Zoning of Streets

Streets are an essential component to the city, which not only provide access, but also act as conduits for placement of street amenities, utilities, street vending kiosks etc., apart from walking/cycling.

At DUAC, we envision Street Design Guidelines (SDG) to serve as a document which defines streets for various users by ensuring equitable distribution of spaces by means of efficient planning, design and management. This would ensure safe and composite streets which have distinguished and defined use zones, free of encroachment and obstructions.

A complete street shall consist of identifiable zones, which have distinguished uses depending on factors including street surroundings/context, street use and width of the street.

Primarily, a street may be divided into the following zones:

Pedestrian zone :

- Frontage Zone
- Walkway
- Multi- utility zone (MUZ)
- Edge Zone
- Refuge Islands

Vehicular zone :

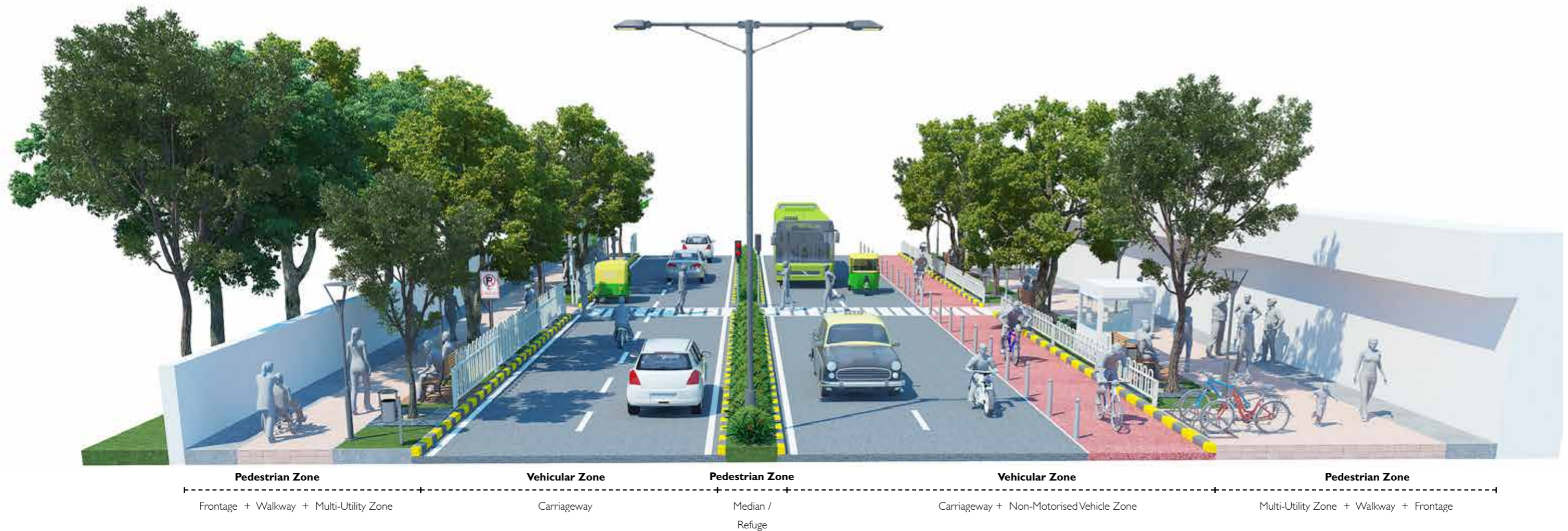
- Carriageway
- Non-Motorised Vehicle
- Road Shoulders
- Medians

ISSUES :

- Pedestrian and vehicular conflicts due to absence of well-segregated zones
- Encroachment of pedestrian walkways by vehicles
- Non-inclusive streets for the aged and disabled
- Street elements and amenities are not evenly distributed.

Context of Delhi

The situation in Delhi and many other Indian cities depicts a picture where there is lack of thoughtful and functional approach to street design wherein these spaces are either encroached or left in despair due to lack of co-ordination and management by various agencies (design and implementation). Also, placement of utilities and amenities in the streets are often seen to be obstructing pedestrian movement and vehicular traffic and thus make the user experience unfavourable and uncomfortable.



Note : The guidelines being for 'Complete streets', a separate chapter on Universal Accessibility has been included in this study that discusses the street elements and utilities pertaining to the differently-abled user group.

3.0

Street Design Recommendations

3.1 Pedestrian Zone

3.2 Vehicular Zone

3.3 Universal Accessibility

3.1 Pedestrian Zone

ISSUES :

- Absence of designated walkway zones and pedestrian crosswalks force pedestrians to walk on the carriageway, leading to pedestrian-vehicular conflicts.
- Encroachment of pedestrian walkways by vehicles due to absent barriers/buffers like bollards/guardrails.
- Absence of proper pedestrian walkways for the aged and differently-abled.



Improper placement of signage obstructing the pedestrian walkway
Source : DUAC

An efficient pedestrian network can reduce dependency on vehicles and encourage sustainable redevelopment of streets. Well-facilitated streets conducive to the needs of a pedestrian, encourage social activities and enable streets to function as a lively public space. Pedestrian friendly streets also provide natural surveillance thereby ensuring safety of the commuters.

- Pedestrian Mobility is one of the key purposes of street design, due to which Pedestrian Realm Zone design has become mandatory. It helps in integrating the livability & synergy quotient of a street. A pedestrian realm zone consists of various components such as footpaths, safe pedestrian crossing, clear signage etc. keeping in view safety & easy accessibility.
- There are four primary zones in the pedestrian realm: *Frontage, Through, Furnishings, and Edge*. It also includes other elements such as crossings, grade separators, medians, refuge islands etc. which help in integrating these various zones of Pedestrian Realm together.

KEY PRINCIPLES:

1. DESIGN:

Street should be designed such that the space encourages people to walk & engage in social activities.

2. ECOLOGY

Along with the basic necessity of a good design & unhindered movement of pedestrians, it is very important to consider the ecological aspect. The design should focus on maximizing natural drainage systems using pervious paving materials, reducing heat island effect, and providing for planting for shade and beauty.

3. SAFETY / COMFORT:

Pedestrian safety & comfort should be kept on a fore front. The design should address differently-abled by providing accessibility ramps and tactile paving and also focus on areas for trees & high- albedo materials in order to ensure optimal climatic comfort.

3.1.1 Pedestrian Zone Specifications

	FRONTAGE ZONE	WALKWAY ZONE	MULTI - UTILITY	EDGE
DESCRIPTION	Narrow space or buffer space adjoining building or property line	- Zone at a height of 150mm (max) from the carriageway, separated and secured by kerbs, bollards, and railings.	Designated space for furniture and utilities so prevent any obstruction of the walkway or carriageway	Part of the footpath adjacent to the carriageway.
FUNCTION	- Space for door opening, architectural elements - Displays, signage, planters - Furnishings aligned with frontage - Free movement for pedestrians - Overhanging elements	Uninterrupted and safe walking zone for pedestrians and the differently-abled.	Accommodates : - Street furniture - Landscaping - Utility equipments - Transit stops - Vending zones, etc.	Accommodates : - Street lights & utility poles - Trees, planting etc.) - Guardrails - Reflectors etc. with 0.5 m clearance to kerb
WIDTH & HEIGHT	Width Min : 0.5m for Inactive frontage 1.0m for active frontage like commercial areas Height : Same as Walkway zone	Width Min : 1.8 m Max : As per context Height : 0.15 m (max) level above carriageway. 2.4 m clear height	Width Min : 1.8 m Max : As per context Height : Same as Walkway zone	Width Min : 0.3 m Max : As per context Height : Same as Walkway zone



3.1.2 Street Elements & Amenities

ISSUES :

- Absence of amenities like Public Toilets, Seating etc. make walking inconvenient for pedestrians.
- Absence or poor placement of pedestrian lights make the walkways unsafe at night and discourage walking.
- Inappropriate placement of street amenities like Garbage Bins, Seating, Bollards can obstruct other activities.

The following utilities and furniture have been discussed briefly in this chapter.

- A. STREET TREES
- B. STORMWATER MANAGEMENT
- C. BUS STOP SHELTER
- D. BICYCLE PARKING
- E. STREET SEATING
- F. PUBLIC TOILETS
- G. GARBAGE BINS & DHALAOS
- H. GUARDRAIL
- J. BOLLARDS
- K. PEDESTRIAN LIGHTS
- L. PEDESTRIAN SIGNALS
- M. SIGNAGE
- N. UNDERGROUND UTILITIES
- P. PUBLIC ART
- Q. PEDESTRIAN CROSSWALKS

Street elements and amenities are the essential functional features which ensure comfort, convenience and safety for all users. The placement and design of these amenities shall be contextual, not obstruct the movement of the commuters and not cause distraction to motorists/NMVs.

The placement of street amenities should be considered as part of a wider strategy, to avoid discomfort and obstacle to the users.

The elements which supports and complement the other major street elements in improving the functionality of the street network are lighting, planting, dustbins, material, underground utilities, public toilets, vending zone, public art, kiosks, traffic signals and signages.

It should be of durable material, easy and cheap to maintain, safe to use, easily available in case of repairs and replacement and aesthetically pleasing. It should be placed such that it does not obstruct the pedestrian or vehicular flow.

KEY PRINCIPLES

- **Design** : Well-placed and designed street utilities inculcate a sense of discipline among users and adds to the aesthetic value of the street.
- **Safety & Comfort** : The street utilities should create safe and comfortable environment for the users. They should be easy to use. These should be designed to discourage theft of parts. Consistent tree plantings along a street narrow the perceived width of a street, encouraging decreased vehicular speed and increased awareness of pedestrians.
- **Ecology** : The utilities should be designed considering the environmental sustainability. Planting and Stormwater drain plays major role in making streets ecologically sustainable. The rest of the utilities also contribute in making street sustainable by using the right material and technique.

Refer the 'Design Manual for Street Elements and Amenities for Delhi' by DUAC for additional data.

3.1.2 A. Street Trees

ISSUES :

- Unshaded routes make walking uncomfortable
- Overgrown tree foliage obstruct views to Signage and Traffic Signals thereby creating confusion for the motorists and the pedestrians.
- Trees on streets that drop fruits / flowers can make the walkways slippery and unsafe
- Improper placement and inappropriate variety of trees on Medians obstruct visual connectivity.
- Protruding tree grates and guards can be injurious.



Tree Pits

Source : New Jersey Street Design

Trees are the natural elements in a street design which impart character to the street. Their placement and the choice of species is of utmost importance. They provide shade for the pedestrians and their placement must not obstruct the light from the street lighting.

PLANNING & DESIGN : BEST PRACTICES

General Considerations

- When trees are too close to a building, location should not be selected opposite to entrance gates, entrances to vehicle garages, and opposite to the main front room windows of residential houses.
- Effort shall be made to select planting location at least 6 metres away from a street light post, unless the light is centrally hung or there is adequate overhead lighting arrangement.
- Plantation should not be done just below overhead telephone or electric lines.
- Plant location should not be very close to underground service lines of power, gas, water mains or sewers. These areas may be frequently excavated for repairs/ reinstallation etc. which may damage tree roots.

Spacing of Avenue Trees

Some broad thumb rules may be as below -

- For some medium sized trees the interval may be 5 to 6 metres but in most design a minimum spacing interval of 10 to 15 metres may be required between the trees.
- When avenue trees are located on kerbed or raised shoulder the distance between the kerb and the nearest point of the tree shall not be less than 1 metre.
- Where adequate off-set land is available on the side of the road, the nearest row of trees may be at a minimum distance of 4.5 to 5 metres from the edge of the carriageway to be finally constructed as per long term design.
- When plantation of two consecutive rows of avenue trees is feasible with adequate land-width being available, the row nearer to the carriageway may be of ornamental flowering type whereas the one away from it can be with shaded trees.

Plantations in Median

- Plants and shrubs growing to a short height (1 to 1.5 metre or so) are best suited for the purpose. Larger height of shrubs adversely affect visibility of traffic on the other lane specially in the area near median gaps and are, therefore, not to be encouraged.
- For a short length near median gap, on each side of the gap and near intersections it may be preferable to



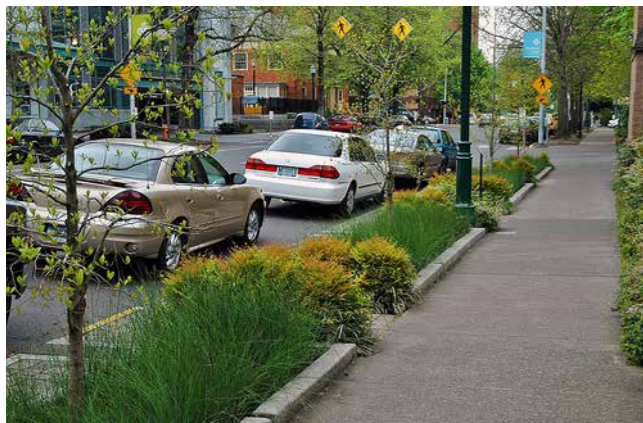
Plantation along footpath

Source : <https://www.semcooutdoor.com/columbus/product/brussels-block/>



Tree grate design

Source : UTTIPEC Street Design



Green strip along footpath

Source : http://www.raisethehammer.org/article/1684/turning_cannon_into_a_complete_street

discontinue planting or to keep them restricted to a low height only by strictly regulating their growth.

Planting Design (General Considerations)

- Trees indigenous to the region may be preferred as they will grow in areas with climatic conditions favorable to them. Selection will also be made keeping an eye to the water level in the region.
- In urban situations the fast growing trees shall get the preference as they have better chance of growth and survival in inhabited areas.
- Nurturing a tree to its full growth is a time consuming effort and their frequent replacement is ruled out. Therefore, trees with long life cycles are preferred.
- Species for plantation in urban areas shall preferably be smog resistant and also tough to withstand harsh environment specially vehicular pollution. The road medians in busy city streets are one of the most polluted areas any plantation has to suffer.
- Trees which drop too many leaves shall not be preferred as in urban areas arrangement has to be made to get the roads swept clean.
- Trees with umbrella or sub-umbrella crowns (like neem, mohua, imli and mango) will be more suitable for plantation in plain area than trees with linear elongated crowns.
- Ornamental flowering trees may be extremely attractive when in blossom. But there should be a word of caution as in most cases the period of blossoming is quite short and in rest of the period they may give a bleak appearance.
- Trees which are evergreen throughout the year or almost round the year or those which shed their leaves at other times than summer usually get preference in selection in regions with a hot summer.
- In general, the so called 'ornamental flowering trees' are mostly deciduous and the ornamental foliage trees' are mostly evergreen. The ornamental foliage trees are therefore, eminently suitable for use as shade trees along highways.
- Trees which have weak wood are considered to be traffic hazards during rain and storm and they may also block traffic for long periods
- For pedestrian roads, trees with heavy but deciduous foliage shall be preferred. While providing deep shade during summer these will allow sun rays to penetrate. Otherwise the area may become dark and desolate during winters and may not be preferred by pedestrians. These may very well be interspersed with some evergreen trees at interval specially where winters are for a shorter duration and suddenly breaks into warm winds at the end of March.

- For service roads meant for light vehicles and cars only a single or double row of trees with branches and foliage at high level may be planted so that vision at lower level permits wider coverage on sides. Where double row plantation is not feasible a more sober design with a single row of alternating flowering and shade trees of medium size may be planted. For such design the same type of flowering and shade trees may be planted for one street or for a length of one or two kilometers on the same road.
- Needless to say that all areas need not be subject to the same design criteria. The roads in business district, the residential areas and approach roads to architectural monuments etc. may have preponderances of different elements like the flowering and shade trees of varying stature.

3.1.2 B. Stormwater Management

ISSUES :

- Inappropriate plant varieties can affect the water filtration process.
- Absence of Swales and other facilities can lead to water-logging thereby creating inconvenience for commuters, especially the pedestrians.
- Inappropriate selection of location and slope can make the stormwater management ineffective.



Bioswales, Pune, India

Source : 2017 State of New Jersey Complete Streets Design Guide

Large extent of paved surfaces discourage the rainwater collection and groundwater recharge. Also, the effluents contaminate the water bodies due to lack of filtering mechanisms designed and incorporated in the streets. Thus, streets shall ensure efficiently designed stormwater management systems which blend and become a part of the streets.

PLANNING & DESIGN : BEST PRACTICES

A variety of sustainable stormwater management techniques can be used to help collect, treat, and slow runoff from impervious roadways, sidewalks, and buildings. surfaces.

BIO-RETENTION FACILITIES : Bio-retention facilities are vegetated retention systems that are designed to manage and treat stormwater by using a conditioned planting soil bed and organic materials that filter runoff stored within shallow depressions or cells. Bio-filtration facilities can be flow through filtration systems with an underground perforated collection pipe that collects and directs the treated runoff to the final discharge point. They can be designed as pure retention facilities, relying on natural soil infiltration as a primary discharge. Both systems rely on engineered soil filtration system, designed to remove particulates and pollutants before proceeding to a discharge location.

BIO-FILTRATION SWALES : Bio-filtration swales are vegetated, shallow landscape conveyance systems designed to collect and treat stormwater runoff as it is discharged to the downstream stormwater system. They slow down runoff velocity and cleanse water while recharging the underlying water table. They are flexible and can be installed in MUB's, central medians, cul-de-sacs and spaces that are not within the pedestrian zone.

Composition and Drainage

Soil mixture consists of max. 5% clay content.

Designed to pass 120 to 250 mm of rain water/hour.

Underlying native soils should be analysed to verify they are not contaminated prior to implementation.

Minimum 1m width should ideally run continuously along a stretch of the road. Ideal slope of 4:1 with a maximum 3:1 slope and a maximum velocity of 600 mm to 900 mm per second should be maintained.

FLOW-THROUGH PLANTERS : Flow-through planters are small bio-retention facilities. They are hard-edged stormwater management facilities with an impermeable base. Flow-



Flow through planters

Source : 2017 State of New Jersey Complete Streets Design Guide



Rain Gardens

Source : 2017 State of New Jersey Complete Streets Design Guide



Pervious Strips

Source : 2017 State of New Jersey Complete Streets Design Guide



Honeycomb Pavers allow water permeation

Source : 2017 State of New Jersey Complete Streets Design Guide

through planters treat water by allowing runoff to soak through its soil and filter into an under drain system that conveys filtered runoff to a downstream discharge point.
Location : Flow-through planters should not be located in constrained areas next to buildings, areas with limited setbacks, poorly draining soils, steep slopes, or areas with contaminated soils.

RAIN GARDENS : Rain gardens are planted depressions or holes that allow rainwater runoff from impervious surfaces to be absorbed. Native plants are recommended for rain gardens because of their tolerance for local climate, soil, and water conditions. Native plants also have deep and variable root systems that enhance water filtration.
Location : A rain garden requires an area where water can collect and infiltrate.

Composition : The bio-retention mixture should typically contain 60% sand and 40% compost (Washington State University Studies).

PERVIOUS STRIPS : Pervious strips are long, linear landscaped areas of permeable pavement or gravel that capture and slow runoff. Pervious strips provide some infiltration but far less than a bio-filtration swale. Pervious strips are an inexpensive step in stormwater management but are less effective than other BMPs for treating a street's full water event. They are also subject to a much higher maintenance cycle due to lack of ability to incorporate an upstream pre-settlement chamber that prevents clogging of permeable and gravel voids.
Location : Pervious strips can be integrated with sidewalks, medians, curbs, and other features. Pervious strips require long, continuous spaces to treat and filter pollutants.
Slopes : A maximum 2% gentle side slope should be used to direct flow into the facility. Additionally, facilities greater than 5% typically are not suitable to pervious applications unless specific design criteria are used that are unique to the geography and topography. The bio-retention mixture should typically contain 60% sand and 40% compost (Washington State University Studies).

PERMEABLE PAVEMENTS : Permeable pavement reduces storm water runoff. Known as green pavement it allows water to run through rather than accumulate it. It captures and stores storm water by filtering the runoff through voids in the pavement surface into an underlying stone reservoir and returns to the conveyance system, or allows it to infiltrate into the soil. The stone or gravel below acts as a natural filter that clears the water of pollutants and improves its quality. It is commonly used in parking lots, sidewalks, low-traffic areas and driveways. This eco-friendly pavement is suitable for hot climates like Delhi, high-speed traffic areas and less-travelled areas.

3.1.2 c. Bus Stop/Shelters

ISSUES :

- Inappropriate placement can obstruct pedestrian movement.
- Signage pertaining to bus-routes if placed incorrectly can cause visual obstruction
- Absence of bus-boxes in front of the stop forces passengers to run onto the carriageway
- Absence of ramps makes boarding and de-boarding inconvenient for the physically disabled.
- Absence of tactile tiles make the bus stops unsafe and inconvenient for the visually impaired.



Bus stop placed on the footpath allowing continuity of the pedestrian route from behind as well as front of the shelter

Source : DUAC

Well-designed bus shelters ensure safe and comfortable transit for the users. The main function of Bus shelters is to provide shade and shelter for the waiting passengers. It requires efficient design and placement which would encourage people to use public transport. In case of space constraints, bus shelters can be altered to provide minimal seating and route information, which are essential for functioning of the system.

PLANNING & DESIGN : BEST PRACTICES

- Multiple bus stops on busy mobility corridor should be constructed as per the size of bus stop.
- On footpath of minimum width, bus stop to be located at edge of right-of-way.
- Transit shelters should be spaced between walkable intervals of 0.8km to 1.0km
- Kerb extensions in parking lanes accommodate the bus stop. Seating if provided should be compact and minimal. Sitting in transit pickup points should be as per pedestrian requirements.
- Bus stop located near carriageway where clear walking space is to be provided between compound wall and bus stop.
- Cycle tracks should be routed around back of bus stop.
- If bus stop is at same level of cycle track then tree pits, vending stalls and bollards can be used to define boundary of the passenger waiting area. All bus stops should offer clear, paved pedestrian access, shade, seating and route information, dustbins, bicycle parking, lighting.
- The design should be compact, robust with anti-skid, levelled floor space, preferably cantilevered roof for sufficient shade and light.

3.1.2d d. Bicycle Parking

ISSUES :

- Absence of designated and safe spaces for parking cycles increases dependency on motorised transport.
- Inappropriate placing of Bicycle Parking on the frontage or walkway zones interfere with the pedestrian movement network.



Typical On-Street Bicycle Parking

Source : 2017 State of New Jersey Complete Streets Design Guide



Cycle Stand : Best Practices

Source : <https://www.broxap.com/cycle-parking-guide-planning-completion/summary/>



Cycle Stand : Best Practices

Source : <https://www.broxap.com/2014/11/01/cycle-parking-dilemmas/>

To encourage cycling as an alternative and sustainable mode of travel, it is imperative to provide bicycle parking slots at various locations across the city, near locations like Metro stations and Bus-stops to provide seamless connectivity for the commuters. Their location and design shall be contextual and sustainable to ensure their longevity in the urban realm. Also, they should be easy to locate.

PLANNING & DESIGN : BEST PRACTICES

- Bicycle parking stands should be conveniently located, well lit, and easily visible for cyclists arriving at a destination.
- Directional signage should be provided where parking is not easily visible to visitors.
- Racks should be durable and securely anchored.
- Rack should support an upright bicycle by its frame.
- Bicycle racks should be properly spaced to allow easy, independent access to each bicycle.

There are primarily two types of bicycle parking :

1. Short-stay Parking

- Open to view and close to entrances of destinations.
- Located in furnishing zones or on kerb extensions within 15m of a main entrance or between buildings.

2. Long-stay Parking

- Can be located in shared areas within private building complexes.
- Should be located in secure, convenient, shaded, and well-lit areas.
- Should be enclosed and protected from weather.
- Bicycle lockers can be provided to encourage bicycle commuting.
- Bicycle parking should be mandatory at all transit stations as cycles provide convenient and affordable private feeder services to MRTS/ BRTS stations.

3.1.2

E. Street Seating

ISSUES :

- Absence of seating mean no resting points for the users
- Inappropriate placement can obstruct pedestrian movement.
- Non-durable or weak materials encourage vandalism and also increase maintenance costs.
- Design flaws i.e inappropriate size, heights discourage people from using it.



Bench in Qutab Minar old monument complex, New Delhi

Source : 2017 State of New Jersey Complete Streets Design Guide



Integrated bench in Delhi University campus, New Delhi

Source : 2017 State of New Jersey Complete Streets Design Guide

Seating is one of the most important element of the street as it serves the purpose of resting and pause points. These elements can be designed creatively and shall ensure principles of universal accessibility, appropriate placement and minimal maintenance. Seating can also be designed as part of Public Art.

PLANNING & DESIGN : BEST PRACTICES

- Seating to be provided along the edge of a building i.e. frontage zone or furnishing zone depending on the area and the context.
- When placed in the furnishing zone, benches should face the building.
- Where footpath width permits, seating in the furnishing zone should be perpendicular to the curb.
- When located away from a building, benches should be in the frontage zone. It should be provided with shade.
- Seating should be designed to encourage sitting and discourage lying down.
- Benches are recommended on all streets at adequate intervals of between 100m - 200m.
- Seating capacity and intervals should be determined as per the adjacent land use and space availability.
- Permanently installed seating should not interfere with building entrances, loading zones, parked vehicles, or other potential conflicts.
- Public seating should be approximately at 0.45m, with back rest at approximately 0.70m, above floor level.

3.1.2

F. Public Toilets

ISSUES :

- Absence of Public Toilets encourages people to defecate in the open.
- Inappropriate placing in the frontage or walkway zones interferes with the pedestrian movement network.
- Public toilets are often under lit and poorly maintained thus discourage people from using them



Public toilets with adequate space in front to maintain continuity of pedestrian network.

Source : 2017 State of New Jersey Complete Streets Design Guide

Public toilets need to be distributed uniformly in the streets to ensure proper access to all users. They must be designed for universal accessibility and be placed appropriately in the street to ensure they cause no obstruction to the movement of users in street. Designs shall be compact, durable and sustainable to ensure its presence in the street is not an obstruction to movement.

PLANNING & DESIGN : BEST PRACTICES

- Provide accessible public toilets every 1.5 km on mobility and feeder corridors.
- One toilet is recommended every 500m - 800m distance, preferably located close to bus stops for easy access by pedestrians and public transport users.
- Public toilets should be located alongside transit stations and commercial areas with high footfall. They can be provided near off-street parking areas as well.
- Public toilets should be integrated in the road design such that it is easily accessible and aesthetically integrated with the surroundings.
- Public toilets should be placed within the MUZ without obstructing footpaths, cycle tracks and the carriageway.
- Public toilets should be connected to sewerage lines and cleaning should be done at regular intervals.
- The design and access for public toilets should be friendly for the differently-abled.

3.1.2

G. Garbage bins

ISSUES :

- Presence of Litter along road side due to absence of bins
- Large open garbage containers and collection points can be a menace as stray animals spill the garbage from them.
- Solid waste is not segregated at source due to absence of separate provisions for wet and dry waste.



Portable Community Bins

Source : <http://liteservices.com/>

Garbage bins are amenities that help keep the streets clean and visually pleasant. Provision of bins at regular intervals on streets with high pedestrian activity discourages littering, resulting in a sanitised environment. Garbage bins need not be solely utilitarian in their design. They can be innovatively designed to suit the character of the street or act as canvas for displaying public art.

PLANNING & DESIGN : BEST PRACTICES

- Maximum interval between two garbage bins in a street should be limited to 200m.
- Design of garbage containers should be such that it conceals the litter bags and facilitates easy cleaning and maintenance of bins.
- Size of the garbage bins should be such that it does not occupy more than 2sqm. of space.
- Ideally, garbage containers should be placed in the Multi-Utility Zone. In case of limitations of the ROW, they may be placed on the frontage zones along the in-active property boundary walls, or the edge zone footpath along the carriageway.
- Separate garbage containers should be provided to segregate wet waste and dry waste. Garbage bins should be located at street junctions and busy nodes, but clear of the pedestrian walking zone.
- They should be provided at high footfall areas such as major public squares, commercial and transit zones.
- It is recommended to provide four trash receptacles at street intersections - one at every junction.
- Garbage bins can be considered as a design element, and the design should reflect aesthetically pleasing and as well as functional concerns.
- They should be selected from the same or a similar design "family" as other site furnishings (such as benches, bollards, bike racks, etc.) and be finished or painted to complement other site furnishings.
- The receptacle should be made of durable, high quality materials, such as galvanized or stainless steel.
- Semi-underground enclosed bin technology should be considered for future garbage collection areas. These hide the garbage and its smell and keep animals away from scavenging for food.



Community Bin

Source : <http://liteservices.com/>

- Existing garbage collection enclosures should not open into the footpath, cycle-tracks or carriageway directly. They can be made a part of an exclusive complex that can accommodate the garbage collection vehicles and follow the standard recommendations for solid waste management.
- The streets leading to a garbage collection centre should be in a service lane with a lay-by, for easy loading of garbage into the truck.
- Two garbage chambers should be located within a radius of 0.5 km. They shall not be near hospitals, heritage monuments, and important landmark buildings.

3.1.2

H. Guardrails



Guardrails obstructing the crosswalk

Source : <https://osceolaefence.net/importance-of-highway-guardrails-for-highway-safety/>

Guardrails/Railings segregate the vehicular traffic on either side of the carriageway. They also restrict encroachment of the pedestrian zone by the vehicles. The design of guardrails shall ensure that there is no trespassing to maintain safety of users. Their placement and design shall be carefully co-ordinated with the design of other elements like the refuge and width of the median.

PLANNING & DESIGN : BEST PRACTICES

- Guardrails should be installed in high footfall areas like dense commercial areas, transit hubs, institutional areas and high speed corridors, to restrict movement of pedestrians within the dedicated zones and avoid erratic movement.
- The guardrails should be clear of a 1.8m (min.) wide pedestrian walking zone.
- Guardrail designs should be such that they do not protrude in the pedestrian zone or the carriageway.
- The top rail or surface should be such that they do not allow people to cross-over or use them as seating,
- Materials for guardrails should be durable and require least maintenance. Railings need to be aesthetically pleasing as per the context and should be aesthetically appealing to the street.
- Inappropriate barricades used as guardrails can cause inconvenience, especially for the pedestrians.
- Guardrails installed on the medians should have a gap as at the junctions and pedestrian crossings as wide as the crosswalks to allow a continuous pedestrian network.
- The guardrails should be set back from the edge of the carriageway by at least 150mm.
- To be clearly detectable, guardrail should be 1100mm high from the median level and painted in contrast to the surrounding, so that it is easily detectable by persons with low vision.
- Guardrails on the footpath should have rounded top to prevent injuries.

3.1.2

J. Bollards

Bollards should be placed such that they discourage vehicular movement inside the pedestrian zones. Their design should be able to integrate with the surroundings. It can also act as Public Art if designed contextually and thoughtfully and add character to the street.

PLANNING & DESIGN : BEST PRACTICES

- Bollards can have a variety of designs and shapes and should be pedestrian friendly. They should not cause obstructions to their movement.
- Its material should allow easy replacement and have a decent span of life, such as concrete bollards. They should be difficult to break or steal.
- Bollards should have light fittings or reflective radium materials to provide clear visibility in the dark.

ISSUES :

- Inappropriate placing of bollards can obstruct the pedestrian walkway.
- Excess spacing between bollards allow two-wheelers to encroach the zones designated for pedestrians.



Bollards segregating the pedestrian space from the carriageway

Source : ITDP Chennai Walkability

3.1.2 κ. Pedestrian Lighting

ISSUES :

- Dark zones often occur due to excess spacing between street lights that make the walkway zone unsafe.
- Light fixtures can get obstructed by trees/vegetation
- Absence of pedestrian lighting on streets discourage commuters to walk at night and increase dependency on motorised vehicles.

Lighting is a key element for creating a safe pedestrian network. Well-lit streets increase a sense of security and safety among the pedestrians. Pedestrian-scale lighting can help create pleasant public spaces and a sense-of-place in a community. Placement of lighting should be done in accordance with other elements such as trees seating etc. The design should add to the aesthetics of the street.

Pedestrian-scale lighting should be provided near transit stops, crossings, commercial areas, or other locations where nighttime pedestrian activity is likely. There are two levels of lighting of a streetscape:

- **Vehicular-oriented lighting** along the motor vehicle carriageway, placed at the edge of a footpath and sometimes combined with the furnishings zone. Different variations of pedestrian-scale lighting can be used to lessen the impact of ambient light.
- **Pedestrian-oriented lighting** along the footpaths and cycle tracks should be placed in the furnishing zone depending on the width of the footpath, it may also be combined with the edge zone or be on buildings. Street lights should be energy efficient, evenly spaced, and focused downward to reduce light pollution.

PLANNING & DESIGN : BEST PRACTICES

Full cut off fixtures with light focused downward and without glare should be used. They do not allow the light to filter upwards.

- Street light-poles should be designed according to the type/theme of the street. It should reflect the aesthetic significance of an area/street.
- Based on site context, street lights should be incorporated with traffic signs wherever possible.
- Concentrated lighting should be on all road intersections, junctions, and bus stops.
- Tree planting plan and lighting plans should be in conjunction so that tree canopies do not obstruct street lighting.
- Light pole and street signage should be coordinated to ensure they do not obstruct each other.
- Poles or fixtures should be placed without disturbing pedestrian flow.
- Light fixtures should be durable, energy efficient and resistant to environmental conditions.
- Usage of solar lighting should depend on the feasibility of the area, its cost effectiveness, and its requirement. Lighting of greater level and uniformity should be provided in areas with high pedestrian activity.



Street lighting inappropriately placed, leading to dark patches in between that render the street unsafe for pedestrians

Source : <https://parallax-wallpapers.com/post/72701128569/street-lights-in-a-dark-road-hd-wallpaper>

3.1.2 λ. Pedestrian Signals

ISSUES :

- Erratic crossing of roads by pedestrians due to lack of indication especially at mid-blocks. (i.e between two junctions)
- Signals can get obstructed by poorly maintained/ overgrown trees/vegetation
- Signals if wrongly placed is may not be used by the commuters.
- Inappropriate placement obstruct the pedestrian routes.



Auditory Traffic Signals

Source : <http://www.ottawasun.com/2013/10/29/more-countdown-audible-signals-for-traffic-lights-in-draft-budget>



PUFFIN Crossing Signals

Source : [https://en.wikipedia.org/wiki/Puffin_crossing#/media/File:Puffin_crossing_in_Belfast_\(35021074385\).jpg](https://en.wikipedia.org/wiki/Puffin_crossing#/media/File:Puffin_crossing_in_Belfast_(35021074385).jpg)

Traffic signals are essential to any junction/intersection/crossing to channel and regulate traffic movement. Its location should be such that it is visible at all times and is not obstructed by other amenities and vegetation. Its placement in the street should be such that it can be accessed by the pedestrians such as PELICAN lights.

Traffic signals help channelizing moving traffic. They are necessary at intersection to:

- Reduce traffic conflicts and delays
- Avoid accidents
- Economize on police time

Pedestrian signals at signalized intersections should notify pedestrians when it is safe to cross the street. Modern signals that incorporate countdown timers to display the number of seconds remaining before the signal changes to "Don't Walk", should be used.

Pedestrian Signal Location

Pedestrian signal indications should be used at all traffic signals. The international pedestrian symbol signal should be used rather than WALK/DON'T WALK text.

PLANNING & DESIGN : BEST PRACTICES

- Signal posts should be fitted with a long outreach arm over which traffic lights can be mounted above each lane.
- These signals should be integrated with CCTV cameras and cycle/pedestrian signals.
- Signal changes are needed to increase pedestrian safety and travel efficiency.
- Signal progression should be adjusted to calm traffic during high-pedestrian volume periods and to minimize congestion during vehicle rush hour.
- Leading pedestrian intervals (LPI) should be used to give pedestrians a head start in crossing before allowing motorists to cross.
- Pedestrian detection signals such as infra-red systems or 'pedestrian user friendly intelligent crossing' (PUFFIN) systems should be used to delay signal change until remaining pedestrians clear the intersection.
- Audible signals should be installed to indicate crossing intervals at major intersections.
- Countdown signals should be used to indicate crossing time to pedestrians.
- Signals should be located near the stop line at a height of min 5.5 m so that they are clearly visible from a recommended distance. This cautions drivers and deters vehicles from stopping on pedestrian crossings.

3.1.2

M. Signage

ISSUES :

- Inappropriate size of signage can be illegible
- Placing along the direction of the road makes the signage difficult to read
- Signage can get visually obstructed due to poor maintenance/over growth of trees/vegetation.
- Incorrect placement can obstruct pedestrian movement and misdirect commuters.



Multiple Signage

Source : <http://www.schreder.com/en/projects/signposts-for-genk-city-centre-transformation>



Multiple Signage

Source : <https://southseattleemerald.com/2016/02/23/rainier-beach-to-city-council-approve-our-plan/>

Signage enhances orientation and wayfinding for pedestrian as well as vehicular users. It includes direction signs, traffic signs, location signs, and emergency/hazard warnings. The information should be distinct and legible and their placement and material shall be in coherence with other elements and amenities.

Signage enhances pedestrian and vehicular mobility experience and helps in wayfinding. Signage includes direction signs, traffic signs, location signs, and emergency/hazard warnings. It shall be ensure that:

- It is lit at night and should be properly visible.
- It should be located at regular intervals with unified visual language.
- Signage must be clear, easy to read and easy to understand.

PLANNING & DESIGN : BEST PRACTICES

1. Light poles should be minimised. Multiple and related signs should be clustered around a single pole to avoid sign clutter.
2. Signage should be placed ideally on shoulders or on parking spaces or in multi-utility zones. If placed on a footpath, they should not obstruct pedestrian flow or access to properties.
3. Signage surface should be of durable weather-resistant material and should prevent glare.
4. The colour of signage should be in contrast to the surrounding surface in order to avoid confusion for people with low vision and blindness (as per IRC standards).
5. Design, colors and fonts of signage should be in accordance with IRC 67 –2010.
6. Vector signage should be used for wayfinding.
7. Signage should be maintained in terms of painting and installations to ensure they are clearly readable.
8. Regulatory and safety signage should be ideally placed along the edge zone or on the kerbside of a footpath so that they can be read easily by motorists and pedestrians.
9. Signage should be uniform in design and patterns for seamless continuity in reading them.
10. Height of directional signage from the lowest edge should be minimum 2.1 m from the level of the footpath.

3.1.2

N. Underground Utilities

ISSUES :

- Protruding man-hole covers can make the pedestrian zone unsafe.
- Concrete stubs i.e indicators of Gas lines, and Feeder pillars placed on the walkway zone obstruct the pedestrian routes, thus forcing the people on foot to walk on the carriageway.

Underground services are namely of the following types:

- Electrical Cables (HT/LT)
- Road Lighting Cables
- Communication Cables
- Cable TV
- Tele/Broadband Cables
- Traffic Signal Cables
- Gas Lines
- Water Supply Lines
- Unfiltered Water/Irrigation Lines
- Drainage Lines
- Sewerage Lines

Utilities are usually embedded underground and need periodic maintenance and repair. The placement in the streets should be such that it allows easy access for maintenance and does not obstruct the movement of the pedestrians during this phase. Their placement should be conceived at the initial stages of street design and should be carefully planned for minimal disturbance.

PLANNING & DESIGN : BEST PRACTICES

- The underground services should be carefully placed in order to cause minimum disturbance to street users during repairs and maintenance of utilities.
- Common utility ducts should be provided to carry services in order to prevent periodic digging up of roads for maintenance.
- Utilities should be placed in such a manner so that a specific utility can be individually serviced, repaired and maintained when needed.
- Locations should be decided after accounting for all the different utilities to be placed under the street.
- Utilities should not be located below the carriageway unless there is an acute lack of space in that area.
- Manhole covers and other obstructive utilities should be located within the edge zone or the Multi-Utility zone of the footpath in order to avoid disruption to pedestrian flow.
- Manhole covers should be flushed properly with the surface so as to have minimal level difference.
- Alignment of electric meters and feeder pillars should be parallel to the footpath near the building edge so that there is no obstruction to pedestrian movement.
- Utilities should be laid underground with proper care, namely electrical LT & HT lines, cable TV lines, fiber optical cables, etc.
- Stormwater drains need to be covered and be along the kerb of the footpath/multi-utility belt. Open jalis should be avoided.
- To avoid misuse, utility covers should not be easily recognizable. Instead they should carry relevant information like utility names, logos, etc.
- Placement of sewage and water pipes is not advisable within the duct bank.

3.1.2

P. Public Art

ISSUES :

- Public Art is most vulnerable to vandalism as its intent is not clear due to lack of information or awareness.
- Public Art installations can obstruct the pedestrian routes when installed outside the multi-utility zone.



Interactive Public Art
Source: Connaught place



J.M. Road, Pune
Source: [Online], Available from: <https://in.pinterest.com/explore/street-art/?p=true>

Public art has the ability to transform a street by imparting identity, improving the character and adding visual interest. It also activates the street by introduction of playful elements. Public art shall be contextual, of appropriate scale and durable material.

PLANNING & DESIGN : BEST PRACTICES

- Public art can impart visual interest, initialize public discourse in areas they are installed in.
- Public art can be located on streets with high pedestrian footfall, but should not block the pedestrian movement.
- The work of art should impart an identity/image to the space and should be contextual to the surroundings. It should be able to become a tool for efficient placemaking.
- Public art can be incorporated in street furniture such as benches, street lights, various spaces on the streets and on other such furniture.
- Proposed public art should be able to engage the audience and not distract or confuse them. It can often impart a social message.
- Art can provide information, such as maps and signage, or be educational and provide information about history and culture of Delhi and its neighborhood. Art does not necessarily have to be educational, it can be playful.
- Public art should be accessible to people with disabilities and must not be placed in a way that compromises the clear path of movement.
- Art pieces may require detectable warning strips around the base of the art piece.
- Public art should be addressed during the planning and design phase to ensure it closely integrates with other streetscape elements.

Note : For further guidelines and specifications refer 'Draft Public Art Policy' by DUAC

3.1.2

Q. Pedestrian Crosswalks

ISSUES :

- Absence of designated points to cross the street creates confusion for the motorists as pedestrians cross the roads at random points.
- Absence of crosswalks does not make streets inclusive for the slower commuters on foot such as - the physically disabled, aged and children, who need the vehicles to halt completely while they cross.



Signalised Crossing
Source: Bangalore



Auditory Pelican Signals
Source: [Online], Available from: <http://www.telegraph.co.uk/motoring/road-safety/10290501/Pedestrians-tricked-by-placebo-buttons-at-crossings.html>

Pedestrian crossings facilitate safe crossovers for the users. These are located at junctions and sometimes at midblocks where significant pedestrian movement is anticipated. Pedestrian crossings should be provided at all traffic-controlled intersections to facilitate safe crossing for pedestrians.

Preferable spacing as per land use:

- 120 m (min. distance) for commercial areas
- 150 m (min. distance) for residential areas
- 200m (min. distance) for industrial areas

Placement of pedestrian crossings should not create conflict with traffic using U-turns. Streets with two or more lanes in each direction and signalized crossings should be designed with refuge islands at junctions. Mid-block crossings should be supported by traffic calming measures.

I. SIGNALISED CROSSINGS

These are the most common type of street crossings, which suits all kind of contexts.

PLANNING & DESIGN : BEST PRACTICES

- Signalised crossings should be placed such that it is visible from a distance of Min. 100 m.
- It is preferable these crossings are installed with auditory signals that are synchronized with traffic signals to provide assistance to the differently-abled.
- Traffic calming treatment should be least 25 m before a crossing.
- Stop-signals or signal-controlled marked crossings with limited crossing visibility or with non-standard geometry, risk poor driver compliance. So they should have advance stop and yield lines.
- Full signal crossings should be located either at street junctions or at mid-blocks where the medians are punctured to allow vehicular crossings and have provision for full turns for all types of vehicles.
- Kerb extension should be provided to maintain proper pedestrian visibility.
- Crossings should be at least as wide as the footpath and wider in locations with high pedestrian demand.



Mid Block Crossing in a Commercial Area

Traffic Surveyors; Source: <http://trafficsurveyors.com/services/pedestrian-survey/>



Mid Block Crossing with a Pedestrian Refuge

Source: [Online], Available from: https://nacto.org/wp-content/themes/sink_nactoviews/design-guides/retrofit/urban-street-design-guide/images/pedestrian-safety-islands/carousel/nycdot_pedsafetyisland.jpg



Mid-Block Crossing

Source: [Online], Available from: <https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/midblock-crosswalks/>

- Crossings should not be less than 3 m in width in order to ensure seamless crossing of pedestrians. A more desirable width is 5 m.
- Crossings should be equipped with kerb ramps and tactile warning strips.
- Stop and yield lines should be located 1 to 15 m ahead of crossings depending upon location, roadway configuration, vehicle speed, and traffic control.
- Wayfinding signage and directional guidance for pedestrians should be provided at street intersections.

MID-BLOCK CROSSINGS

Mid-block crossings are located at mid-block with the median punctured minimally to allow pedestrians and non-motorized vehicles to cross the road safely at-grade. These crossings are preferred at mid-block, transit/bus stops, and long blocks, which are greater than 250 m. They attract pedestrians, especially in shopping areas, schools, community centers, etc.

PLANNING & DESIGN : BEST PRACTICES

- Mid-block crossing placement/location should be such that the signage is visible from min. 100 m distance.
- Mid-block crossings should be installed with auditory signals to assist the specially-abled. The pedestrian signal should last for minimum 20 seconds or should be synchronised with the nearest full traffic signal.
- Mid-block crossings should be provided at regular intervals as per the following standards:
 - **Residential Areas:** Spacing range of a mid-block crossings should be within every 80 to 250 m, and should be coordinated with entry points to residential complexes, bus/train stops, public facilities, etc.
 - **Commercial/ Mixed Use areas:** Spacing range of a mid-block crossing should be within every 80 to 150 m in order to facilitate easy transition for both residents and visitors.
 - **High Intensity Commercial Areas:** It is preferable to have pedestrian only streets in order to reduce the probability of discomfort to the pedestrians.
- Mid-block crossings should be located based on pedestrian movement, building entrances, attractions, etc.
- Overhead signage and lights should be included at mid-block crossings to guide pedestrians.
- Kerb extension should be provided for on-street parking in order to maintain pedestrian visibility.



Raised Crossing

Source: [Online], Available from: http://www.pedbikesafe.org/PEDSAFE/cm_images/RaiPed1.jpg



Raised Crossing

Source: [Online], Available from: http://www.pedbikesafe.org/PEDSAFE/cm_images/RaiPed1.jpg



Raised Table Top Crossing

ITDP; Source: https://www.itdp.in/wp-content/uploads/2014/04/05-Footpath-Design_Handout.pdf

- Raised crossings should be provided as an alternate to traffic calming wherever necessary where there is lack of space.
- At-grade mid-block crossings should be staggered to orient pedestrians towards oncoming traffic.
- Refuge-islands are a must at mid-block crossings for roads of ROW 18 m and more or where pedestrians need to cross more than two lanes at a stretch.
- Raised mid-block crossings or table-top crossings need to be supplemented by traffic calming measures like kerb extensions.
- The height of raised mid-block crossings should be at the same level as the footpath so as to provide a smooth transition for pedestrians.
- The crossing should have sufficient signage and illumination to help pedestrians cross.
- Mid-block zebra crossing should be provided only when the distance between two consecutive intersections is more than 250 m and a high volume of pedestrians need to cross the street.
- Reflective paints, cat's eye, bollards and light poles should be used to provide better visibility to pedestrians.

RAISED CROSSINGS

A raised crossing is essentially a speed table with the full width of a crosswalk contained within the flat portion of the table. It is usually 3 to 4.5 m wide. It combines the benefits of a raised speed reducer with enhanced visibility of pedestrian crossings. It compels drivers to travel at a speed as mandated by the design of the street thus improving awareness of a pedestrian crossing, particularly at mid-block.

PLANNING & DESIGN : BEST PRACTICES

- Raised crossings bring the level of the roadway to the level of the footpath, forcing vehicles to slow down before passing over the crossing.
- It helps to enhance the crossing by providing a levelled pedestrian path from kerb to kerb. It increases visibility of pedestrians and helps them to cross safely by physically slowing down the traffic.
- Raised crossings should be located at slip roads (free left turns), mid-block crossings, intersections between high-volume and low-volume streets, neighborhood residential streets, etc.
- Raised crossings should be avoided on arterial roadways as it would be unsafe at the speed at which vehicles travel on them.



Raised Intersection

Source: [Online], Available from: <https://nacto.org/wp-content/themes/>

- Appropriate warning signs and roadway markings should accompany raised crossings.
- Enhanced and high visibility street materials should be used to draw attention to raised crossings.
- The crossing should be applied at areas where demand exists for a stop-controlled pedestrian crossing, especially on narrower streets (maximum of two moving lanes), etc.
- On the slope of the raised crossing, materials with rough texture with gratings should be used in order to slow down the speed of a vehicle.
- Raised crosswalks should be elevated to the level of the adjacent footpath, (75 –150 mm above road surface) with ramps for motor vehicles. The slope for vehicles should be at least 1:4.

4. Raised Intersection

An entire intersection raised above the level of the surrounding roadways to the height of the footpath is known as a raised intersection. It helps in encouraging vehicles to reduce speed and visually provides a sense of a pedestrian-oriented zone. It acts as a controlled intersection for crossings with high pedestrian volume and targets bringing down vehicular speed. It helps in enhancing pedestrian movement in locations such as transit stops or commercial areas.

PLANNING & DESIGN : BEST PRACTICES

- Slope of entrance ramps for motorized traffic can be steep or shallow, depending on target speeds.
- Enhanced high-visibility street materials should be used to draw attention to raised intersections.
- It should be avoided on truck routes and other locations where use of raised intersections to reduce speed is not appropriate.

CROSSWALKS/ZEBRA CROSSINGS

Crosswalks delineate an area for pedestrian movement and **stops** perpendicular traffic. It is aligned with the through movement corridor on the footpath. It marks where vehicles are required to stop at signalled and un-signalized intersections. Painted crosswalks do not improve pedestrian safety unless accompanied by a speed bump or speed table. At un-signalized mid-block locations, informal crossing points should be provided without painted zebra markings.

PLANNING & DESIGN : BEST PRACTICES

- At-grade crosswalks are preferred by pedestrians. Zebra crossings on street with heavy traffic should be provided with pedestrian operating signals.
- At-grade pedestrian crossings must be provided at all 4-way intersections, T-junctions and traffic-controlled



At-Grade Zebra Crossing

Source: India.com; <https://www.india.com/car-and-bike/latest-news/news-cars/delhi-gets-its-first-ever-3d-zebra-crossing-3295254/>



Zebra Crossing

Source: Traffic Police, Raj Path, New Delhi

junction legs.

- Zebra crossing should join footpaths on both sides from edge to edge while connecting refuge spaces in between.
- Raised medians, railings or other obstructions should not be placed on zebra crossings. If a street has a median, handicap access shall be made possible by maintaining the refuge space at the same level as the street.
- Informal crossings in the form of cutouts should be provided at regular intervals on fenced medians to prevent risky crossings.
- At formal and informal crossings, parking lanes should be converted into bulb-outs in order to reduce the crossing distance for pedestrians. A zebra crossing should be always accompanied with a stop line.
- Tactile pavings should be embedded in zebra crossings in order to guide the differently-abled.
- Crosswalks should be as wide as the adjacent footpath, but it should not be less than 2 m.
- Formal pedestrian crossings and vehicular ramps are required on major streets. In between formal crossings hardscaped pedestrian refuge islands should be provided at regular intervals of approximately 50 m.
- A zebra crossing should be 3 m in length and 0.3 m in width with coloured strips at 0.3 m gaps.
- Zebra crossings can be painted in thermoplastic paint in white or yellow colour. It should be easily visible and highlighted with reflective cats eye.

3.1.3

Medians & Refuge Islands

ISSUES :

- Poorly designed medians allow vehicles to make u-turns at random points.
- The refuge islands on the median become unsafe without proper barriers.



Pedestrian Refuge Island

Source: ITDP. https://www.itdp.in/wp-content/uploads/2014/04/05-Footpath-Design_Handout.pdf



Refuge Island with Mid-Block Crossing

Source: [Online], Available from: <https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/pedestrian-safety-islands/>



Refuge Island, New York

Source: [Online], Available from: <https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/median-refuge-island/>

Medians or dividers are raised barriers that separate a street in two halves and direct traffic flow. Medians help to streamline traffic and avoid conflicts between traffic moving in opposite directions. It enhances pedestrian safety and accessibility by reducing crossing distances by providing a refuge island to cross the road in stage. Medians are an opportunity for planting, drainage and groundwater recharge.

PLANNING & DESIGN : BEST PRACTICES

MEDIANS

- Medians wherever provided must have a minimum width of 1.2m and can vary as per ROW.
- Maximum height of a median kerb should be 0.15m
- Medians should be made green to beautify the streetscape with trees or vegetation including storm water source controls. Trees increase the visibility of an island, thereby improves safety.
- Medians should be provided only on roads where design speeds are greater than 20-25 km/hr.
- Median design should allow emergency vehicle movement and access, but should not be used inappropriately to make U-turns.
- Median placement and design should take into account underground utilities.
- For central medians to be continuous they should not have cuts or breaks in between.
- Railings or concrete dividers should be designed in such a way that they are easy to replace or repair but difficult to lift or move.
- Medians can use colors to make them easily visible. They should have reflective materials like cats eyes or be fitted with radium easy visibility at night to avoid accidents.
- Medians should extend beyond the crosswalk at intersections wherever possible. They should not infringe on the crosswalk width at intersections such that there is space for turning vehicles.
- Medians should be made adjacent to BRT lanes. They should have longer stretches of guardrail and breaks at formal crossings at 150–200 m.
- Vertical elements such as bollards, trees, banner, slight poles, etc., should be included in medians to enhance the visibility.
- Medians should be provided with tactile cues for pedestrians with visual impairments. It helps them to differentiate between pedestrian refuge areas and the carriageway.
- Medians should be designed to retain, cleanse, and infiltrate storm water runoff from the roadway. In the process it helps to replenish the groundwater and decrease the peak flow burden on storm water infrastructure.



Refuge Island, New Delhi



Pedestrian Refuge Island

Source: [Online], Available from: https://nacto.org/wp-content/themes/sink_nacto/views/design-guides/retrofit/urban-street-design-guide/images/pedestrian-safety-islands/carousel/nyc_nycdot.jpg

- Trees should be clustered where shade is needed, such as at pedestrian crossings of the median, while also ensuring pedestrians are clearly visible to oncoming traffic.

REFUGE ISLAND

- Refuge islands are to be provided at all intersections, which require pedestrians to cross two-way traffic or two or more lanes.
- Clear width of a median refuge island should be 1.8 m.
- If the kerb-to-kerb carriageway width is 11 m or narrower, periodic pedestrian refuges should be added to enhance safety. If a carriageway has a width of 12 m or more, a continuous walkable median for pedestrians (maximum elevation 150 mm) is advised.
- In order for a median to function as a refuge island, a minimum width of 1.0m should be provided. For a cycle refuge, a minimum width of 2.0 m is advised.
- Guardrails and high kerbs are discouraged because they hinder pedestrian and cycle movements.
- Median cycle boulevards reduce conflicts between cycles and motor vehicles and discourage encroachment by parked vehicles. To make the median accessible to cyclists, ramps should be provided at regular intervals of about 50m.
- The buffer between a BRT lane and the carriageway should be widened to 1.0 m in order to serve as a pedestrian refuge at formal crossings.
- For corner traffic management, median spaces near intersections should be treated as refuge spaces. The minimum width of refuge islands should be 0.9 m.

3.1.4 Pedestrian Grade Separators

ISSUES :

- Poorly designed medians allow vehicles to make U-turns at random points.
- The refuge islands on the median become unsafe without proper barriers.



Footover Bridge

Source: [Online] <http://toolkit.irap.org/default.asp?page=treatment&id=17>



Footover Bridge, Cyber City, Gurugram

Source: [Online], Available from: <http://www.skyscrapercity.com/showthread.php?t=1922507&page=21>

Pedestrian Grade Separators include :

- Foot Over Bridges (FOB)
- Elevated Walkways
- Sub-ways

PLANNING & DESIGN : BEST PRACTICES

- In the proposed urban extension, streets having ROW 30 m and above should have space reserved for grade separators, cloverleaves and left slip roads at intersections.
- Grade separated junctions shall be considered on roads having no other possibility of including traffic flow.
- The grade separators should reserve separate areas for pedestrians and cyclists. Grade separated infrastructure needs to address the requirements of both current and potential cyclists.
- Foot overbridges should be provided only under circumstances where no at-grade crossings are feasible.
- Underpasses should not be provided unless no other solutions (including FOBs) are feasible.
- Grade separation of intersecting motorized vehicle carriageway, flyovers, etc., may be suitable for highways or expressways.
- Grade separation of cycle and pedestrian traffic across high-speed and high volume motorized vehicle carriageways should be provided to ensure safety of cyclists and pedestrians.
- Pedestrian bridges, tunnels and flyovers should not cause visual obstacles at any point, especially on highways.
- Direct pedestrian route should be provided in areas like elevated Metro stations, stadiums, etc., where there is extensive pedestrian flow.
- The design of a grade separator should be based on its requirements and the availability of space for construction.
- FOB's should be designed to cater to pedestrian traffic only in the absence of an at-grade crossing solution.
- Tactile paving/tiles and colour contrast should be provided at the top and bottom of a flight of steps. The steps should be well lit in order to guide both general and differently-abled pedestrians.

3.0

Street Design Recommendations

3.1 Pedestrian Zone

3.2 Vehicular Zone

3.3 Universal Accessibility

3.2.1

Vehicular Zone Specification

ISSUES :

- Absence of designated walkway zones alongside the carriageway force pedestrians to walk on the vehicular zone leading to pedestrian-vehicular conflicts.
- Insufficient parking zones may lead to encroachment of pedestrian walkways by vehicles due to absent barriers/buffers like bollards/guardrails.

The vehicular zone should be designed to cater to the expected traffic volumes. The street design should ensure equitable distribution to non-motorised vehicles including bicycles, rickshaw etc. The vehicular zone should be designed to minimize the conflict between pedestrian and vehicular movement.

KEY PRINCIPLES

1. REDUCING VEHICLE SPEED

- Vehicle speed is a significant determining factor in safety with various conflicting modes.
- Vehicle speed in heavily populated areas should be kept below 50-70 km/h on arterials, 20-30 km/h on Collector and 10-20 km/h (UTTIPEC) on local streets to reduce severity of accidents.

2. ENSURING PEDESTRIAN SAFETY

- Shorter crossing distances and pedestrian priority at signals reduce pedestrian and bicycle exposure to risks of accidents.
- Locations where pedestrian safety is of special concern, such as near schools, traffic calming devices should be integrated as part of the new street design process.

3. RESPONSIVE MECHANISMS

- Traffic calming help users to accurately predict and respond to their surroundings.
- It enables efficient management of the traffic by managing traffic speed rather than redirecting the traffic to adjacent streets.



3.2.2

Carriageway Design

ISSUES :

- Lack of traffic calming elements can lead to over-speeding of vehicles and thus accidents.
- Streets without shading makes the commute uncomfortable for the motorists.
- Absence of clear visual demarcation of elements on the carriageway can confuse the vehicle users.
- Absence of designated lanes for larger vehicles such as buses can lead to chaos on busy streets



Carriageways in Delhi

Source : DUAC



Carriageway

Source: [Online] <https://timesofindia.indiatimes.com/city/delhi/riot-of-spring-colours-heralds-end-of-winter/articleshow/74532573.cms>

Carriageway design should ensure clear segregation for movement of vehicles, turning, stopping at intersections and lane changing by means of appropriate design including lane markings, railings, bollards etc. which ensure no-conflict and seamless movement between different modes of transport.

CARRIAGEWAY

Carriageway is the portion of the right of way that is dedicated to motorized vehicles. It should be well defined and demarcated using lane markings. It can be divided using a median, or a railing, or both depending on the intensity of traffic. It should have clear defined boundaries created with the help of kerbs and material distinctions. Parking, hawking /vendors, jaywalking, encroachments and laying of utilities should not be allowed on the carriageway.

MIXED CARRIAGEWAY

Narrow or local streets with low vehicle volume and high pedestrian volume can be converted into a shared street where the carriageway could be minimized in comparison to the sidewalk.

PLANNING & DESIGN : BEST PRACTICES

- The carriageway should preferably be oriented at right angles to enhance the blending of traffic with ease.
- Width of the carriageway should be constant irrespective of crossings or intersections unless there is a change in their hierarchy. The hierarchy can be achieved by demarcating lanes using reflective paint to ensure overall safety.
- Traffic calming devices should be installed at intervals in order to guide vehicles to maintain steady constant speed.
- As per land use and context, a carriageway width should optimally be designed to take into account all modes of transport, such as NMT, public transport, motor vehicles, pedestrian count/flow, etc.
- Clear boundaries should be defined through kerbs and material differences.
- The carriageway should have a levelled surface in accordance to the adjacent elements such as footpath, etc., along with a gradual slope (camber) without abrasions to drain off water.



Mixed Carriageway

Source: <http://njbikeped.org/wp-content/uploads/2015/07/shared-space2.jpg>



Mixed Carriageway

Source: Pradeep Sachdeva Architects, Delhi

- The width of a street should be defined by the function of the street and the surrounding context rather than the available right-of-way.
- Services should not be provided underneath the carriageway as it creates inconvenience during repair and maintenance of the utilities and disrupts smooth traffic flow.
- Signage promoting road safety and driver behaviour
- The design of a mixed/shared carriageway should take into account both vehicle and pedestrian flow. Only if the situation permits, mixed street concept should be adopted.
- Permeable and durable material with lush green cover on both sides of the mixed carriageway to facilitate storm water management and to beautify the area.
- Signage promoting road safety and driver behaviour should be installed along the carriageway as a pre-warning or caution to users. They should be installed along the carriageway as a warning/caution to users.
- Reflectors should be installed alongside the carriageway to indicate the edge of the carriageway and pedestrian walkways .

3.2.3

Traffic Calming Methods

ISSUES :

- Absence of Traffic calming methods encourages over speeding by the vehicles at crossings and intersections leading to pedestrians-vehicular conflicts/ road-accidents.



Speed Hump

Source: <https://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements/speed-hump/>

Traffic calming is essential to control vehicular speeds especially in areas that have high pedestrian activity. The traffic calming methods work best when two or more mechanisms are combined. Their location and use should be contextual and be designed appropriately for comfortable access for pedestrians and cyclists. Traffic calming helps to reduce the impact of traffic on residents, pedestrians and other users by reduction of vehicular speed. It can take different forms depending on the context and is most effective where two or more mechanisms are combined.

I. RAISED SPEED BREAKERS

- Speed humps are one of the most effective traffic calming devices and can be used on virtually any kind of road with posted speed limits of up to 50 km/hr.
- The two basic types of raised speed reducers are speed humps and speed tables.
- Trapezoidal humps with a flat top is generally 2.5 m wide. A flat top with a width of 8 m or more is known as a platform or table top.
- While a speed hump is relatively short in length (4 m long), a speed table is longer (7 m to 9 m long), with a flat section in the middle, which acts as a raised pedestrian crossing.
- Speed cushions are a type of speed hump designed primarily for emergency vehicles, buses, and trucks. On the other hand, table-top crossings are designed for comfortable pedestrian access with reduced speed of mobility.
- The gap between speed humps depend on the speed it aims to achieve. To maintain a speed of 30 km/hr the gap varies between 50 m to 100 m. For a speed of 50 km/hr the humps are spaced between 80 m and 150 m apart. Depending on the intended speed, the design of the speed humps is calibrated.

PLANNING & DESIGN : BEST PRACTICES

- Speed reducers should have appropriate warning signs on the roadway.
- Table-top crossings are generally applied on intersections and mid-block crossings to slow down vehicles and allow pedestrians and cyclists to cross safely.
- Recycled material should be used for paving of speed reducers.
- Raised speed reducers should be located in the middle of a roadway with the gutters kept clear for road drainage.
- It is advisable to use rumble strips 50 m - 100 m ahead of speed humps to caution vehicles on arterial road.



Paving variations at Crossings

Source: <https://socialmillennial.com/2014/10/22/love-haters-and-hipsters-the-irony-of-being-a-millennial/>

2. PAVING VARIATIONS AT CROSSINGS, STOP SIGNS, INTERSECTIONS

Areas lacking space for installing traffic calming devices can use colour variations to calm traffic.

PLANNING & DESIGN : BEST PRACTICES

- Paving material or colour at crossings should be used to provide visual continuity to pedestrians and to make crossings clearly visible to drivers from a distance.
- Rumble strips and bars generate a lot of noise and hence should be avoided in residential streets.



Mini Traffic Calming Circles

Source: <http://www.ouruptown.com/2012/04/traffic-calming-potential-strategies/>

3. MINI TRAFFIC CALMING CIRCLES

- Mini-traffic calming circle is a raised island located in the centre of an intersection around which traffic moves. They are ideal for streets, 30-40 m or lower, where design speeds are to be kept below 30 km/hr for safety reasons.

PLANNING & DESIGN : BEST PRACTICES

- Mini traffic circles should be large enough to force cars to slow down to go around them; but the outer two feet of the circle should have a low kerb in order to allow emergency vehicles when necessary.
- Mini traffic calming circles should not be confused with full roundabouts. As the latter handles higher traffic volume and encourages free flowing and faster movement of motor vehicles. This makes full roundabout intersections less safe for pedestrians.
- Typical speed of movement around the circle should be 15 - 25 km/hr; exit speed should be limited to 25 km/hr. The circles should be designed for this speed wherever possible.
- Centres of mini traffic circles shall be attractively landscaped. Planting of local, drought-tolerant and low-maintenance plants is encouraged.
- Rain gardens and local planting in traffic circles can be provided for storm water treatment. It helps to reduce run-off and seasonal flooding. It thus reduces the pressure on the existing storm water infrastructure.
- Full roundabouts are not recommended, unless 5 or 6 arm road intersections have to be handled.

3.2.4

Design for Transit

ISSUES :

- Transit between two modes of transport often has connectivity issues due to lack of a continuous and well facilitated pedestrian and NMV network, safe boarding-de-boarding points/bays, parking and ride options for cyclists and motorist.
- Due to the absence of designated routes between different transit hubs, pedestrians face issues related to their safety and security.

An efficient transit network demands seamless transition between various modes of transport. This can be enabled by appropriate placement and design of transit hubs including Metro, bus rapid transit, Lay-bys for taxis and private buses etc. The access to the transit modes should be well-defined and provide universal accessibility. Segregation of vehicular and pedestrian zones should be clear for safe and comfortable movement of the commuters. Signage in these modes should be appropriately placed to ensure wayfinding in the complex systems.

Types of Transit Modes

I. METRO

Entrances to Metro stations should be placed in the furnishing zone of the pedestrian realm along the street. If required, the minimum and maximum pedestrian realm dimensions can be used to accommodate a Metro station entrance.

PLANNING & DESIGN : BEST PRACTICES

- Elevated Metro stations or Metro terminals should not cause any hindrance to pedestrians and the flow of motor vehicle movement. The Metro entrance should not obstruct the through zone.
- The terminals should have sufficient setback from adjoining properties. If required the road should be widened in stretches.
- Full access should be provided to people with mobility impairments. Streets with a dedicated or elevated Metro/monorail should have minimum 2.5 m footpaths on both sides.
- A footpath of minimum 3 m width is required near terminals and stations that expect major pedestrian footfall.
- If an elevated Metro or a monorail station is constructed with columns/pillars on the carriageway, a minimum clear width of 6 m carriageway should be available for the on-going traffic.



Entrance to Metro Station

Source: <http://parisdesignagenda.com/wp-content/uploads/2016/03/Design-Icon-The-Best-Paris-Metro-Entrances-5.jpg>



Entrance to Metro Station

Source: https://en.wikipedia.org/wiki/Central_Secretariat_metro_station



Buses are a major form of Public Transport in the city

Source: <http://3.walesonline.co.uk/incoming/article/10694533.ece/ALTERNATES/615/579759442.jpg>



Bus Rapid Transit

Source: https://upload.wikimedia.org/wikipedia/commons/thumb/0/03/Harmoni_Central_Busway_Transjakarta_1.JPG/1200px-Harmoni_Central_Busway_Transjakarta_1.JPG



Ahemdabad BRT

Source: [Online], Available from: http://itdp.in/wp-content/uploads/2015/07/who-we-are_cover.jpg

2. BUS

Access to bus-stops should be unobstructed by other furniture and elements of the street. The zones should have ramps and guardrails to facilitate the physically disabled.

PLANNING & DESIGN : BEST PRACTICES

• Connectivity

- Bus connectivity needs to be planned extensively in the form of feeder services to the Metro Rail stations and the rail system.
- Park and ride facilities have to be developed at important bus terminals.
- New bus terminals should be planned and developed in strategic locations to make use of BRTS and Metro stations convenient to all commuters.
- Bus routes and stops should form key elements of a walkable neighbourhood. Layouts should be designed with strong local networking, avoiding long one-way loops or long distances without passenger catchments.
- Streets with dedicated bus routes should be minimum 6 m wide.
- New bus terminals should be planned and developed in strategic locations to make use of BRTS and Metro stations convenient to all commuters.
- The gap between a platform and the entrance to a bus should be minimal.
- Timetables should be easy to read. It should be easy to understand directions via large print formats or touchscreens.

• Bus Rapid Transit

- Every BRT should have clearly marked platform edges with contrasting colours and tactile surfaces.
- BRT's should have all elements incorporated, for eg. kerb ramps and other accessible features.
- Exclusive bus lanes must be provided except on small streets where mixed traffic runs as one-way on one side of the street.
- The minimum desirable width of a BRT lane should be 3.3 m with a buffer space next to mixed traffic.
- At crossings, a minimum 1 m pedestrian refuge should be given between mixed traffic and a BRT lane.
- If centrally located, BRT stations require a minimum of 3 m (preferably 4 m) in the cross section. Larger widths may be required if demand is high.
- Safe pedestrian access via crosswalks should be elevated to a minimum desirable level of 150 mm, same as that of a footpath.
- Stations should be placed 37 m or more off the intersection stop lines to create sufficient space for bus and mixed traffic queues to move.



Bus Lanes

Source: https://i2.wp.com/nycstreetsblog.org/wp-content/uploads/2017/02/queens_bus_lanes.jpg?w=525&crop=0%2C0px%2C100%2C320px



Bus Stop

Source: http://road.cc/sites/default/files/styles/main_width/public/images/News/Manchester%20Oxford%20Road%20bus%20stop%20bypass%20image%20supplied%20by%20TfGM%29.jpg?itak=L9Qxp27v



Bus Lanes in the Middle of the Carriageway

Source: <https://www.infrastructure-ni.gov.uk/articles/use-bus-lanes>

- Cycle parking should be provided at stations as an option for the users to complete their trip.
- The BRT lanes plus buffer normally require minimum 7.6 m at a street cross section. At stations, the width may increase to 11.6 m, with an additional 4 m width for on-street parking lanes.
- Pedestrian access to the station should be provided via a raised crosswalk to ensure safety.
- A 30 m right-of-way can accommodate BRT along with pedestrian footpaths, cycle tracks, on-street parking, and a local street carriageway,

• Bus Lanes

- Bus lanes and busways may be located adjacent to the kerb or in the middle of a road with boarding island stations (median bus lane or busway), based on the requirement.
- All bus lane and busway types can be one or two lanes in each direction based on bus volume, operating characteristics, and the road width.
- A median bus lane and busway should be considered on two-way streets when sufficient right-of-way is available. It should accommodate the bus facilities and its associated boarding islands while managing both bus and pedestrian movement safety.
- For median bus lane or busway designs, boarding platforms must be included for bus passengers at bus stops, which can also function as median safety islands. In such cases left turns across the bus facility should either be prohibited or provided as a protected lane.
- A kerb-aligned bus lane or busway should be used when ROW may be constrained or the median facility is not operated safely, impacting the adjoining parking area.
- At locations where dedicated bus lane is not feasible but a bus lane is necessary, the option of elevated exclusive bus lanes can be explored.
- Proper provision for street crossing to access a median bus station can be made with clear signage.
- All bus lane and busway designs can accommodate one or two directions of bus traffic. Special considerations for signals and design of intersections should be made in order to avoid turning conflicts.
- Dedicated bus lanes are generally recommended for streets with moderate to high bus volume that lead to traffic congestion.
- Bus lanes should be segregated from the main carriageway by a median or railing. Bus lanes should be avoided where the roadway geometry prevents safe operation of a bus lane or a busway in conjunction with other necessary uses of the roadway.
- Dedicated bus lanes are recommended on all roads with ROW 24 m and more. The recommended width of a bus lane should be a minimum 6 m to allow a two-way bus flow.



Shade must be provided at major Taxi Stands

Source: [Online], Available from: <http://www.hongkongextras.com/resources/Latest+-+DB+Taxi.jpg>



Cycle Track and Carriageway separated by a Green Buffer

Source: [Online], Available from: <https://bikeeastbay.org/sites/default/files/images/alameda2wayCycleTrack.jpg>



Cycle Track and Carriageway separated by Kerb Stones

Source: BRT Corridor, Delhi; UTTIPEC Street Design Guidelines



Cycle Track with different colour Paving

Source: <https://www.insauga.com/top-5-roads-in-mississauga-for-segregated-bike-lanes>

3. TAXIS & PRIVATE TRANSIT (INTERMEDIATE PUBLIC TRANSPORT)

Intermediate Public Transport (IPT), sometimes known as Para transit, refers to road vehicles used on hire for flexible passenger transportation, which do not follow a fixed time schedule. They may or may not follow a fixed route. Para transit services include: cycle rickshaws, auto rickshaws, taxis etc. This form of transport bridges the gap between the private transport and formal public transport modes in cities.

PLANNING & DESIGN : BEST PRACTICES

- Lay-bys to be provided for taxis and private buses near major destinations. Amenities like Taxi stands, to be appropriately shaded for waiting passengers.
- Where the introduction of lay-by affect pedestrian activity or bicycle facilities, parking should be eliminated on the frontage lane. The combined width of the edge and furnishing zones should be narrowed in such cases.
- Extra space for taxi lay-bys should be created for waiting passengers by eliminating parking at frontage lanes. This will allow expansion of the side median, shrinking of the furnishing zone, and re-aligning of the frontage lane.
- The design of lay-bys should enable taxi and other transit drivers to stop clear of carriageways. They should always be provided at intervals along long straight routes with guide maps and other public conveniences to enable drivers to stop clear of carriageways.
- Suitable arrangements should be made for drainage of surface water from lay-bys. They should normally be 3 m wide and at least 30 m long with 15 m end tapers on both sides.

4. SEGREGATED CYCLE & NMV LANE

CYCLE LANE

- A portion of a roadway within a specified ROW designated exclusively for bicyclists. It is marked by striping signs on the pavement.
- A 1.5 – 2.5 m wide bicycle lane reserved for cyclists that is designed to discourage drivers from blocking bicyclists in this lane.
- The parking lane should be reduced to a minimum width while the bicycle lane will be increased to maximum width, if the bicycle lane is located adjacent to street parking.



Well Planned Carriageway with segregated lanes for cyclists and on-street parking

Source: <http://fbtarch.com/wp-content/uploads/2015/01/complete-streets.png>

CYCLETRACK

- A track intended for the use of bicycles that is physically separated from motorised vehicle traffic by an open space or barrier within the existing ROW.
- Cycle tracks, pedestrian and disabled friendly features should be provided in all arterial and sub-arterial roads as per MPD-2021. Minimum acceptable width for single lane movement is 2.0 m.

PLANNING & DESIGN : BEST PRACTICES

- The easiest location for cycle tracks is on the carriageway between parking and the travel lanes. It provides continuity and simplicity of implementation.
- NMV lane should be constructed on both sides of the street with smooth-finished cement concrete or asphalt. It provides a smooth riding surface that requires low maintenance.
- Bicycle facilities should be highlighted with colored material, especially at junctions and other conflict zones.
- Street-side cycle tracks should be provided where parking encroachments from commercial activity are minimal and a service lane is available.
- Intersections should be available for cyclists to change his/her direction without hampering the continuity of the cycle track.
- Cycle tracks located on wider roads should not affect the larger network of cycle tracks.
- Cyclists should have a barrier-free design. Junctions should be designed to slow the speed of motor vehicles as it forms the point where motorists interact with cyclists.
- Bicycle lanes crossing a bus stop should be marked clearly and preferably routed behind the bus stop.
- A cycle track should have a minimum clear width of 2 m for one-way cycle movement, minimum width of 2.5 m to accommodate cycle rickshaws and a minimum width of 3 m to accommodate two-way movements.
- The surface of a cycle track should be of smooth surface material such as asphalt or concrete. A continuous shade through tree cover over the track is desirable.
- A 0.7 m landscaped buffer should be kept between NMV and MV lanes in high speed and/or high volume streets.
- Manhole level should be at the same level as the surrounding surface.
- There should be a level difference between a carriageway and a cycle track to allow storm water runoff.
- Adopting median cycle tracks will reduce conflicts between parking and property access.

3.2.5 Parking

ISSUES :

- Absence of designated parking zones lead to erratic onstreet parking of four-wheelers and two-wheelers. This leads to bottle-necks and encroachment of pedestrian zones.
- Absence of parking areas near transit hubs discourages park-n-ride options and increases dependency on private transport

Parking is one of the greatest concerns of city planning. It needs to be rationally distributed and located in street design. The allocation of parking space should not encroach or alter the space dedicated for pedestrian zone. The parking space shall be clearly earmarked and should include zones for pick-up/drop-off, refuge etc. These spaces should also follow the standards for safety and convenience.

The problem of parking in the city can be broadly divided into the following categories:

- Along commercialized streets
- At commercial centres
- In residential colonies
- At large institutional complexes
- Access to parking should be well defined and conducive to its usage, whether on the surface or underground. Basement parking lots should be structured properly and access to its vertical cores should be clearly defined. Surface parking should not hinder the continuity and homogeneity of pedestrian movement. (For Disabled Friendly Design refer section 3.8)

PLANNING & DESIGN : BEST PRACTICES

PARKING :

Parking spaces should be allotted after providing sufficient area to pedestrians, cyclists, trees, and street vendors.

- Tree pits can be integrated in a parking stretch to provide shade. Otherwise, shaded street elements, such as footpaths is likely to be encroached by parked vehicles.
- Near intersections, parking lanes should be discontinued to reduce conflict and to give additional vehicle queueing space.
- Bulb-outs should be provided between parking areas for street furniture and vending.
- In service lanes, parking should be located on the left side so that passengers do not spill over on the cycle track when they exit a vehicle.
- On-street parking should be permissible only in designated spaces and in multi-utility belts.
- Parallel parking for cars is the safest and most efficient parking layout in terms of the number of vehicles it can accommodate relative to the area occupied. The same parking lane can be used as perpendicular parking for two-wheelers.



Vehicular parking encroaching pedestrian zones as well as NMV zones
Source: Author



On-Street parking in Connaught Place

Source: <https://www.neptunautomatic.com/parking-management/parking-solutions-in-india/>



Parallel On-Street Parking Layout

Source: http://4.bp.blogspot.com/_nO-H2ebi09s/TSyg8t-f6Q/AAAAAAAAAul/NPK9yercLE/s1600/VBD+Chester+Way.jpg

ON-STREET PARKING

- No on-street parking should be permitted at locations where the carriageway width is less than 7 meters.
- Street parking should not be allowed on roads with heavy vehicular traffic having speed less than 20 km/hr.
- Parking and other encroachments should not be allowed on intersections and other critical locations for a minimum distance of 50 m on all junction arms.
- Kerbside area should be kept clear of on-street parking especially near bus bays.
- Parking should not be allowed on footpaths or other corridors meant exclusively for pedestrians. Vehicles if parked on footpaths should be penalized.
- In some areas, street parking may be permitted on one side of the road based on requirements.
- Kerb extensions should be included at crossings, transit stops, and junctions.
- Angled and perpendicular parking should be avoided except in retrofit cases and on streets where there is ground floor retail with a need for front door parking.
- A minimum of 0.5 m horizontal clearance in the edge zone should be provided for parallel on-street parking and 0.7 m clearance where there is angled parking.
- Parallel parking should be ideally 2.4 m wide.
- Vehicles parked on the sides of the street is defined as On street parking and is usually controlled by local government agencies itself.

Types of On-street parking :

Parallel Parking : The vehicles when parked along the length of the road, consume the maximum curb length and therefore only a minimum number of vehicles can be parked for a given kerb length. This method of parking produces least obstruction to the on-going road traffic since least road width is used.

Angular Parking: Vehicles are parked at 30, 45 and 60 degrees. More vehicles can be accommodated with this type of parking.

Perpendicular : Parking: In right angle parking or 90 degree parking, the vehicles are parked perpendicular to the direction of the road.

LAYOUT

- Parallel car parking is recommended on streets where parking is permitted. Inclined/perpendicular car parking should be avoided.



Angular On-Street Parking Layout

Source: http://flyingpigeon-la.com/wp-content/uploads/2012/01/nose-in_on_Larchmont.jpg



Parallel On-Street Parking Layout

Source: [Online], Available from: <https://aseasyasridingabike.files.wordpress.com/2012/08/picture-2.png>



Drop-Off Zone

- Parking area should be well demarcated with line marks.
- The area should have a level and clean surface. The parking area should be well lit and surrounded with trees for shade.
- Combination of parallel and inclined parking is acceptable in case of high parking demand.
- Angular two-wheeler parking is recommended on all streets with provision of parking.
- Auto stands should be provided within MUZ's, adjacent to bus stops and in mid-blocks on local streets.
- Auto stands should be located along footpaths for easy transition of passengers while getting in and out of the vehicle.
- For local streets with ROW less than 12 m following should be provided:
 - * Four-wheeler parallel parking on either side
 - * Inclined two-wheeler parking
 - * Mandatory traffic calming measures
- Capacity of auto stands should be limited to 5-6 autos in one parking zone.
- Proper auto rickshaw bay should be designed around buildings that have a high pedestrian footfall such as hospitals, commercial areas, etc.

DROP- OFF ZONES

- Drop-off zones should be positioned within 30 m from building entrances to reduce the walk to destination.
- Drop-off zones should be provided with clear signage to reduce confusion.
- Drop-off zones should be minimum 3.2 m wide for ease of mobility and safety.
- They should be provided with kerb ramps to negotiate changes in level between parking and footpaths.
- Tactile guide strips should be provided for improved security and safety.

3.2.6

Traffic Junctions

ISSUES :

- Absence of designated walkway zones alongside the carriageway forces pedestrians to walk on the vehicular zone leading to pedestrian-vehicular conflicts.
- Insufficient parking zones may lead to encroachment of pedestrian walkways by vehicles due to absent barriers/buffers like bollards/guardrails.



Traffic Signal at Lodhi Road

Source: DUAC

Junctions are critical zones of a street design as they regulate movement of pedestrians and vehicles in various directions. Thus their design should allow seamless and conflict free movement. Also, the pedestrians/cyclists crosswalks should be incorporated in the design by the provision of appropriate traffic calming measures and other street elements.

KEY PRINCIPLES

- **STOPPING SIGHT DISTANCE :** Stopping sight distance (SSD) is the distance along a roadway throughout which an object of a particular height is visible to the driver. This distance is dependent on the height of the driver's vision above the street surface, the approaching object's height above the street surface, and the height and lateral position of sight obstructions within the driver's line of sight.
- **VISIBILITY REQUIREMENTS :** Visibility should be checked at junctions and along streets. Visibility is measured horizontally and vertically. There should be periodic visibility checks to ensure there are no vertical obstructions in the horizontal plane and similarly there are no horizontal obstructions in the vertical plane.

Visibility considerations are of three types:

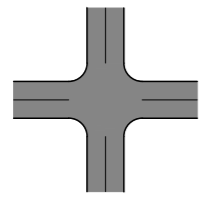
Forward Visibility : It is the distance required by a driver to see ahead and stop safely to avoid obstructions on the street. The minimum forward visibility requirement should be equal to the minimum SSD. It is measured along the curve of the centerline of a traffic lane.

Visibility along Street Edge : Visibility along a street edge should not be very wide. Focussed visibility assists drivers to drive cautiously. Visibility depends upon the frequency of vehicle movement, amount of pedestrian activity and the width of the footpath.

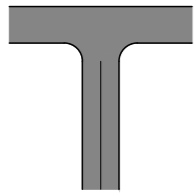
Obstacles to Visibility : The impact of obstacles such as street trees, street lighting, columns, encroachment of parking space, etc., should be assessed on the overall envelope of visibility.

JUNCTION LAYOUT

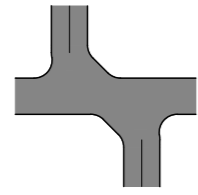
- It is important to look into the functionality and capacity of street networks and individual streets along with maintaining a minimum desirable spacing between junctions.
- Intersections should not be spaced too far apart from each other as it may result in insufficient connectivity within the overall street network and its capacity.



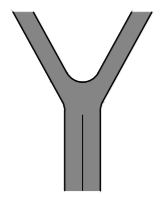
Rectilinear Junction



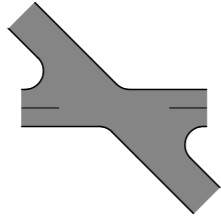
T-Junction



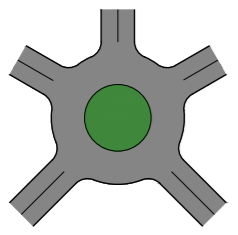
Offset - Junction



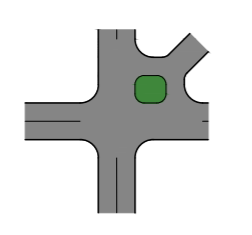
Y-Junction



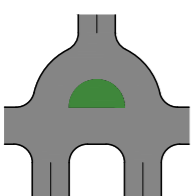
Angle Junction



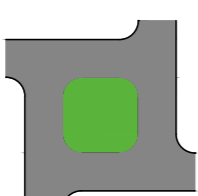
Roundabouts



Cul-de-Sac



Crescent Junction



Square Junction

Source: <https://www.gov.scot/publications/designing-streets-policy-statement-scotland/pages/6/>

SIGHT DISTANCES

1. Kerb extensions and restricted parking should be provided near crossings to improve visibility between motorists and pedestrians.
2. Lower vehicle speed and restricted turning movements help maintain proper sight distances.
3. Urban signalized junctions should have lower sight distance requirements than other junctions.
4. Un-signalized junctions should have a minimum clear sight distance of 25.0 m from the centre line of the side street and a distance of 2.4 m from the stop line.
5. The maximum speed of vehicles should be determined at turns, which implies for all street types
6. Vehicles must be accommodated within their travel lanes without encroaching upon the opposite carriageway.
7. Junctions should be designed to accommodate large vehicles, allowing faster turns by smaller vehicles. Non-motorized vehicles should be given priority.

TYPES :

Rectilinear Junction

These are one of the most common junctions where the roads are at a 90° angle with each other.

T- Junction

These are similar to rectilinear junctions but have two roads meeting at a 90° angle with each other.

Offset Junction

It is an at-grade road intersection where a conventional four leg intersection is split into two three-leg T-intersections to reduce the number of conflicts and improve traffic flow.

Y Junction

It is a 3-way junction where three roads meet. Two streets from different directions meet at an angle of 15° to form a single lane in the shape of a Y.

Angle Junction

When two Y junctions meet to form a single junction.

Roundabout

When several legs are severed by a central circular loop.

Cul-de-Sac

It is a dead end street with only one inlet/outlet. It has no exit road and is in the form of a cul-de-sac. The dead end is usually in a circular form. The available turning space is based on the surrounding and not on vehicular movement. This space is effective and usable and the turning space needs to be kept clear of parked vehicles. This kind of arrangement is popular in residential areas.

Crescent Junction

This is not a very common junction. It is mainly used in areas having curved urban forms.

Square Junction :

In this junction the streets form a square shaped island at the intersection.

It forms a chowk and is a popular junction in the Indian context.

3.2.7

Roundabouts

ISSUES :

- Absence of designated crosswalks at the intersection of the radial streets and the roundabouts lead to pedestrian-vehicular conflicts.
- Excessive vegetation on the roundabout islands lead to visual disconnect.
- Absence of traffic calming elements lead to over-speeding by motorists in the roundabouts.



Roundabout in Central Delhi

Source: <http://archive.indianexpress.com/news/thieves-leave-lutyens-delhi-roads-nameless/1019843/>

The integration of roundabouts in the streets allow safe connections for the pedestrians and cyclists. Their size, and design should be contextual and be incorporated with sustainability features including storm water management, solar lighting etc. The roundabout being a focal point can also be considered as a space for Public Art, landscaping and other recreational uses after giving due consideration to the safety of the users.

PLANNING & DESIGN : BEST PRACTICES

- One-lane & Two lane roundabouts may have raised crossings across entry and exit areas. Dimensions of a two-lane roundabout is determined by the volume and requirements of vehicles using it.
- Roundabouts with more than two lanes should be determined after thorough investigation and approval.
- Marked crosswalks and bicycle lanes are not required within mini roundabouts, but may be needed on adjoining streets depending upon the street type.
- Visibility to the central island can be improved by using reflective signs on the island and reflective paint on the curb.
- The introduction of a roundabout should not impact the existing underground utilities.
- Bicycle lanes should end minimum 20m ahead of the roundabout pedestrian crossing.
- The design should integrate storm water management.
- Locations with heavy vehicle turning movements should have pedestrian crossings at strategic points for efficient dispersal of pedestrians and bicyclists.
- Roundabout islands with attractive vegetation, art, sustainable green features within the central island can become active public spaces.
- Splitter islands with a minimum desirable width of 3.0 m can serve as pedestrian refuges at pedestrian crossings.

3.3

UNIVERSAL ACCESSIBILITY

3.0 Street Design Recommendations

3.1 Pedestrian Zone

3.2 Vehicular Zone

3.3 Universal Accessibility

3.3 Universal Accessibility

ISSUES :

- Absence of designated crosswalks at the intersection of the radial streets and the roundabouts leading to pedestrian-vehicular conflicts.
- Excessive vegetation on the roundabout islands lead to visual disconnect.
- Absence of traffic calming elements lead to over-speeding by motorists in the roundabouts.



Absence of designated space for the pedestrian and the physically disabled

Source : <https://www.heraldnews.com/news/20160615indian-city-on-alert-as-polio-strain-found-in-sewage-water?template=ampart>



Universal designs and access

Source : <https://thecityfix.com/blog/universal-street-design-matter-ensuring-accessibility-belo-horizonte-paula-manoela-dos-santos/>

Streets are public spaces and should be designed keeping in consideration the principles of Universal Accessibility. The spaces should be flexible and equitable at the same time. In addition to being easily navigable, streets should allow unobstructed movement by users of all ages and abilities. The facilities meant to aid the specially-abled should be clearly defined by appropriate design elements/amenities and should cater to the needs of all users groups.

Design with consideration to the physically disabled is important as it bridges the gap between the people with disabilities and the able bodied by providing access to all the amenities and elements on the street, regardless of their age, size or ability and making the street inclusive.

In more specific terms, streets should be designed such that it provides amenities for people using wheelchairs, strollers, walkers, crutches, handcarts, and bicycles. It should also cater to senior citizens, people with visual/hearing impairments, and pedestrians with challenges with mobility or injuries.

KEY PRINCIPLES

1. Equitable Use

Design for people with diverse abilities.

2. Flexibility in Use

Adapt for wide range of individual abilities.

3. Simple and Intuitive Use

Easy to understand, regardless of user's experience, knowledge, language skills, or focus of attention.

4. Clear Information

Communicate information effectively, regardless of local conditions, or user's sensory abilities.

5. Tolerance for Error

Minimize hazards and adverse consequences of accidents or unintended actions.

6. Low Physical Effort

Design for efficiency, comfort and rest from fatigue.

7. Size & space for Approach and Use

Provide appropriate space for approach and use regardless of user's body type, posture, or mobility

Guidelines were formulated by the government and passed by the Indian Parliament in 2016 to fulfil its obligation to the United Nations Convention on Rights of Persons with Disabilities, 2006.



Absence of designated space for the pedestrian and the physically disabled

Source : <https://brtguideline.org/branch/master/guide/universal-access/station-access>



Pedestrian footpath in Pune

Source : <https://www.hindustantimes.com/bhopal/pune-s-footpaths-get-a-welcome-makeover/story-9YTc3snNjrvZXsyqOprCXI.html?html&psig=AOvVaw3fCwifRSymmgyS1kaLaH&ust=1602831350335000&source=images&cd=vfe&ved=0CAIQRqFwoTCQJKi56CtuwCFQAAAAAdAAAAABAt>

UNIVERSAL ACCESSIBILITY REQUIREMENTS

It is necessary to understand the requirement of people with disabilities, as their requirements vary according to the nature of the disabilities.

Space Requirement

- Space or the minimum width required should be able to accommodate a person on wheelchair. Minimum width of a footpath or a ramp should accommodate two wheelchairs passing each other side-by-side without obstructing each other. In such cases the minimum width should be 1.8 m.
- In some cases where achieving 1.8 m is difficult, 1.2 m should be targeted to enable at least one person on a wheelchair to share the footpath width with another person on foot.
- The minimum clear turning required for a wheelchair is 1.5 M

PLANNING & DESIGN : BEST PRACTICES

I. PEDESTRIAN FOOTPATH

- The standards specified by Govt. of India, CPWD's Disabilities Act 2016 advises minimum footpath widths to accommodate one wheelchair requiring a minimum distance of 1.2 m, serves people using crutches, and walkers and additional space needed at intervals no greater than 60 m apart for two wheelchairs to pass. Space for accommodating two wheelchairs is minimum of 1.5 m and to accommodate two wheelchairs comfortably a distance of 1.65 m - 1.8 m is required. 1.8 m minimum clear path comfortably accommodates two wheelchairs passing each other.
- Pathways should be levelled. They should have adequate width to enable pedestrians and people on wheelchairs to safely pass each other. A minimum 1 m is required for wheelchair access on ramps and a minimum 1.8 m for two wheelchairs to pass simultaneously.
- All footpaths should have continuous, non-slip and even surfaces. It is desirable to seal or upgrade unpaved footpath surfaces, where possible, as these are hazardous especially in adverse weather conditions.
- A guide strip comprising of a tactile line should be installed for people with low vision and blindness. The line should contrast in colour and texture with the pavement.



Universal crosswalks

Source: <https://www.asla.org/universalstreets.aspx>

- Drains, grating and manholes should be placed outside the pedestrian footpaths to avoid changes in terms of texture and height. Drains, gratings, and manholes on the path of a footpath should be properly covered. The covers should be flushed with the footpath surface and should have a narrow grid pattern to ensure pedestrian safety & comfort.
- Plant varieties should be chosen carefully. Thorny/poisonous plants that drop seeds/fruits should be avoided. Guiding floor material should be selected suitably to direct the visually challenged. Kerbs wherever provided should blend to a common level.
- Kerb cuts should be provided for people to get on and off footpaths.
- Footpaths slopes should not exceed a gradient of 1:20 for the convenience of wheelchair users.
- Handrails and guide strips should be installed wherever possible, which can also be used as a location aid.
- Change of levels should be indicated on warning signs, or with illuminated strips to guide the specially-abled.
- Contrasting colors and warning blocks should be used to identify doors, stairs, ramps, passageways, etc.
- Tactile tiles with minimum 30% luminance contrast to adjacent surfaces should be installed to guide users with impaired vision.
- Bollards should be erected at entrances of footpaths or pathways with a minimum clear space of 0.9 m. To ensure obstacle free movement of wheelchairs, a clear space of 1.2 m should be provided between bollards.
- Footpaths should have gradual slopes towards street storm water drain to avoid water accumulation.

2. CROSSWALKS

- Safe and independent crossing for the specially-abled people can be achieved by effective design such as raised crossings and refuge islands that act as speed bumps for approaching vehicles.
- Level differences/kerb heights between footpaths and carriageways should be kept to maximum 0.15m to make it easy for the specially-disabled to manoeuvre the street.
- Crossings should be located such that it is clearly visible from a distance by users with disabilities.
- Kerb ramps of recommended standard should be provided at both edges of raised crossings.
- Crossings should have traffic control signals with push buttons that provide audible and visual signals. They should have timed intervals that take into the account slower crossing of people.
- Other traffic calming measures, such as speed bumps, should be introduced to increase safe crossing of vulnerable groups.
- Pedestrian refuges and kerb bulb-outs should be used separately, or in combination, to effectively narrow the carriageway and reduce crossing distance.



Universal crosswalks

Source: <https://www.google.com/url?sa=i&url=http%3A%2F%2Fwww.universaldesign.com%2Fstreets%2F&psig=AOvWaw048kQF-wreLRNrvnxLnujC&ust=1602833197436000&source=images&cd=vfe&ved=0CAIQjRxxqFwoTCKDVIzWJtuwCFQAAAAAABAD>



Universal parking

Source: <https://www.universaldesign.com/streets/>



Universal parking

Source: <https://www.proptiger.com/guide/post/policy-tweaks-that-can-help-overcome-parking-perils>

- Footbridges and subways should be avoided as far as possible. "At-Grade crossings" should be prioritized for pedestrians.
- Footbridges and subways should be provided with slope ramps at both ends for wheelchair accessibility.
- Crossings should have a colour in contrast to the road and the surrounding to guide users with impaired or low vision.
- Guide strips leading pedestrians to traffic light push buttons, for security and guidance, should be installed.
- A coloured tactile marking strip of minimum 0.6 m wide should be put on traffic islands to mark its beginning and end to guide pedestrians with impaired vision.
- Push buttons should be tactile and easy to locate and operate. It should be placed between 0.90 m and 1.20 m off the ground for the benefit of wheelchair users.
- All raised crosswalks should be facilitated with kerb ramps to provide access to users with wheelchairs, strollers, walkers etc. Kerb ramps should be installed in areas which require easy movement of the specially-abled.

3. PARKING

- As per Unified Building Bylaws, surface parking for two cars shall be provided near the entrance of a building for the differently-abled with a maximum travel distance of 30 m from the building entrance.
- As per National Building Code 2016, adequate parking space should be provided to the specially-abled according to their parking needs and frequency of usage.
- Parking bays in close proximity to facilities/ building entrances should be identified and allocated to individuals with physical disabilities.
- A parking space open on one side with room for individuals in wheelchairs or on braces/crutches to get in and out of the vehicle on to a level surface, should be addressed carefully. It should have a minimum width of 2.7 m to 3.0 m. Wheelchairs users should be able to access a vehicle from both the sides and rear.
- Care in planning should be taken to ensure people in wheelchairs or people using braces and crutches are not compelled to move behind parked cars.
- Kerbs should be designed in a manner such that they enable wheelchair users to access footpaths easily.
- Signage stating the space is reserved for wheelchair users should be displayed clearly.
- Guiding floor materials along with audible signals or other devices should be provided to guide the visually challenged.
- The width of a parking bay reserved for the specially-abled shall be minimum 3.6 m.
- Parking space for individuals with physical disabilities when placed between two conventional, diagonal or head-on parking spaces, should be 3.6 m to 3.8 m wide. The length of the aisle should be 7.3 m, 6.1 m and 6.5 m



Bus Rapid Transit

Source: [Online], Available from: <http://www.steerdaviesgleave.com/sites/default/files/casestudies/transmileneo-01.jpg>



Universal transit

Source: <https://www.forensisgroup.com/expert-witness/transit-accessibility/>



Signages should be Legible for easy understanding

Source: [Online], Available from: <https://southseattlemerald.com/2016/02/23/rainier-beach-to-city-council-approve-our-plan/>

for head-on, 90° and 60° parking respectively.

4. TRANSIT

PLANNING & DESIGN : BEST PRACTICES

- Well facilitated bays for a wheelchair user to get in and out of a vehicle and/or fold the wheelchair should be provided.
- Ramps should be provided where ever there are level differences.
- Connectivity between two different modes of transport must include, resting points, ramps and lifts at the entrances of Metro/Bus entrances.
- Explore opportunities for using low floor buses or high-floor buses with bridges that serve all passengers from high platforms.
- Transits should be designed to encourage access and integration so that people with disabilities can safely move between different forms of transport with ease.
- Facilities in stations and bus stops should run efficiently to provide better service to users with disabilities.
- Clear pictograms and large print route numbers should be provided along with destination signs for users with low & impaired vision .
- Options, such as lift-equipped buses and mechanical lifting devices could be considered in order to make the travel easy and convenient.
- Low floor buses or high-floor buses with bridges could be considered as an option that can serve all kind of passengers.
- Accessible and prioritized seats for passengers with disability and other groups, including the elderly, pregnant women, children and people with a temporary illness or injury should be provided on the bus stops or other transit stations.
- Boarding zones for the disabled should be marked at the bus-stop closest to the position of the reserved seats in the bus/vehicle.
- Adequate hand grips and vertical supports should be installed at doors and inside vehicles to reduce potential for falls.
- Flooring materials should be of anti-skid type.
- Tactile information should be provided, such as floor markings etc. and an accessible bell for stopping the bus, for people with low vision and blindness
- All the transport should be installed with a retractable first step and a manual ramp at bus entrance for semi-ambulatory passengers.
- Comfortable hand grips and rails, about 25 mm to 50 mm in diameter, painted in bright contrasting colours should be installed at every step and on floors.



Public convenience

Source: DUAC; http://duac.org/site_content/attachments/Smart%20Toilet_English.pdf



Traffic Signals with Signage to avoid clutter

Source: [Online], Available from: <http://www.trafficsignals.net/west.htm>



Bench in Qutab Minar old monument complex, New Delhi

Source: [Online], Available from: <https://www.alamy.com/stock-photo-old-bench-in-qutab-minar-old-monument-complex-in-delhi-india-21273840.html>

5. STREET ELEMENTS & AMENITIES

Signage

As specially-abled people have restricted head movement or have reduced peripheral vision, signage should be positioned perpendicular to their path of travel to make it easy for them to notice the signs.

- Signage and signs should be in contrasting colours and made of reflective material. They should also be embossed to allow people with visual impairment to access information through touch.
- Audible signs should be installed in all areas wherever possible, especially at crossings, to guide people with visual impairment and other disabilities.

Public Toilets

- A toilet should be designed for seamless movement of wheelchair users. The space required for a wheelchair user is 1.5M x 1.5M. Therefore it is mandatory to design a toilet having floor space of minimum 2.2 m x 2 m.
- A clear opening of minimum 0.9 m for doors should be provided. Door must open outwards with handrail for support.
- The floor should be level and slip resistant.
- Toilets should have switches near the WC, one at 300 mm and another at 900 mm from floor level, which should activate an emergency audio alarm (at the reception/ attendants desk, etc.) in case required.
- For the convenience of users, grab bars should be installed in toilets.

Traffic Signals

- Traffic signals should be pedestrian centric with clear audible signals to guide users with disabilities.
- These acoustic devices should be placed on poles at the start of a crossing to guide users.
- Care should be taken not to install two acoustic devices adjacent to each other as it tends to disorient users.
- Time interval for crossings should be programmed in accordance with the existing standards for people with disabilities.
- Traffic signals should have signs to indicate pedestrians in the process of using a crossing to alert motor vehicles drivers advance.

Street Furniture

- Street furniture should be placed such that they allow hazard-free passage for all people.



Street furniture

Source: <https://www.shutterstock.com/search/street+furniture>



Shared surface

Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FShared_space&psig=AOvWaw2nED527KjTuNbREAQJmQx&ust=1602843185452000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCJCltaqutuwCFQAAAAAAdAAAAABAK



Surface materials

Source: <http://www.genematcomposites.com/case/genemat-singapore-rain-composite-manhole-cover-project>

- Seating should allow a minimum of 1.2m of adjoining space for wheelchair users.
- 1.5m minimum clear path behind a bench when located at the front of the footpath facing the kerb
- Outlets and controls, such as mail boxes, public telephones, vending machines and water fountains, should be mounted at 850 mm to 1 m above ground to enable access and ease of use.
- Seating should be installed at regular intervals of 100 m to 200 m and at prominent public facilities such as bus stops, public service areas, and public toilets, to enable rest opportunities.
- Seating areas should be installed outside main circulation pathways which should include spaces for wheelchairs.

6. Surface Materials

- Tactile paving should be provided in the line of travel and should avoid obstructions such as manholes/tree guards/lamp posts, etc. These tiles should be textured and brightly coloured in contrast to surrounding the surface.
- These guiding blocks should be installed as a warning to high traffic zones, such as stairway entrances/exits, ramps, lift corridors, multilevel crossings, footpaths, etc., to act as property access.
- Texture and profile of tactile paving must be maintained. A height of about 5 mm is enough for people with impaired vision to detect it without causing discomfort.
- Tactile tile size should be a minimum of 300 mm x 300 mm. Tiles should be applied at a minimum distance of 600 mm from the edge of a footpath to warn users about the edge.
- In case of ramps and staircases, tactile tiles should be installed a minimum 300 mm before the start line in order to act as a warning or act as a guiding strip leading towards the same.
- Texture change in walkways adjacent to seating areas to guide the visually challenged.
- Gradient of tiled surface should not be more than 12 mm rise for every 750 mm. If greater, surface to be levelled or ramp installed with a maximum gradient of 8%.

Materials to Avoid:

- Irregular surfaces such as cobble stones, coarsely exposed aggregate, concrete, bricks, etc. as they create bumpy rides.
- Decorative surfaces that create a vibrating, bumpy ride for wheelchair users.
- Material that have grooves or odd spacing that can catch a wheelchair wheel or create tripping hazards for pedestrians.

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4.0

Recommended Streets Sections

- 4.1 12 m - 2 variations
- 4.2 18 m - 3 variations
- 4.3 20 m - 3 variations
- 4.4 24 m - 4 variations
- 4.5 30 m - 6 variations
- 4.6 45 m - 4 variations
- 4.7 60 m - 3 variations



4.1.1 12M ROW



View showing residential street section with Vending activities accommodated in the Multi-utility Zone

NOTES:

TREE PIT

- 1.8m is considered as the optimum tree pit size for street widths ranging over 18m.
- However, for lesser street widths, i.e less than 18m, 1.2x1.2m should be considered the minimum tree pit size.

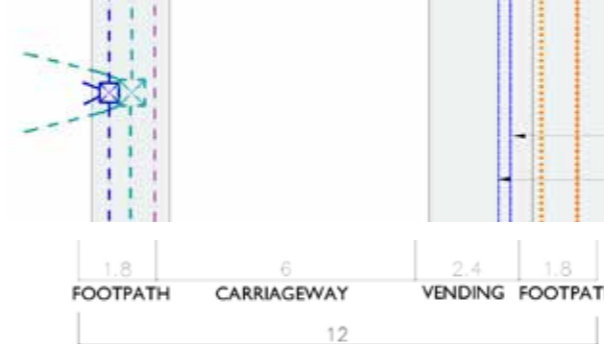
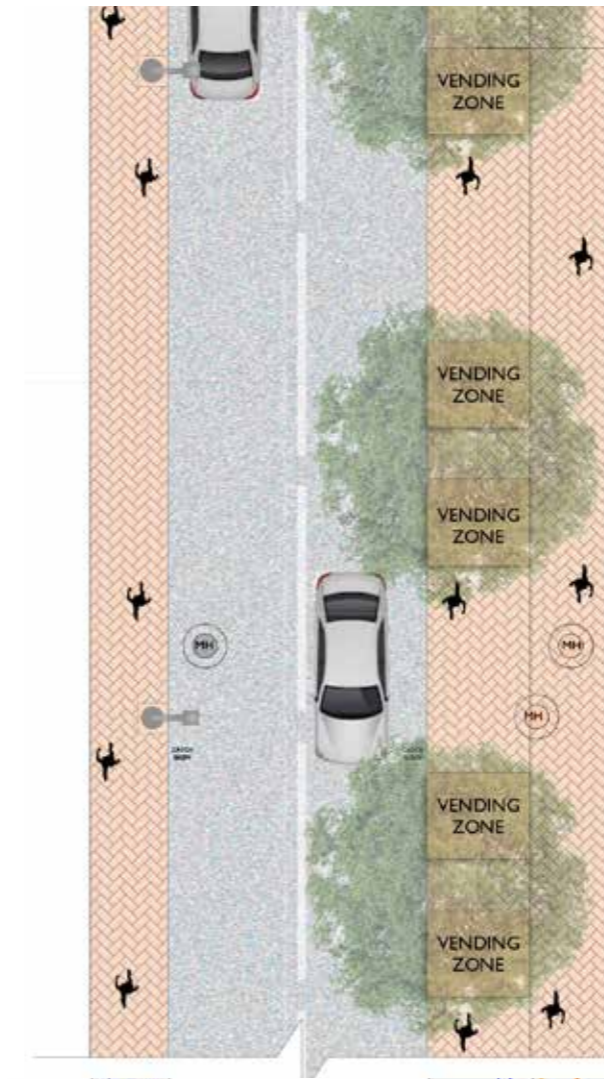
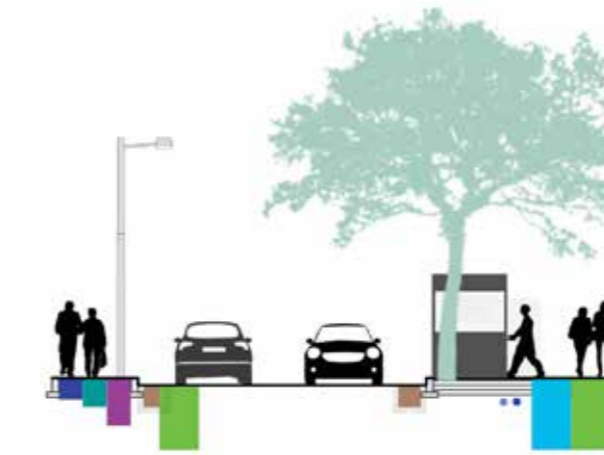
DISCLAIMER

- The services shown in plans are indicative. This drawing depicts the interrelationship between elements at planning and design stages.
- The service plan is for representational purpose only, it depicts 5 main services, however there may be far more services than depicted in this drawing.

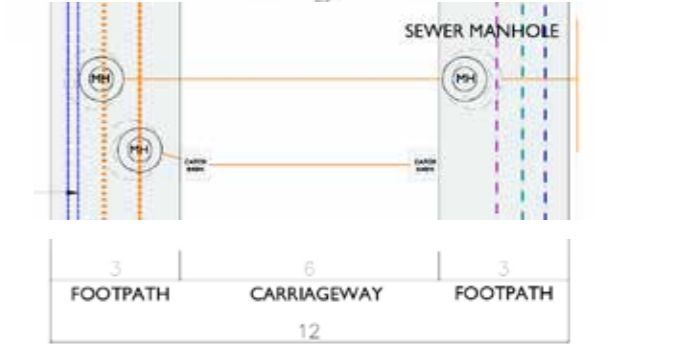
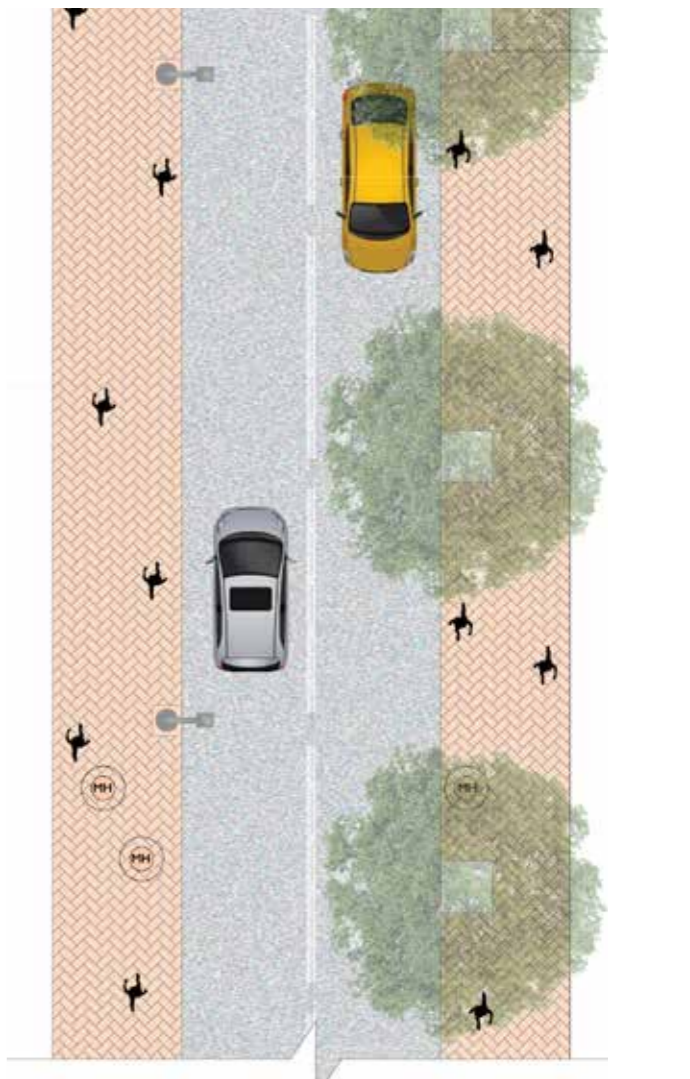
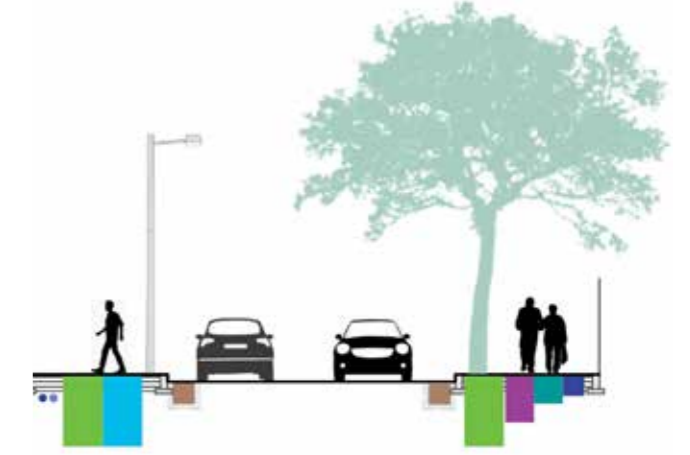
LEGEND

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

12M - RESIDENTIAL STREETS with Vending in the MUZ



12M - RESIDENTIAL STREETS without Vending zone



4.2.1 18M ROW



View showing residential street section with Vending activities accommodated in the Multi-utility Zone

NOTES:

The following are generic aspects on the design of street elements:

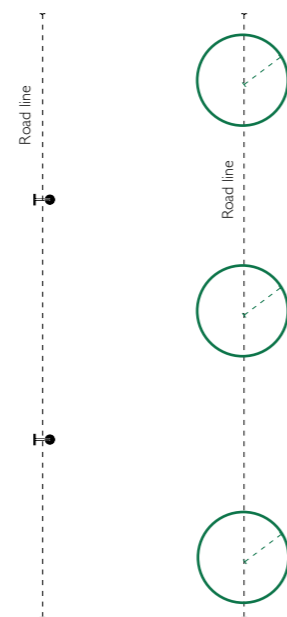
LIGHTING

POSITION

- For street width's ranging from 12-18m the lighting may be provided only along one side.
- It is financially viable to have electric cables on one side and trees on the other side.

TYPE

- For smaller street widths, (one side lighting-replace term), lighting only on one side is preferred.
- Parallel placement of lights creates hotspots and alternate dark spots thus alternate arrangement is preferred.



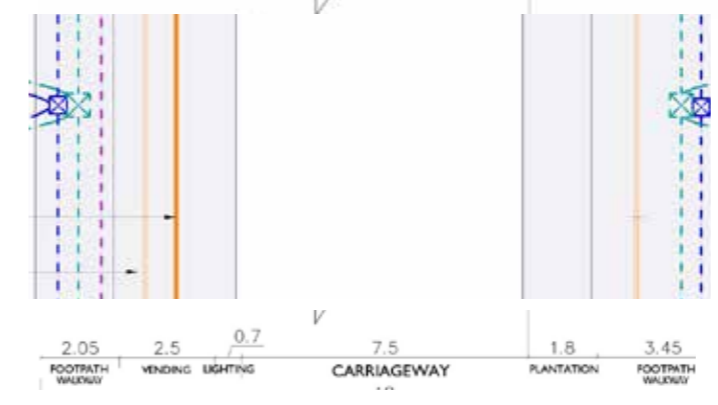
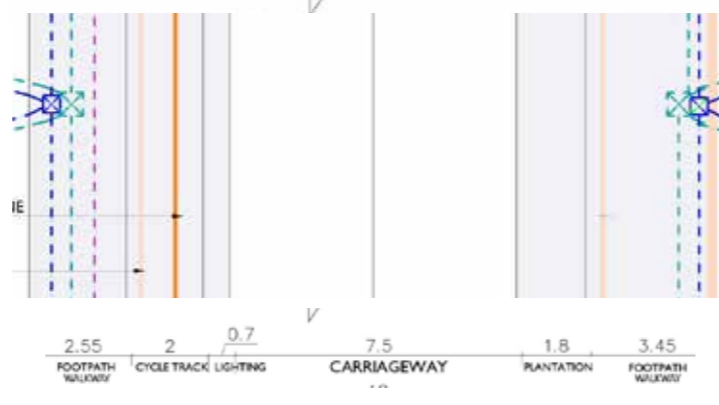
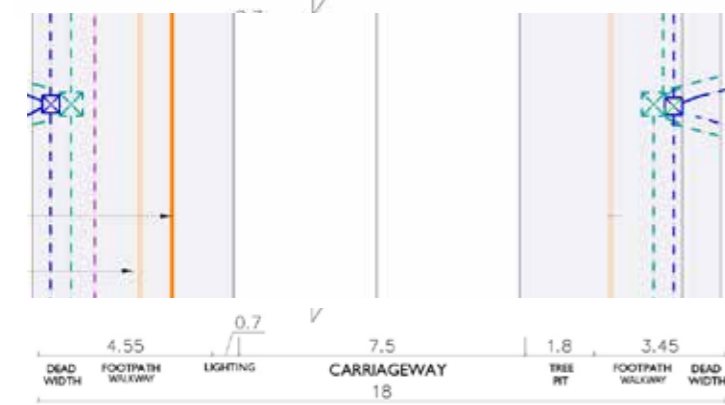
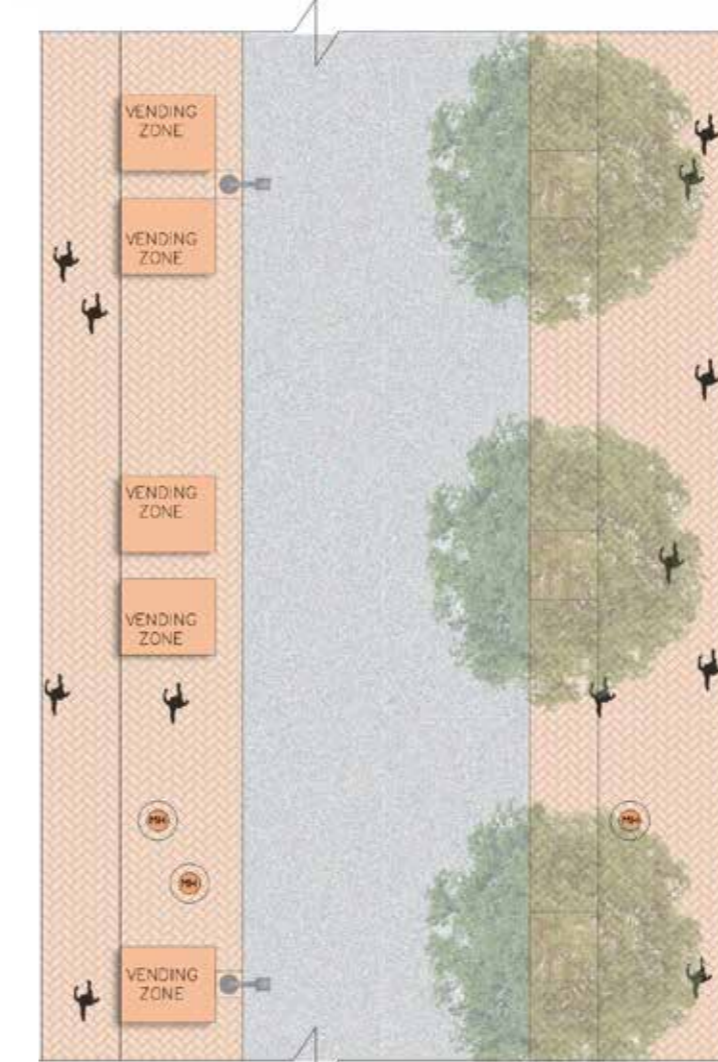
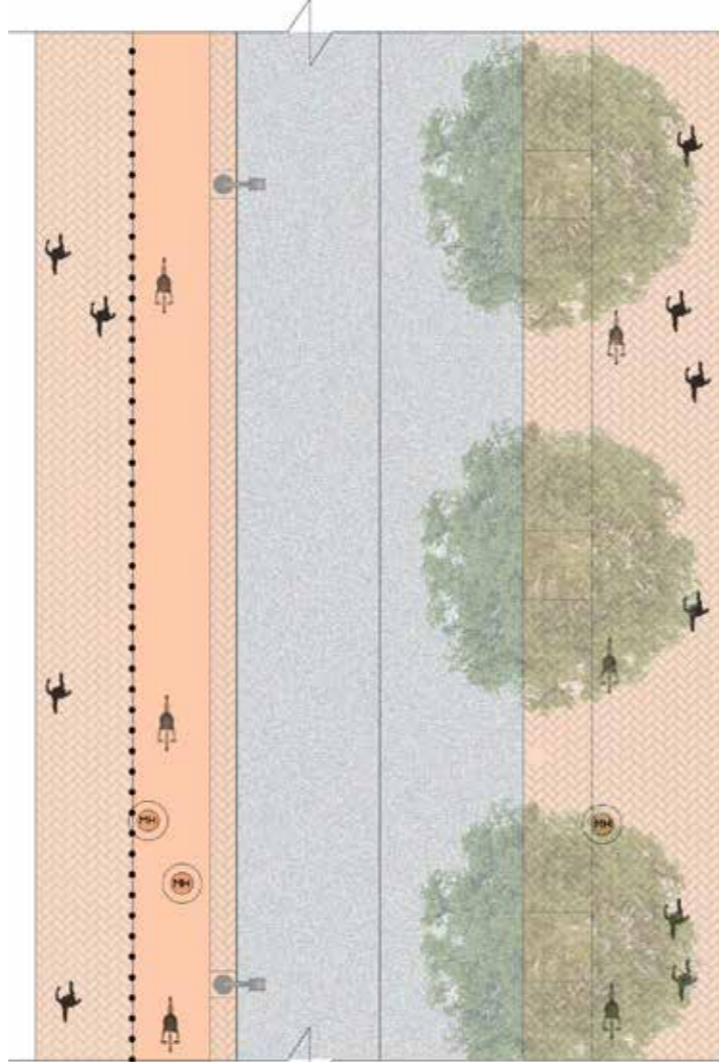
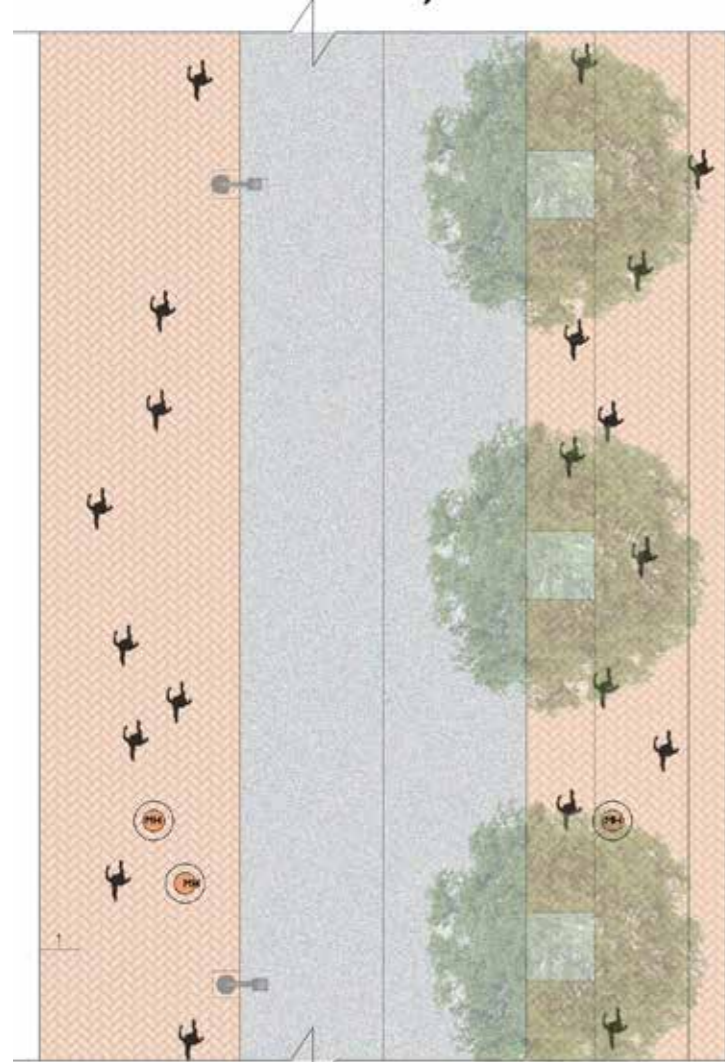
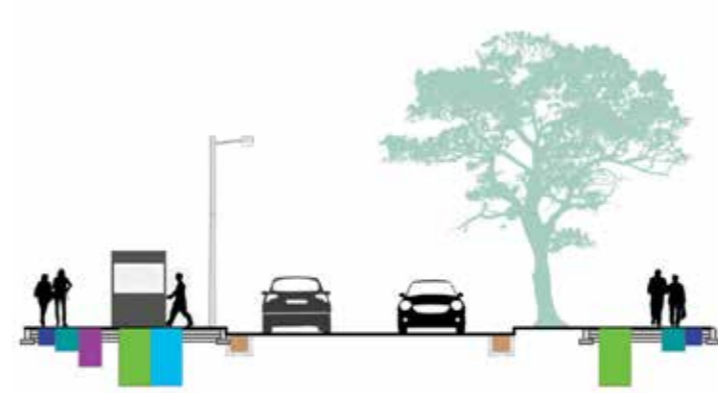
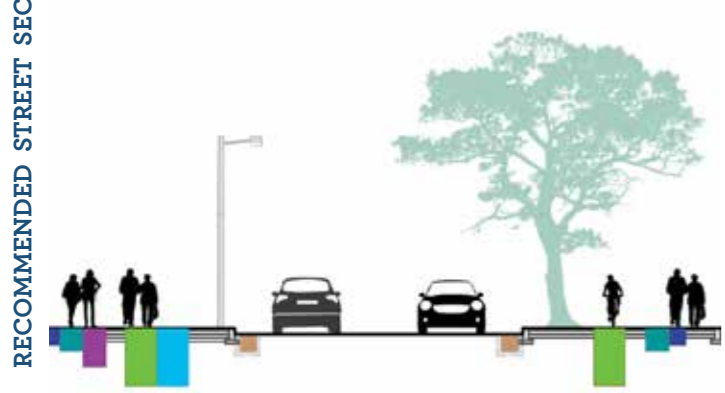
LEGEND

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

18M - COMMERCIAL STREETS

18M - COMMERCIAL STREETS with Cycle track

18M - COMMERCIAL STREETS with Vending in the MUZ



- LEGEND**
- HT LINE
 - LT LINE
 - LV LINE
 - WATER LINE - DOMESTIC AND FLUSHING
 - STORMWATER LINE
 - SEWAGE LINE
 - STORMWATER MANHOLE
 - SEWER MANHOLE
 - FOR HT CABLES
 - FOR LT CABLES
 - FOR LV CABLES
 - DOMESTIC WATER LINE
 - FLUSHING WATER LINE
 - CATCH BASIN

4.3.1 20M ROW



View showing Commercial / Industrial 20m ROW street section

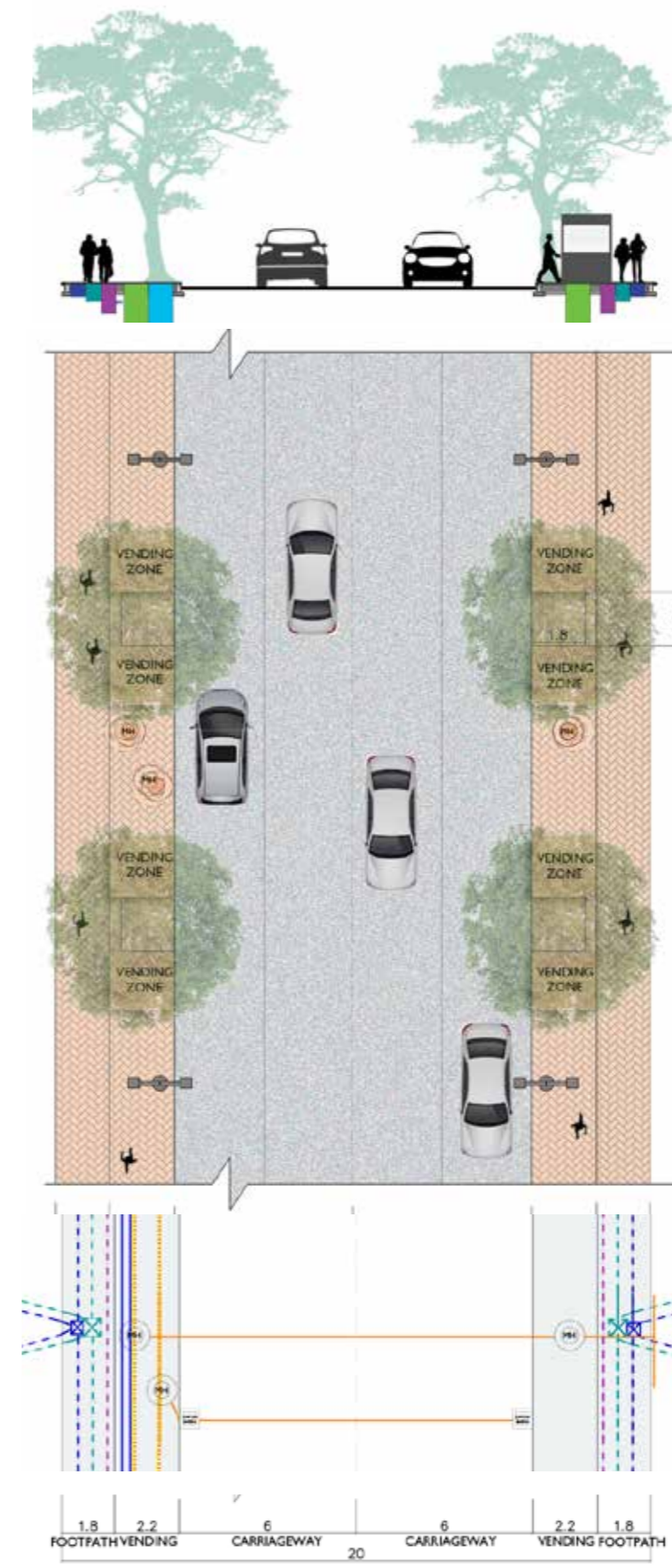
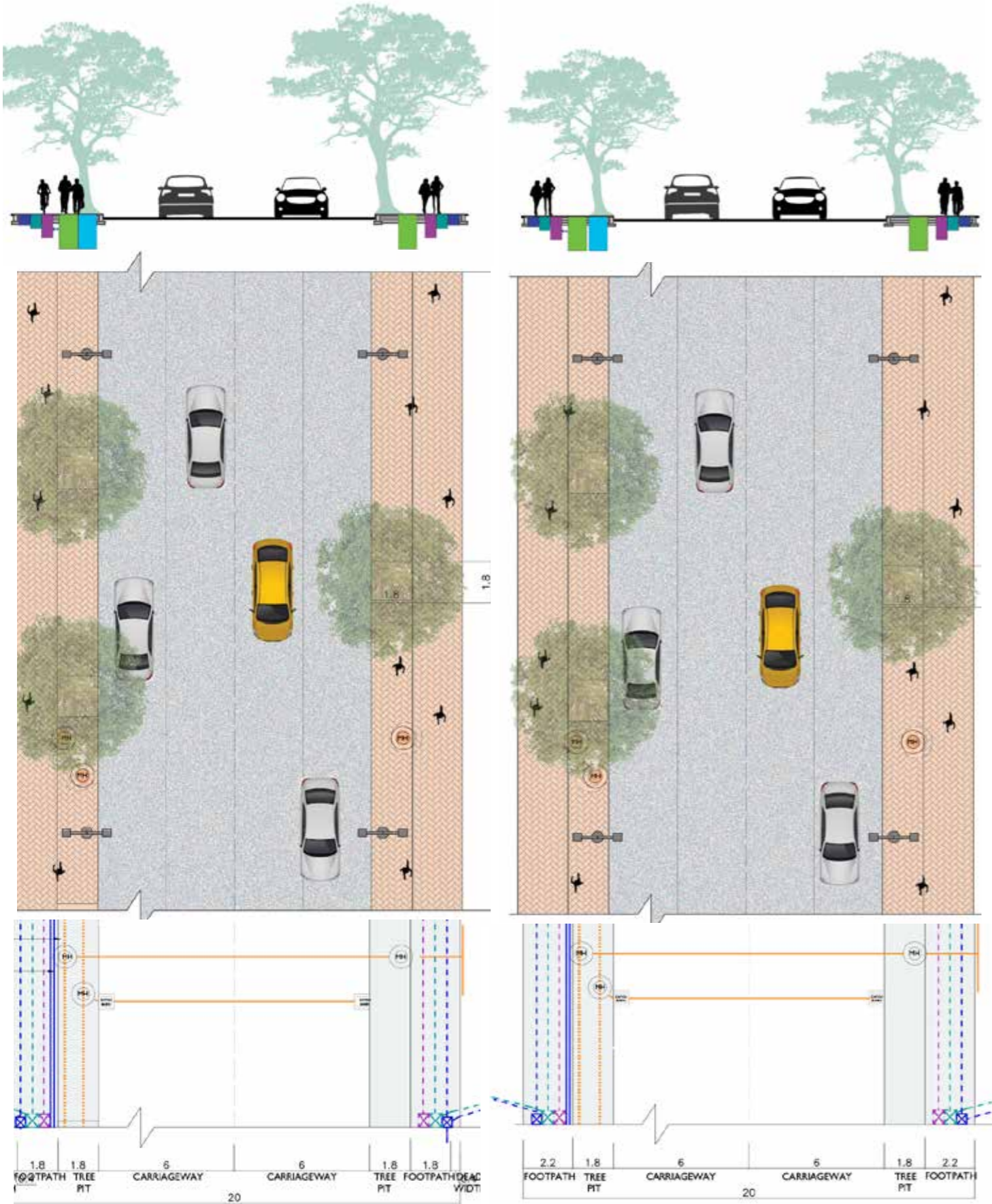
LEGEND

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

20M - **COMMERCIAL/INDUSTRIAL** STREETS

20M - **RESIDENTIAL** STREETS

20M - **COMMERCIAL** STREETS with Vending in the MUZ



LEGEND

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

4.4.1 24M ROW



View showing Residential 20m ROW street section with Vending activities accommodated in the Multi-utility Zone

LEGEND

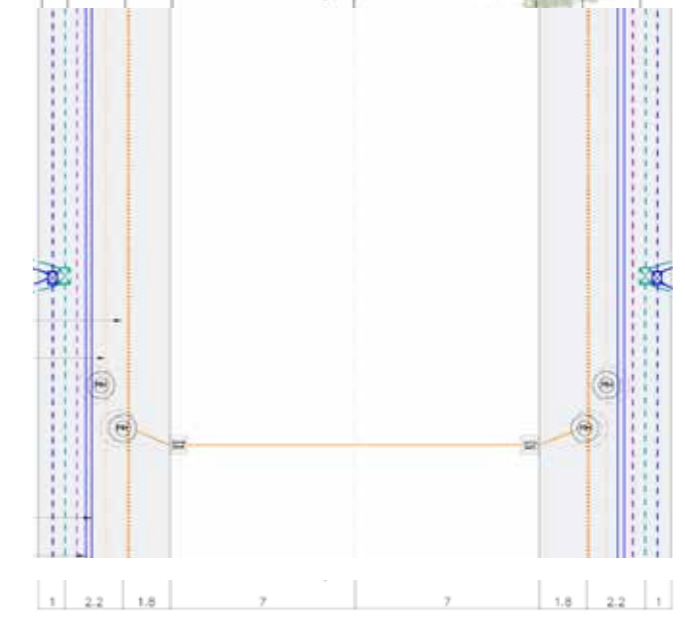
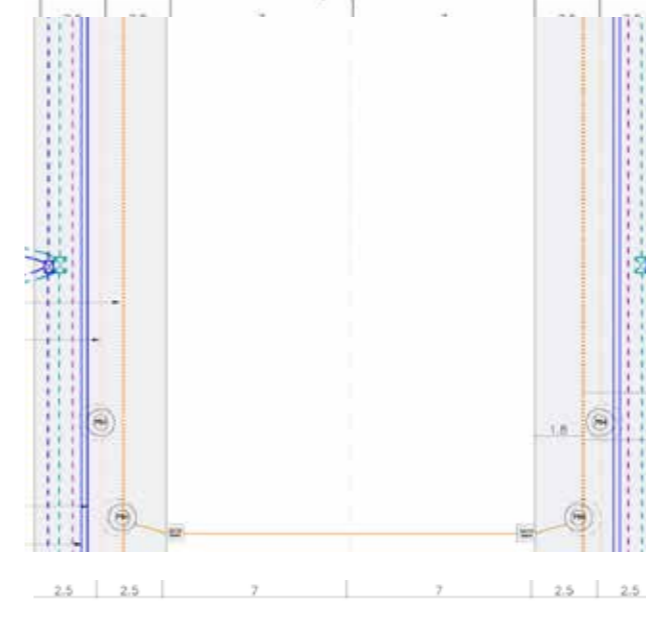
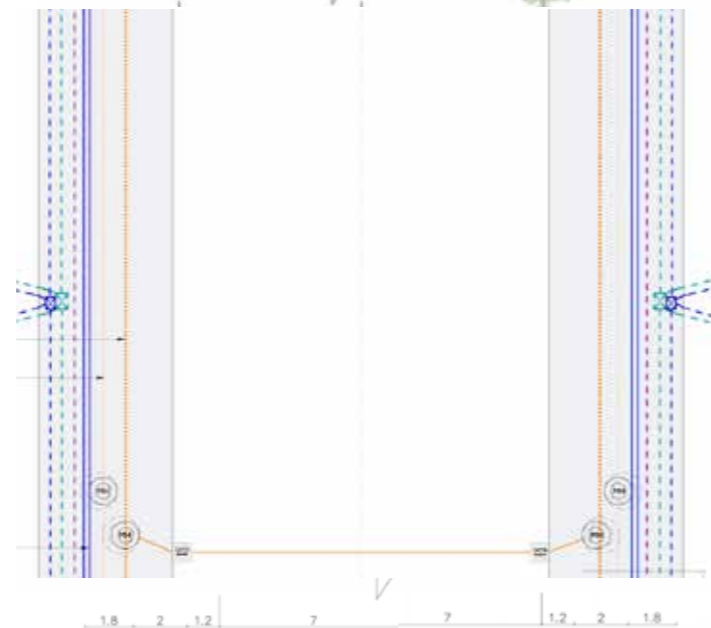
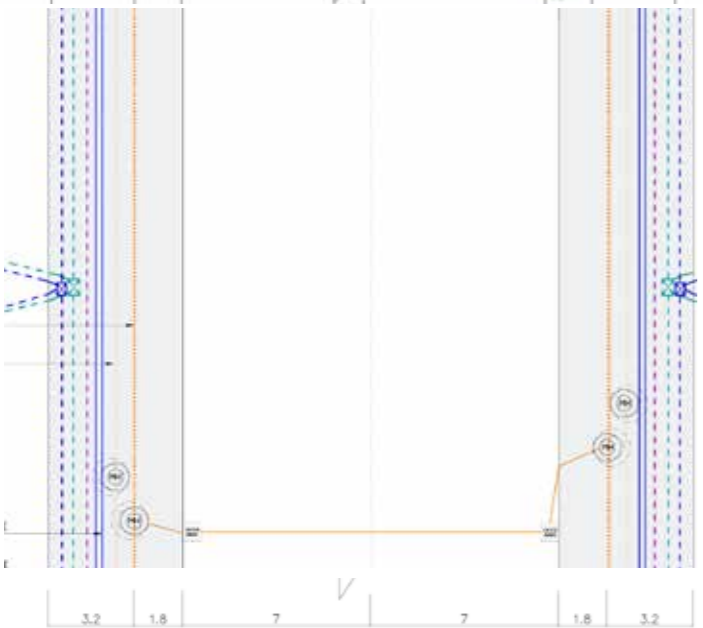
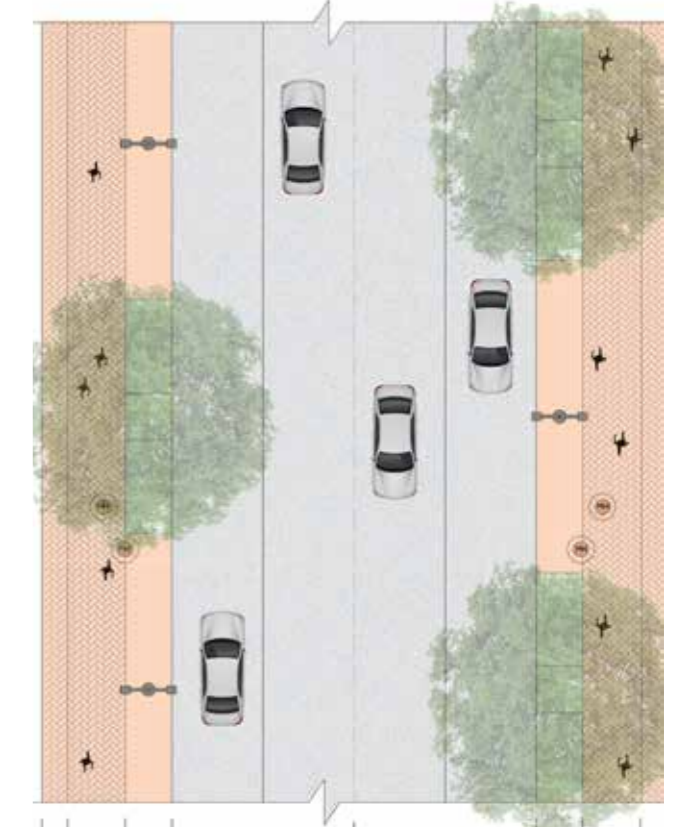
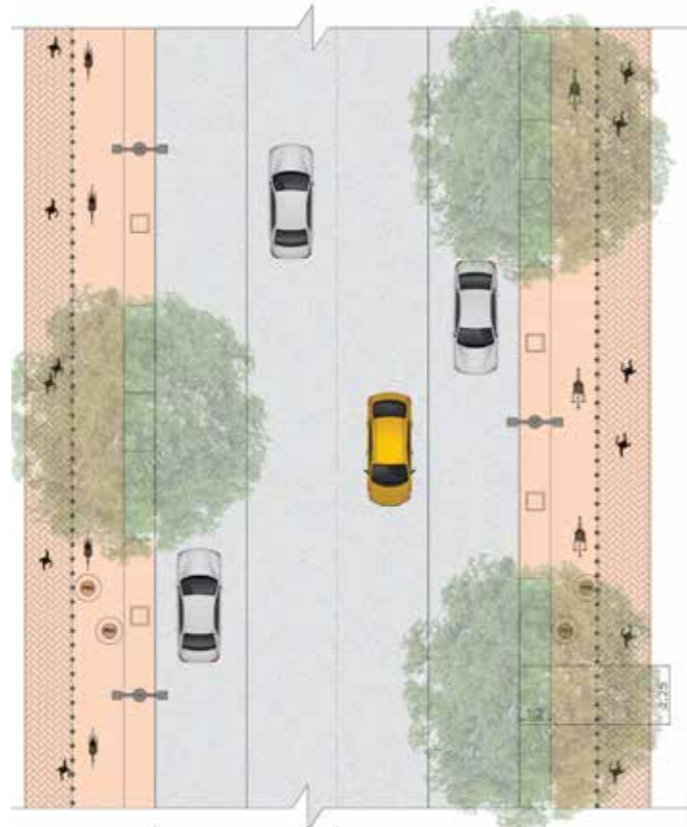
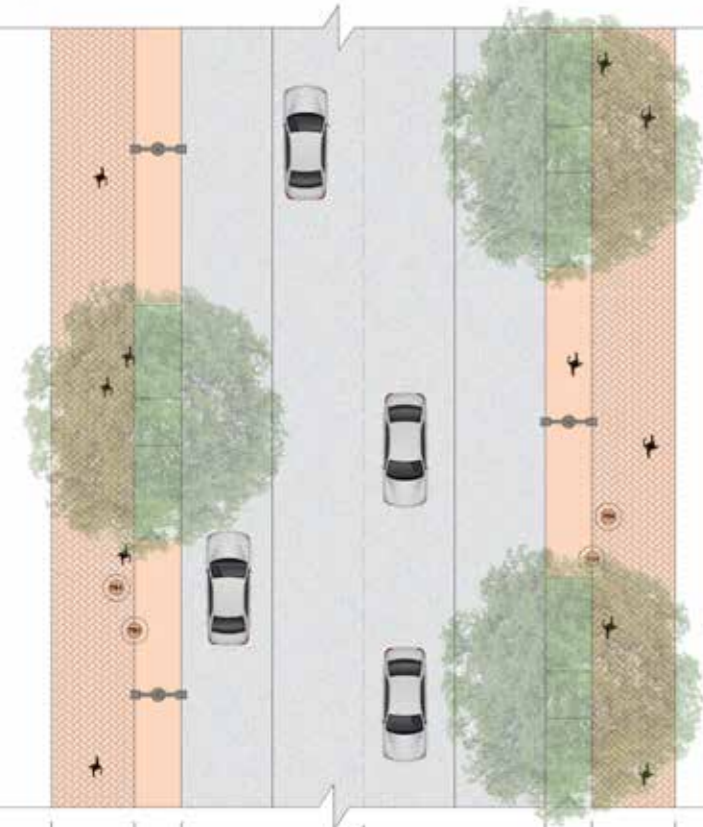
- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

24M - RESIDENTIAL streets

24M - RESIDENTIAL streets with Cycle Track

30M - RESIDENTIAL streets with Vending in the MUZ

30M - COMMERCIAL/INDUSTRIAL streets



4.5.1 30M ROW

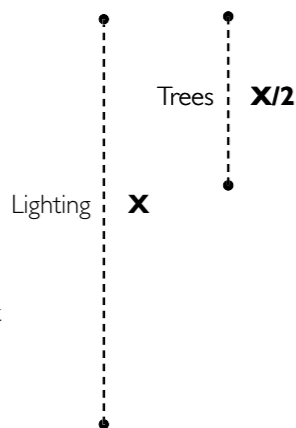


View showing Commercial/Industrial 30m ROW street section with overhead Metro line on the Median

NOTES:
The following are generic aspects on the design of street elements:

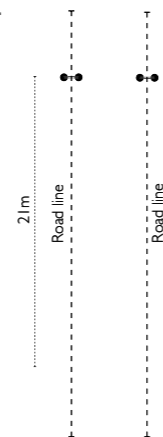
LIGHTING & TREES PLACEMENT

- The relationship between lighting and trees, is determined by:
- Horticulture should not be placed in front of trees that leads to camouflaged lights by the foliage.



ARRANGEMENT

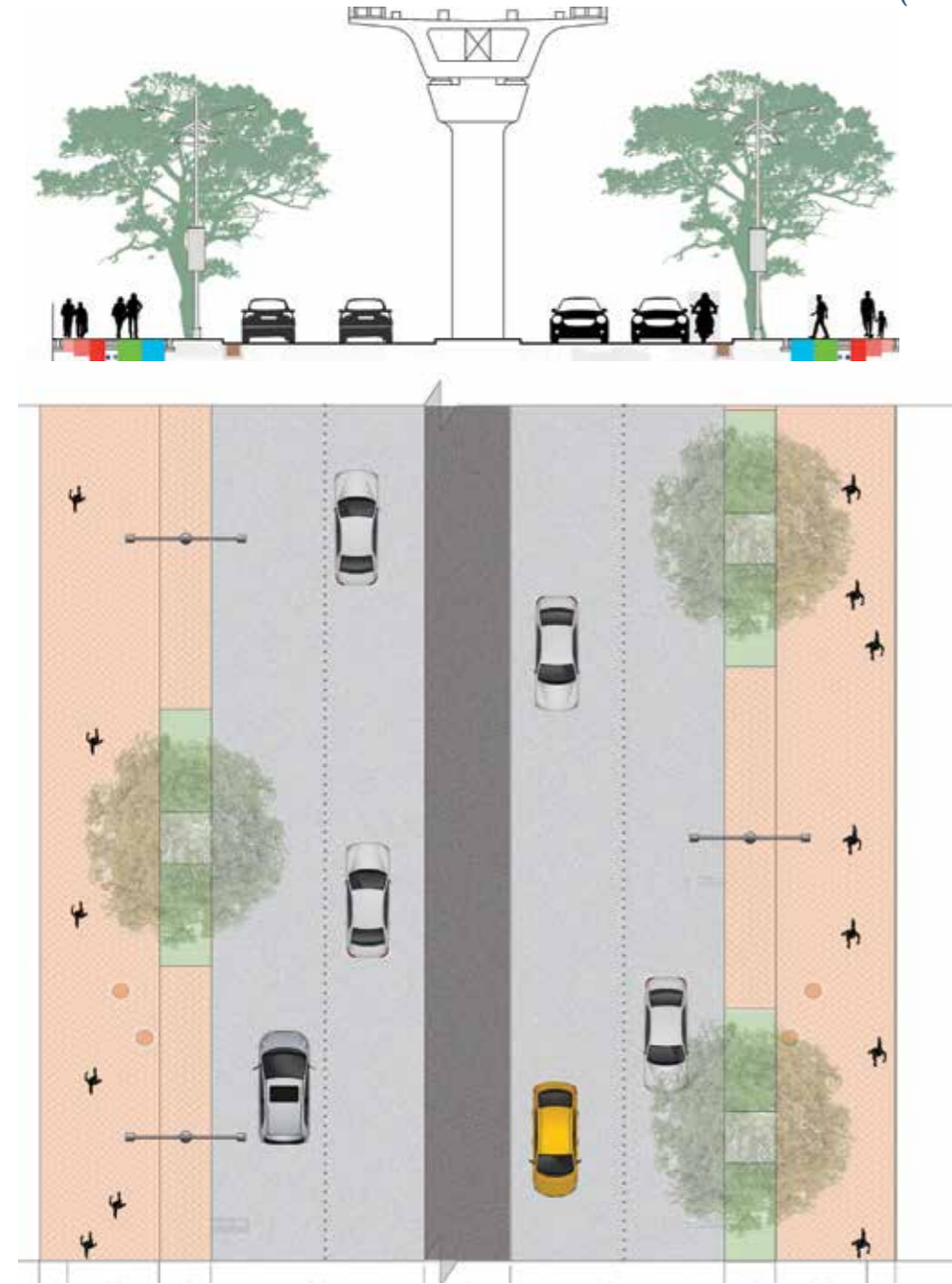
- Lighting spacing is 21m then it may be placed in a parallel arrangement.



LEGEND

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

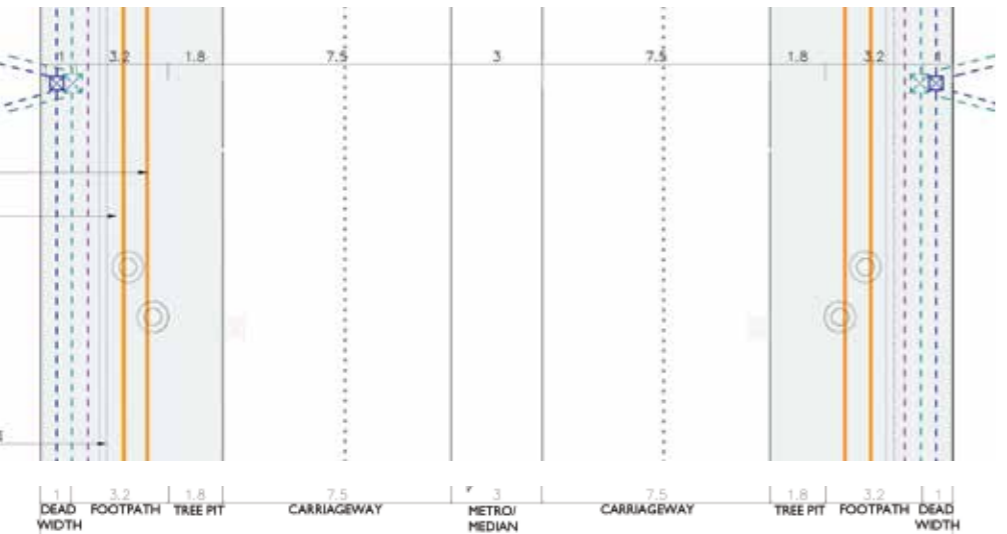
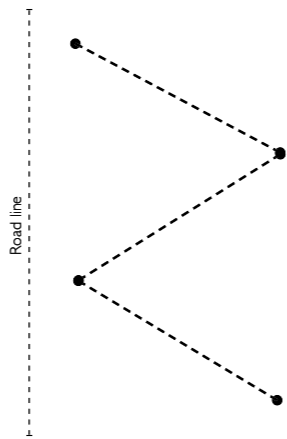
30M - **COMMERCIAL/ INDUSTRIAL** streets with overhead Metro (Arterial Road)



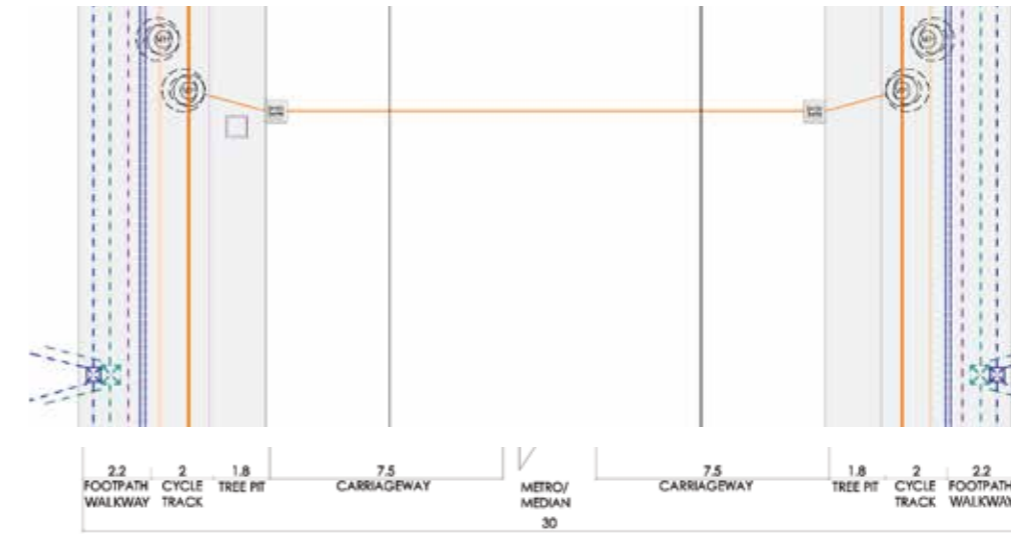
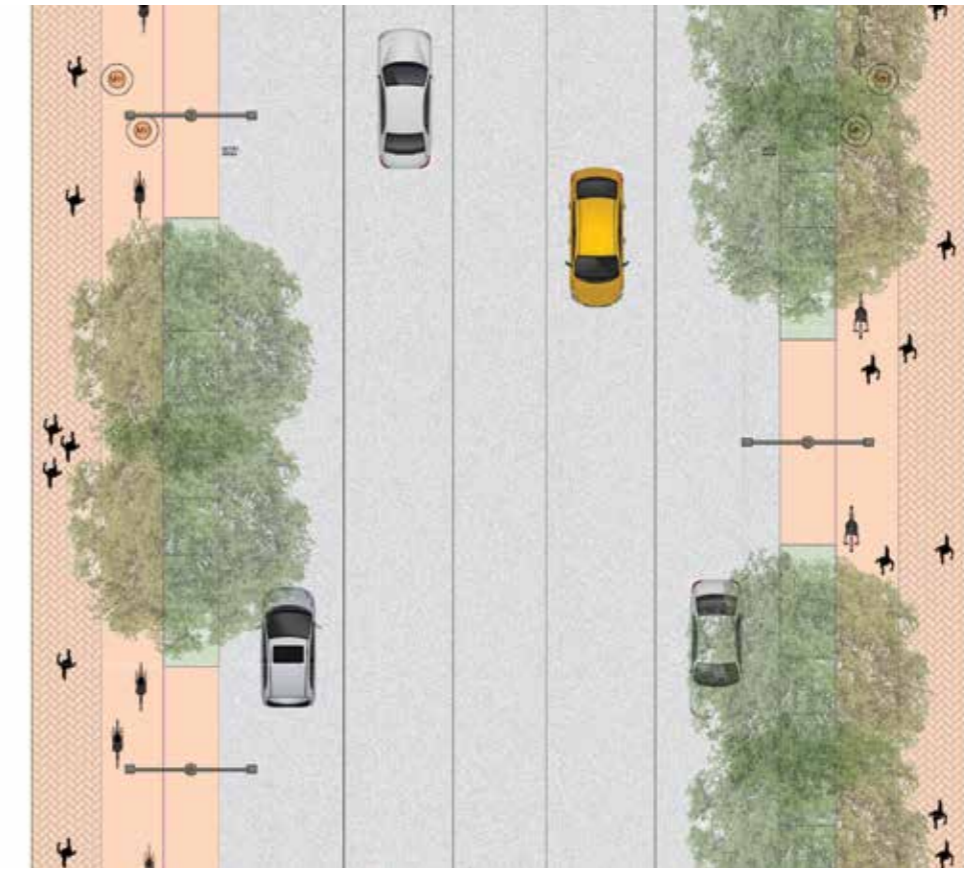
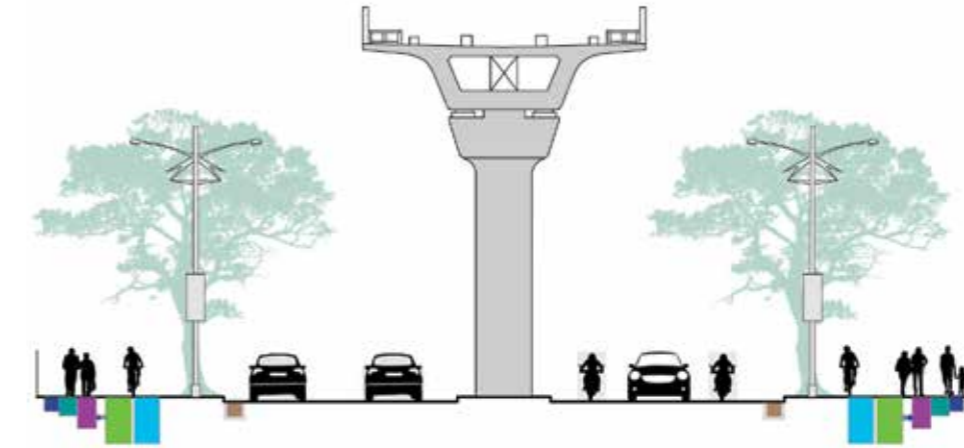
NOTES:
LIGHTING & TREES

ARRANGEMENT

- Lighting should be placed in a staggered arrangement such that the illumination has maximum coverage.



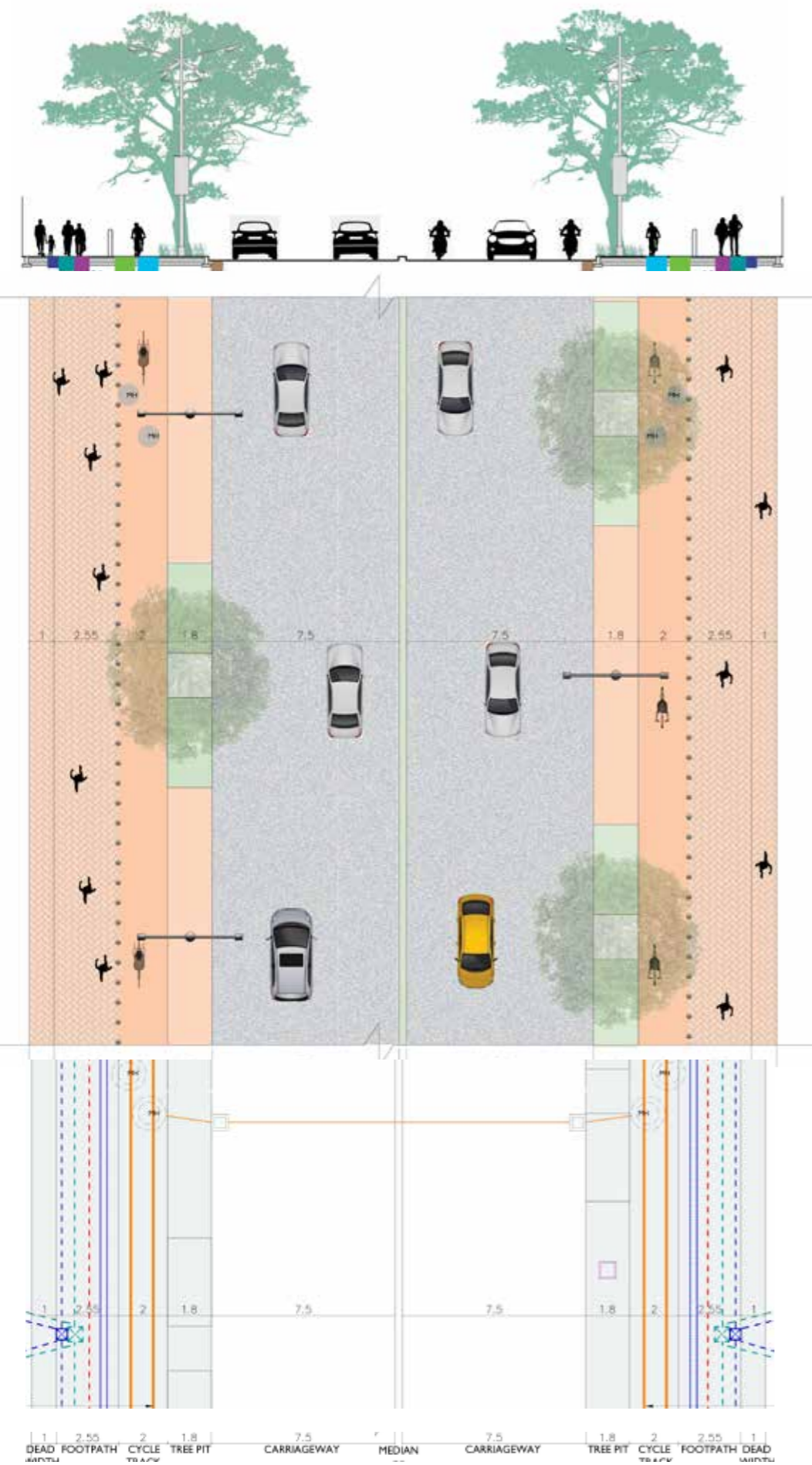
30M - **COMMERCIAL** streets with overhead Metro line and Cycle Track



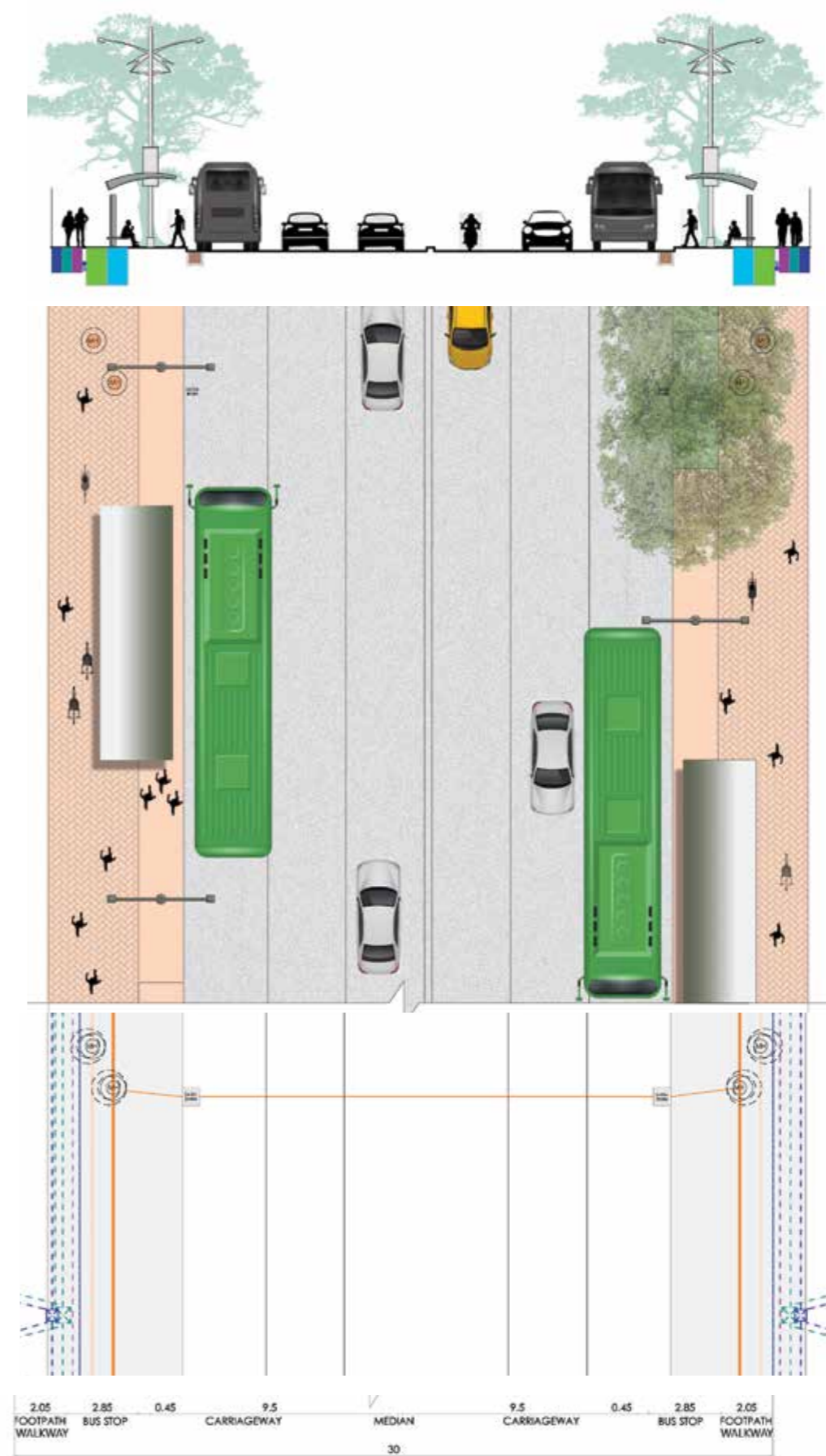
NOTES:
FINISHES
The main two types of street finishes used in the Indian context are:
a) **Modular finish:** Paver blocks such as concrete blocks, or sandstone paving
b) **Cast in-situ:** Concrete or IPS or colored, neutral asphalt paving

In general practice, it is observed that largely interlocking paver blocks are used for pedestrian pathways. Ideally, cast in-situ paving should be practiced as it is low on maintenance and provides a uniform finish for walking and cycling.

30M - **COMMERCIAL/ INDUSTRIAL** streets without Metro (Arterial Road)



30M - **COMMERCIAL** streets with Bus Stops



4.5.1 30M ROW



View showing Residential 30m ROW street section with shaded Cycle Tracks

NOTES:

SERVICE LAYERS

1. Storm water line
2. Sewage line
3. LT- Low tension cables
4. LV- Low voltage cables
5. HT-High tension cables

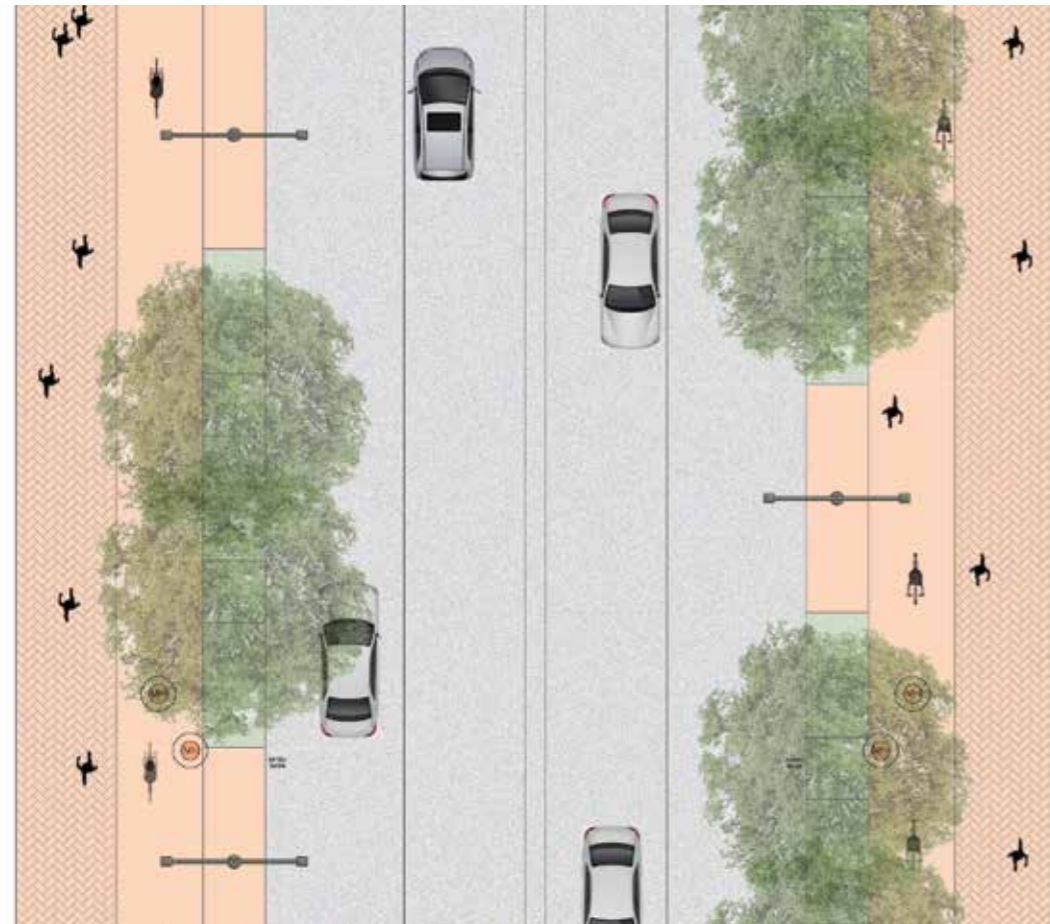
Street layout must depict allotment of spaces for all the service layers, for each variation in the section.

OTHER SERVICES

- a) **18 m streets and below:** No other entity should be allowed
- b) **30m and above:** Any additional entities such as police booth, kiosks, information booths may be added at appropriate locations only beyond the footpath width.

	HT LINE
	LT LINE
	LV LINE
	WATER LINE - DOMESTIC AND FLUSHING
	STORMWATER LINE
	SEWAGE LINE
	STORMWATER MANHOLE
	SEWER MANHOLE
	FOR HT CABLES
	FOR LT CABLES
	FOR LV CABLES
	DOMESTIC WATER LINE
	FLUSHING WATER LINE
	CATCH BASIN

30M - RESIDENTIAL streets with Cycle Tracks (Collector Road)

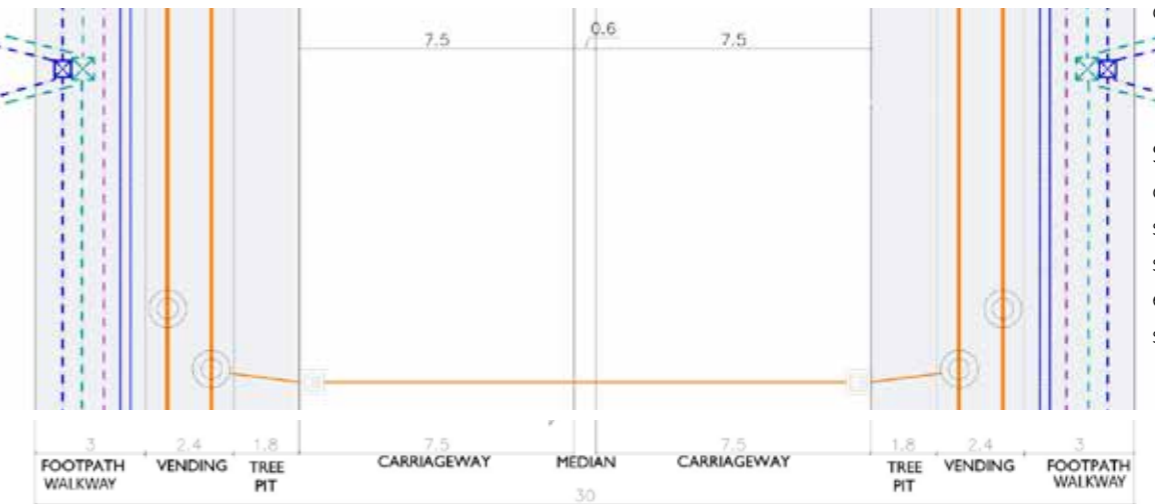
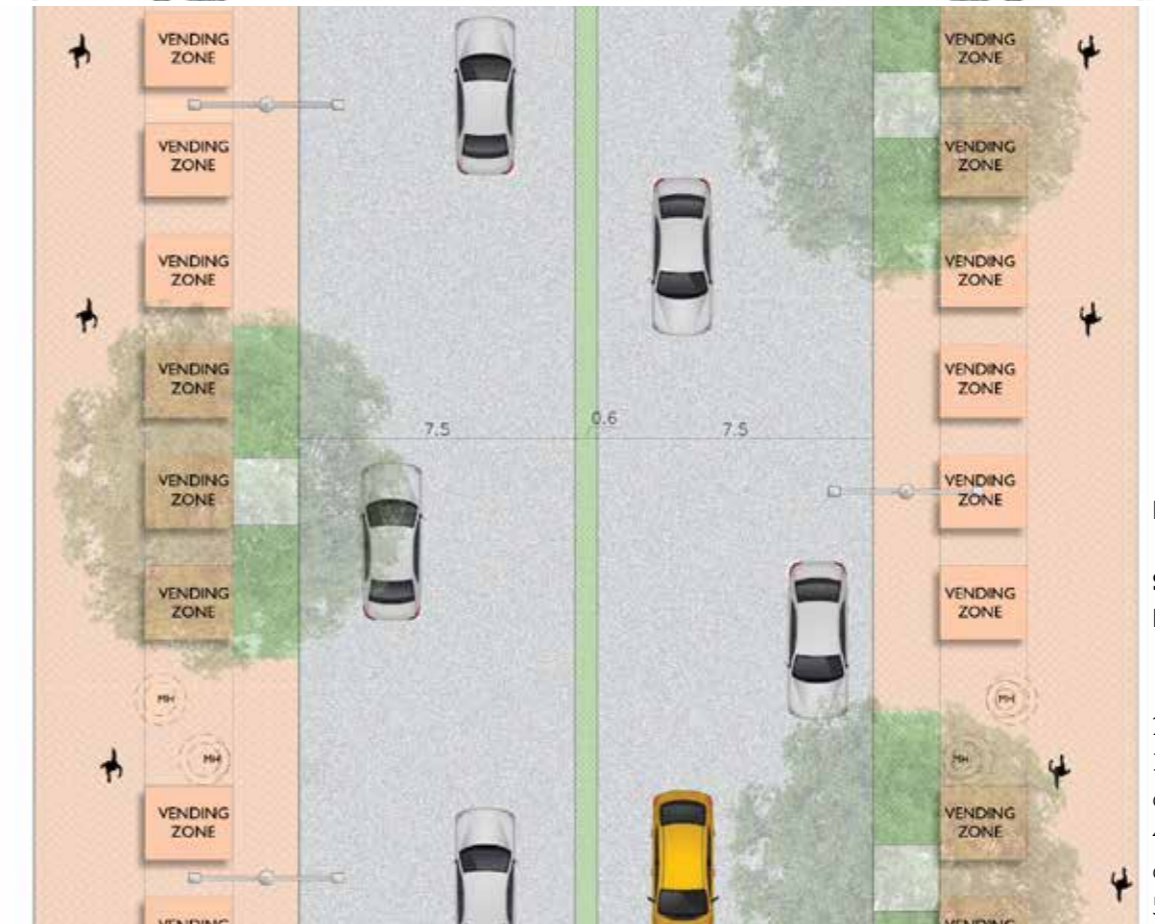
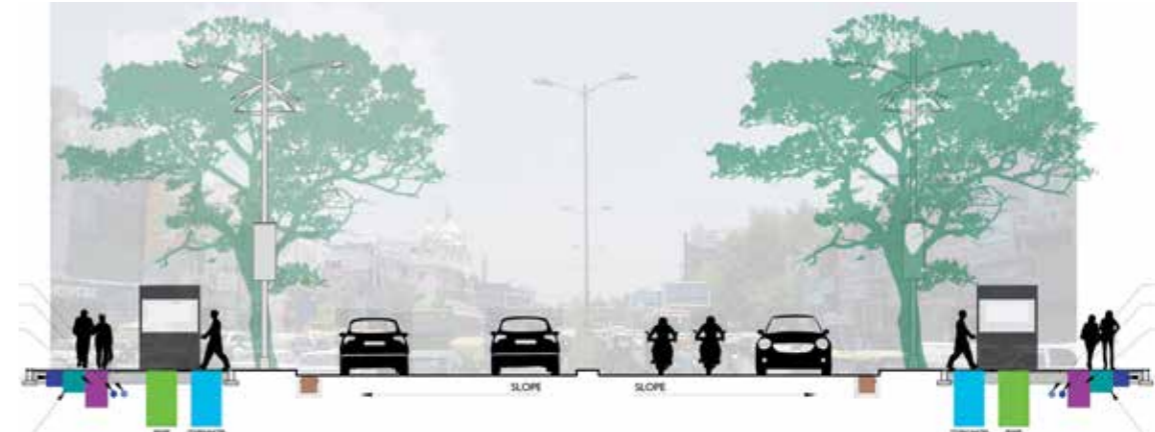


OTHER SERVICES

a) 18 m streets and below: No other entity should be allowed

b) 30m and above: Any additional entities such as police booth, kiosks, information booths may be added at appropriate locations only beyond the footpath width.

30M - RESIDENTIAL streets with Vending zone in the MUZ



NOTES:

SERVICE LAYERS

1. Storm water line
2. Sewage line
3. LT- Low tension cables
4. LV- Low voltage cables
5. HT-High tension cables

Street layout must depict allotment of spaces for all the service layers, for each variation in the section.

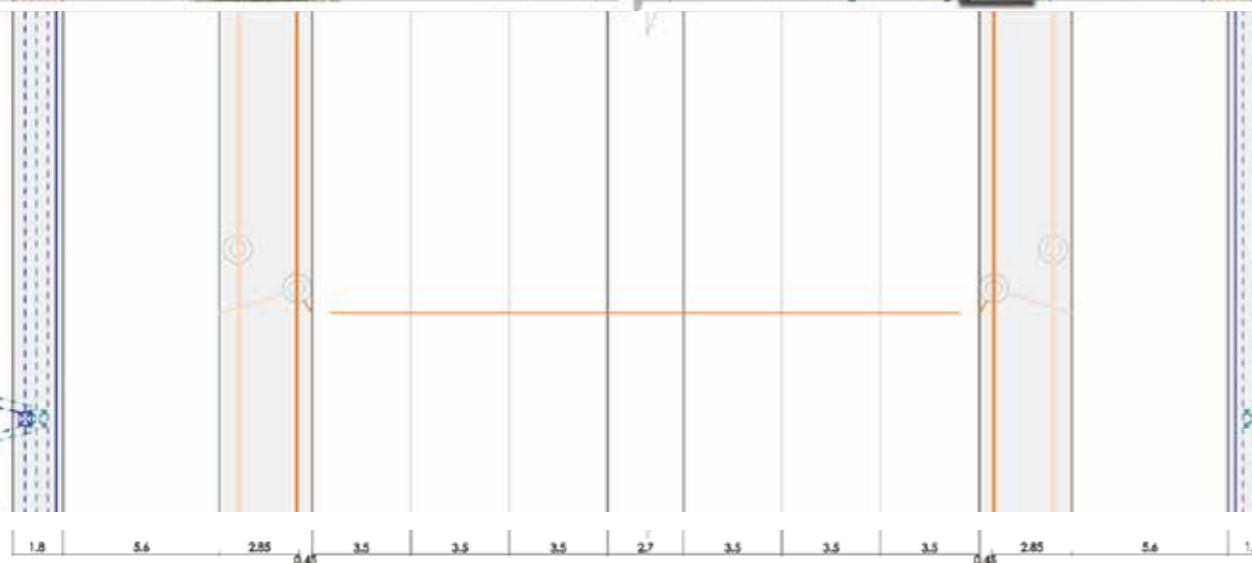
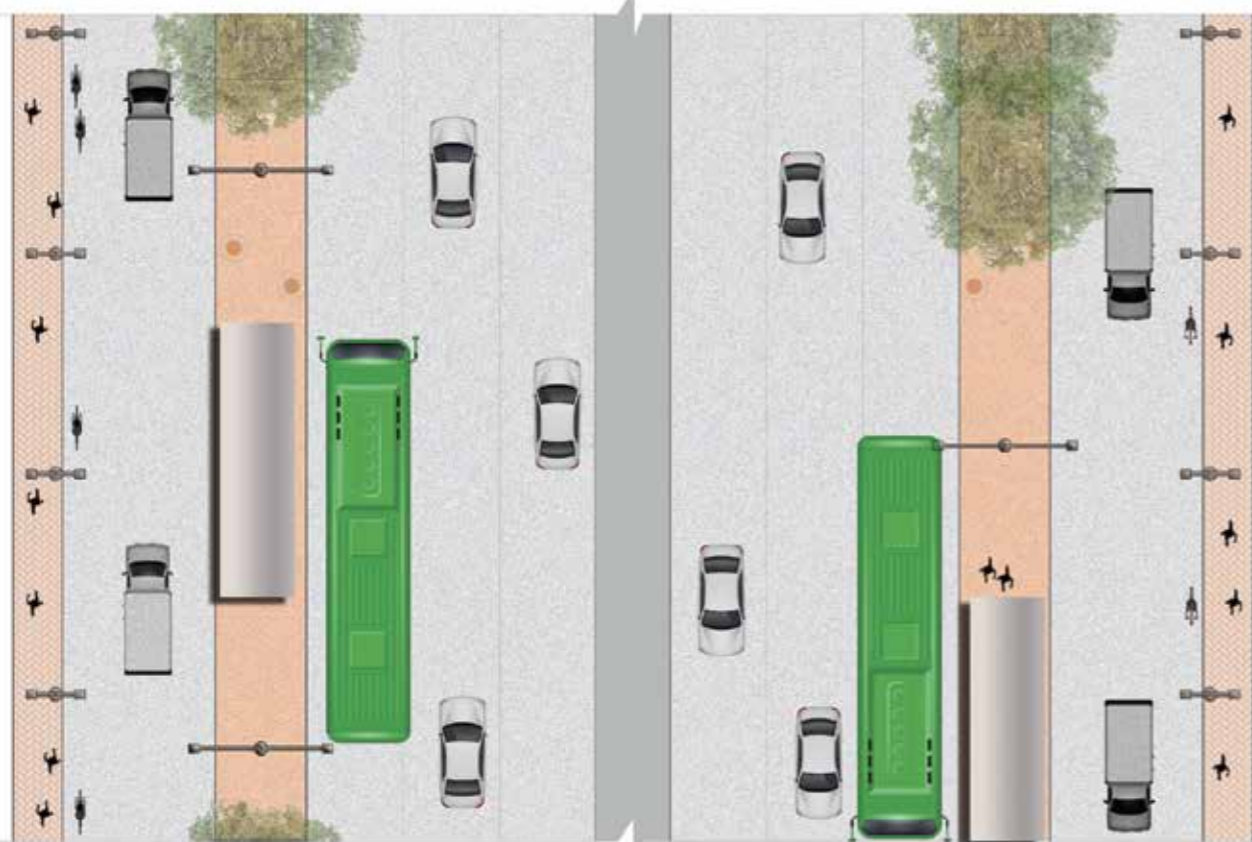
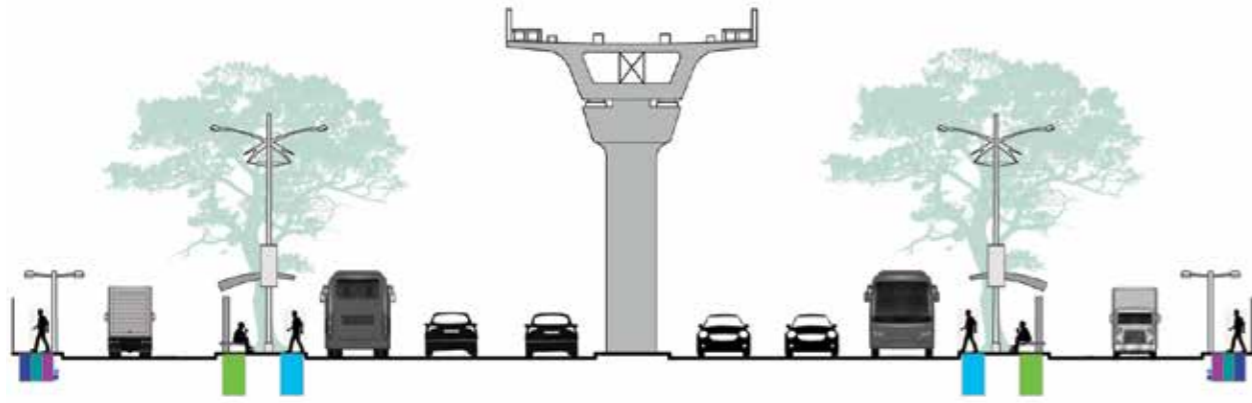
4.6.1 45M ROW



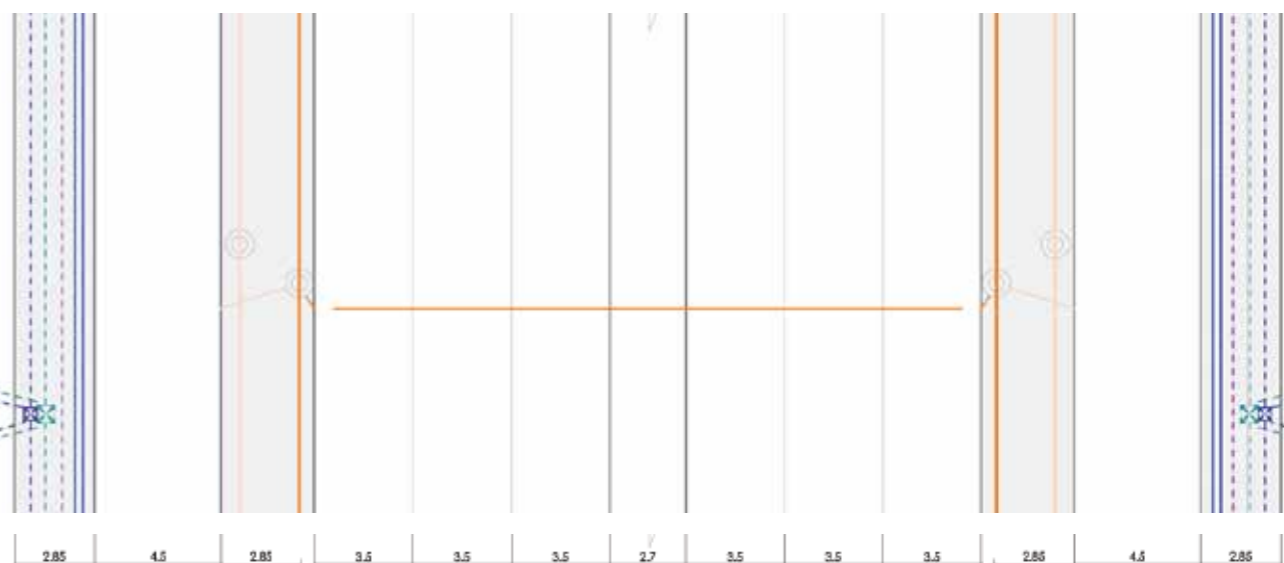
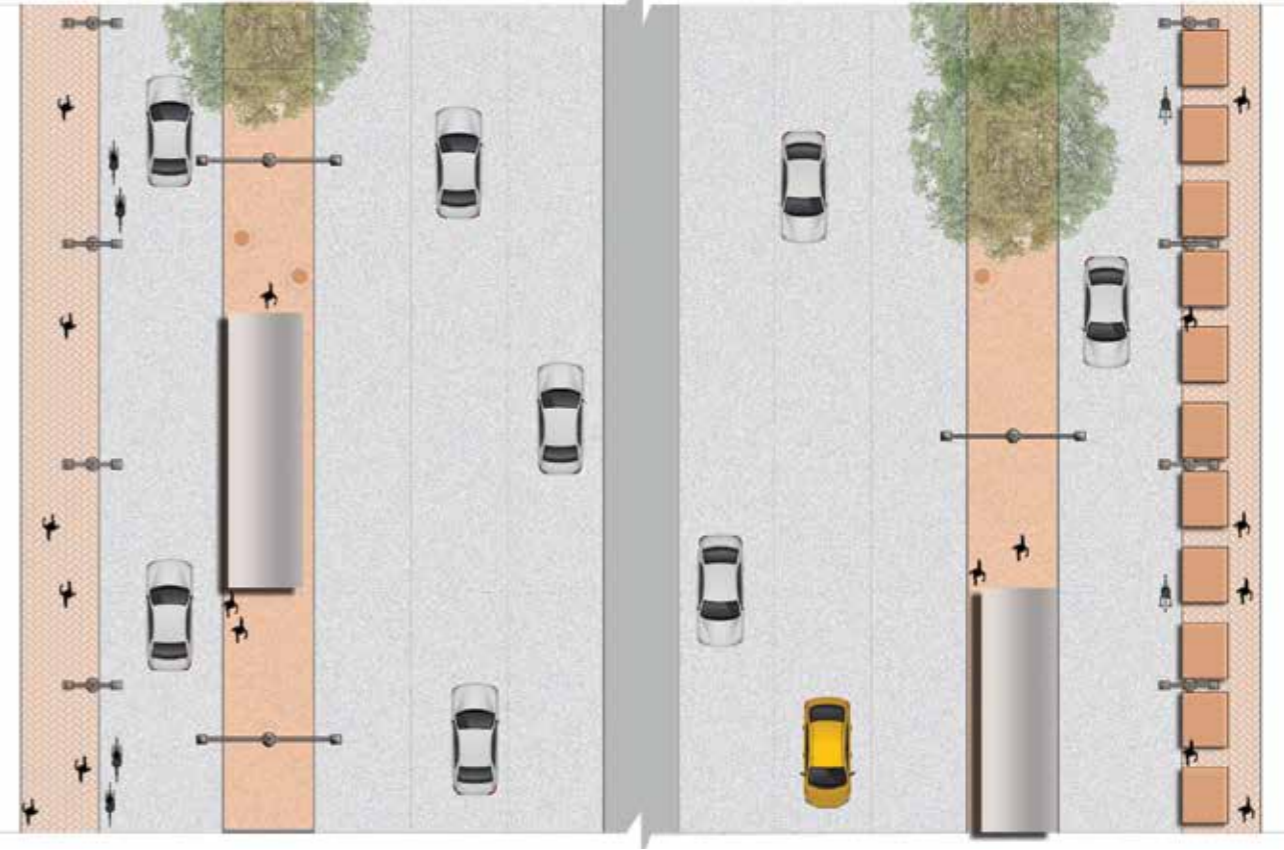
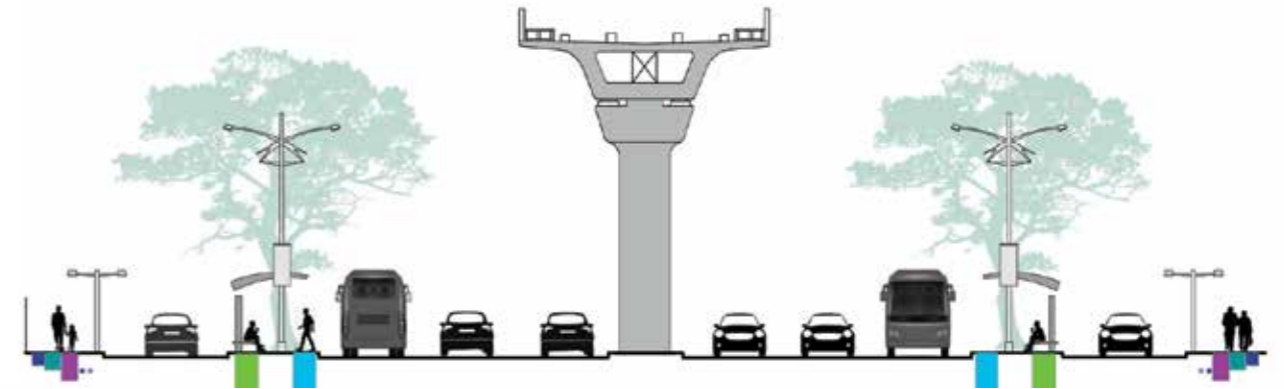
View showing Residential 45m ROW street section with Bus Stops on the MUZ and Overhead Metro line on the Median

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

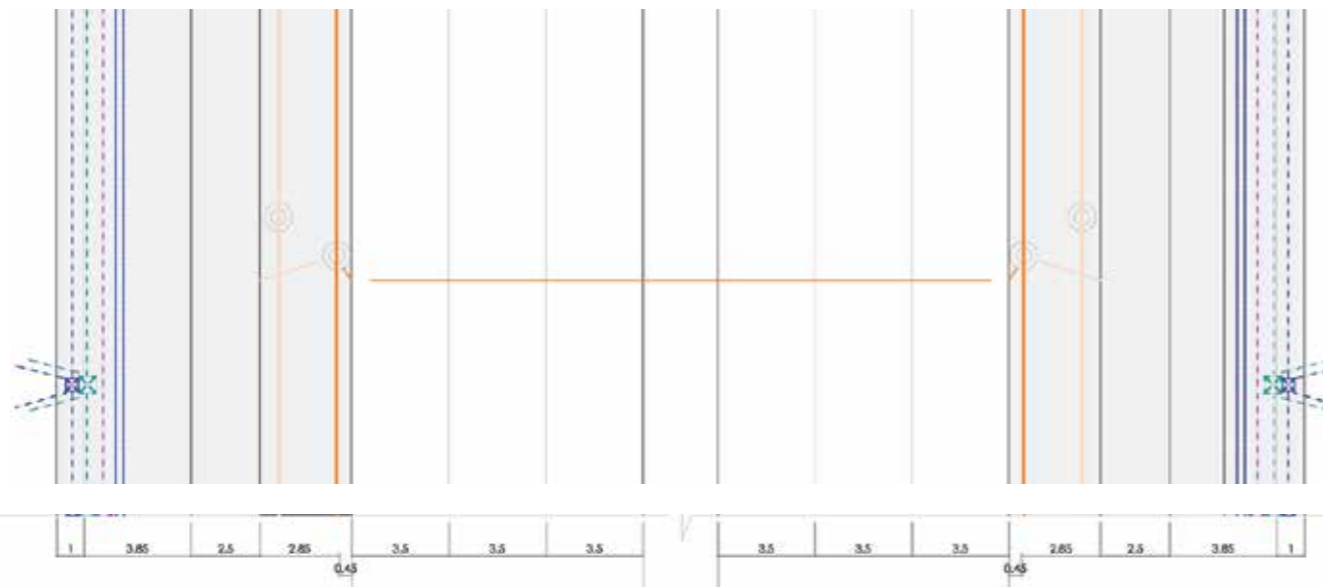
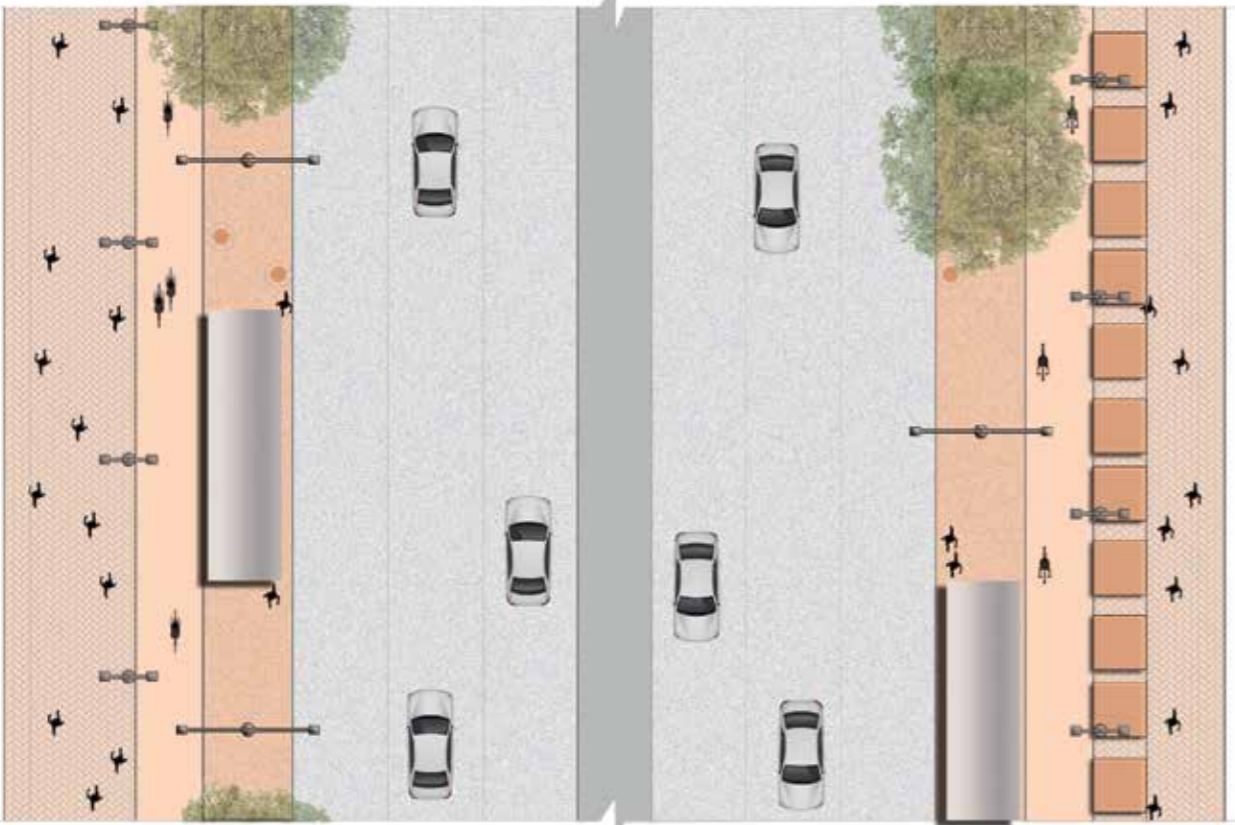
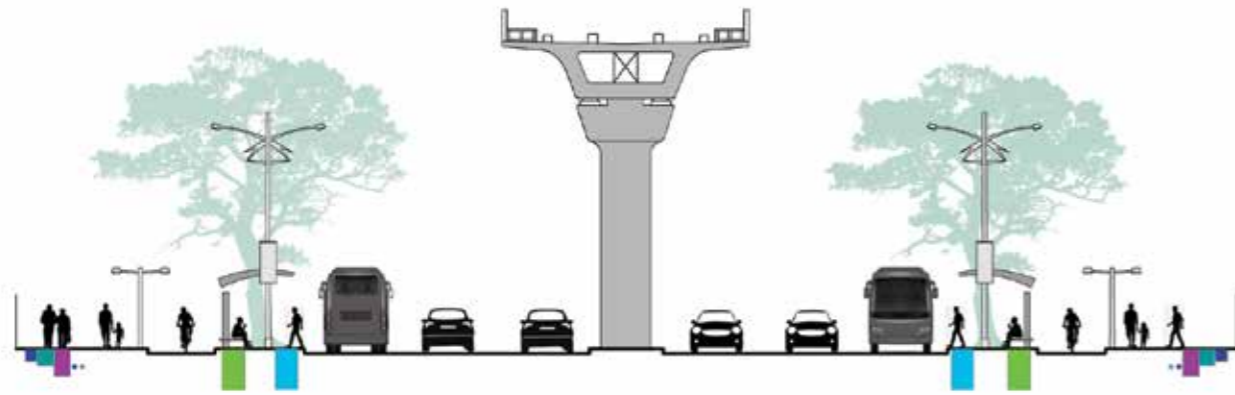
45M - **INDUSTRIAL STREET** with overhead Metro line on the median and Bus lane



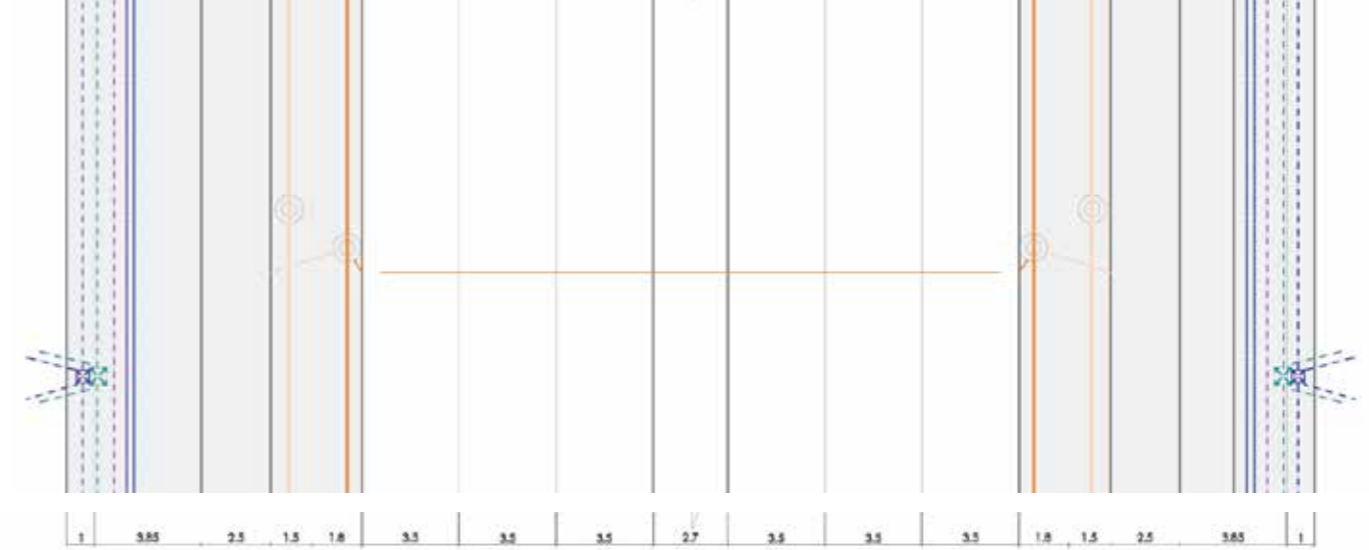
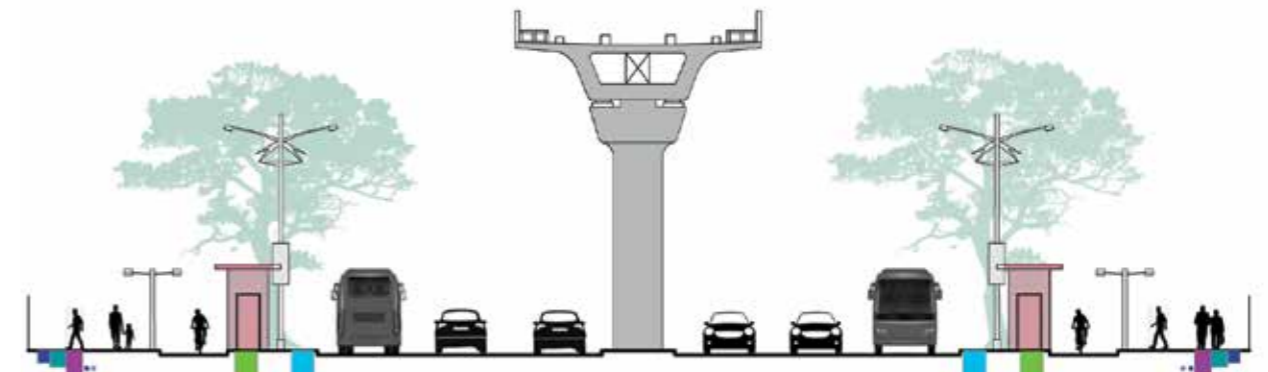
45M - **RESIDENTIAL** streets with overhead Metro line and Bus lane



45M - **COMMERCIAL** streets with overhead Metro line and Bus lanes (at junctions)



45M - **COMMERCIAL** streets with overhead Metro line and Bus lanes (Midblocks)



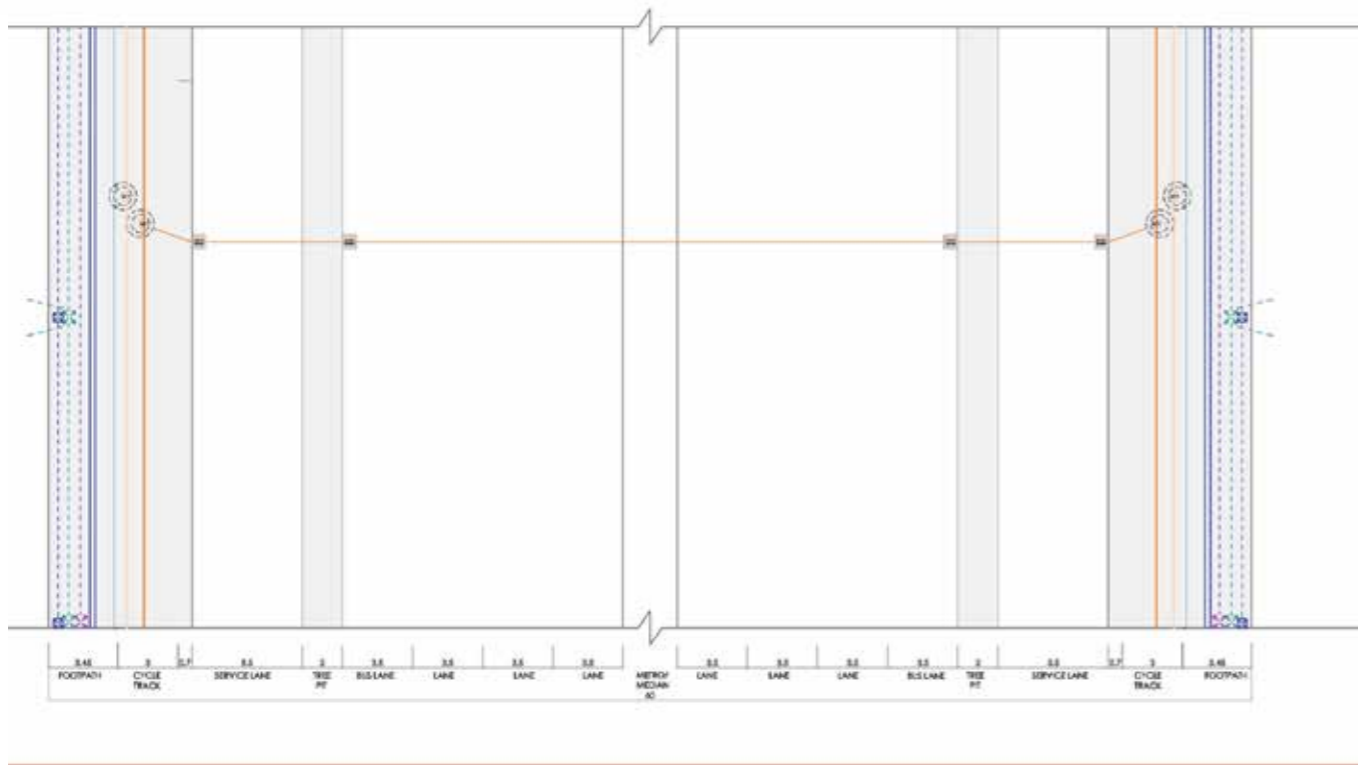
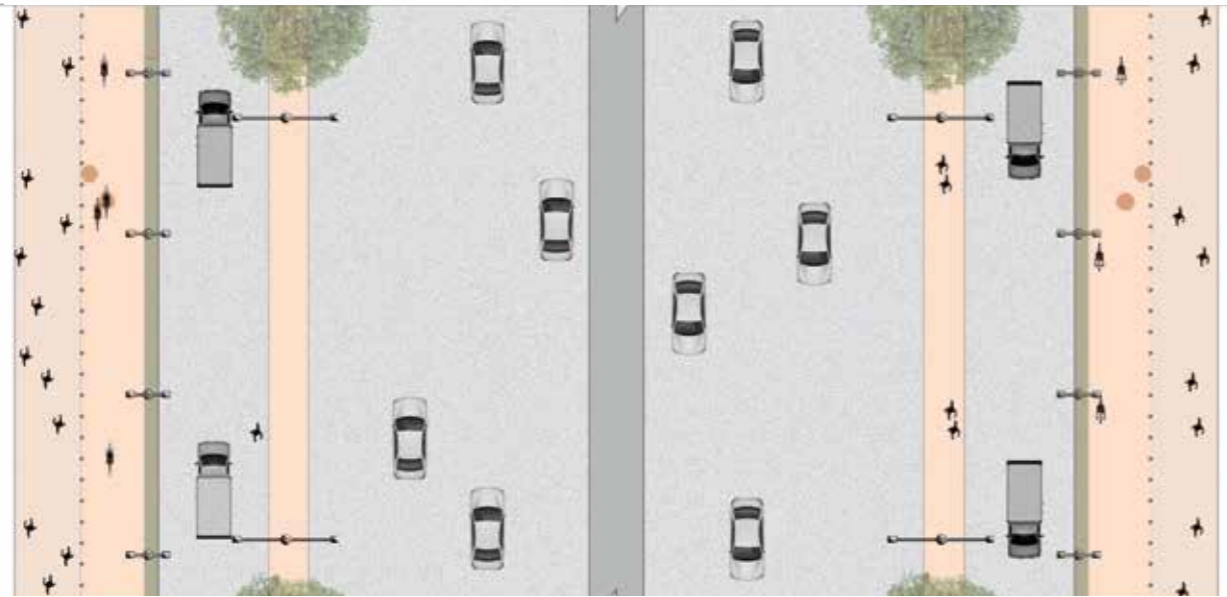
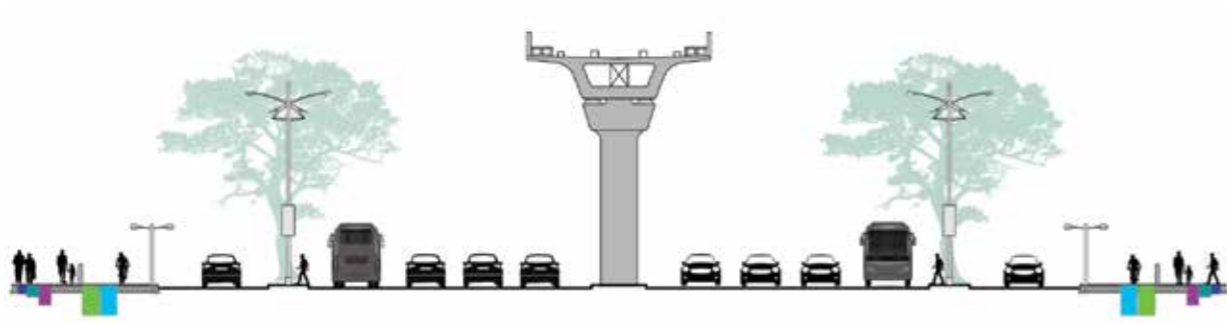
4.5.2 60M ROW



View showing Residential 45m ROW street section with Bus Stops on the MUZ and Overhead Metro line on the Median

- HT LINE
- LT LINE
- LV LINE
- WATER LINE - DOMESTIC AND FLUSHING
- STORMWATER LINE
- SEWAGE LINE
- STORMWATER MANHOLE
- SEWER MANHOLE
- FOR HT CABLES
- FOR LT CABLES
- FOR LV CABLES
- DOMESTIC WATER LINE
- FLUSHING WATER LINE
- CATCH BASIN

60M - RESIDENTIAL streets with overhead Metro line and Bus lane (at Mid-Block)



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5.0

Maintenance & Management

5.0 Maintenance & Management

- Delhi has an approximate road length of 30,000 kms, including 400 kms of five National Highways that originate or pass through the city, three expressways, and 87 kms of three Ring Roads (inner, outer, Eastern & Western Periphery). PWD, MCD's and Urban Development Authorities are in charge of planning, construction and maintenance of urban roads.
- PWD maintains about 1280 kms of roads, which are 18 m (60 ft) and more in width. This includes 40 kms of Ring Road, 65 km of Outer Ring Road and rest main arterial roads. MCD is responsible for roads less than 18 m (60 ft) wide, which is 28,000 kms (or 94%) of Delhi's urban road network.
- Number of vehicles in Delhi has increased multiple times more than the expansion of road network during the past decade. The consequence has resulted in not only traffic congestion but also heavy wear and tear of streets and footpaths. The condition of many residential/commercial city streets has reached the end of their lives and requires replacement or maintenance.

ROAD OWNERSHIP

- Different government agencies are responsible for streets (based on ROW width) and its elements. The government agency responsible for a street, based on the width of ROW, is also responsible for the footpaths on that street.
- PWD is responsible for streets 18 m and more in width and for the street lights, schools, hospitals and housing societies on those streets. MCD's are responsible for streets less than 18 m in width and also for the footpaths on these streets and some utilities on it. It collects all revenue generated by any element on the road/footpath.
- DDA is the largest land-owning agency in Delhi. However after development it hands over responsibility of the developed site to MCD or the developer.

A city needs regular street and footpath improvements. The purpose of having a maintenance plan is to provide information and recommendations for the upkeep and improvement of the city's street network. Indian Roads Congress (IRC) recommends maintenance as an essential element to get optimum service from streets and footpaths during its life period.

ROAD OWNING AGENCIES

- NDMC: New Delhi Municipal Council
- North DMC: North Delhi Municipal Corporation
- East DMC: East Delhi Municipal Corporation
- South DMC: South Delhi Municipal Corporation
- DCB: Delhi Cantonment Board
- PWD: Public Works Department, State of Delhi
- DDA: Delhi Development Authority (agency responsible for planned development of Delhi)
- NHA: National Highways Authority of India

STRUCTURE OF ROAD REPAIR

- The government agency responsible for a street is also responsible for footpaths on that street and its repairs. Multiple agencies are responsible for the street elements/ utilities on and below the footpath.
- MCD's are responsible for a number of utilities under and above footpaths of ROW's less than 18 m and some utilities on ROW's 18 m and more. The remaining utilities are the responsibility of individual agencies, eg. DJB for water and sanitation, etc. Multiple utility providers do not necessarily work in tandem during repairs.

However all utility providers are informed in advance about new developments via on-site meetings. Routine maintenance plans either do not exist or its implementation is not enforced or is very lax. Thus repair of streets and footpaths involves a need based process and not a regular one.

RESPONSIBILITIES OF ROAD OWNING AGENCY

The road-owning agency is also responsible for maintenance of footpaths, street elements and utilities on that road. Therefore for street and footpath improvements, it is important to know who exactly is responsible for what in maintaining and managing street improvements.

	Components	Sub Components	ROW < 18m	ROW 18m & > 18m	Undeveloped Land	Highways
	Street Description		MCD Inner colony local roads	PWD Major city roads	DDA • Land-owning govt. agency • Land handover to developer after development • BOT ¹ transfer	NHAI • 5 National Highways ² • 3 Expressways ³ • 3 Ring Roads ⁴ • All Central Govt. roads
PEDESTRIAN MOBILITY						
I	Pedestrian Mobility	1 Footpath	MCD	PWD	DDA	NHAI
		2 Kerbs	MCD	PWD	Developer (MCD/ PWD)	NHAI
		3 Slopes & Grades	MCD	PWD	Developer (MCD/ PWD)	NHAI
		4 Crossings	MCD	PWD	-NA-	NHAI
		5 Medians & Refuge Islands	MCD	PWD	Developer (MCD/ PWD)	NHAI
		6 Foot Over Bridge	-NA-	PWD	Developer (MCD/ PWD)	NHAI
NMV MOBILITY						
II	NMV ⁵ Mobility	1 Pedestrian / Cycle	MCD	PWD	Developer (MCD/ PWD)	NHAI
		2 Cycle / NMV	MCD	PWD	Developer (MCD/ PWD)	NHAI
		3 Cycle Intersections	MCD	PWD	Developer (MCD/ PWD)	NHAI
		4 Cycle Parking	MCD	PWD	-NA-	-NA-
		5 Cycle Turnings	MCD	PWD	-NA-	-NA-
VEHICULAR MOBILITY						
III	Vehicular Mobility	1 Carriageway	MCD	PWD	DDA	NHAI
		2 Road Shoulders	MCD	PWD	Developer (MCD/ PWD)	NHAI
		3 Transits	MCD	PWD	Developer (MCD/ PWD)	NHAI
		4 Bus Lane	MCD	PWD	Developer (MCD/ PWD)	NHAI
		5 BRT	-NA-	PWD	Developer (MCD/ PWD)	NHAI

		6	Grade Separator	-NA-	PWD	Developer (MCD/ PWD)	NHAI
TRAFFIC CALMING							
IV	Traffic Calming	1	Intersections	MCD	PWD	DDA	NHAI
		2	Slip Roads	-NA-	PWD	DDA	NHAI
		3	Roundabouts	MCD	PWD	Developer (MCD/ PWD)	NHAI
		4	Traffic Calmers	MCD	PWD	Developer (MCD/ PWD)	NHAI
PARKING							
V	Parking		Parking	MCD DMRC has its own	PWD DMRC has its own	DDA DMRC has its own	NHAI DMRC has its own
UTILITIES							
VI	Utilities	1	Bus Stops	DTIDC/ Transport Dept. Delhi Govt.	DTC/ Transport Dept. Delhi Govt.	DTC/ Transport Dept. Delhi Govt.	DTC/ Transport Dept. Delhi Govt.
		2	Street Furniture	MCD	MCD	MCD	MCD
		3	Traffic Signals	Installation: PWD Permit & Operation: Delhi Traffic Police	PWD & Delhi Traffic Police	PWD & Delhi Traffic Police	PWD & Delhi Traffic Police
		4	Street Lights	MCD	PWD	DDA	NHAI
		5	Street Markings	MCD	PWD	DDA	NHAI
		6	Signage	MCD	PWD	MCD/PWD	NHAI
		7	Advertisements	MCD	MCD	DDA	NHAI
		8	Street Art	MCD Pvt. owners in non-public realm	MCD Pvt. owners in non- public realm	Developer (MCD/ PWD)	NHAI
		9	Electric Cable Lines	Duct: MCD Cable: BSES	Duct: MCD Cable: BSES	Duct: MCD Cable: BSES	Duct: MCD Cable: BSES
		10	TV Cable Lines	Private Agency	Private Agency	Private Agency	Private Agency
		11	IGL Gas Line	IGL	IGL	IGL	IGL
		12	Water	DJB	DJB	DJB	DJB
		13	Sewerage	DJB	DJB	DJB	DJB
		14	Public Toilets	MCD	MCD	MCD	MCD

		15	Garbage Bins/ Dhalaos	MCD	MCD	MCD	MCD
		16	Solid Waste Management	MCD	MCD	MCD	MCD
		17	Storm water drainage	MCD, Flood & Irrigation	PWD, Flood & Irrigation	DDA, Flood & Irrigation	NHAI, Flood & Irrigation
		18	Tehbazari Street Vendors	MCD	MCD	-NA-	-NA-
LANDSCAPING							
VII	Landscaping	1	Trees	MCD, Horticulture Dept.	PWD, Horticulture Dept.	Horticulture Dept.	NHAI, Horticulture Dept.
		2	Landscape	MCD	PWD	Landscape Dept +Horticulture Dept., DDA	NHAI Horticulture Dept.
		3	Parks	MCD	MCD/DDA	DDA	Appropriate Municipalities

FOOTNOTES:

1 BOT: Build Operate and Transfer

2 National Highways: NH1, NH2, NH8, NH10, NH 24

3 Expressways: Gurgaon Delhi Expressway, Greater Noida Direct (DND) Expressway, Yamuna Expressway to Agra

4 Inner Ring Road and Outer Ring Road: 87 kms; Third Ring (Eastern & Western Periphery) Road

5 NMV: Non-Motorised Vehicle

6 DTIDC: Delhi Transport Infrastructure Development Corporation

7 DTC: Delhi Transport Corporation

CURRENT STREET MAINTENANCE PLAN

Guide for planning, construction and maintenance of roads is based mostly on IRC publications, other publications by Delhi Development Authority (DDA) and Municipal Corporation of Delhi (MCD).

Rigid pavements are more capital intensive and low on maintenance cost, while flexible pavements are cheaper to construct initially but more resource intensive in terms of maintenance. The damages in rigid pavements are difficult to rectify while flexible pavements are comparatively easy to rectify. Under mix traffic conditions of Delhi's roads, where 28 types of vehicles ply, high temperature variations during the year and poor drainage system, flexible pavements are preferred. Rigid pavements are adopted in areas which are prone to water logging.

Maintenance and management of Delhi streets and footpaths fall under the following broad categories:

1. Routine Maintenance
2. Periodic Maintenance
3. Emergency Repairs
4. New Developments

I. ROUTINE MAINTENANCE

Routine maintenance is the most important form of maintenance. Regular supervision and monitoring avert major repairs and reduces path deterioration, increases user safety, and prolongs the lifespan of the street/pathway through preventive care. It is time sensitive and is carried out before an actual major damage takes place. It is done even when roads are in good condition to ensure they remain so.

Existing Constraints:

Lack of routine maintenance system of the streets and footpaths.

Existing Opportunities:

Very few government agencies have provision for routine maintenance.

Procedure for Routine Maintenance

NHAI Manual describes routine maintenance as planned ongoing works and activities required for public safety, repair of small defects and maintenance of ROW's in its original

condition. All maintenance is carried out in accordance to IRC guidelines and specifications. In the absence of a particular provision, it can refer to the latest codes and specifications of BIS (Bureau of Indian Standards), or other international standards. Where none of these work, it will conform to sound engineering with the approval of IRC. Manuals and guidelines for routine maintenance currently exist in agencies such as PWD, NHAI, etc.

Recommendations for Routine Maintenance

- Existing examples of preventive maintenance plans, e.g. PWD's Preventive Maintenance Schedule, can be reviewed.
- Similar/modified formats of maintenance plans can be created by different civic and utility agencies.
- Maintenance plan may include policy direction, project priority, funding mechanism and scheduling.
- Plan may include short-term and long-term preventive maintenance.
- The schedules shall be reviewed every three years.
- Periodic monitoring of damages shall be done at planned intervals.
- Methods, procedures, equipment, personnel qualifications, and other aspects of work may be specified.

2. PERIODIC MAINTENANCE

Periodic maintenance is done when substantial work is carried out after long intervals.

Existing Constraints: Periodic maintenance either does not exist or its implementation is lax.

Existing Opportunities: Some government agencies such as PWD and NHAI have provision for routine maintenance.

Procedure for Periodic Maintenance

Develop a proactive procedure in place of the existing need-based process. Government and its subsidiary agencies need to have an agreed-upon maintenance strategy to coordinate and synchronize periodic maintenance. As projects increase in complexity and scale, maintenance needs and arrangements also become increasingly complex. A citywide street database provides an appropriate solution.

A number of government agencies currently use a centralized citywide street database by GSDL (Geospatial Delhi Limited) sponsored by GNCTC (Government of National Territory Capital) of Delhi. DSSDI (Delhi State Spatial Data Infrastructure) has made this database available to the government via a Spatial Data Infrastructure (SDI) geoportal.

Existing Constraints :

Departments generally do not upload their data into the centralized database. So data does not reflect real-time interdepartmental information.

Many departments have their own street database done in GIS. Individual databases may not synchronize with the street database due to inaccuracies.

Existing Opportunities :

- Many departments access this database.
- The system collects and collates information from line departments of GNCTD, including departments of over-ground and underground utilities, e.g. water, sewer, telephones and power lines, etc.
- Information on underground utilities in digital format allows faults to be located with precision, which allows transparency between departments.

Recommendations for Periodic Maintenance

- Cloud-based applications may be used to build web applications and create an infrastructure to host street data.
- Real-time, interactive web mapping services can be developed that include tools to corroboratively manage, create, edit and resolve overlapping repairs and maintenance issues.
- Web applications can be used to access data across multiple departments accessible in one central customized platform.

3. EMERGENCY REPAIRS

Emergency repairs are conducted when major damages have already taken place and access to a road might have already been impaired. Responsibilities for repairs belong to the same agency that owns the road. They happen when a need for repair is noted or reported. Emergency work is undertaken after floods or landslide, or to reopen or keep a path open for users. Funds are usually released for emergency maintenance.

Existing Constraints:

- Lack of coordination between multiple utility agencies responsible for varied services on pathways.
- Agencies work in silos and not in tandem, resulting in unplanned multiple diggings and unattended debris.
- Duplicative work and poor drainage lead to unsatisfactory repairs.

Existing Opportunities:

A citywide database of Delhi streets sponsored by GNCTC (Government of National Territory Capital) launched in 2009, provides 3D GIS mapping on a large-scale base map created

from aerial photographs. It covers the state of National Capital Territory of Delhi across an area of about 1500 sq kms. It also collates information from different civic departments.

4. NEW DEVELOPMENTS

New projects are carried out by a specific government agency responsible for a specific type of road based on the width of the ROW (right-of-way) and its characteristics. The agency in charge of a road is also responsible for the footpath on that road. Multiple agencies provide utility services in and on the footpath.

Existing Constraints:

May or may not have provision for maintenance. Even if there are terms of maintenance built into the project, they are either not followed or are very lax.

Existing Opportunities:

Some roadway agencies sign an Operation and Maintenance (O&M) contract before commencing a new development, eg. NHAI signs a 15 year O&M for national highways.

All concerned agencies are informed of new developments before it takes place, usually through a joint-site meeting.

Agencies responsible for construction and maintenance of roads in the NCT (National Capital Territory) of Delhi are :

1. Municipal Corporation of Delhi
2. New Delhi Municipal Committee
3. Public Works Department, GNCT of Delhi
4. Delhi Development Authority
5. Delhi Cantonment Board
6. National Highways Authority of India

Urban Roads Manual by Public Works Department (PWD), Government of Delhi's, provides the methodology of road maintenance.

PWD follows the Street Design Guidelines recommended by UTTIPEC.

ENFORCEMENT

Most municipal agencies have their own system of inspection and enforcement departments with their own guidelines, procedures, schedules, responsibilities, notices and rules. However implementation of these processes are lax and tools for their enforcement are either non-existent or not mandatory.

RECOMMENDATIONS ENFORCEMENT

There isn't any one action or policy that can fix every problem or even effectively change the status quo. Everything starts with context and the unique needs of a community. A multi-

pronged strategy will ensure effective maintenance of streets. The solution is to create a connected and coordinated effort for the implementation of maintenance.

The process can be a combination of the following steps:

1. Create a Maintenance Cell
2. Integrate Maintenance in Street Policy Guidelines
3. Create Implementation Plan
4. Involve Stakeholders and Community

1. Maintenance Cell

A special agency may be created and given full responsibility for maintenance and for bringing all stakeholders on the same page. The agency can be:

- A special task force or Cell
- A Bureau of Street and Mapping Inspection and Enforcement Division under CPWD
- A unified agency with representatives from PWD, MCD's, DDA, other involved agencies and members of citizen groups.

Job of the cell would be to:

- Inspect Programs
- Pavement Improvement and Repair Accelerated Footpath Abatement

Inspection Services

- Ward Footpath Inspection
- Street Improvement Inspection
- Utility Inspection

2. Policy

An effective Complete Streets policy can be developed to lay the foundation for the implementation process, which acknowledges the benefits of planning, designing, and maintaining a street network that balances the needs of all users and modes. Steer an institutional shift in how the city, municipality, and community views its streets and integrates and codifies Complete Streets principles into its daily operations and maintenance. The policy shall integrate routine and periodic maintenance.

3. Implementation Plan

The process of maintenance can be formalized by involving the staff and decision makers who are engaged in planning, design, construction, and maintenance of the jurisdiction's streets. The plan may include:

- Assessment of street layout and design, transportation infrastructure, and network gaps
- Evaluation of streets condition of and how its users are being served
- A Street/Footpath Design Checklist

Following are some good examples of implementation plans:

- Pune Municipal Corporation; ITDP Pedestrians First: Urban Street Guidelines, Pune
- Corporation of Chennai, ITDP, Chennai Street Design Project
- ITDP, Urban Street Design Guidelines
- California Department of Transportation: Complete Streets Implementation Action Plan

4. Involve Stakeholders and Members of Community

Decisions about transportation and other public works projects shall be guided by public input and feedback from different community stakeholder groups. The key to this challenge is to formalize an inclusive decision-making process. Conduct outreach via community groups such as RWA's, other (social, spiritual, cultural) community organizations, neighbourhood businesses, local vendors, individual residents, etc. Involve them on the overall and continuing upkeep of streets and demonstrate how it fits into the larger network and needs of the community.

Following are some methods that are generally successful in involving the community to build support for Complete Streets and enforce maintenance of streets.

- Streets Committee
- Workshops
- Road Safety Audits
- Education and Training
- Advocates, Volunteers, and Community Action
- Engaging the Creative Community

Refer Annexure 2: How to involve stakeholders and the community

DUAC'S RECOMMENDATIONS

Like every city, Delhi has its own unique terrain, soil and erosion conditions, available maintenance materials, weather patterns, and responsibilities to citizens. The suggestions are based on common best practices, evolving technology and future demands that are adapted to suit Delhi's own operating procedures, and current ways of conducting roadway maintenance activities.

Proposed types of maintenance & its schedule:

1. Routine Maintenance

- All concerned agencies shall be informed when a

routine maintenance in a neighbourhood is scheduled. The line of communication, currently practised for new developments, shall be adopted.

- Different civic and utility agencies may use a similar format followed by PWD and NHAI to create routine maintenance schedules.
- Routine maintenance schedules of all service agencies may be made available in the public domain to allow schedules of different agencies to try and be in tandem with each other.

2. Periodic Maintenance

- The line of communication for periodic maintenance and repair, practised for new developments, can be adopted.
- The GSDL (Geospatial Delhi Ltd.) citywide database provides a great opportunity for all government agencies to connect to a central hub of data in a common standard format that is interoperable.
- Utility agencies shall be incentivised to upload their current data into a citywide street database.
- All stakeholders shall be involved to coordinate in advance their individual requirements and repair schedules.

3. New Developments

- All agencies shall be informed about new developments via on-site meetings, the same way as it is done currently.
- Building A citywide street database that connects with other agencies and informs about upcoming new projects is suggested.
- Adapt maintenance methods adopted by NHAI of signing a long-term O&M (Operation and Maintenance) contract with the agency constructing a ROW. The O&M clause should be an integral part of the tender/contract process and its enforcement could be similar to NHAI's.

4. Others

- Periodic meetings of all stakeholders such as PWD, MCD's, DDA, other involved agencies and members of citizen groups shall be conducted.
- An unified agency with representatives from PWD (Public Works Department, MCD's (Municipal Corporation of Delhi) shall be established.
- Citizens involvement in providing suggestions and reporting concerns, using mobile Apps that generate time-bound fixing schedules may be promoted.
- A central helpline phone number to report street issues and online grievance reporting/redressal mechanism, shall be suggested.
- Enforceable law mandating agencies shall be formed, to notify

the road-owning agency at least 48 hours in advance of any surface excavation projects they plan.

RECOMMENDATIONS OVERVIEW :

The suggested recommendations shift focus from vehicular movement to improved traffic condition by reducing private automobile use. An updated metric should look at crash reduction, reduced vehicles on the street, or shifts in mode share to walking, biking, and/or transit trips as measures of success. Common activities to measure success can include

- Count the number of new or repaired facilities each year (e.g., blocks of footpaths)
- Track crashes and injuries for all types of roadway users
- Track use of street facilities by different modes (e.g., number of people walking)
- Conduct project-level "before" and "after" studies

This approach would extend beyond the street itself and include how the community as a whole functions. Metrics that are not directly tied to transportation can therefore be used to measure the success. Potential indicators include:

- Stakeholder satisfaction (e.g., user and resident feedback)
- Public health (obesity, diabetes)
- Economic vitality (tax revenue, property values)
- Environmental benefits (e.g. trees planted, reduction in impervious cover, decrease in storm-water flow into street sewer system, solid waste management)

Annexure 1 : Relevant information from MPD-2021

Table 12.1 : Guidelines for Road Hierarchy

	Arterial Roads	Collector Roads	Local Streets
RIGHT OF WAY	> 30 M	>12 - 30 M	9 - 12 M
SUGGESTED SPEED LIMIT	40 - 50 km/hr	20 - 30 km/hr	10 - 20 km/hr
SPEED CONTROL	Enforcement and Traffic Calming required	Enforcement and Traffic calming required.	Enforcement and Traffic calming required
BUSWAYS	Segregated busways (3.5 M) per direction	Demarcated bus-lanes (3.3 M) per direction.	No segregated bus lanes required.
MOTORIZED LANES	2 to 3 motorized lanes (min. 3.3 m wide each) per direction, excluding busways	1 to 2 motorized lanes (min. 3.1 m wide each) per direction, excluding buslanes	No minimum lane width specification.
CYCLE/ NMV TRACKS	Segregated cycle tracks required; min. 2.5 m wide for two-way movement.	Traffic calming essential where segregated cycle lanes (min. 2.5 m) are not provided.	No special provision for cyclists
SERVICE LANES	Service lanes required.	No service lane required	No service lane required
MEDIANS AND JUNCTIONS	Continuous median; all openings and intersections accompanied by signals and traffic calming.	Intermittent or No median; openings/ intersections accompanied by signals and traffic calming.	No medians; traffic calmed crossings, or mini roundabouts

Annexure 12.0 (I) Street Design Regulations

CHAPTER 20 Transit Oriented Development Policy

Annexure 2 : How to involve stakeholders and the community

i. **Complete Streets Committee**: Involve relevant stakeholders throughout the entire planning and decision-making process to achieve buy-in, support, and coordination between various actors. It should comprise of representatives and officials from various local agencies, including planning, engineering, police, fire, public works, elected officials, and other stakeholders and decision makers.

ii. **Workshops** : Provide forums to educate and collect input from the general public, decision-makers, and stakeholders. It is an effective tool to:

- Develop plans that reflect needs of the community
- Demonstrate an open process and support outcomes
- Involve decision makers, stakeholders, and other contributors in an on-going process

iii. **Road Safety Audits** : A road safety audit is a community-driven process that can generate momentum and support for action. It provides an opportunity for diverse groups of decision makers, stakeholders and the community to jointly visit a problem and assess existing conditions. A checklist is often used during the audit for participants to keep track of problem areas, deficient or missing infrastructure, and other observations. The audit is an effective educational and outreach tool. Participants are given the opportunity to not only observe deficiencies, but understand why it might be imperative to take action. It is a collaborative process that helps participants and decision makers see and experience the problem spot, revealing issues they might not otherwise detect. Following are some examples of audits being conducted in Delhi:

- Street Safety: Safetipin, a social app provides nine parameters of safety audits to make neighbourhoods safer for women and others. The community of C.R. Park, a neighbourhood in Ward 190 in central zone of Delhi, conducted an audit to check the safety of walkability of that area. The collected data covered major roads and inner travel paths and was shared with the community, stakeholders and planners to provide inputs to PWD and MCD to improve safety and maintenance of streets.

- Air and Noise Pollution: Centre for Science and Environment (CSE)

- Solid Waste Management: Chintan (Environmental Research and Action Group)

Data from audits help document project need and build consensus amongst stakeholders for support and action.

iv **Education and Training** : Education is an extremely important component of a successful street program. Planners, engineers,

consultants, decision makers and agencies need a thorough understanding of new procedures. Officials should receive on-going education to understand the community benefits of Complete Streets and how the goals will be translated into projects. Common education strategies include, but are not limited to:

- Workshops for staff and consultants, with auxiliary sessions for community leaders and the public
- Invite PWD and MCD's, professional organizations, and transportation non-profits to provide professional development training to community
- Provide on-the-job training for staff
- Lead walking audits and bicycle rides for decision-makers, staff, and the public
- Engage community through formal public engagement activities and project-based meetings.

v. **Advocates, Volunteers, and Community Action** : Interested residents and stakeholders are effective allies in building community support for maintaining a neighbourhood. Working with stakeholders can help enforce implementation and maintenance more efficiently. On smaller-scale projects, advocates and volunteers can also assist with implementation. They may be able to provide private funding resources to support construction or volunteer labour.

v. **Advocates, Volunteers, and Community Action** : Interested residents and stakeholders are effective allies in building community support for maintaining a neighbourhood. Working with stakeholders and involving them can help enforce implementation and maintenance more efficiently. On smaller-scale projects, advocates and volunteers can also assist with implementation. They may be able to provide private funding resources to support construction or volunteer labour to reduce maintenance costs.

Further Guidance

- **St+art India Foundation, India**

Lodhi Road Colony, a public art district was designed and created by local, national and international artists in conjunction with St+art.

- **Gyandeeep Growth Foundation, New Delhi**

Came together with Green Park Extension community to implement "The Beautification Project" to transform dilapidated walls of N-Block into a creative wall art.

Annexure 3 : Definitions

Access: Approach to a plot or a building from a road or street.

Accessibility: The ability for all people, including people with impaired mobility and of all ages, to physically reach their desired destinations, services and/or activities with ease. See also Universal accessibility.

Accessible Pedestrian Signal (APS): A device that communicates information about pedestrian signal timing in a non-visual format, which include audible tones, verbal messages, and/or tactile vibrations.

Angled Parking: Parking provided at an angle between 90 degrees (perpendicular) and 0 degrees (parallel) to the path of travel.

Approach: The section of an accessible route that comes within range of an entry point to a street.

Arterial Road: It is a high-capacity urban road that delivers traffic from collector (low to moderate capacity) roads to highways and between urban centres in the most efficient manner possible.

At-grade: Being on the same level.

ATP: Audio Tactile Profile is a system of road marking that provides both edge and centre line treatment along a continuous route with essential breaks in between. A recommended minimum width between centre line and edge line of the lane is approximately 3.35 m .

Audible Warning: A device used to aid people with visual impairments. See Accessible Pedestrian Signal (APS).

Bicycle: A non-motorized, human powered two-wheeled vehicle. It can include 2-wheel bicycles, tandem bicycles, 3-wheel tricycles, bikes with trailers, etc., but also may not include 3-wheel tricycles unless specifically indicated.

Bicycle Facilities: A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling, including parking and storage facilities.

Bicyclist: A person using a non-motorized, human-powered wheeled vehicle for travel (with the exception of wheelchairs).

Bicycle Box: A space for cyclists to turn near junctions while waiting at a red light ahead of mixed traffic.

Bicycle Path: A path separated from motorized traffic and dedicated to cycling or shared with pedestrians or other non-motorized users.

Bio-swale: A vegetated depression running alongside the road into which storm water is directed. This landscape element is designed to remove debris and pollution out of surface runoff water.

Bollards: A sturdy, short, vertical post installed to control road traffic and designed to prevent motorized vehicles from entering areas reserved for pedestrians.

Bus Rapid Transit (BRT): Also known as busway or transit-way is a bus-based public transport system designed to improve capacity and reliability relative to a conventional bus system.

Building Line: A designated line drawn along the edge of a municipality's footpath beyond which a building must not extend into the street.

Bulb-Outs: Is a traffic calming measure used by extending the footpath to reduce a distance pedestrians have to cross across a street. It facilitates approaching drivers to see each other when parked vehicles in a parking lane block visibility.

Buffer: A safety area between adjoining land uses or developments created to mitigate the impact of one over the other, such as separating traffic flow from pedestrians with a transitional recovery space.

BRTS: Bus Rapid Transit System is a bus-based public transport system designed to improve capacity and reliability relative to a conventional bus system. It combines capacity and speed of metro with flexibility, lower cost and simplicity of a bus system. Types of BRTS:

- i. Closed Bus Rapid Transit System: A rapid transit system termed as "rail on rubber wheels", uses segregated operation-controlled corridors to provide high capacity and high speed transportation without the need for grade separation.
- ii. Open Bus Rapid Transit System: A rapid transit system is a flexible system involving a combination of fully segregated and mixed-traffic movement corridors for buses.

Busways: The line up to which the plinth or projection of a building adjoining a street or an extension of a street or on a future street may lawfully extend. It includes the lines prescribed in the MPD (Master Plan Delhi) or specifically indicated in any scheme or layout plan, or in guidelines.

Carriageway: Part of a road intended primarily for vehicles movement rather than for pedestrians. It consists of a width of road on which a vehicle is not restricted by any physical barriers or separation to move laterally.

Catchment: An area from which a city, service or institution attracts a population that uses its services.

Cat's Eye: Is a retro-reflective safety device used in road marking, usually as raised pavement markers.

CCTV: Closed circuit television is a TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security purposes. It relies on strategic placement of cameras and private observation of the camera's input on monitors.

Chicane: A traffic calmer with alternating parking lanes between two sides of a street that prevent vehicles from speeding. The alternating obstacles are known as chicanes.

Choker: Is a traffic calmer that narrows a street by placing an island at the centre of the street, which forces drivers to slow down and steer around it to negotiate oncoming traffic. Coupled with on-street parking it can create a chicane or a pedestrian refuge.

Circulation Path: Are pathways people take through and around buildings or urban places. It captures the experience of moving three-dimensionally and through time.

Clear Width: The portion of a surface that is free of obstruction.

Cloverleaf: Is an interchange of two highways/expressways with one roadway crossing over the other. It has a series of exit and entrance ramps arranged in the form of a four-leaf clover such that traffic may proceed from either highway in any directions.

Collector Street: It is a distributor road that is a low-to-moderate-capacity road. It serves to move traffic from local streets to arterial roads and provide access to residential properties.

Commercial Uses: Areas throughout the city intended to provide a variety of working, shopping, and service options and convenience.

Complete Street: Are streets designed to provide safe access to all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. Complete Streets make it easy to cross the street, walk to shops, and bicycle to work.

Crossings: A designated crosswalk for pedestrians to cross a road or street. Pelican crosswalk is one such crossing with provisions for pedestrian to operate traffic lights that allow them to cross.

Cul-de-sac: Is a dead-end street with only one inlet/outlet with no exit road.

Cut-through: A short cut opening instead of the intended opening on the main road.

Dead Width: Also called the frontage zone is an area adjoining a building or property line that provides additional space to ensure conflict free movement for pedestrians.

Deciduous Trees: Are trees that seasonally lose their leaves in fall and re-grow them in spring.

Dhalao: A large three-walled open concrete structure meant for collection of garbage from a locality or market place.

Differently-abled/Specially-abled: Are people who are physically or mentally different from the average people, thus need special design considerations to cater to their requirements.

Drop-off Zone: Designated area for passenger drop-off.

Ecology: The pattern and balance of relationships between people, plants, and the environments of a particular place.

Effective Width: The portion of the clear width that excludes any shy distances.

Effective Turning Radius: The actual, inside turning radius of a vehicle around a corner.

Eyes-on-the-street: The idea that streets with plenty of activity and pedestrians who care about what goes on in them, creates safe and secure streets.

Façade: The principal front of a building that faces a street or an open space.

Feasibility: Capable of being accomplished with a reasonable amount of effort, cost, or other hardship.

Flush Kerb: A kerb, which is level with the surrounding area. They allow easy crossings from footways across carriageways and cycle-ways, particularly for those with mobility problems.

Foot Overbridge (FOB): Is a bridge designed for pedestrians and in some cases cyclists, and does not cater to vehicular traffic.

Forced Turn: Is an island or sidewalk extension at the approach of an intersection. It prevents left or right turns and through movements from the intersecting street.

Full Sidewalk: A full sidewalk accommodates both pedestrian traffic and a range of street utilities.

Grade: The slope parallel to the direction of travel that is calculated by dividing the vertical change in elevation by the horizontal distance or length of the travelled way and measured as a percentage.

Grade Separation: A facility that allows movement over or under a barrier such as a road or waterway.

Grate: A framework of lattice, grid, or bars that prevent large objects from falling through a drainage inlet but permits water to flow through the slots.

Guardrails: A rail at the edge of a kerb that prevents people from falling off.

Guideline: Guidelines are not mandatory but are considered the preferred practice in typical situations.

Guide Strip: Some type of raised material with grooves that pedestrian with vision impairments use for directional cues.

Gutter: Space along the kerb line designed to carry drainage water that runs off the roadway. The gutter line is also the lip along the edge of a kerb ramp.

Heat Island: An urban area where significantly more heat is absorbed and retained compared to the surrounding areas.

Heritage Monument: A historic building, landscape or site of cultural value that is of local, regional, or national significance.

Highway: A limited access roadway designed largely for use by automobiles. The design requirements for highways are different from those of urban streets and are not covered in these guidelines.

Implementation: An action, procedure, program, or technique that ensures that policies are followed and goals and objectives are achieved.

Industrial Uses: Areas for businesses that allows for general industrial use, heavy and light industry use, warehousing, and distribution with support commercial services and ancillary office space. They have the potential to create adverse visual, noise, or other impacts to adjoining public and residential properties.

Intermodal: Refer to connections between transportation modes. Intermodal transportation involves a combination of travel mobility, efficiency, sustainability, economy, and environmental health.

Jay-walking: When pedestrians cross or walk on the street unlawfully or without regard for approaching traffic.

Landing: Level area of walkway or driveway at the top or bottom of a ramp.

Landscape: Plantings, configuration and maintenance of trees, ground cover, shrubs and other plant material, natural decorative and structural features, earth patterning and bedding materials, and other similar site improvements that serve an aesthetic, functional or sustainable purpose.

Land-use: Involves management and modification of regulating the use of land in an effort to promote more desirable social and environmental outcomes as well as more efficient use of resources.

Lane Drop: A transition where one travel lane is eliminated from the travelled way.

Lay-by: A portion of the travelled way recessed into the pedestrian realm for taxis and loading so that travel lanes are not blocked.

Leading Pedestrian Intervals (LPI): Typically gives pedestrians a 3–7 second head start when entering an intersection with a corresponding green signal in the same direction of travel.

Light Fixture: The assembly that holds a lamp.

Local Street: Is a thoroughfare, which usually includes the footpath in front of buildings on either side of the street. It allows local traffic to gain access to property.

Long-term: Occurring over a relatively long period of time.

Lux: The SI (international system of units) unit of illuminance and luminous emittance on a surface equal to 1 lumen per square meter.

Major Road: A road commonly used to go through the main part of the city.

Main Street: A primary retail street of a city, which is usually a focal point for shops and shopping.

MPD: Master Plan of Delhi (referred in these guidelines is up to year 2021) caters to the requirements of the city's population and the changing necessities of the city.

Median Barrier: An elevated median or median safety island extended through an intersection to prevent left turns and through movements to and from the intersecting street.

Minimum Clearance Width: The narrowest width that is maintained free of obstacles.

Mixed-use: Areas that include more than one major type of uses. Blends residential, commercial, cultural, institutional, or entertainment uses to physically and functionally integrate their functions and provide pedestrian connections.

Mobility: The ability of people or goods to move within the transportation system.

Mountable Kerb: A kerb that is easily driven over by large vehicles, especially fire trucks; also known as a sloping kerb or a low kerb

MRTS: Mass Rapid Transit System of Delhi is the Delhi Metro system, which serves Delhi and its satellite cities of Bahadurgarh, Ballabhgarh, Faridabad, Ghaziabad, Gurgaon and Noida in the National Capital Region (NCR) of India. It is a mix of underground,

at-grade, and elevated stations using both broad-gauge and standard-gauge rail lines. It augments the city's existing suburban railway and road transport networks.

Multimodal: Refers to the availability of transportation options within a system or corridor.

MUZ: Multi Utility Zone accommodates functions like street furniture, bus stops, auto/ taxi stops, utility boxes, fire hydrants, street vendors, landscape, etc. IRC 103 recommends a minimum of 1.80 m. However, where there are space constraints, a minimum width of 1 m maybe considered .

MV Lanes: Motorized Vehicle lanes cater to motorized vehicles (MVs) such as cars, bus, trucks, motor cycles/bikes, auto rickshaw, etc.

Network: A system of interconnecting streets.

New Construction: Project where an entirely new facility or street will be constructed.

NMT: Non-motorized Transport is human powered transportation, which includes walking, bicycling, and small-wheeled transport (cycle rickshaws, skates, skateboards, push scooters and hand carts) and wheelchair.

NMV: Non-motorized vehicles are pedal powered vehicles used in the Indian subcontinent.

Objective: A specific outcome, condition, or state that is an intermediate step toward attaining a general goal.

Obstacle: An object that limits the horizontal or vertical passage space by protruding into the circulation route and reducing the clearance width of the travel way.

Off-street Parking: To park a vehicle anywhere but on the streets. It can be indoors or outdoors and include private lots, garages and driveways. Users of off-street parking usually use the space for a longer period of time such as monthly tenants and regular users. The development cost of off-street parking is relatively high compared to on-street parking.

On-street Parking: When vehicles are parked on the street, along with the sidewalk or anywhere on the street is called on-street parking. Users of on-street parking are usually casual users who use the space for a short period of time. Development cost of on-street parking is relatively low compared to off-street parking.

Parallel Kerb Ramp: Kerb ramp design where the pedestrian realm slopes down on either side of a landing.

Parallel Parking: Parking that is parallel to the kerb and path of travel.

Parking Bay: Parking that is provided in combination with kerb extensions; also known as parking lay-by.

Parking Space: It is an area enclosed or unenclosed, covered or open, sufficient in size to park vehicles, together with a driveway connecting the parking space with a street or alley and permitting ingress and egress of the vehicles.

Path/Pathway: A track or route along which pedestrians and/or cyclists are intended to travel.

Pedestrian: A person on foot or in a wheelchair.

Pedestrian Realm: The public area between the kerb and the boundary of the right-of-way that is generally accessible to pedestrians.

Perpendicular Kerb Ramp: Kerb ramp design where the ramp path is perpendicular to the edge of the kerb.

Permeable Pavement: A paving system which allows rainfall to percolate into the soil. It can also aggregate in an underground storage reservoir where storm water is stored and filtrated in underlying subgrade or removed by an overflow drainage system.

Pictogram: Is a pictorial symbol for a word or phrase. It is an icon that conveys a meaning like 'Stop' or 'Go' through a pictorial resemblance of a physical person standing or walking.

Plaza: Public plaza is a community space that serves a variety of amenities to users including building tenants, visitors and members of the public. Plazas are a beneficial feature of a lively and active streetscape.

Primary Street: Major roads used to get across a neighbourhood or city. It is usually given higher priority for right of way with traffic controls as it is typically a city/town's primary street. The primary designation is relative to population and traffic densities. In dense urban areas it may be divided into multiple lanes with traffic controls at intersections.

Policy: An adopted course of action, procedure, or strategy that guides decision-making and commitment from the government.

Public Space: It is a space that is open and accessible to people of all levels. Street and roads are public spaces, which typically include pavements, public squares, parks and beaches, etc.

Public Realm: Publicly used land or right-of-way.

Public Transport: It is a system of vehicles such as buses, trains and other forms of transport that are available to the public, operate at regular times on fixed routes and charge a set fare.

Ramp: A sloping surface joining two different levels as at the entrance or between floors of a building.

Refractive Index: The index of refraction of a material is a dimensionless number that describes how fast light transmits through a material. It affects colour and energy resulting in differences in the bending angle causing white light to split into its constituent colours.

Refuge Island: An area within the travelled way, such as a median, where pedestrians may wait protected from motor vehicles.

Residential Uses: Areas that provide a variety of housing opportunities, allowing for densities varying from villa to multi-dwelling residential buildings.

Road/Street: Any highway, street, lane, pathway, alley, stairway, passageway, carriageway, footway, square, place or bridge, whether a thoroughfare or not, over which the public have a right of passage or have uninterrupted access for a specified period. It includes bunds, channels, ditches, storm-water drains, culverts, sidewalks, traffic islands, roadside trees and hedges, retaining walls, fences, barriers and railings within the street lines.

Road/Street Level or Grade: The level and gradient of a roadway determined along the centre line of street.

Roadside Safety: A condition of being safe, free from danger, risk, or injury.

Road Shoulder: An extended portion on the left side of the carriageway by the verge of the road. It serves as an emergency stopping lane. It provides an advantage for future expansion of the carriageway.

Recycled Material: Recycling is a process of converting waste materials into new materials and objects. Amidst a long list, some of recycled road material are - reclaimed asphalt pavement, recycled concrete aggregates, plastic wastes, scrap tires, mine wastes, recycled crushed glass, foundry sand, coal combustion products as fly ash, bottom ash, and pond ash, steel slag, oil sand, oil shale sand, lateritic soil, etc.

Reflective Radium: It is a material made from synthetic resin. Its protective features help withstand the damaging effects of inclement weather. It also reflects long distance light and provides high visibility at night.

Right-of-way (ROW): Is the legal right to pass along public property such as a thoroughfare. A street ROW is the width between property boundaries on one side to property boundaries on the other. A footpath is a right of way that can only be used by pedestrians.

Service Road: A road/lane provided at the rear or side of a plot for service purposes.

Pedestrian Scale: It is the use of human proportioned architectural features and site design elements oriented towards pedestrian activity.

Secondary Road: It is a collector road that supplements the main road. Usually it is wide enough and suitable for two-way, all-weather traffic, at moderate or slow speeds.

Setback: Is the minimum distance which a structure must be set back from a street or road, or any other place which is deemed to need protection.

Shared Street: Often referred to as a "pedestrian-priority street," a shared street is a low-speed, typically kerbless road designed as a single surface, shared among pedestrians, bicyclists, and low-speed motor vehicles.

Short-term: Occurring over or relating to a short period of time.

Shy Distance: Space left between vehicles or pedestrians as they pass each other. The amount of shy distance required for safety increases with speed.

Sight Distance: Distance that a driver can see ahead in order to observe and successfully react to pedestrians, bicyclists, other vehicles, decision point, manoeuvre, obstruction, or hazard. This may also be the length of distance visible to a pedestrian, i.e., the distance a person can see along an unobstructed line of sight.

Signage: Is the design or use of signs and symbols to communicate a message to a specific group or used for the purpose of advocacy.

Slip Road: A short road connecting a main road or a dual carriageway.

Slope & Grade: Incline of a physical feature, landform or constructed line refers to the tangent of a surface to the horizontal. Zero indicates horizontality and a larger number indicates higher or steeper degree of gradient.

Solid Waste Management: Actions required to manage waste from its inception to its final disposal. It includes collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process. It offers solutions for recycling items that is not garbage.

Speed Cushion: Narrow speed hump that reduces traffic speed without causing vertical displacement of vehicles with wide wheel bases such as trucks, buses, and emergency vehicles.

Speed Humps: Are undulations used for 10–15 mph speed zones. They are used on local streets where traffic needs to flow smoothly but at a slower speed. Playground and school zones often use these in traffic management. Speed bumps on the other hand are more aggressive traffic calming options, and are used in places where pedestrians and cars share space closely, like parking lots and driveways.

Splitter Island: Is a channelizing island that separates traffic in opposing directions of travel. They are particularly appropriate on approaches to skewed intersections.

Stakeholders: Groups or individuals that have an interest/stake in the outcome of the planning or development of a project.

Standard: A requirement or mandate.

Stopping Sight Distance: SSD is the minimum sight distance available to a driver on a highway at any spot. It provides

sufficient length to enable the driver to stop a vehicle safely without colliding with an obstruction.

Storm-water Drainage: Is designed to drain excess rain and ground water from impervious surfaces such as paved streets, car parks, parking lots, footpaths, sidewalks, and roofs.

Street Furniture: Items of furnishing in outdoor landscaping such as benches, trash receptacle, signage, play equipment, etc.

Street Type: A system of categorizing similar streets by contextual land use for the purpose of description, design, and management.

Streetscape: A view or scene of streets in a city. The visual elements of the street include the road, adjoining buildings, sidewalks, street furniture, trees and open spaces, etc.

Sub-grade: It is the lowest point of a pavement structure - the underground level at which excavation ceases and construction starts. Sub-grade mostly comprises of compacted earth, except for permeable pavements where it must be kept non-compacted.

Sustainable: Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Tactile Warning: Change in surface condition providing a tactile cue to alert pedestrians with vision impairments of a potentially hazardous situation.

Target Speed: The speed at which vehicles should operate on a thoroughfare in a specific context. It should be consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility for motor vehicles and a safe environment for pedestrians and bicyclists.

Tehbazari: It is an informal commercial vending zone where vendors with handcarts and other portable vending items are legally allowed to sell their wares. Under Section 225 of New Delhi Municipal Council Act, 1994, they have permission to place their carts, kiosks, stalls, thellas in open spaces identified by 'Thareja Committee' and allotted by the NDMC. It provides essential goods and services to a wide range of population groups and also makes public spaces safer by contributing "eyes on the street" vigilance.

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Thermoplastic Paint: Is a road marking paint. A hot melt kettle is used to heat it to 200 °C then sprayed on the road surface as markings. The coating becomes a line after cooling.

Thoroughfare: Any roadway intended for regional or inter-district travel.

Through Zone: The main area within the pedestrian realm where pedestrians travel.

Traffic: Pedestrians, ridden or herded animals, vehicles, bicycles, and other conveyances either singly or together while using any highway for purposes of travel.

Traffic-calming Measures (TCM): Deliberate slowing of traffic by using physical design and other measures to improve safety for motorists, pedestrians and cyclists. It encourages safer, more responsible driving and aims to potentially reduce traffic flow.

Transit: Any type of transport shared by the public in large numbers, including bus, light rail, tram, or Metro.

Transit Median: A portion of median reserved for the exclusive use of public transit vehicles. See Median.

Transit Way: It is a route designated for the exclusive use by public transport such as buses, taxis or other designated high-occupancy vehicles. The roadway may also be permitted to other vehicles for the purpose of delivery of goods/services or for picking-up/dropping-off passengers.

Transitions: A change in street type, context, right-of-way width, number of lanes, or neighbourhood or district. The provision of a smooth taper where lanes change width, lanes diverge or merge, or lanes have been added or dropped.

Travelled Way: The public right-of-way between kerbs, including parking lanes and travel lanes for private vehicles, goods

movement, transit vehicles, and bicycle lanes.

Tree Grate: A grille installed at the base of a tree in a pavement. It allows free passage of air, water, and nutrients to the tree root but does not interfere with the foot traffic.

Tree Pits: Excavated pits that allow for the planting of street trees within the public right of way.

Turning Radius: The path that a vehicle takes during a turn.

Universal Accessibility: Design techniques that accommodate all people, including pedestrians requiring special mobility consideration, such as pedestrians pushing strollers/delivery carts, and pedestrians using personal mobility devices such as wheelchairs.

Urban: A comparative term, distinct from “suburban” or “rural,” characterized by density, development intensity, and activity. It typically has a population of 200 or more persons per square kilometre.

Urban Relief Roads: Additional/alternative access corridors for reducing congestion on existing roads. They are subject to feasibility studies such as along drains (including their covering), identification of new alignment, upgradation/strengthening of an existing road/alignment or in the form of elevated roads/grade separators, etc.

Utilities: Crucial infrastructural components of street services located mostly underground. These service mains may include lines for electricity distribution, traffic/street lights, telecommunication, signal lights, cable television, fibre optics, natural gas, water supply, irrigation lines, storm drains, waste-water, sewerage pipes, etc.

U-turn: Performing a 180° rotation to reverse a vehicle’s direction to face the opposite direction.

Vector Signage: Street signs that can be scaled up or down as per requirement without losing its image quality.

Vehicle: A mechanical item used for transporting people or goods, especially on land, such as a car, lorry, or cart.

Verge: Part of the street reserved between the carriageway and the boundary of adjacent lots. It can be a strip of grass, plants or trees located between the carriageway and the footpath. It may accommodate public utilities, footpaths, storm-water flows, street lighting poles and planting.

Vertical Clearance: Minimum unobstructed vertical passage along the pedestrian realm and travelled way.

Vertical Kerb: A steep-faced kerb designed with the intention of discouraging vehicles from leaving the travelled way.

Vision: The faculty or state of being able to see. Also to create a process for the city’s future reflecting the desires of the community that is implemented by responsible public and private leaders.

Vision Impairment: Loss or partial loss of vision.

Walk/Walking: The act of pedestrian travel.

Walkable: Streets and places designed or constructed to provide comfortable facilities for pedestrians that are safe and easy to cross for people of all ages and abilities.

Walkability: It is a measure of how friendly an area is to walking. It is related to walkable footpaths, proximity to transit facilities, air quality, accessible to work and social activities, safety from moving vehicles, lack of street crime, etc., while providing health, environmental, and economic benefits.

Water Catchment: Is an area of land where surface storm water from rain collects and drains towards the down slope usually towards an exit of a basin to join another water body.

Wayfinding: Ways in which people orient themselves in physical space and navigate from place to place.

Wayfinding Signage: Signs that help direct people from one point to another, or confirm their progress along a route. The message can be directional, confirmational, or informational.

Wickets: Is a pedestrian door or gate built into a larger door or into a wall or fence.

Width of Road: The whole extent of space within the boundaries of a road on which a vehicle can travel where it is not restricted by any physical barrier to move laterally. It generally consists of a number of traffic lanes together with any associated shoulder, but may also be a sole lane in width.

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