RWANDA URBAN STREET DESIGN MANUAL

MINISTRY OF INFRASTRUCTURE

INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY

UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

MAY 2025

CONTENTS

1. INTRODUCTION

In any urban setting, streets play a critical role in enabling residents to move from one part of the city to another, engage in business activities, socialise, and relax. Consequently, the design of streets has a profound impact on the overall quality of life.

Over recent years, most African cities have witnessed a significant increase in motor vehicle usage. This surge has resulted in escalating traffic congestion, air pollution, and the degradation of the urban environment. As cities strive to accommodate the growing volume of motorised traffic, a larger portion of the public realm is being occupied by vehicles, leaving limited or no space for the social and economic activities that foster vibrant cities. Considering Rwanda's objective to accelerate urbanisation and achieve an urbanisation rate of 35 percent by 2024, as outlined in the National Strategy for Transformation (Republic of Rwanda, 2017), the provision of adequate urban transport facilities and services is crucial for enabling citizens to access opportunities safely and efficiently.

To address these issues, the Ministry of Infrastructure (MININFRA) has partnered with the Institute for Transportation and Development Policy (ITDP) and United Nations Human Settlements Programme (UN-Habitat) to develop the Rwanda Urban Street Design Manual (RUSDM). This design manual aims to promote best practices in street design that prioritise sustainable modes of transport and enhance safety for vulnerable road users, particularly pedestrians and cyclists. By reducing the risk of fatalities and severe injuries, the implementation of safe and inclusive urban street designs will yield significant co-benefits. Safer streets will not only improve road safety but also enhance access to employment and social opportunities, reduce the demand for motorised travel, and mitigate air pollution.

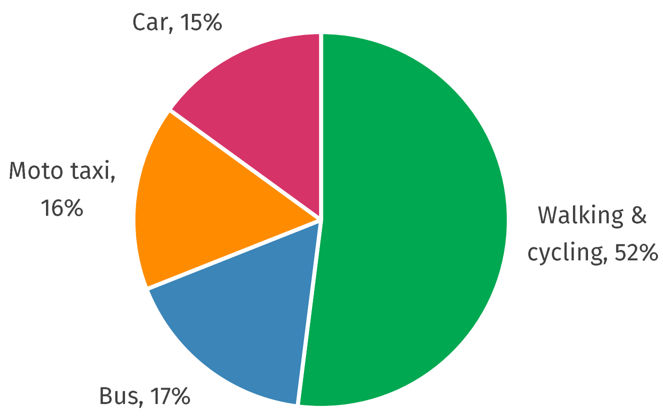


Figure 1. Modal split in Kigali (City of Kigali, 2018).

1.1 POLICIES AND LEGISLATION

Rwanda is a signatory to the Sustainable Development Goals. SDG 11.2 emphasises the need to provide safe, accessible, affordable, and sustainable public transport systems for all by 2030, while SDG 3.6 calls for thriving to reduce the number of deaths and injuries from road traffic crashes by half by 2020. As of 2023, the country had only managed to reduce the death rate by circa 7 percent (Republic of Rwanda, 2023).

The development of the Rwanda Urban Street Design Manual (RUSDM) is guided by various policies and strategies that prioritise sustainable and efficient transport systems, including:

- National Transport Policy and Strategy for Rwanda (MININFRA, 2021): The Policy focuses on promoting sustainable and accessible transport options. For non-motorised transport (NMT), the policy aims to provide safe facilities for walking, cycling, and other NMT modes, while also enhancing public spaces and introducing bikeshare systems. In terms of public transport, the policy aims to expand city bus services, improve infrastructure, introduce high-quality services, and create dedicated bus lanes and BRT in high-demand areas.
- Public Transport Policy and Strategy for Rwanda (MININFRA, 2012): This strategy focuses on ensuring universal access to public transport services, promoting accessibility, mobility, availability, reliability, safety, security, and user satisfaction.
- Transport Plan (City of Kigali, 2020): The Transport Plan prepared as part of the Kigali Master Plan 2050 outlines a vision for Kigali to develop a green transport system with an integrated network of mass rapid transit and NMT. The Transport Plan calls for avoiding the construction of flyovers and instead prioritising investments in public transport and NMT infrastructure. The Plan sets a goal of achieving a 70:30 ratio between public and private motorised modes.
- Development of Appropriate Strategy for Reduction of Traffic Congestion and Air Pollution in Kigali City (UNEP, 2018): This strategy emphasises investments and measures to enhance public transport NMT. It prioritises pedestrians as the primary street users and recommends buses for longer and high-speed travel, while short-distance travel can be served by bicycles and walking.
- Rwandan Government Official Gazette No. 04 of 23/01/2012 and No. Special of 03/12/2015: This legislation defines different street categories, such as national roads, district link roads, urban area streets (Class 1 and Class 2), and specific roads. It establishes road dimensions, including minimum lane widths, carriageway widths, and road reserves. The gazette specifies a road reserve of 44 m for national roads, district, and urban area Class One streets, and 24 m for district and urban area Class 2 streets. However, it also states that local master plans take precedence in determining road reserve widths for the City of Kigali and other urban areas.
- National Land Use and Development Master Plan (NLUDMP) (Republic of Rwanda, 2020): The Master Plan sets out the overall land use framework for the country and outlines the long-term development vision for the country's land resources. It recognises the crucial role of NMT and public transport. The policies aim to prioritise access for people and goods rather than vehicles, and advocate for the creation of streets that can be enjoyed by individuals of all ages and abilities.

These policies and regulations provide the foundation for designing and implementing sustainable and people-centred street networks in Rwanda.

1.2 VISION OF THE MANUAL

The Rwanda Urban Street Design Manual aims to create sustainable, safe, and comfortable streets that promote efficient mobility for pedestrians, cyclists, mass public transport, freight movement, and mixed traffic. The designs enable cities to adhere to international complete street standards, incorporating best practices.

1.3 HOW TO USE THE MANUAL

This manual provides guidance on designing urban streets in the City of Kigali, satellite towns, and secondary cities, and urban areas in other districts. Users are advised to refer to the accompanying documents for material specifications, drainage designs, and construction techniques. For the design of intercity highways and rural roads, readers are encouraged to consult the Road Geometric Design Manual developed by RTDA in 2014.

2. COMPLETE STREET DESIGN PRINCIPLES

Streets rank among the most valuable assets in any city. They not only ensure residents' mobility, allowing them to travel from one place to another, but they also serve as places for people to meet, interact, conduct business, and have fun. Streets make a city liveable by fostering social and economic bonds and bringing people together. Decisions regarding the allocation and design of street space have a tremendous impact on the quality of life. Effective street designs ensure the safety of all users, particularly pedestrians and cyclists, and facilitate the efficient use of street space.

2.1 DESIGN FOR SAFETY

Safe street design also aims to encourage moderate vehicle speeds. Street designs that effectively reduce motor vehicle speeds can have a profound impact on pedestrian safety. Research shows that the likelihood of pedestrian fatalities in collisions increases dramatically when motor vehicle speeds exceed 30 km/h. For instance, a pedestrian struck by a car traveling at less than 30 km/h has a 90 percent chance of survival, whereas the survival rate drops to only 50 percent when the impact occurs at 45 km/h.

By promoting lower vehicle speeds, safe street design prioritises the well-being and safety of pedestrians, significantly reducing the severity of potential accidents. This emphasizes the importance of implementing street design measures that encourage responsible and moderate vehicle speeds, ultimately creating safer environments for all road users.

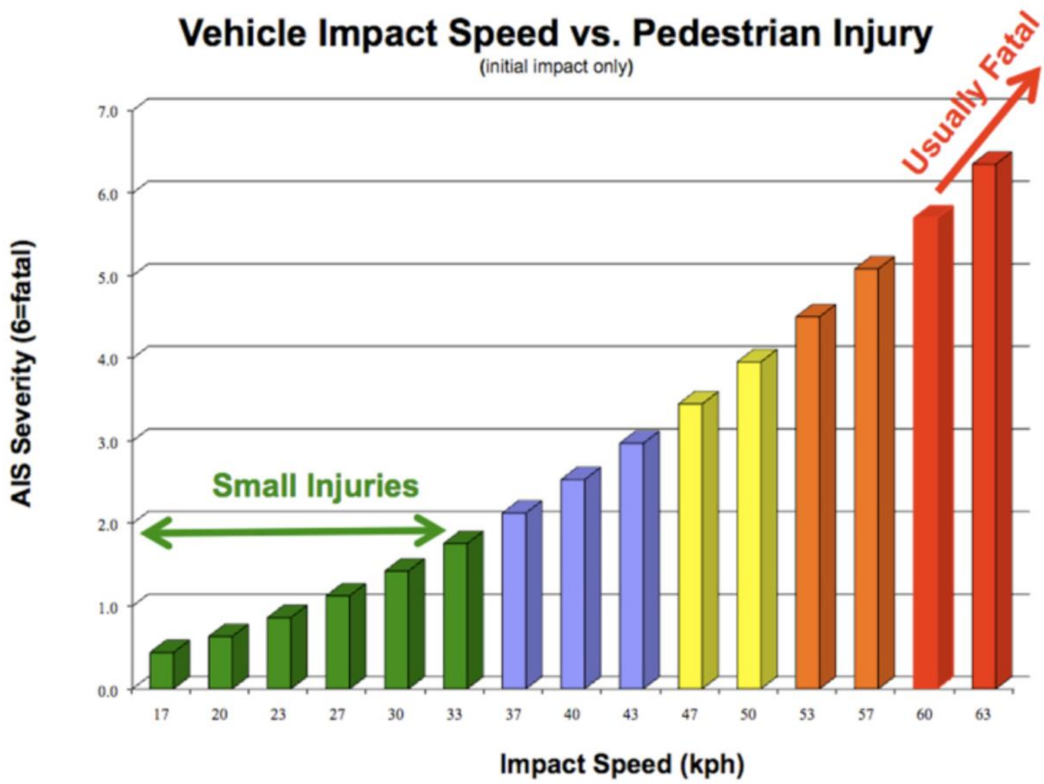


Figure 1. Speed reduction is critical for safe pedestrian environments because the chance of pedestrian death in a collision increases dramatically when vehicle speeds exceed 30 km/h.

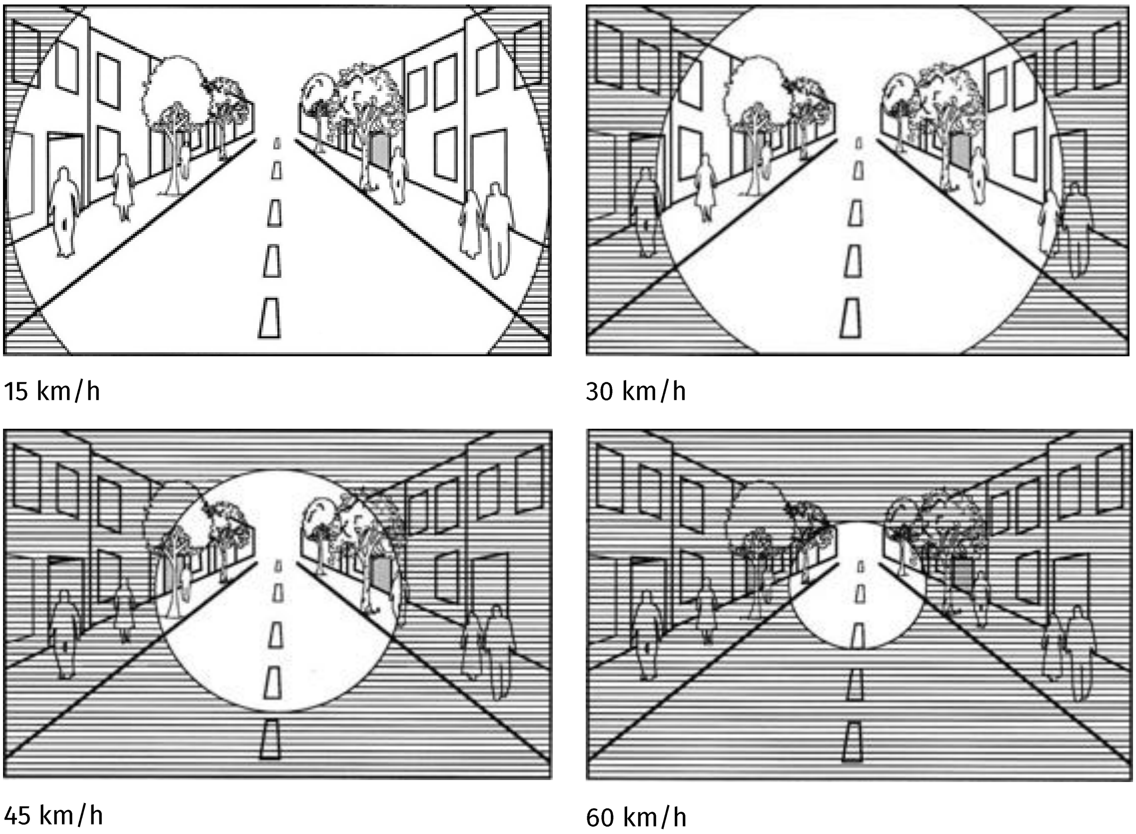


Figure 2. As the speed of a motor vehicle increases, the field of vision narrows, making it harder for the driver to respond to sudden incidents—such as a child running into the street.

In addition to the risks associated with collisions, high speed also diminishes the driver's field of view, thereby impairing their ability to effectively respond to changing conditions on the road. When traveling at speeds below 30 km/h, drivers have a greater ability to perceive their surroundings and identify potential conflicts with pedestrians, cyclists, or other motor vehicles. Slower vehicle speeds also contribute to a heightened sense of safety for pedestrians.

The physical design of streets and the provision of footpaths, crossings, and other related infrastructure play a crucial role in managing motor vehicle speeds and creating a safe environment for walking and cycling. Accommodating NMT modes safely involves employing the following fundamental techniques:

- Systematic traffic calming measures are implemented on smaller streets to reduce motor vehicle speeds and create safe environments for pedestrians and other modes of transport. Shared lanes can be utilised if speeds are restricted to 15 km/h, allowing pedestrians, cyclists, and motor vehicles to travel together. For speeds up to 30 km/h, separate footpaths should be provided, while cyclists can use the carriageway.
- On larger streets, pedestrian and cycle infrastructure should be physically separated from motor vehicle traffic. This can be achieved through dedicated pedestrian footpaths and cycle tracks, paired with traffic calming or traffic control measures to

facilitate safe crossings. Pedestrian footpaths should offer clear walking spaces, strategically positioned to accommodate other elements. Similarly, dedicated cycle tracks should be separate from mixed traffic carriageways. Speed limits of up to 50 km/h are appropriate for urban streets.

Appropriately designed motor vehicle lanes are crucial for ensuring safe and efficient traffic flow. The width of carriageway lanes should be tailored to reflect the designated speed limit. On arterial streets, it is recommended to have carriageway lanes that range from 3 m to 3.25 m in width per lane. This design approach offers several benefits, including improved lane discipline, minimised risk of lane encroachment, and sufficient space for safe vehicle manoeuvring.

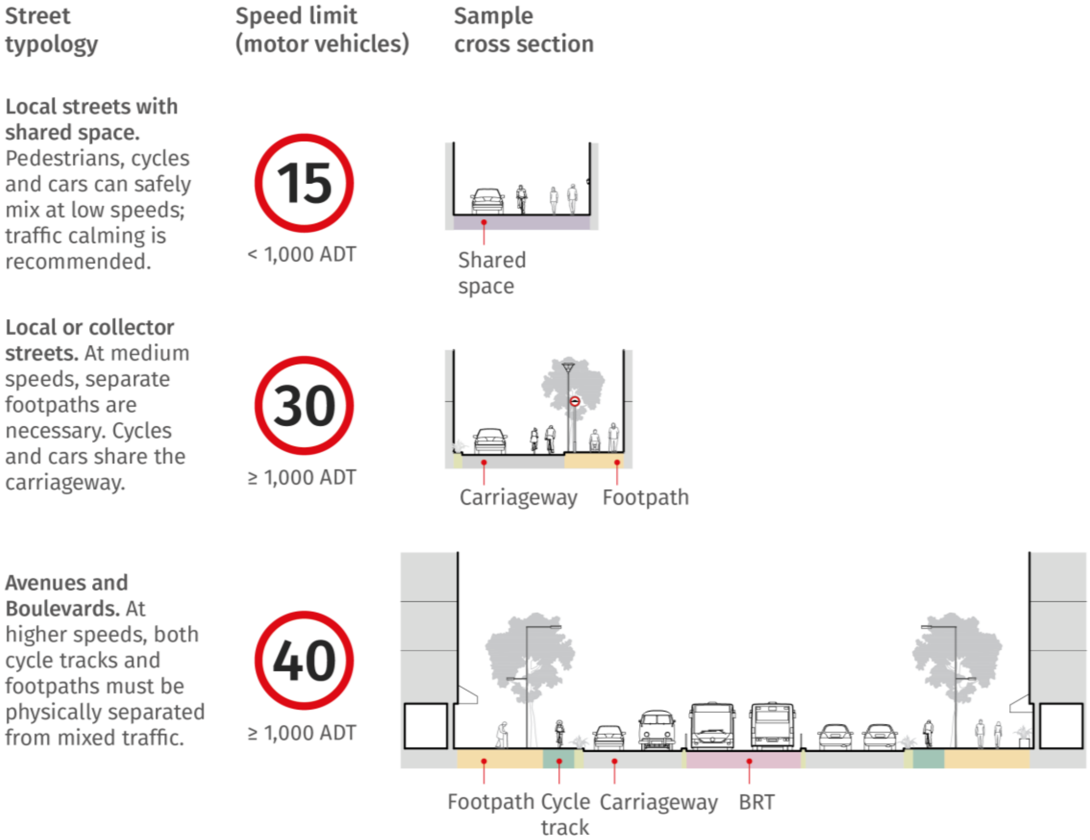


Figure 3. Smaller streets can function as shared spaces where pedestrians walk together with slow-moving vehicles. On larger streets with heavy vehicles and faster speeds, separate space for pedestrians and cycles is needed.

2.2 DESIGN FOR EFFICIENCY

Streets are often designed with a primary focus on accommodating motor vehicle movement, but it is essential to recognise that vehicle movement and mobility are not synonymous. Mobility entails efficiently, conveniently, and safely transporting people and goods to their desired destinations. High-quality and high-capacity public transport can effectively provide mobility without solely relying on increasing the number of vehicles in operation.

Although widening roads, constructing flyovers, or building elevated highways may temporarily alleviate congestion, the improvement is typically short-lived. The underlying reason is straightforward: expanding road space initially leads to increased speed and comfort, which in turn encourages people to travel more frequently and take longer trips using private vehicles. Consequently, more users flock to the route, eventually resulting in the wider road reverting to its original congested state, but with a significantly higher number of vehicles stuck in traffic.

The government may face pressure to widen the road once again, but it is not a sustainable solution to tackle traffic jams by endlessly constructing larger roads. Evidence demonstrates that increasing vehicle capacity also stimulates travel demand, leading to induced demand and exacerbating congestion (GDCI, 2016).

The only viable long-term solution for ensuring mobility is to invest in high-quality infrastructure for public transport and non-motorised modes. These modes have the capacity to transport large numbers of passengers without requiring exponential increases in road space. In many cases, an effective solution is the implementation of bus rapid transit (BRT) systems. A single BRT lane, with articulated buses, can carry up to 13,000 passengers per hour per direction (pphpd), and with passing lanes at stations, the capacity can increase to 45,000 pphpd. In comparison, the same lane can only accommodate around 800 cars per hour, with an occupancy rate of 1,200 to 1,600 individuals (typical occupancy rates) if the lane receives half of the signal time at intersections.

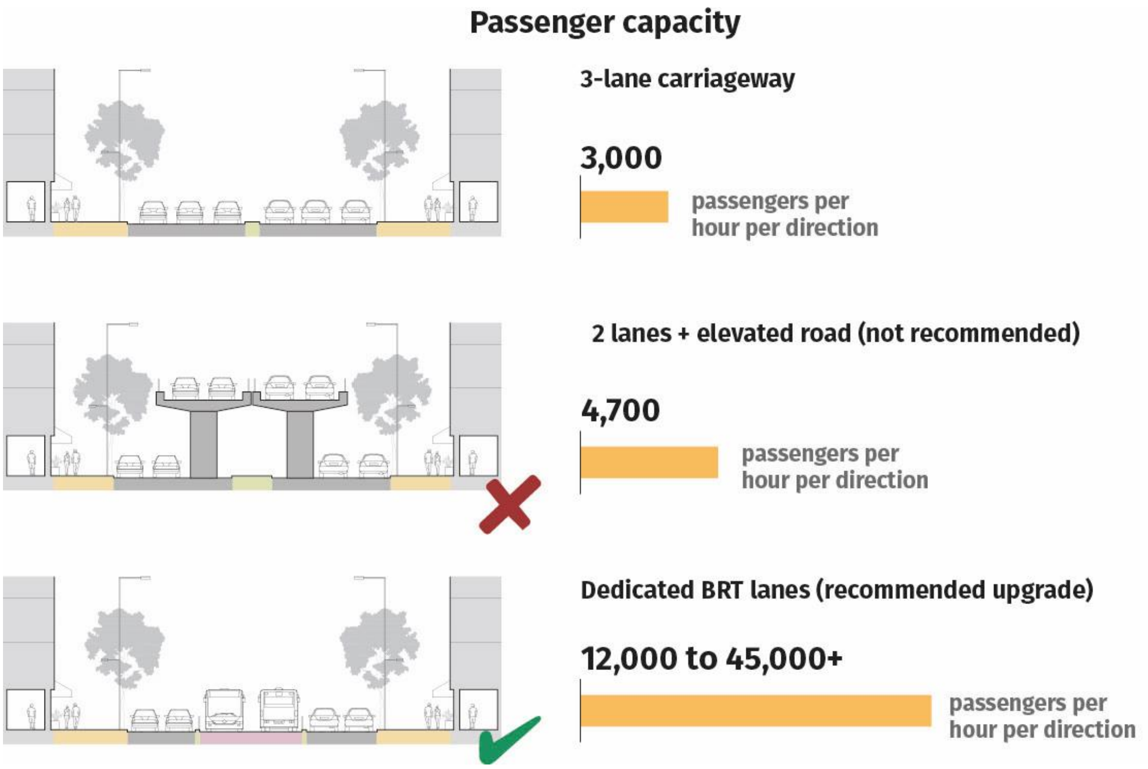


Figure 4. To maximise person-carrying capacity, streets should incorporate dedicated space for public transport and NMT.

There are solutions to traffic congestion as well. The key to reducing congestion is to lower the number of vehicles on streets instead of increasing street widths to accommodate an ever-growing number of vehicles. This can be achieved through various means, including implementing parking fees, congestion pricing, and employing other travel demand management tools. Cities can also restrict the movement of large trucks in the city centre during peak hours to improve safety and reduce congestion. On a larger scale, the key to reducing congestion lies in compact, walkable transit-oriented development, which helps keep trip lengths short.

2.3 UNIVERSAL ACCESS

Universal access is the concept of designing transport services and environments that as many people as possible can use, regardless of age or ability. Streets designed according to universal access principles accommodate assistive devices for groups of persons with disabilities.

To ensure that persons with disabilities can complete their journeys, their needs should be incorporated at every step of the transport chain, from origin to destination. The strength of accessibility to transport relies on its weakest link, so inclusive design must encompass public passages, public transport stops and boarding, vehicle interiors, alighting, and passage to the destination.

An accessible environment has ample, well-connected pedestrian facilities with unobstructed space for movement, consistent pavement surfaces, appropriately and continuously sloped ramps, and safe pedestrian crossings. Multiple elements of the streetscape must be designed in an integrated manner for the space to function effectively. People with small children, individuals carrying heavy shopping or luggage, those with temporary accident injuries, and older people can all benefit from an inclusive transport environment.

2.4 GENDER SENSETIVE DESIGN

Until recently, transport planning has tended to take a “one-size-fits-all” approach, assuming that men and women would equally benefit from improvements in transport services. However, in reality, women and men have different expectations from the transport system and distinct perceptions of security. Consequently, transport policies and plans need to be responsive to these differences. An integrated and safe transport system provides access to education, work, healthcare, cultural activities, and other essential aspects that are crucial for women’s participation in society. Particularly in the context of street design, the level of safety and security experienced by female users is of great concern. Inclusive designs help to enhance the experiences of women and girls, making walking, cycling, or using public transport easier.

2.5 CHILD FRIENDLY STREETS

Children are among the most vulnerable road users due to their limited awareness of road safety, restricted field of vision due to their small body size, and reduced visibility to drivers. Therefore, it is crucial to prioritise children’s safety when designing streets that are frequently used by them, such as streets in school zones. This can be accomplished by implementing speed control features like speed humps, narrower lanes, raised crossing facilities, and refuge islands. Streets in school zones should have wide walkways and lower speed limits to enable children to play freely without compromising their safety. Additionally, appropriate traffic signs should be installed to alert drivers to exercise extra caution when entering school zones.

Figure 5. Street should be designed to ensure the safety and security of children.

2.6 MODAL HIERARCHY

To promote safe and efficient designs, this manual utilises modal hierarchies to guide design and operational decisions. The primary modes considered include pedestrians, bicycles, public transport, personal vehicles, and freight. The default hierarchy established in this manual is as follows: pedestrian > bicycle > public transport > freight > personal vehicles > personal vehicle parking. This hierarchy prioritises the modes in terms of their importance and impact on the design process.

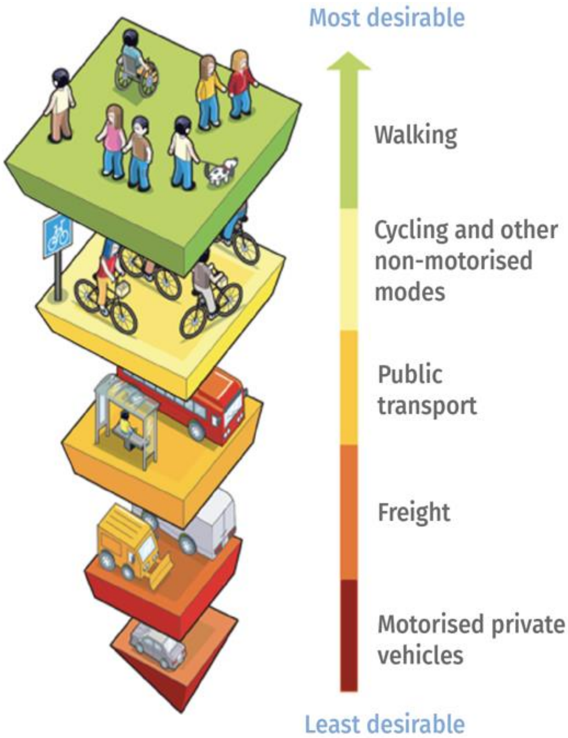


Figure 6. User hierarchy prioritising pedestrians, cyclists, and public transport to encourage safe and efficient street design.

2.7 SUSTAINABILITY

Climate variation is causing increasing temperatures leading to rising sea levels and extreme weather conditions such as flooding, drought, and storms. Unstable weather patterns affect transport systems, negatively impacting the longevity of roadways, public transport systems, and other facilities. At the same time, it is estimated that cities contribute over two thirds of global carbon emissions, with transport and buildings being the key contributors (World Bank Blogs, 2022). Cities must therefore play a leading role in combating climate change.

By prioritising and improving walking, cycling, and public transport options to discourage a shift towards highly polluting personal motor vehicles, urban areas can minimise greenhouse gas emissions while simultaneously improving local air quality and enhancing the health of urban residents. Designing tree-lined streets that support and promote sustainable modes of transport can make a significant contribution to reducing the impacts of climate change.

3. STREET NETWORK

Urban areas must focus on redesigning street networks with priority to pedestrian, bicycle, and public transport access. Walking and cycling make up a significant proportion of trips in Rwandan cities, and public transport journeys often begin and end on foot. Additionally, cities require high-quality public transport to cater to longer trips. Therefore, street designs should facilitate NMT and provide convenient, comfortable, and safe access to public transport.

3.1 MULTI-MODAL STREETS

Urban streets are inherently multi-modal; however, the functions for specific modes may not mirror the legal classification of the street. For example, a BRT system could apply on a collector, thereby making it an “arterial” for public transport. Similarly, if an arterial has cycle tracks, then it would be an “arterial” for cyclists; otherwise not.

Figure 7 describes recommended multi-modal configurations by street class to be used as part of this guide. Urban arterials can incorporate footpaths, cycle tracks, at-grade crossings, and public transport facilities, with design speeds of 50 km/h or below. Traffic calming measures should be provided to keep vehicle speeds moderate and enhance pedestrian safety. Collector streets in urban areas typically have footpaths, cycle tracks, and, in some cases, public transport services. Local streets in urban areas can have separate footpaths and carriageways, with cycles operating in the carriageway. Alternatively, a local street can be designed as a shared space, with all vehicles sharing the same space at low speeds (i.e., 15 km/h or below). See section 5 for typical street configurations.

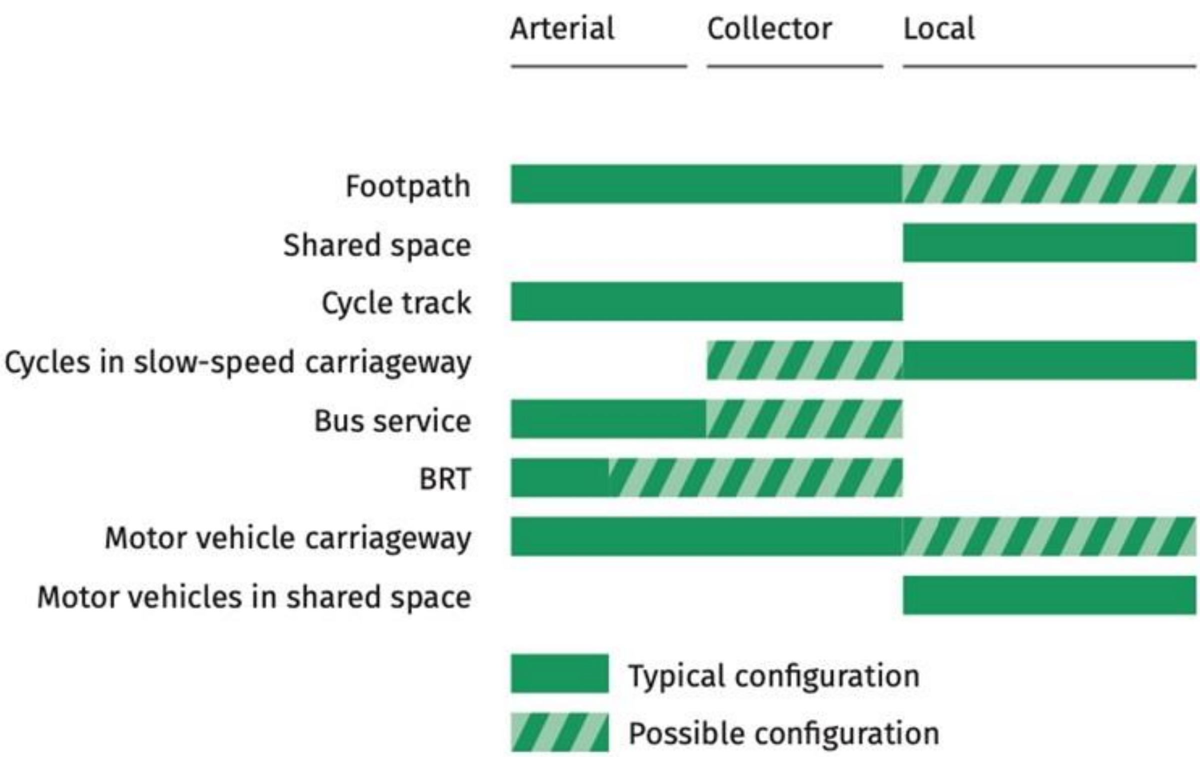


Figure 7. Recommended multi-modal configurations by street class.

3.2 STREET NETWORK SPACING

Street networks have spaced requirements. Blocks should be small enough to facilitate walking. Main driving roads (e.g., arterials) should be spaced sufficiently apart from each other. This spacing is necessary to prevent the road system from becoming overloaded or overwhelmed with traffic, ensuring smoother traffic flow and better overall efficiency in urban transportation. Public transport lines and stops are spaced to balance speed (e.g., of BRT buses) and access (to the stop or station). Table below lists the network spacing to be used as part of this guide. This guidance is intended to address:

- Operational efficiency and safety: Higher category streets have a limited number of motor vehicle crossings to facilitate operations of public transport. Lower category streets are spaced closely to provide access to each parcel.
- Connectivity for all road users: Smaller blocks facilitate walking and cycling.
- Distribution of resources: Rather than simply upgrading one main corridor through a community, mobility planning should emphasise the need for a complete street network.
- Adequate amount of land in the public realm: Land use plans should aim to allocate at least 20 percent of urban land to streets and pedestrian access routes.

To support the permeability of the pedestrian network, streets should incorporate pedestrian crossings at existing or expected desire lines, such as at bus stops, schools, or cross streets. If crossing behaviour is not considered, road corridors themselves can become barriers to pedestrian connectivity, dividing one part of a community from another. It is important to maintain neighbourhood access even as a street is being upgraded.

Table 1. Spacing of streets and facilities.

Type of street or facility	*Classification*	*Spacing (m)*
Public transport	Express stop/station	600-800
	Local stop/station	300-500
NMT	Cycleway	150-200
	Walking path	50-100
	Street crossing	60-120
Street (vehicle)	Major Arterial	1,500
	Minor Arterial	1,000
	Collector	250-500
	Local	60-100

3.3 NETWORK CONFIGURATION

Complete streets and networks have the power to create walkable communities where people are safe from traffic violence and have a lower greenhouse gas footprint. This section outlines a process to create a complete network that prioritises walking, cycling, and public transport. Motor vehicles are accommodated, but in a supportive role.

The typical street grids in use today are shown in. Districts are outlined by arterial roads and highways. The district on the left is divided by a series of collectors, which are in turn sub-divided by a series of local streets. There is no hierarchy, even though the street classification suggests one. One can drive on any street in any direction. It is mono-modal with no regard for walking, cycling, or public transport. This network is a plumbing diagram for traffic. The district on the right is hierarchical. It funnels drivers from local streets to the arterials via collectors. While it is also mono-modal and auto-centric, there is no through traffic on smaller streets.

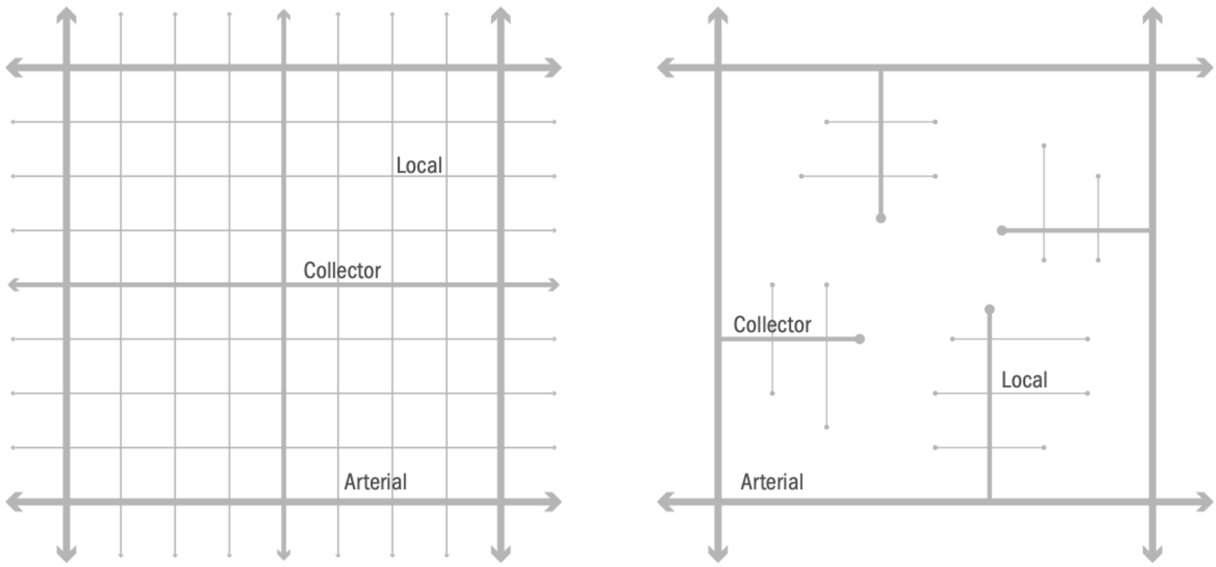


Figure 8. Traditional mono-modal street grids for motor vehicle movement: typical non-hierarchical street grid (left) and typical hierarchical street grid (right).

By contrast, the starting point of a complete network is public transport and walking. Public transport can move large numbers of people quickly and efficiently in urban areas. A well-connected street network enables public transport to operate within walking distance of all urban residents. Street networks should enable public transport services to operate with direct routing and minimal detours. High-demand corridors can incorporate dedicated right-of-way services such as BRT to enable buses to bypass the jam. On corridors with regular bus services, street designs should provide for convenient public transport access through shelters, signage, and safe pedestrian crossings.

Walking is a dominant mode in Rwandan cities, and public transport trips also start and end on foot. As a healthy and pollution-free form of mobility and recreation, walking is key to urban life. Pedestrian networks must have complete, publicly accessible walkways where all destinations are connected to each other and protected from vehicle traffic.

Figure 11 shows two versions of a representative transit-oriented district with a BRT system that plies the arterial street network. The network of streets and paths leads to the rapid transit stations, with a 5-minute (400 m) walking radius around the stations.

Greenways, paths, and other NMT facilities play a key role in complete networks. Cycling offers low-cost, pollution-free mobility. For cycling to be safe and comfortable for people of all ages, cities should create complete cycle networks serving all city areas and key destinations through the shortest possible routes. The cycle network can include various types of facilities, including slow-speed neighbourhood streets, physically separated cycle tracks on major streets, and cycle paths running through parks and greenways. The cycle network should be integrated with public transport systems and pedestrian priority areas. Secure cycle parking should be available at destinations.

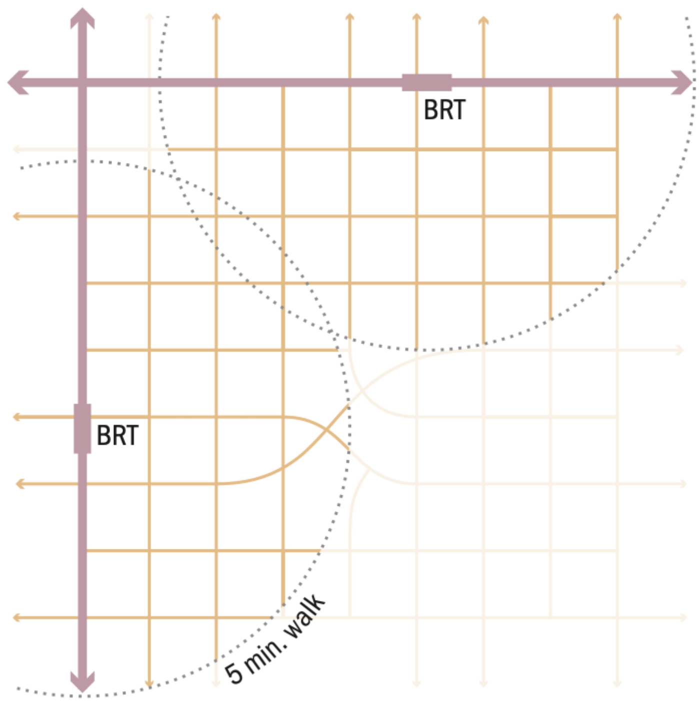


Figure 9. Transit-oriented districts: BRT-based transport.

Figure 12 shows the greenway and cycle track components of a complete network. The left image illustrates how cycling facilities may or may not follow the grid. Aside from corridors on streets, the cycle network can follow a river or train tracks. On the right, the greenways are overlaid on the transit-oriented grid.

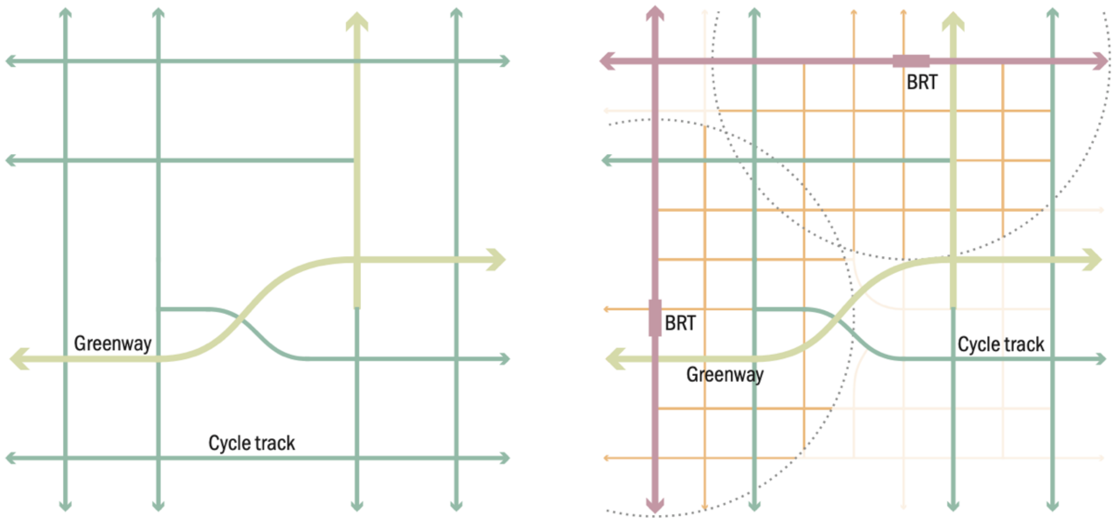


Figure 10. Greenway components (left). Transit-oriented district with greenway (right).

Complete networks accommodate motor vehicles, but in a supportive role. They are primarily for service and deliveries. Specific measures, including on-street parking systems and congestion charging, manage the overall use of personal motor vehicles. These measures should seek to cap the overall vehicle kilometres travelled by personal motor vehicles and limit the mode share of personal motor vehicles to 20 percent or less of trips.

The motorist network should provide access to the urban area while ensuring safety and efficient movement for pedestrians, cyclists, and public transport. A well-connected motor vehicle network can reduce bottlenecks and congestion. To ensure safety for all users, motor vehicle speeds must be managed carefully through traffic calming, appropriate street spacing, safe intersection designs, and automatic enforcement.

Local and collector streets lead drivers to perimeter arterials. Through traffic is discouraged. By contrast, interconnected walking networks with short block lengths allow for short and direct routes through neighbourhoods for pedestrians and cyclists. As shown in the right image in Figure 11, it will often be faster to walk or cycle within the district.

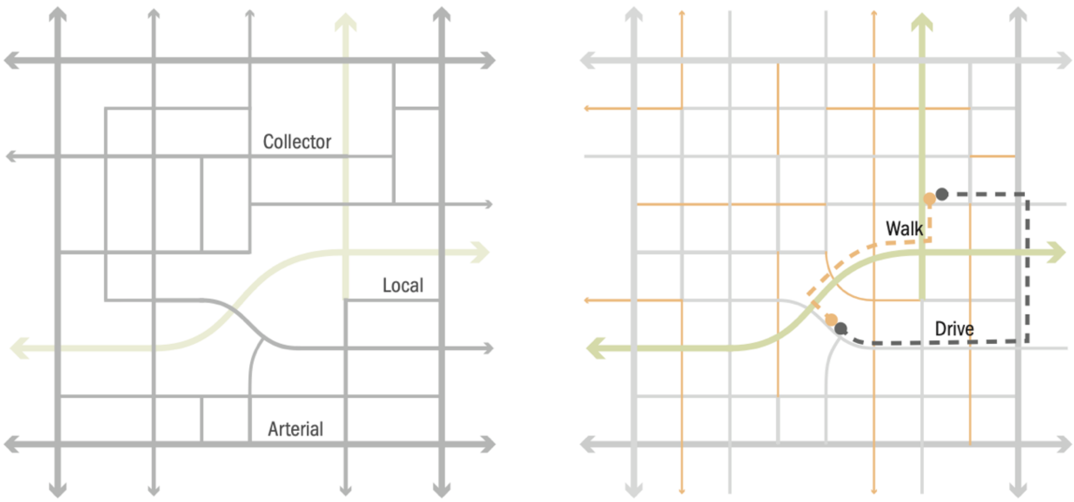


Figure 11. Motor vehicle network (left). It is often faster to walk or cycle within the district (right).

Finally, a complete, transit-oriented network can be formed, as displayed in Figure 12. The starting point is public transport, in this case a surface-based system (red) such as a BRT system passing through the district with a station at the centre. Emanating out from the station are the principal walkways (yellow)—promenades for people accessing the station, and probably the signature streets of the district. Walking spurs connect to this walkway and provide access to all blocks and surrounding districts.

A greenway (yellow-green) passes through the district, potentially along a waterway. Cycleways (green) provide high speed and comfortable passage for cyclists. Cycling infrastructure also extends the reach of the transit station. A network for drivers circumscribes the district but does not interrupt it. Access is provided to all blocks, but drivers are channelled to the surrounding arterials. Motor vehicles support the neighbourhood, but do not define it.

The centre of the community is highly "green"—oriented towards walking, cycling, and public transport. Fine-grained networks offer multiple routes to various destinations and make it convenient to complete trips by foot or cycle. In areas where large blocks exist, redevelopment provides an opportunity to break up large blocks to improve pedestrian connectivity. The complete, transit-oriented district supports access for residents of all incomes, genders, and abilities.

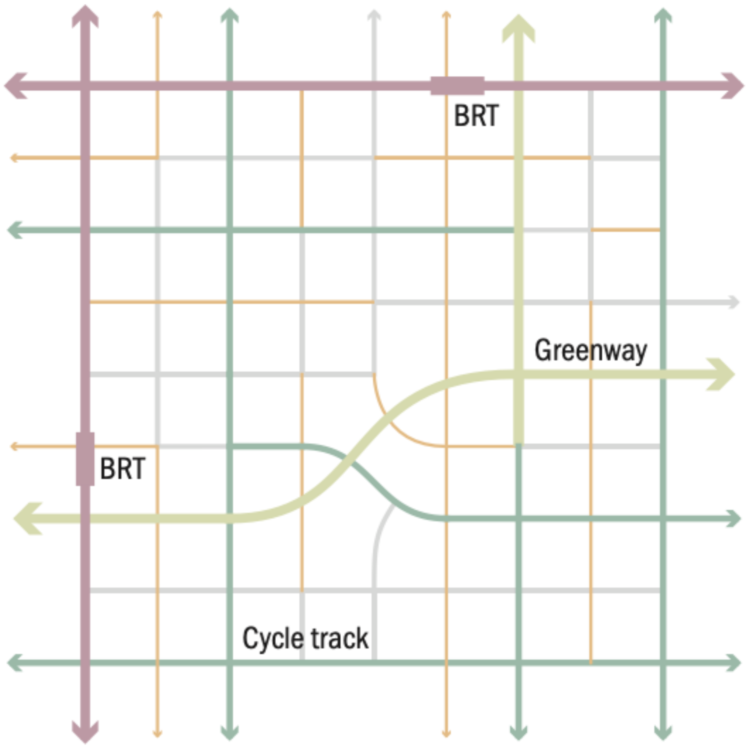


Figure 12. Complete, transit-oriented network.

4. STREET ELEMENTS

This manual serves as a comprehensive guide for understanding and implementing street design elements effectively. It emphasizes the importance of considering the local context, such as the surrounding environment, community needs, and transport patterns.

Achieving a harmonious balance among the various elements requires careful coordination and collaboration between urban planners, engineers, and designers. Factors such as traffic flow, accessibility, aesthetics, and sustainability must all be considered during the planning and implementation stages.

Furthermore, the manual recognizes that street design is not a one-size-fits-all approach. Each street and neighbourhood may have unique characteristics and requirements, necessitating a tailored approach to incorporate the appropriate elements. Flexibility and adaptability in design are crucial to accommodate future changes and developments.

Ultimately, by adhering to the principles outlined in this manual and considering the interplay of street design elements, communities can create functional, safe, and visually appealing streets that enhance the overall quality of life for residents and visitors alike.

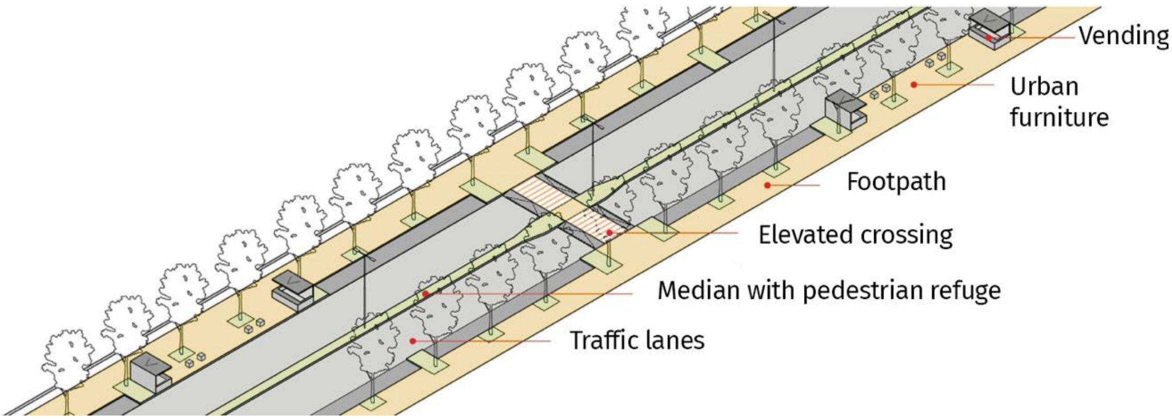


Figure 13. Well-planned streets provide uninterrupted space for walking and cycling, while also accommodating other activities such as street vending, waiting at bus stops, and vehicle movement without compromising pedestrian mobility.

4.1 FOOTPATHS

Good footpaths promote safe and comfortable pedestrian mobility. As the primary public space in a city, they should be accessible to all users, regardless of age, gender, disability level, or special needs. Comfort, continuity, and safety are the guiding criteria for the design and construction of pedestrian facilities. For this reason, footpaths are divided into three main zones: the frontage zone, the pedestrian zone, and the furniture zone. The pedestrian zone provides continuous space for walking and should be clear of any obstructions.

DESIGN STANDARDS

- Minimum clear width of 2 m. For areas with high pedestrian volumes, footpaths should be wider.
- Elevation over the carriageway of +150 mm.
- Ramp slopes are no steeper than 1:10. Slopes of 1:12 are preferred.
- Continuous shade through tree cover.
- No railings or barrier obstructions.
- Bollards to prevent encroachments by cars. Spacing of 900 mm between at least one pair of bollards for universal access.
- Constant height at property entrances. Ramps can be provided for vehicles, with a slope of 1:6 to 1:12 (maximum 1:4).
- Cross slope no more than 2%.
- Tactile pavers for people with visual impairments.
- Footpaths along high-capacity and major arterial roads should be separated from motor vehicles by buffer.

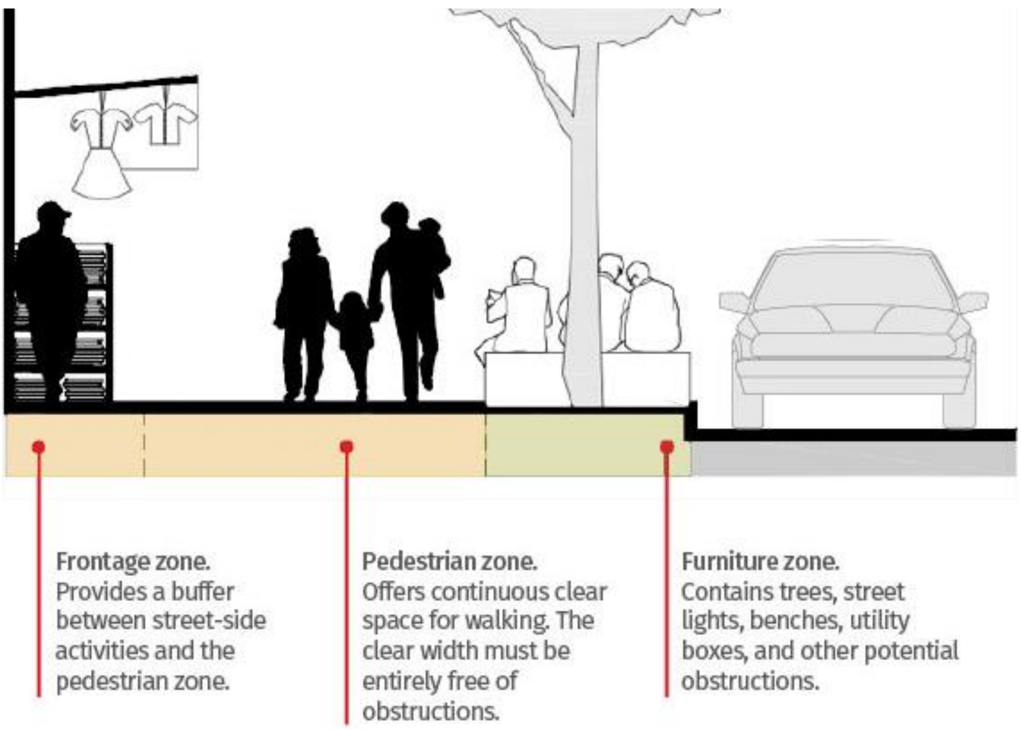


Figure 14. Footpaths have distinct zones that serve separate purposes.

Figure 15. Footpaths designed according to the zoning system provide uninterrupted walking space for pedestrians. The pedestrian zone should have a minimum of 2 meters of clear space. (Nairobi)

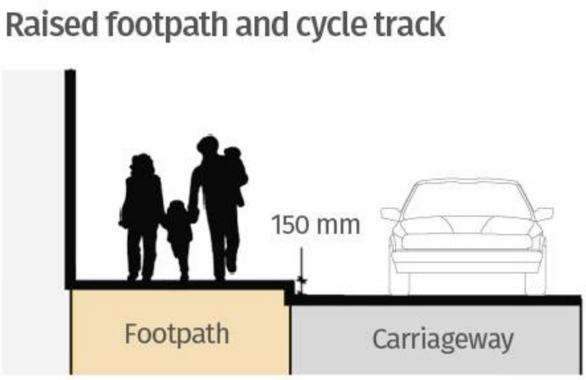


Figure 16. Footpaths should be raised +150 mm above the carriageway to prevent the accumulation of storm water and debris. A cross slope of 1:50 is required.

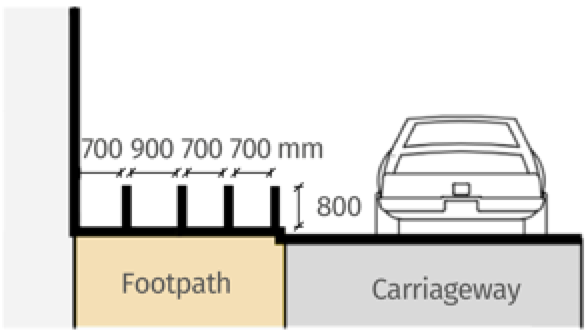


Figure 17. Bollards should be installed to prevent vehicles from parking on footpaths, with spacing of 0.9 m between at least one set of bollards to allow wheelchairs to pass.

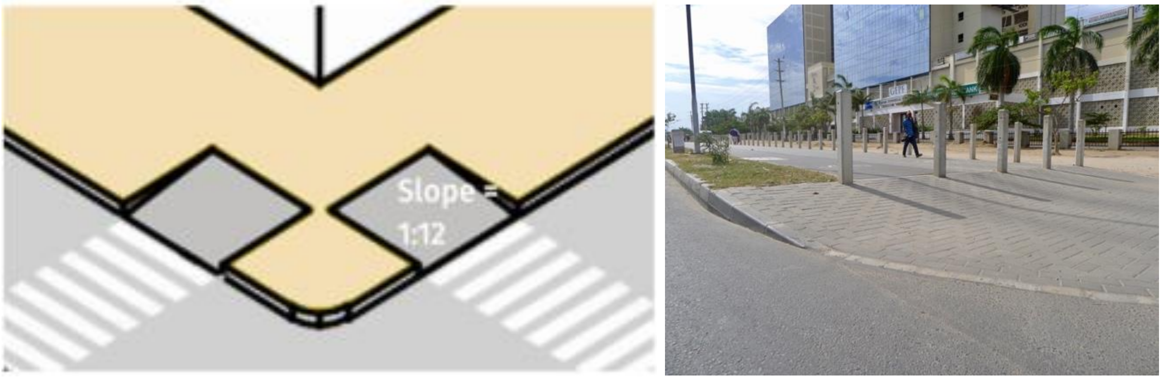
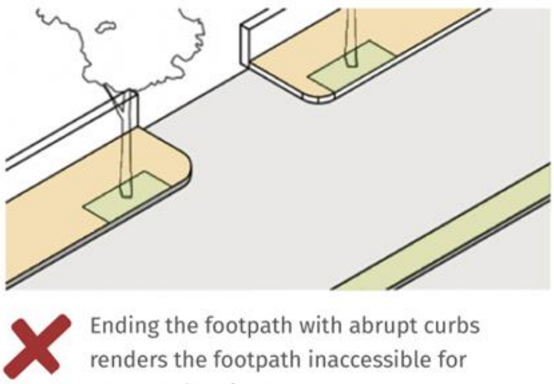
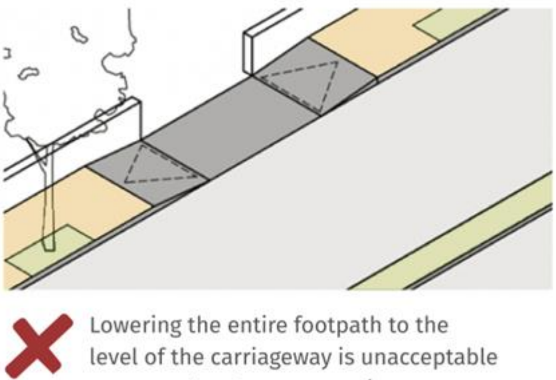


Figure 18. Where footpaths are ramped down to the level of the carriageway, the maximum ramp slope is 1:12.

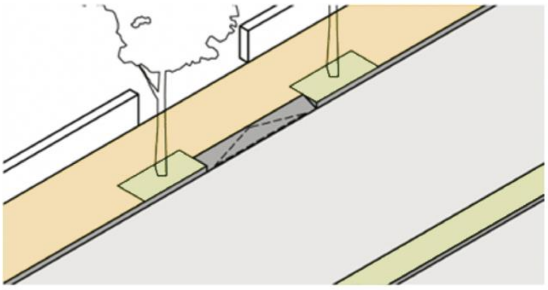
Figure 19. Footpaths that maintain a constant level through property entrances are convenient for pedestrians to use. Vehicles use a ramp, helping to reduce speeds.



Ending the footpath with abrupt curbs renders the footpath inaccessible for many pedestrians.



Lowering the entire footpath to the level of the carriageway is unacceptable as property entrances may become waterlogged.



Where required to provide the access to private properties, vehicle ramps should be provided in the furniture zone.

Figure 20. Footpaths must be continuous at property entrances for uninterrupted pedestrian movement. The height of the footpath should remain the same, with ramps for vehicles.

4.2 CROSSINGS

Good crossings allow pedestrians and cyclists to safely and conveniently cross busy streets. A formal pedestrian crossing should be located wherever there is a concentrated need for people to cross the street, such as at a bus stop, an entrance to a shopping mall, or where a path intersects the street. In busy commercial areas, crossings should be spaced at more frequent intervals.

At-grade crossings are a preferable alternative to pedestrian footpaths over bridges or tunnels. Pedestrians dislike having to climb stairways in order to cross the street, so they are likely to avoid them and cross at-grade as they please. This preference makes costly bridges and tunnels an unwise use of limited resources.

DESIGN STANDARDS

- Pedestrian crossings should be located at pedestrian desire lines.
- Signalised or raised to the level of the footpath to provide universal access and traffic calming. People can cross a street with up to two lanes, low vehicle volumes, and slower speeds (i.e., 30 km/h or below). If a street has two or more lanes per direction, higher volumes, or faster speeds, crossings are made safer through median refuge islands combined with traffic calming and/or signal control.
- For tabletop crossings, the height should match the height of the adjacent footpath. A ramp slope of 1:8 is preferred.
- If a speed hump is used, the hump should be placed 5 m before the crossing.
- Drainage inlets should be provided upstream of the tabletop crossing to prevent waterlogging.

- The pedestrian crossing should have a minimum width of 5 m or equivalent width to the adjacent footpath, whichever is larger.
- Bulb-outs should be added in parking lanes to reduce the crossing distance.

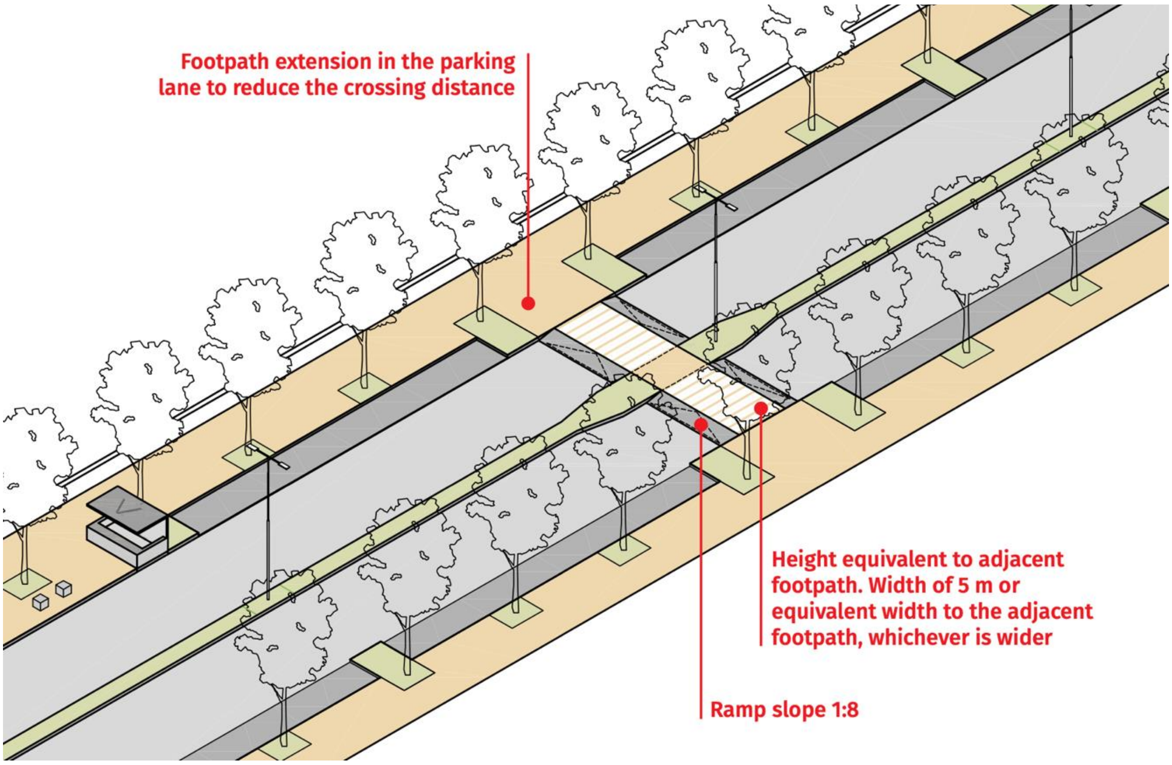


Figure 21. To ensure safety, formal crossings should be signalised or should be constructed as tabletop crossings with ramps for vehicles.

Figure 22. Pedestrian crossings should be direct and should offer universal access. Moreover, raised crossings compel vehicles to reduce their speeds, thereby increasing pedestrian safety.

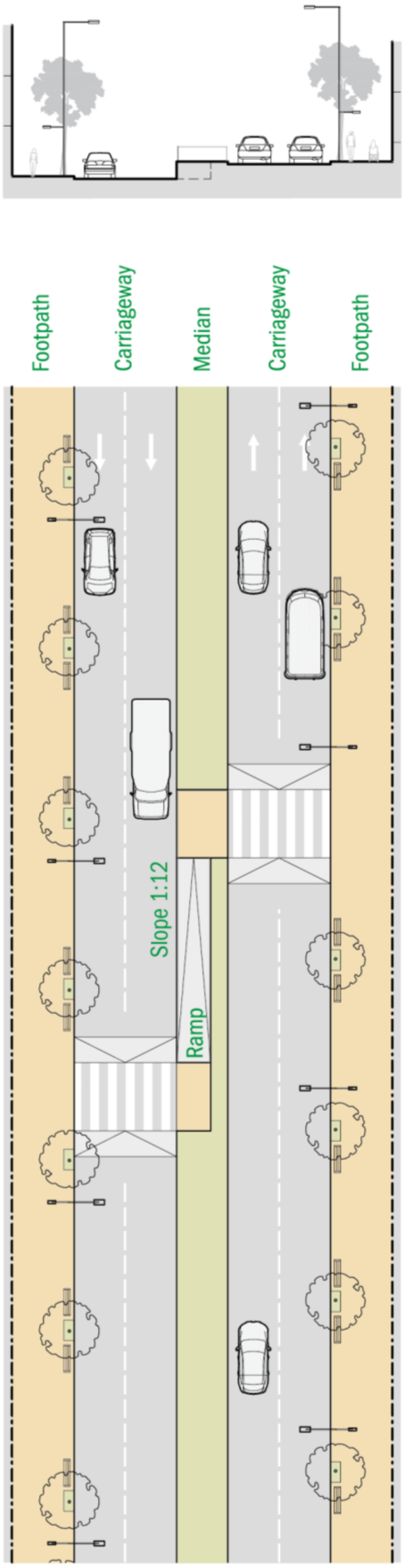


Figure 23. If two sides of the carriageway are at two different levels, the crossing should incorporate a ramp in the median, and not only stairs, for universal access.

BEST TO AVOID: PEDESTRIAN BRIDGE AND UNDERPASSES

To increase motor vehicle speeds, at-grade pedestrian crossings are frequently replaced by foot over- bridges or subways. Since these facilities are inaccessible to many people, they should be avoided as much as possible. Grade-separated pedestrian crossings have numerus drawbacks:

- Increase in travel time. Footbridges lead to circuitous walking routes that typically increase travel distances and times, thereby discouraging walking. Pedestrians typically seek out short, direct routes to their destinations.
- Lack of universal access. Footbridges are often inaccessible and in- crease barriers to persons with disabilities, people carrying luggage, and parents with strollers. Extensive ramping may be installed to accommodate wheelchairs and bicyclists, but long crossing distances and steep slopes still discourage use.
- Obstructions on footpaths. Due to land constraints, footbridges can sometimes block footpaths. To accommodate both footbridges and footpaths, there might be needed to acquire land outside the public right-of-way (ROW), which can be expensive.
- Prohibitive cost. Footbridges cost upwards of twenty times as much as at-grade crossings.
- Harassment and other crimes. The walking environment in grade separated facilities is generally poor and potentially unsafe with regard to sexual assault and other crimes, especially during night-time hours, since the facilities are by definition removed from street-level activity and the security it provides.
- Increased vehicle speeds. Grade separation also tends to increase motor vehicle speeds, further degrading the overall walking environment in the vicinity of the footbridge, especially for those who cross at grade.

Footbridges should be used only if at grade crossings are not viable. On a few selected cases such as on the limited access highways and places where there is surrounding land that is much higher than carriage level making it more convenient for people to use, constructing footbridges would be beneficial. The rule of thumb is that the footbridge should not lead to more than 50% increase in walking time.

Figure 24. Footbridges often represent a wasted investment. When presented with a choice, pedestrians prefer to cross at street level. (Gaborone)

4.3 CYCLE TRACKS

A cycle track is physically separated from motor traffic and is distinct from a painted cycle lane, which offers little protection for cyclists. Cycle tracks can reduce conflicts between cyclists and motor vehicles, making it possible for even novice users to choose cycling. Efficient cycle tracks are safe, convenient, continuous, and direct. Cycle tracks come in various forms but share common elements: they provide exclusive and are physically separated from motor vehicle travel lanes, parking lanes, and footpaths.

DESIGN STANDARDS

- Physically separated from the carriageway—as distinguished from painted cycle lanes, which offer little protection to cyclists.
- Clear width of at least 2.0 m for one-way movement. The clear, or "effective" width, is the width clear of obstructions such as utility poles, shrubs, etc. 3.0 m of clear width for two-way movement. For the relationship between cycle volumes and width, see Table 2.
- A smooth surface material—asphalt or concrete. Paver blocks should be avoided.
- Elevated 150 mm above the carriageway.
- Positioned between the footpath and carriageway. Provide a buffer of at least 0.5 m between the cycle track and carriageway. The buffer should be paved if it is adjacent to a parking lane. Increase the buffer to 0.75 m next to buildings, walls, etc.

- Bollards to prevent encroachments by cars. One bollard placed in the middle of the cycle track, to allow for cyclists to pass on either side. Bollard spacing of 1.2 m.
- See ***Error! Reference source not found.*** for facility selection.

Table 2. Relationship between cycle track width and volume.

One-way volume (bicycles/hr)	*Bidirectional volume (bicycles/hr)*	*Effective width (m)**
< 150	N/A	2.0
150-750	< 100	3.0
> 750	> 100	4.0

* Add 0.5 m where there are 10% or more tricycles or cargo bicycles.

Table 3. Bicycle facility selection.

Bicycle facility	*Motor vehicle speed, 95th percentile*	*Motor vehicle volume, daily, both directions*
Shared street	≤ 15 km/h	-
Bicycle boulevard (bicycles in moderate-speed carriageway)	≤ 30 km/h	< 2,000 and under 50 motor vehicles per hour, peak hour, peak direction
	≤ 40 km/h	< 1,500 and under 50 motor vehicles per hour, peak hour, peak direction
Cycle track or protected bike lane	≤ 40 km/h	≥ 1,500
	> 40 km/h	≥ 1,500

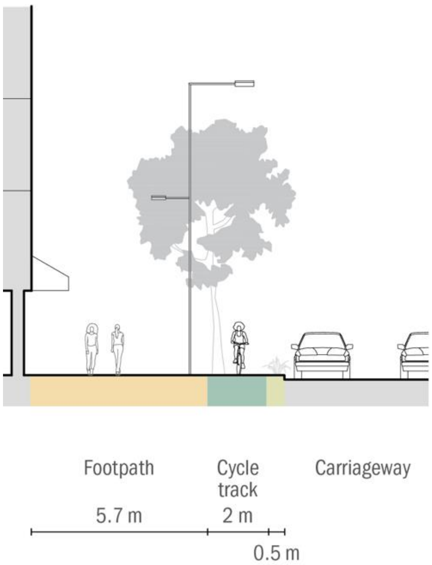


Figure 25. For one-way movement, cycle tracks should have a width of 2 m plus a 0.5 m buffer next to the carriageway. The width should be increased to 3.0 m for two-way movement.

Figure 26. Cycle tracks should be wide enough for cyclists to overtake one another and flushed with the footpath level. Kerbs between the cycle track and footpath should be avoided.

4.4 CARRIAGEWAYS

When carriageways become congested, they can no longer fulfil their role of providing vehicle mobility. This can be addressed through road pricing and traffic demand management measures aimed at reducing the number of vehicles on the streets while increasing public transport ridership. These measures reduce congestion and improve conditions for the remaining users.

Street space should be allocated to the carriageway only after adequate usable space has been reserved for walking, cycling, trees, public transport (including BRT if the street falls on the city's rapid transit network), and street vending. Otherwise, these activities may spill over onto the carriageway. The carriageway should be designed for appropriate speeds that are suitable for the street's role in the network.

Motorbikes are classified as motorised traffic and should, therefore, share the carriageway with mixed traffic. To enhance pedestrian safety, the movement of commercial motorcycles should be controlled in the central business district (CBD) where there is high pedestrian movement.

DESIGN STANDARDS

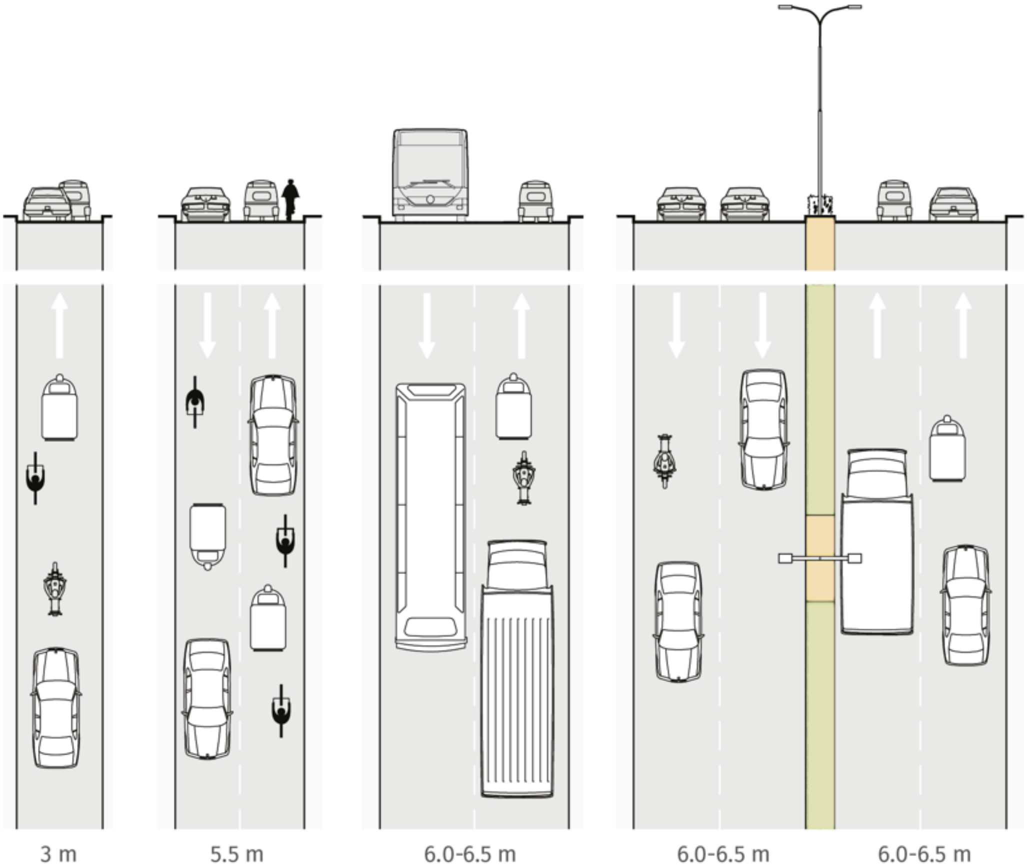
- A carriageway lane width of 3.0-3.25 m is appropriate for streets in urban areas to encourage safe driving speeds and facilitate safe interactions with other street users. Carriageways on urban streets should not be wider than three lanes per direction. In industrial zones, a 3.5 m lane width is acceptable. These measurements are taken between the street edge markings.
- Design speeds should reflect the surrounding urban context, especially the level of pedestrian and cyclist activity.
- Superelevation is generally not used on streets with speeds of 70 km/h or below in urban areas. It negatively impacts drainage, footpaths, adjacent properties, intersections, and vehicle speeds. Instead, streets are to be crowned with maximum 2.0% cross-slope (2.5% where there is heavy rain).
- Vertical curves are to follow the natural grade of the land and/or match adjoining properties. Where vertical curves impact stopping sight distance, lower driver speeds along the affected sections.

Horizontal curves are designed to manage vehicle speeds (see

- Table 4). Where a smaller right-of-way is available, reduce the horizontal radius to ensure continuity in cycle tracks and footpaths.
- Maximum grade of 5%, except in cases of geographical constraints.

Table 4. Minimum horizontal curve radius.

Speed (km/h)	*Minimum horizontal curve radius (m)*
20	10
30	28
40	62
50	90 m for Road Class 1, and 80 m for Road Class 2 and 3



For a shared-street, the optimum width for a carriageway is 3 m for one-way movement and 5.5 m for two-way movement.

For local and collector streets that need to accommodate buses and trucks, the width of a two-way carriageway can vary between 6.5 and 7.0 m, depending on the volume of heavy vehicles.

In arterial streets, the optimum width of a two-lane carriageway is 6.0-6.5 m, and that of a three-lane carriageway, 9.0-9.75 m.

Figure 27. Appropriate carriageway widths play a crucial role in encouraging safe driving practices.

4.5 BUS RAPID TRANSIT

Bus rapid transit (BRT) offers high-capacity and high-quality public transport service at a fraction of the cost of rail systems. Realising the advantages of BRT is a function of several design elements, including median-aligned dedicated BRT lanes, platform-level boarding, off-board fare collection, and intersection treatments. BRT also requires safe footpaths, cycle tracks, and crossings to enable convenient passenger access. Besides good physical design, successful implementation of BRT requires effective system management, operations planning, and traffic control. Emergency vehicles including fire engines and ambulances will have emergency access to dedicated BRT lanes while commercial motorcycles will be fully restricted.

DESIGN STANDARDS

- Exclusive BRT lanes with a width of 3.5 meters must be provided in the centre of the street. These lanes should be separated from mixed traffic by a physical barrier.
- Centrally located BRT stations require a width of 4 meters. Larger widths may be necessary if the demand is high.
- For high-demand corridors, passing lanes, multiple station sub-stops, and express services are needed.
- Safe pedestrian access via crosswalks elevated to the level of the footpath (+150 mm) across mixed traffic lanes. The BRT lanes should be raised to +150 mm for the length of the station, with a ramp slope of 1:100 for buses.
- Stations should be positioned at least 40 m away from intersection stop lines to allow sufficient space for bus and mixed traffic queues.
- BRT stations are generally spaced 300 to 800 meters apart, with the optimal distance in urban areas being around 450 meters. Beyond this, customers would spend more time walking to stations than the time saved from higher bus speeds.
- Two-phase intersections to minimise delays for buses.
- Maximum grade of 5% for BRT lanes and 2% at stations.

Figure 28. BRT offers fast, reliable public transport service.

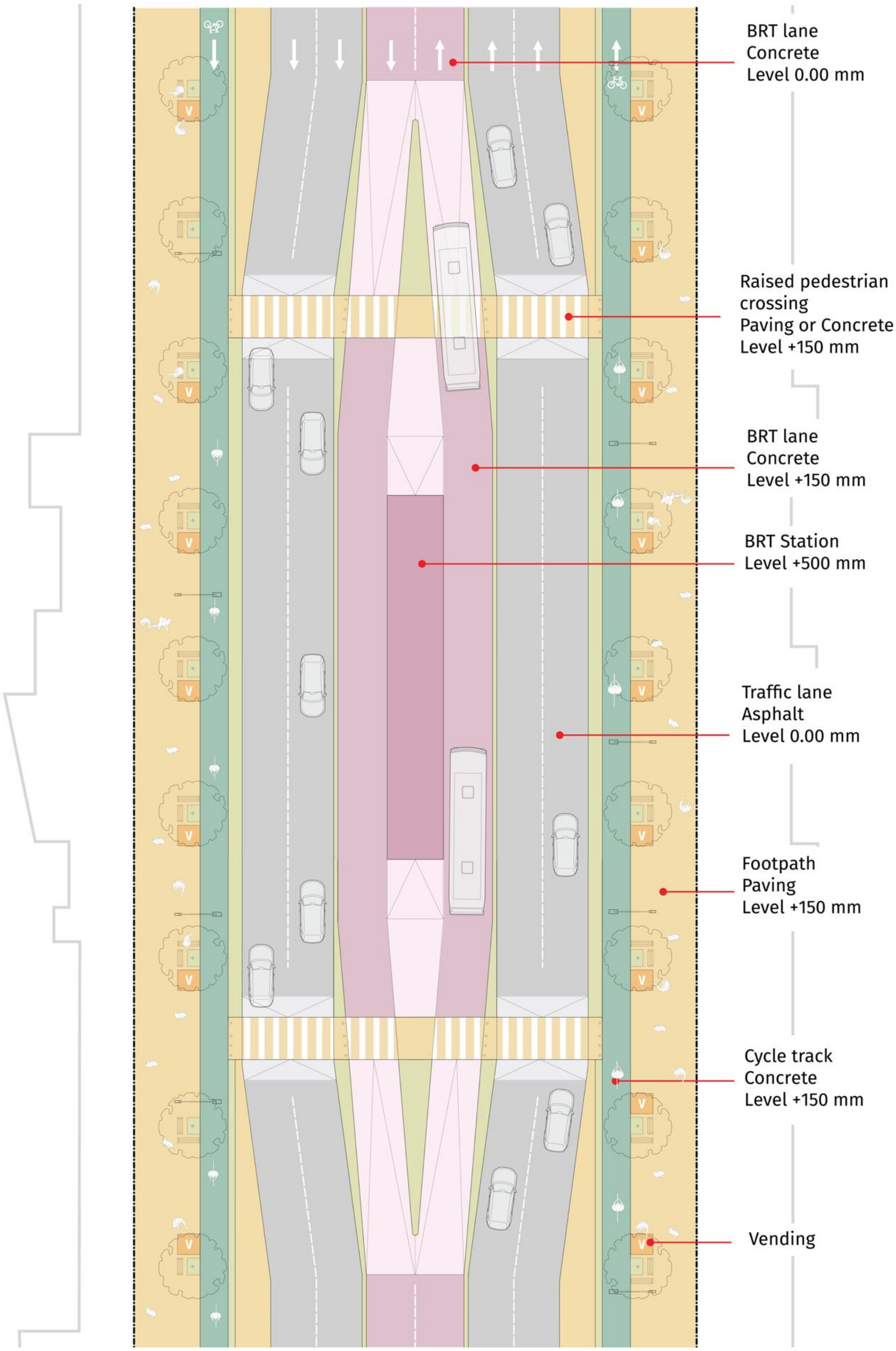


Figure 29. Safe pedestrian crossings are key to facilitating access to BRT systems. BRT lanes are elevated at station locations to match the height of the tabletop crossings.

4.6 BUS STOPS

Well-designed bus stops provide a comfortable and weather-protected waiting area for public transport passengers while leaving clear space for pedestrian movement behind the shelter. Bus bays should be avoided because they increase travel times for public transport users and result in commuters standing in the street while waiting for the bus. However, bus bays may be warranted in some cases where buses queue for long periods of time or on undivided carriageways, provided that the adjacent footpath and cycle track meet minimum standards. The width of the bus bay should be no more than 2.5 meters, to avoid challenging buses to maneuver in and out efficiently, leading to delays and operational inefficiencies, and bus stop length should be sufficient to accommodate the projected bus station demand, ensuring at least two buses can be accommodated simultaneously.

DESIGN STANDARDS

- On a street with two or more carriageway lanes per direction, the bus stop should be placed adjacent to the bus's line of travel so that the bus does not need to pull over.
- On a street with one carriageway lane per direction or at terminal locations, the stop may incorporate a bus bay provided that there is sufficient clear space for walking behind the shelter. The width of the bus bay should be no more than 2.5 m.
- Shelter with adequate lighting, protection from sun and rain, and customer information.
- Cycle tracks should be routed behind bus shelters.
- Bus stops should be provided at intervals of 200-400 m, depending on the level of demand.

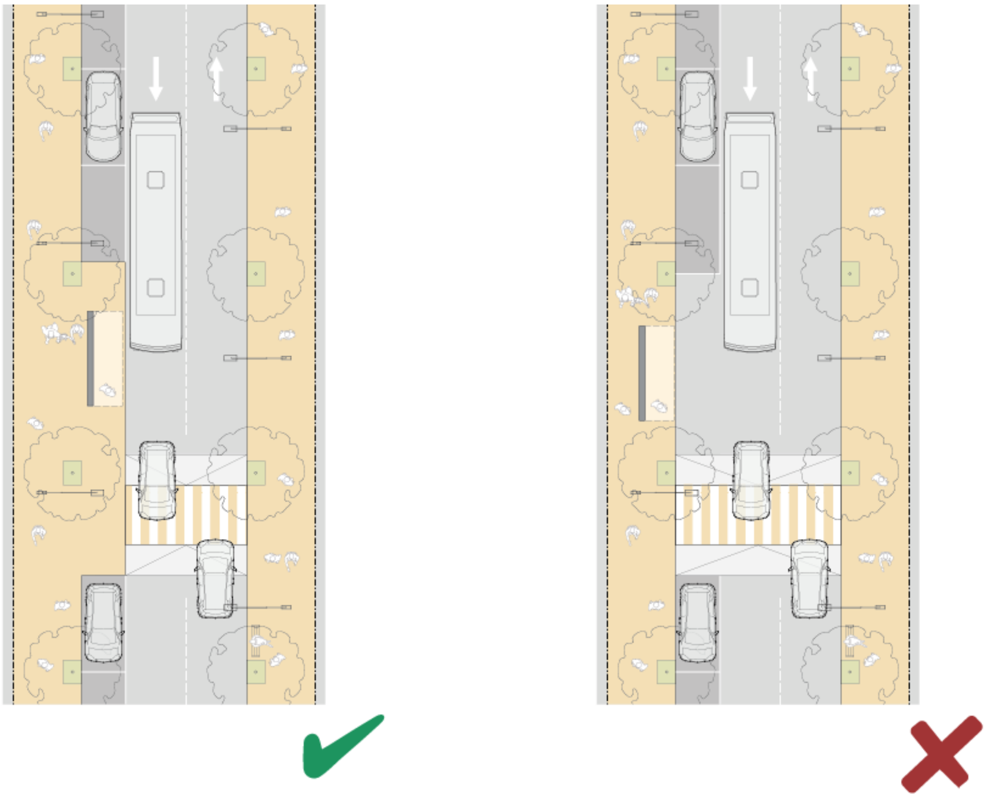


Figure 30. On streets with two-way undivided carriageways, a bus bay may be provided if there is sufficient clear with for walking behind the shelter. For carriageways with more than two lanes per direction, the bus stop must be placed on a bulb-out in the parking lane, leaving a clear width of at least 2 m on the footpath.

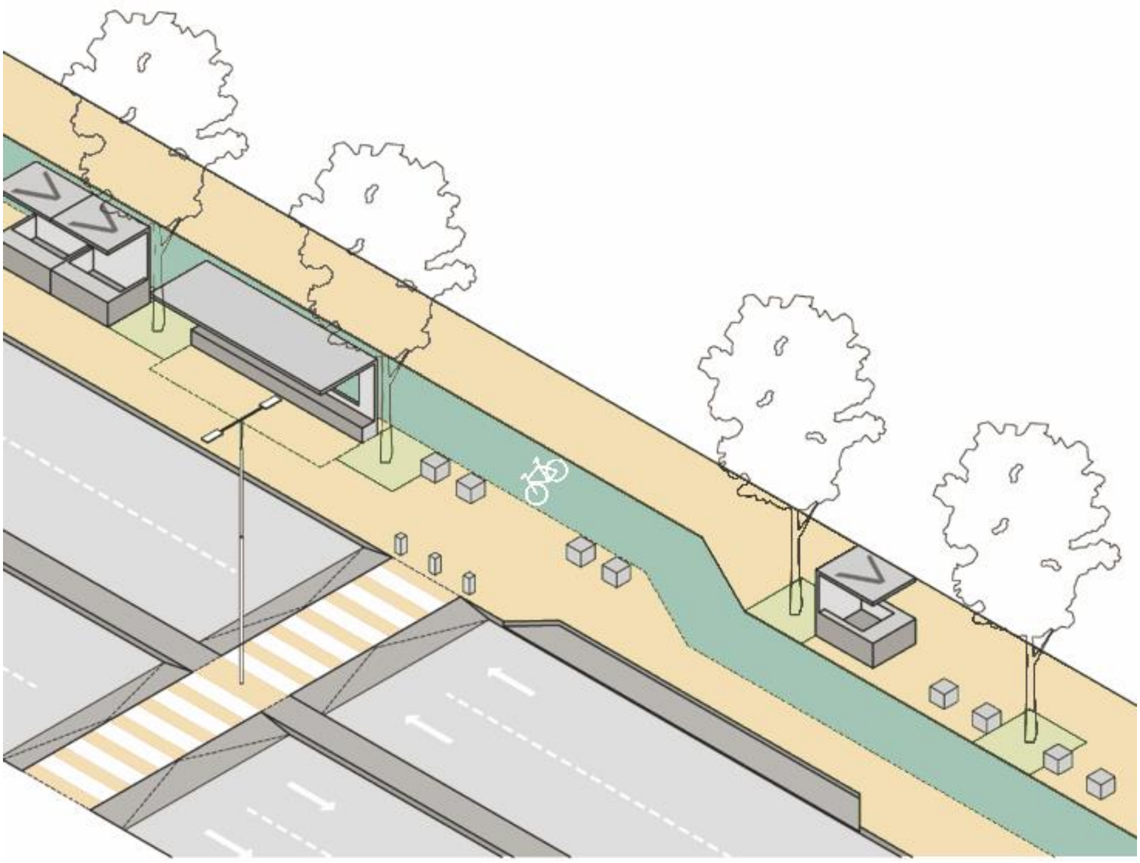


Figure 31. Cycle tracks should be shifted behind bus shelters to create sufficient waiting area for passengers.

Bus shelter

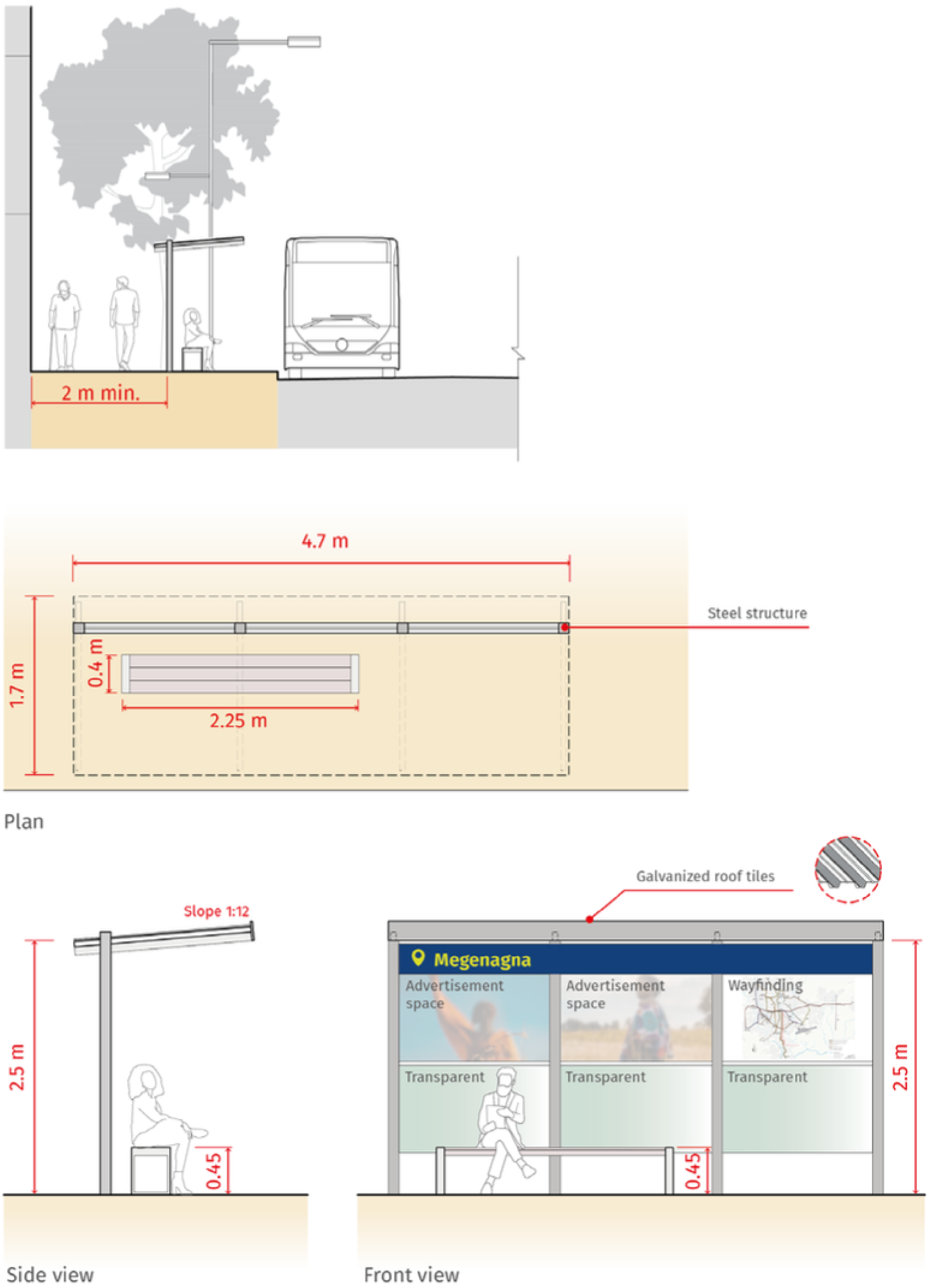


Figure 32. A high-quality bus shelter offers rain protection and shade through opaque roof tile. Open sides and transparent rear panels improve visibility. The shelter should include seating space and wayfinding information.

4.7 BUS TERMINALS

Bus terminals facilitate public transport operations, including passenger transfers, at major origins and destinations. Well-designed bus terminals have adequate passenger facilities such as seating and waiting areas provided. The passenger shelters should offer protection from adverse weather conditions, with the roofs extending over the bus. Walkways inside terminals should follow pedestrian desire lines and offer universally accessible routes to surrounding streets.

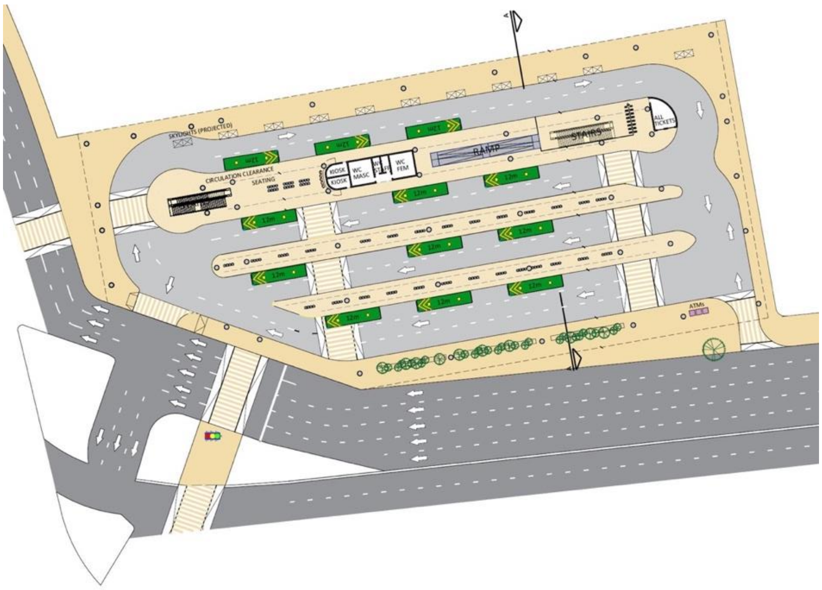


Figure 33. Representative bus terminal layout with raised boarding areas, a continuous pedestrian realm, crosswalks, and connections to nearby streets. (Location: Cairo)

4.8 LANDSCAPING

Landscaping improves the liveability of streets by playing a functional role in providing shade to pedestrians, cyclists, vendors, and public transport passengers. It also enhances the aesthetic qualities of streets. On urban streets, landscaping can serve as a separator between NMT facilities and the carriageway.

DESIGN STANDARDS

- Existing trees are to be retained during street improvement projects.
- Minimum distance between trees to provide continuous shade, depending on the individual trees' canopy size and shape. A typical interval is 5-10 m between trees.
- Tree pit locations should be coordinated with the position of streetlights.
- Tree pits should have dimensions of at least 1.5 m by 1.5 m to accommodate the trunk and root structure at full maturity. On narrow footpaths, 1 m wide tree pits are acceptable. On wider footpaths, the preferred permeable area for a tree pit is 5 sqm.

- Hume pipes can help lower the level at which roots spread out, thereby reducing damage to road surfaces and utilities.
- Trees with high branching structures are preferable.
- Medium-height vegetation should be trimmed next to formal crossings to improve the visibility of pedestrians and cyclists.
- Indigenous, drought-resistant species are preferable.

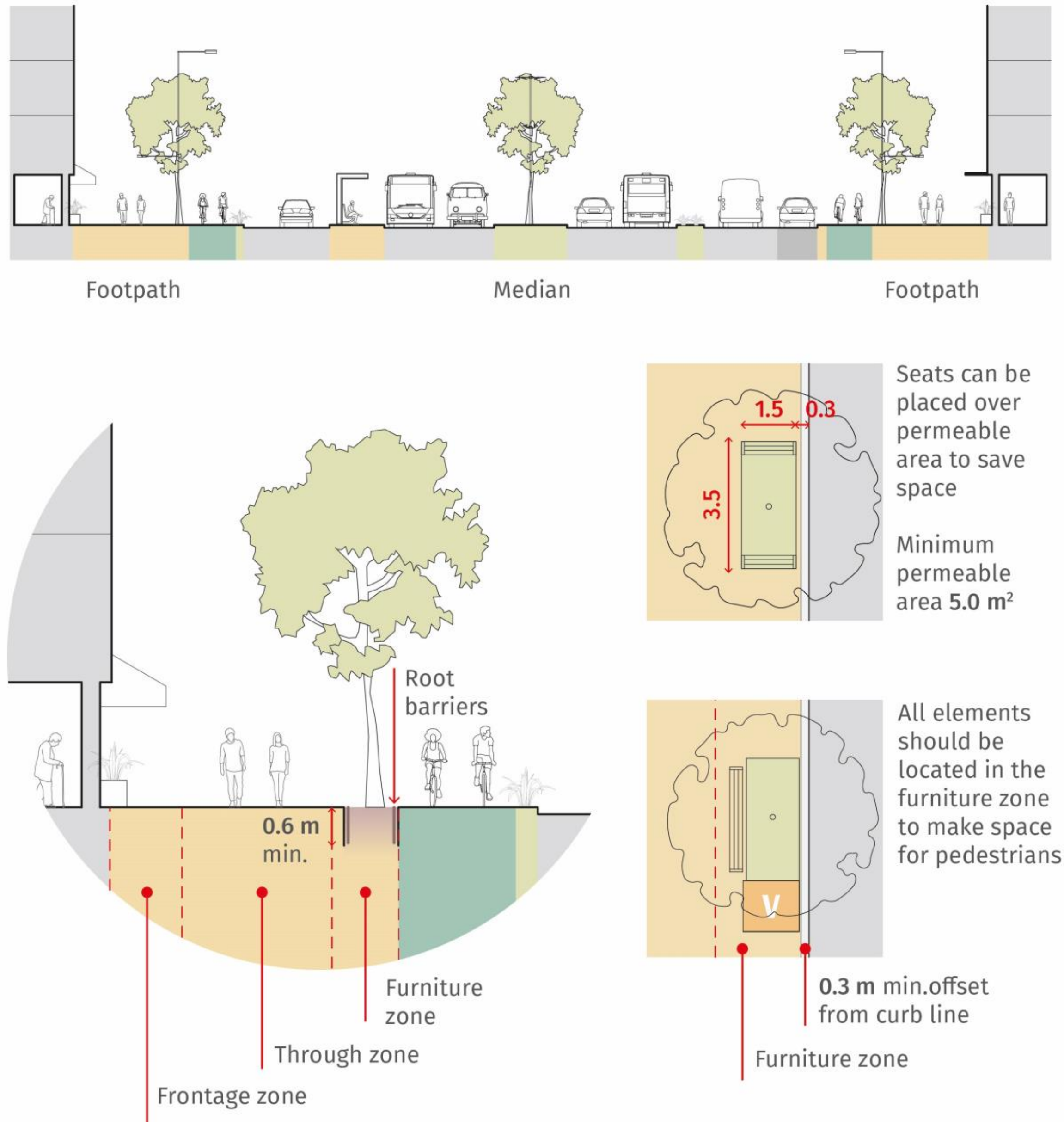
Figure 34. A well-shaded footpath and cycle track.

Table 5. Location and spacing of street trees.

Location	*Crown diameter*		
	< 6 m	6-9 m	≥ 9 m
Footpaths	6-8 m spacing	8-12 m spacing	Best for 12 m or wider spacing
Medians	6-8 m spacing	8-12 m spacing	Not appropriate
Intersections and residual spaces outside ROW	At the edges, where views to traffic will not be obscured	As proposed in the urban or landscape design	As designed in the urban or landscape design
City parks, greenways, etc.	As proposed in the urban or landscape design		

Table 6. Tree pit dimensions (Paulo, 2015)

Footpath width (m)	Minimum width (m)	Minimum tree pit area (sq m)	Suggested tree calliper (m)
< 2	Tree planting not recommended		
2.00 - 2.09	1.00	2.25	Up to 0.50
2.10 to 2.39	1.00	2.25	Up to 0.70
2.40 to 2.79	1.00	2.25	Up to 0.90
Over 2.80	1.50	1.50	Up to 1.20



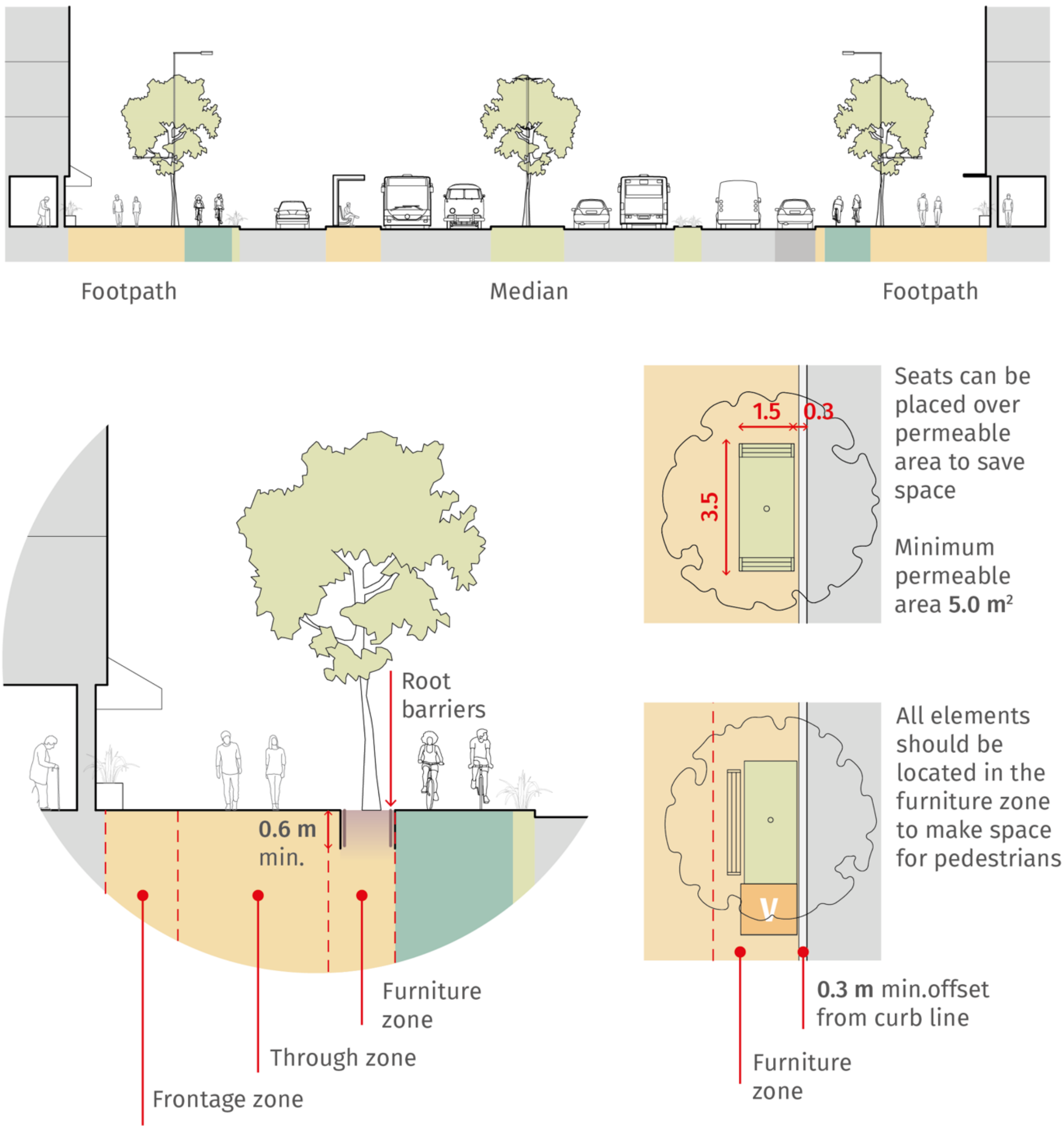


Figure 35. Every footpath and cycle track should have continuous shade from trees. Trees should be aligned to improve compatibility with underground utilities. Additional tree lines may be included in medians to further enhance the streetscape.

4.9 VENDING

Street vending provides essential goods and services to a wide range of population groups. It also enhances public safety by contributing to the presence of "eyes on the street," especially on streets with compound walls. When properly designed, vending can be incorporated into the streetscape without interfering with other uses. The city administration can allocate vending space in the furniture zone of the footpaths for formalized and licensed vendors, ensuring security and generating tax revenue.

DESIGN STANDARDS

- Street vendors should be accommodated in areas where there is demand for their goods and services—near major intersections, public transport stops, parks, and other high-traffic locations.
- Supporting infrastructure, including cooperatively managed water taps, electricity points, trash bins, and public toilets, should be provided.
- Vending areas should be strategically positioned to ensure the continuity of cycle tracks and footpaths. The furniture zone of the footpath or a bulbout in the parking lane are ideal locations.
- The material used for the vending area should facilitate proper drainage to prevent water accumulation and ensure a clean and hygienic environment for vendors and customers.

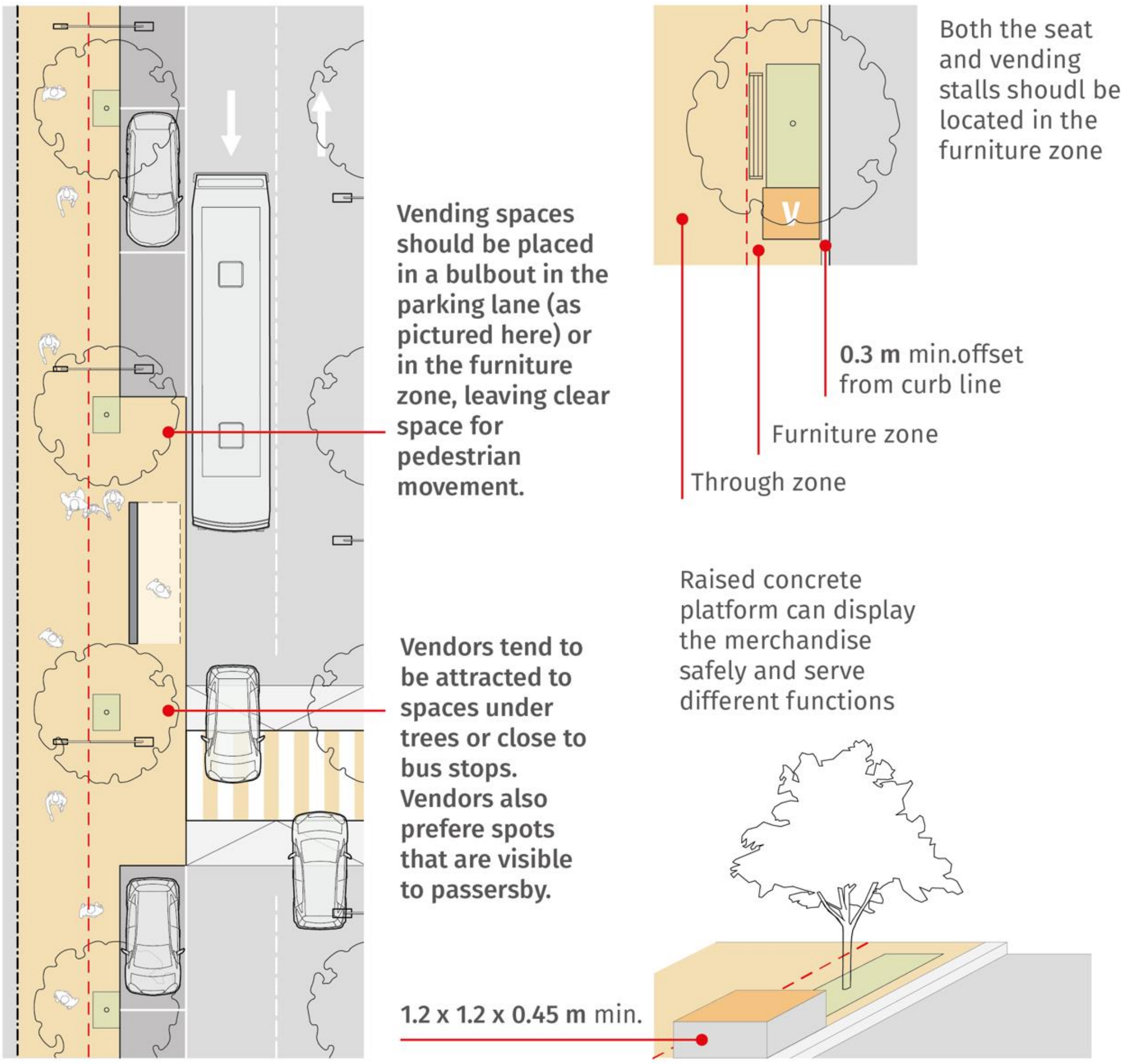


Figure 36. Footpaths should be designed such that there is sufficient space for vending outside of the pedestrian zone.

4.10 STREET LIGHTING

Well-designed street lighting enables motor vehicle drivers, cyclists, and pedestrians to move safely and comfortably by reducing the risk of traffic crashes and improving personal security. From a traffic safety standpoint, street lighting is especially important in potential conflict points, such as intersections, driveways, and public transport stops. Additionally, lighting helps road users avoid potholes and missing drain covers.

From a personal safety standpoint, street lighting is essential for mitigating the pedestrian's sense of isolation and reducing the risk of theft and sexual assault. Thus, improved lighting is particularly important in isolated spaces such as under- and overpasses and walkways next to parks or blank façades. Pedestrian-scale lamps should be provided to increase illumination for pedestrians and to beautify urban spaces.

DESIGN STANDARDS

- The spacing between two light poles should be uniform and correspond to 3-3.5 times the height of the fixture. The distribution of poles can be single-sided, double-sided, staggered (when on footpaths), or placed on central medians.
- Height as per Table 7 The placement of street lighting should be coordinated with other street elements so that trees or advertisement hoardings do not impede proper illumination.

Table 7. Relationships between street width (w), light fixture spacing (d) and height (h). Source: Adapted from Electrical Technology, 2021.

Layout of streetlights	Relationship between street width (w) and height (h)	Relationship between pole spacing (d) and height (h)
Single-sided	w = h	d = 3 x h (min.) d = 3.5 x h (max.)
Double-sided	w = 2 x h	
Central median	w = 2 x h	
Staggered	w = h (min.) w = 1.5 x h (max.)	

Table 8. Type of street and the required light

Type of street	Layout	Illuminance (Lux)
Major Arterial	Two sides and double-sided at central median	30

Minor Arterial	Two sides	30
Collector Street	Two sides or in medians	25
Local street	One side	25

Figure 37. Continuous lighting improves safety and personal security.

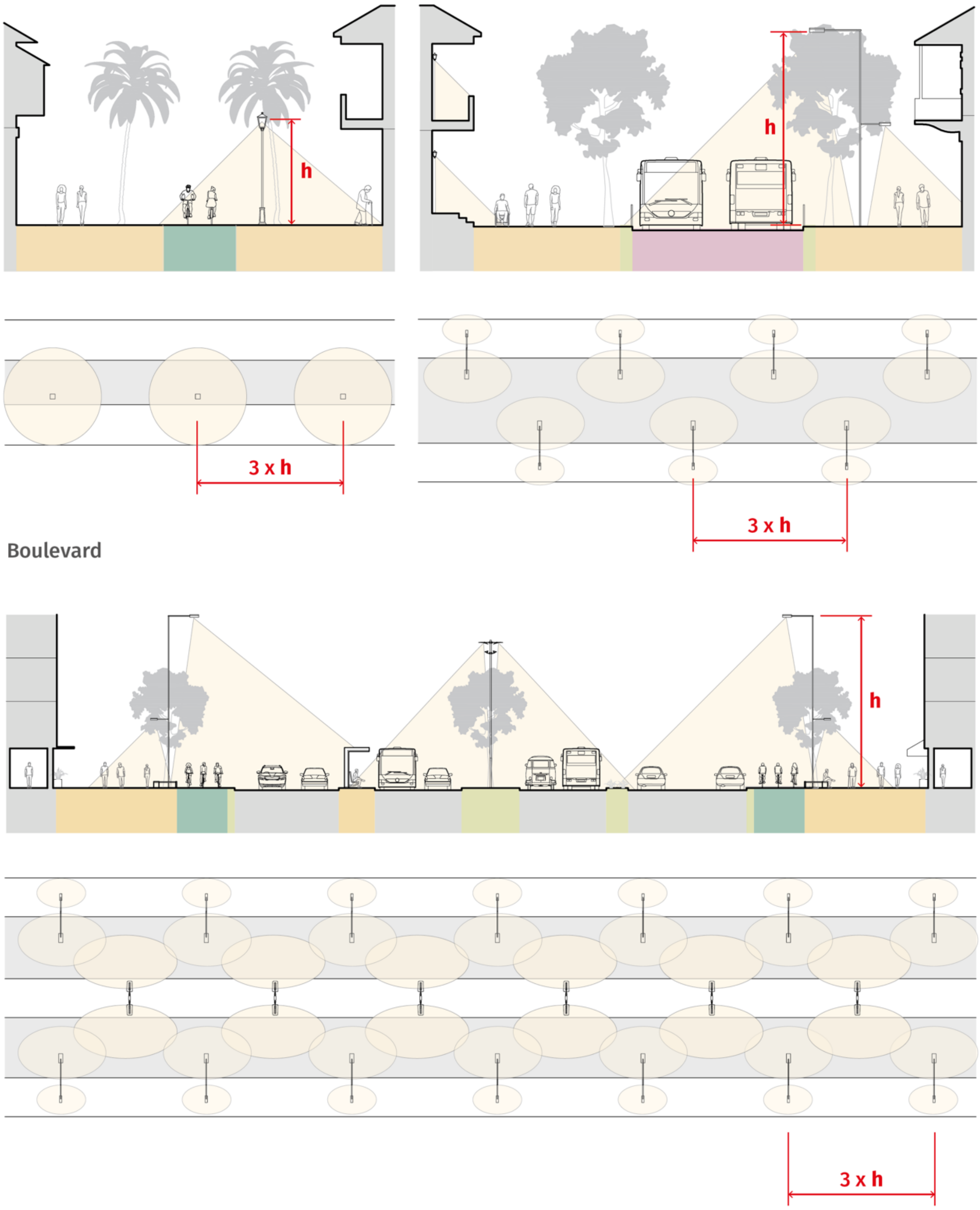


Figure 38. Streetlights typically illuminate an elliptical area. As a rule of thumb, the longitudinal dimension is equivalent to three times the pole height, and horizontal dimension is slightly longer than the pole height.

4.11 STREET FURNITURE

Street furniture provides people with places to sit, rest, and interact. Street furniture also includes service-related infrastructure, such as trash cans, street vending, toilets, and signage. Vending stands, tables, roofs, and water taps can support the formalisation of street vending and promote improved sanitary conditions. Additionally, other types of street furniture, such as wayfinding signs and bus stops, provide information to the public.

DESIGN STANDARDS

- Furniture and amenities should be located in areas where they are likely to be used. Larger quantities of furniture are needed in commercial hubs, market areas, crossroads, bus stops, BRT stations, and public buildings.
- Most street furniture, particularly benches and tables, should be placed in areas where it receives shade.
- Furniture should be situated where it does not obstruct pedestrian movement.
- On streets with high pedestrian traffic and significant commercial activity, especially near eateries, trash bins should be provided at regular intervals, approximately every 20 m.
- Traffic signs should be located at a height of at least 2.2 m from the ground to the bottom of the sign plate.

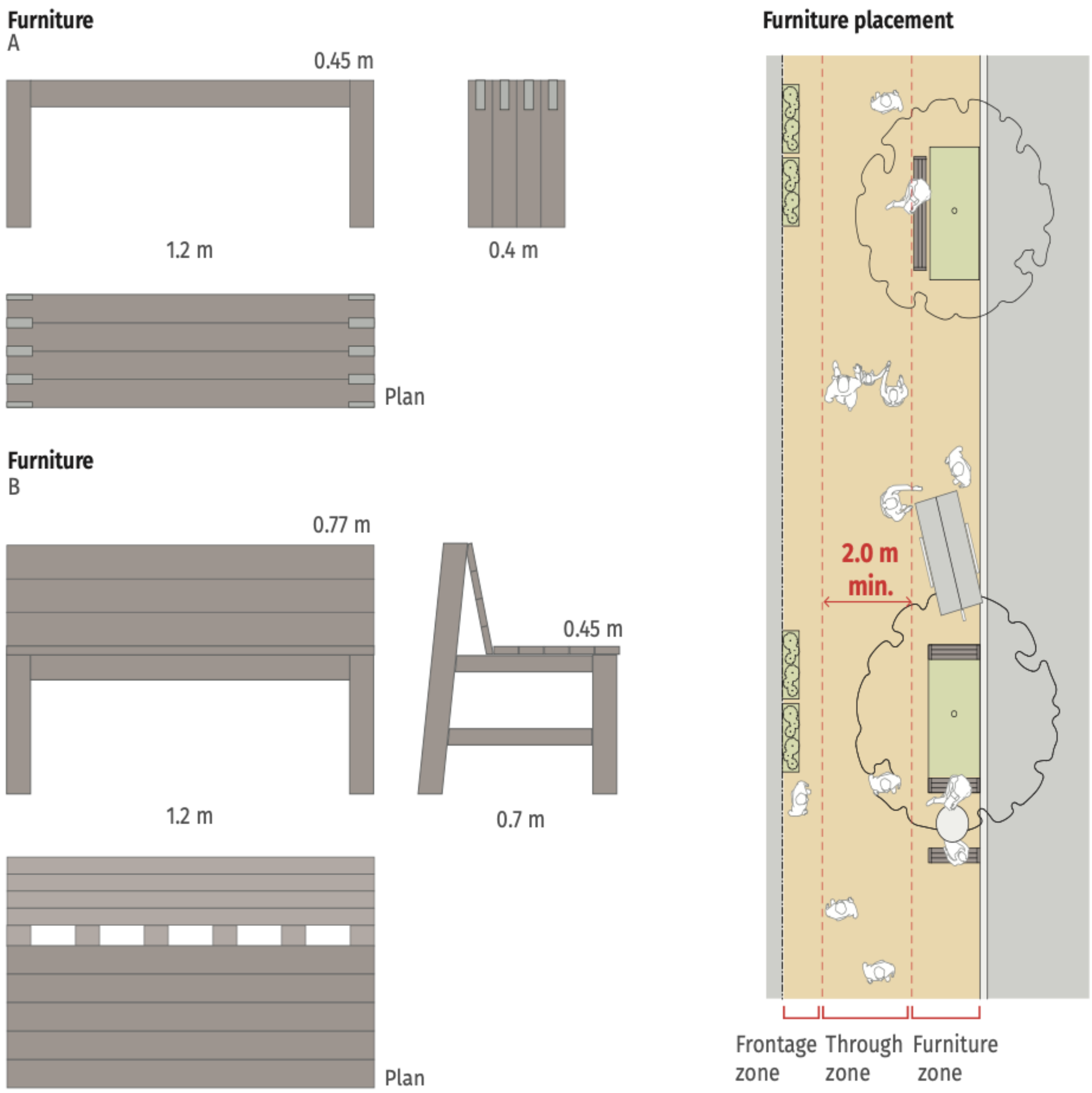


Figure 39. Furniture design and placement.

4.12 PUBLIC TOILETS

Public toilets contribute to the betterment of the urban environment and improve public health. The location of public toilets shall be determined in local development plans, urban design (access control, plans, street designs or block designs; and implemented in the construction and furnishing phase of streets. They could also be installed as part of street improvements. Public toilets could be run and managed through micro-scale enterprises to create employment opportunities. Potential funding sources include donations, sponsorships, and advertisements.

DESIGN STANDARDS

- The lowest point in the cross section should occur on the carriageway. Cycle tracks, footpaths, bus stops, and street vending areas should be at a higher level.
- 1:50 camber for footpaths and cycle tracks.
- Drain surfaces should be at grade with the surrounding street surface unless provided in landscaped areas. Drain access points should be surfaced appropriately to avoid interrupting pedestrian and bicycle movement. Drain cover slats should be perpendicular to the direction of travel to avoid catching bicycle wheels.
- Catch pits should be located at regular intervals, depending on their size and the catchment area, and at the lowest point of the street cross section. Gratings should be designed so that they do not catch cycle wheels.
- Drainage channels should be provided underground to maximise the area available for NMT.
- More environmentally benign approaches such as landscaped swales improve groundwater recharge, reduce stormwater run-off, and improve the overall liveability of a street.

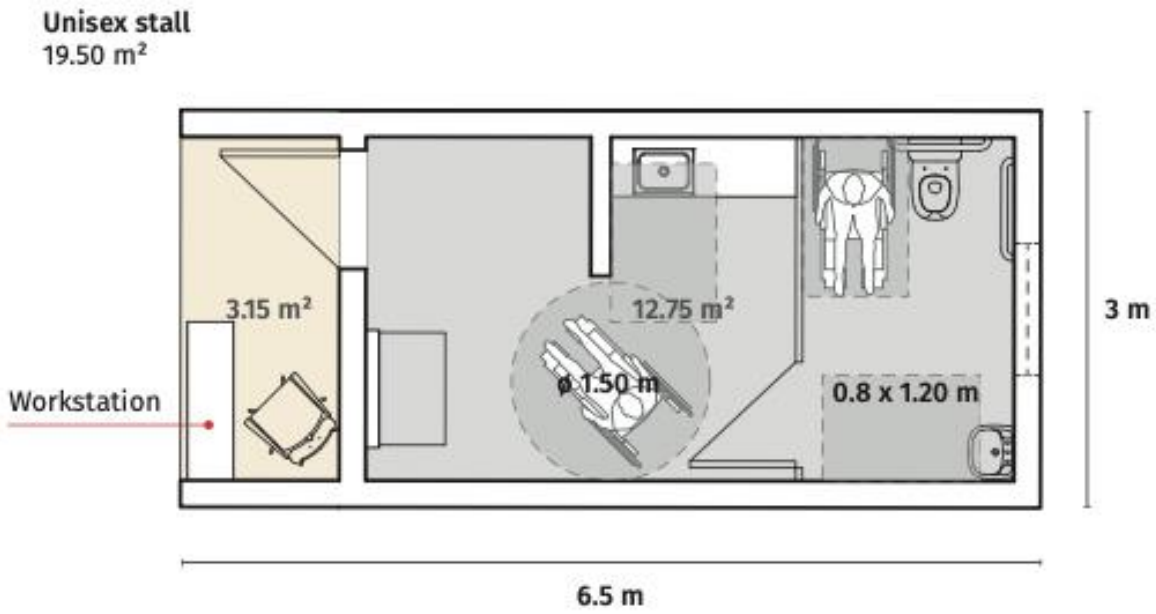


Figure 40. Public toilets: unisex stall with universal access.

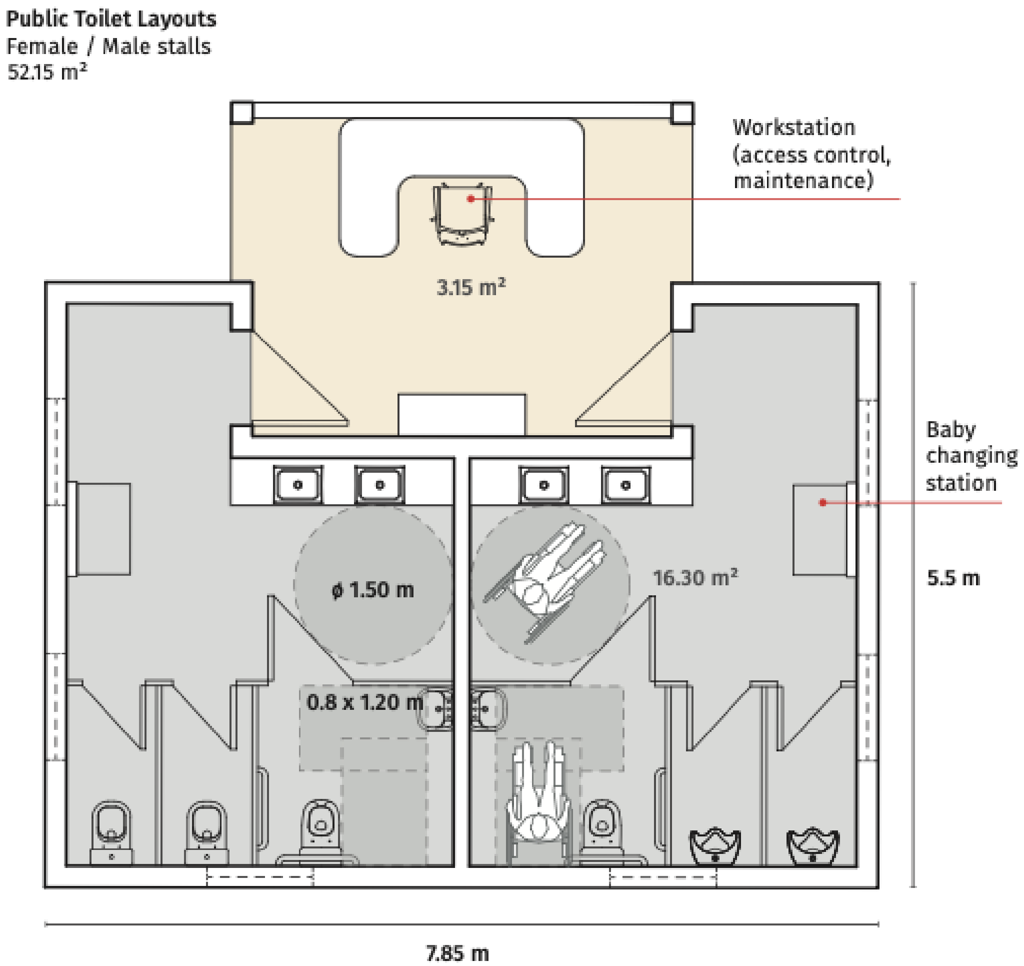


Figure 41. Public toilets: male and female stalls with universal access.

4.13 STORM WATER

Adequate and efficient storm water drainage prevents water logging and erosion. Storm water should be carried through closed drains to free up road space for pedestrian and cycle facilities. Water channels should be covered to ensure the safety of street users.

DESIGN STANDARDS

- The lowest point in the cross section should occur on the carriageway. Cycle tracks, footpaths, bus stops, and street vending areas should be at a higher level.
- 1:50 camber for footpaths and cycle tracks.
- Drain surfaces should be at grade with the surrounding street surface unless provided in landscaped areas. Drain access points should be surfaced appropriately to avoid interrupting pedestrian and bicycle movement. Drain cover slats should be perpendicular to the direction of travel to avoid catching bicycle wheels.
- Catch pits should be located at regular intervals, depending on their size and the catchment area, and at the lowest point of the street cross section. Gratings should be designed so that they do not catch cycle wheels.
- Drainage channels should be provided underground to maximise the area available for NMT.
- More environmentally benign approaches such as landscaped swales improve groundwater recharge, reduce stormwater run-off, and improve the overall liveability of a street.

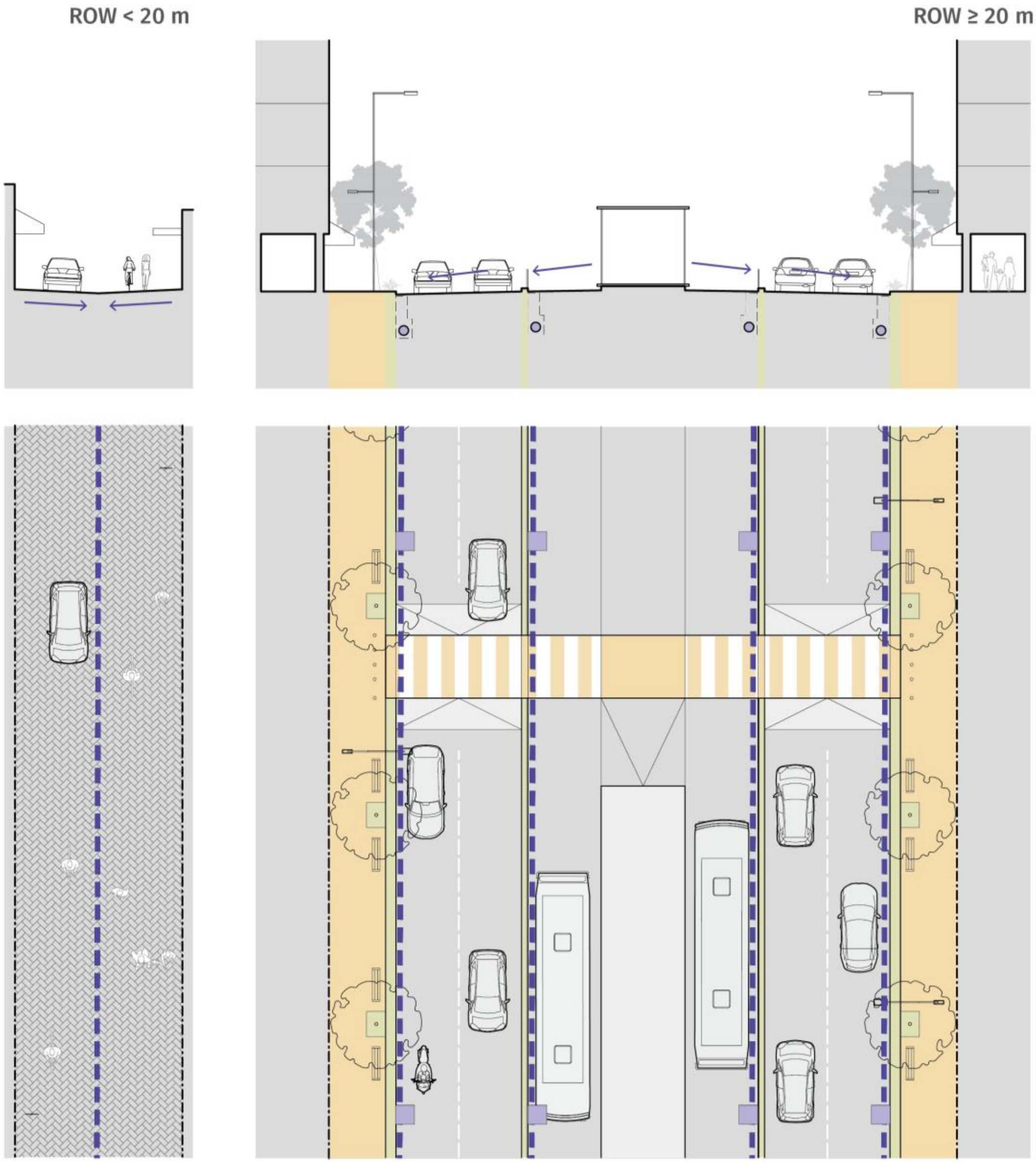


Figure 42. Storm water drainage arrangements allow for storm water to drain off footpaths and cycle tracks. Water is collected in the carriageway.

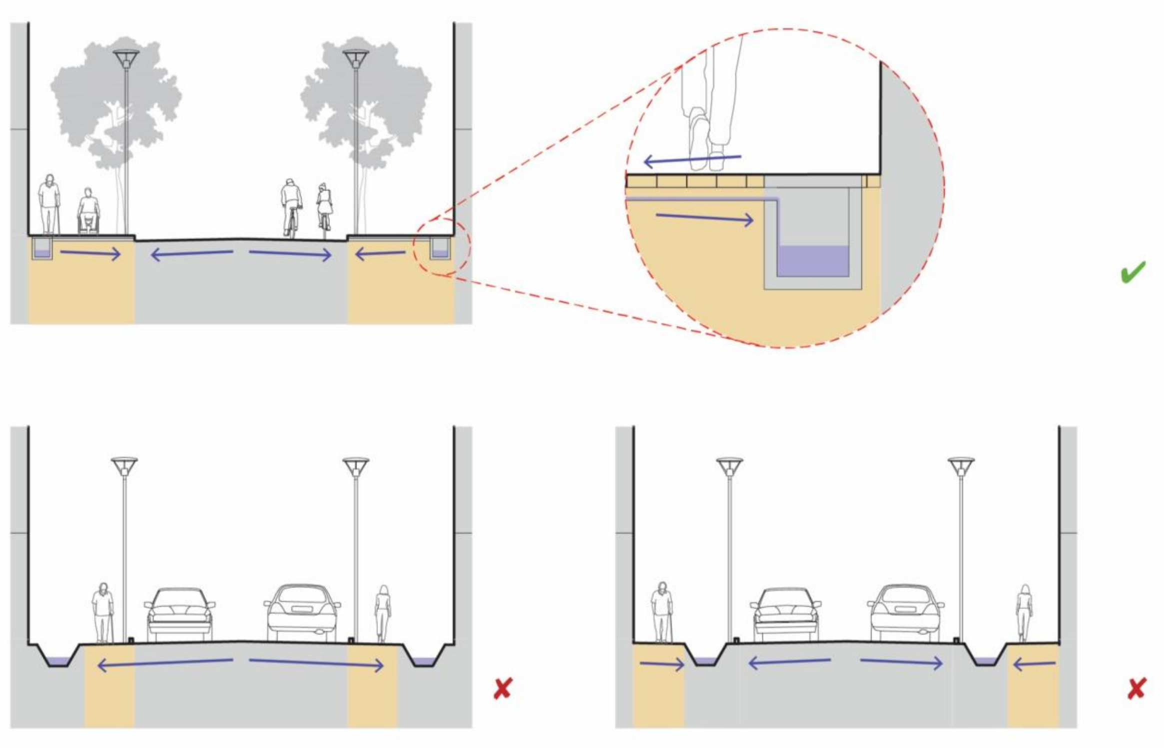


Figure 43. Raise footpaths above the level of the carriageway to prevent waterlogging. Place drains on the outer edge of the footpath to make space for a tree line between the footpath and the carriageway. Drain covers increase the footpath width.

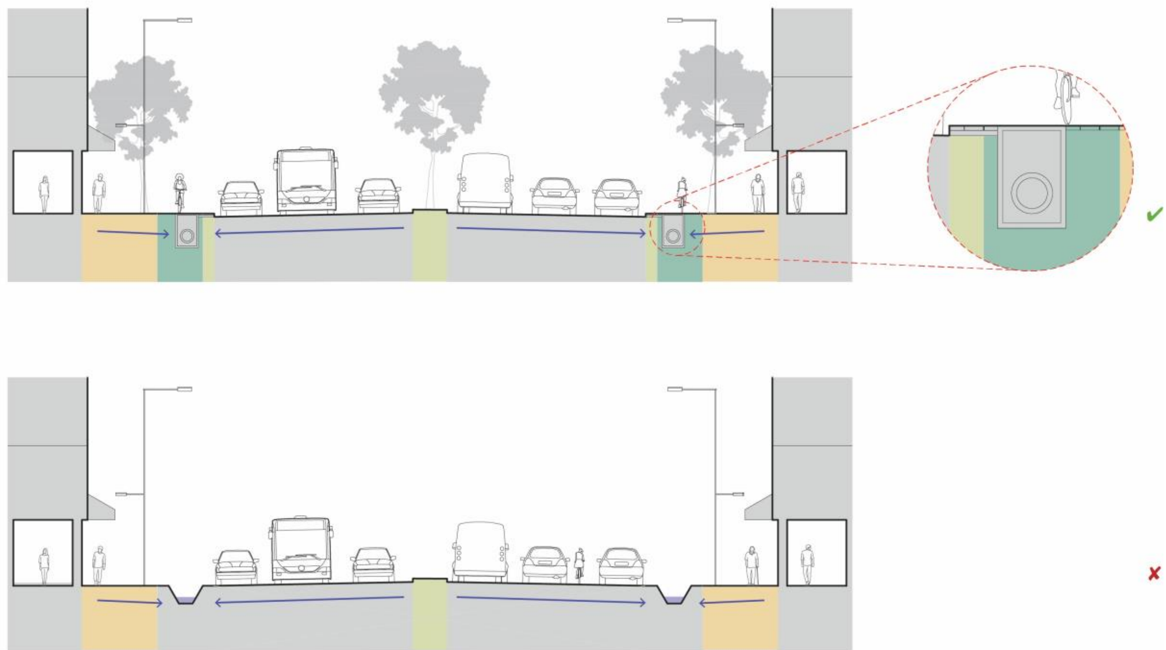


Figure 44. On collector and arterial streets , stormwater should be carried underground to free up space for cycle tracks, wider footpaths, trees, and street furniture.

4.14 SERVICE LANES

Service lanes improve safety and throughput by segregating property access points and parking from the main carriageway. Service lanes can increase the mobility function of the main carriageway while also maintaining liveability for non-motorised road users. They also reduce interruptions in cycle tracks, and with reduced speeds because of traffic calming, service lanes can function as slow shared spaces. Service lanes that are too wide encourage fast driving. In addition, wide service lanes invite encroachment by shops, parked vehicles, or street vendors. Therefore, moderate service lane widths are needed to ensure safe user behaviour.

DESIGN STANDARDS

- A service lane should be between 3 and 3.5 m wide for a single lane and 5.5-6.0 m for two lanes.
- Service lanes should contain traffic calming elements to maintain safe driving speeds.
- A service lane need not be continuous, lest it become an alternative to the main road.

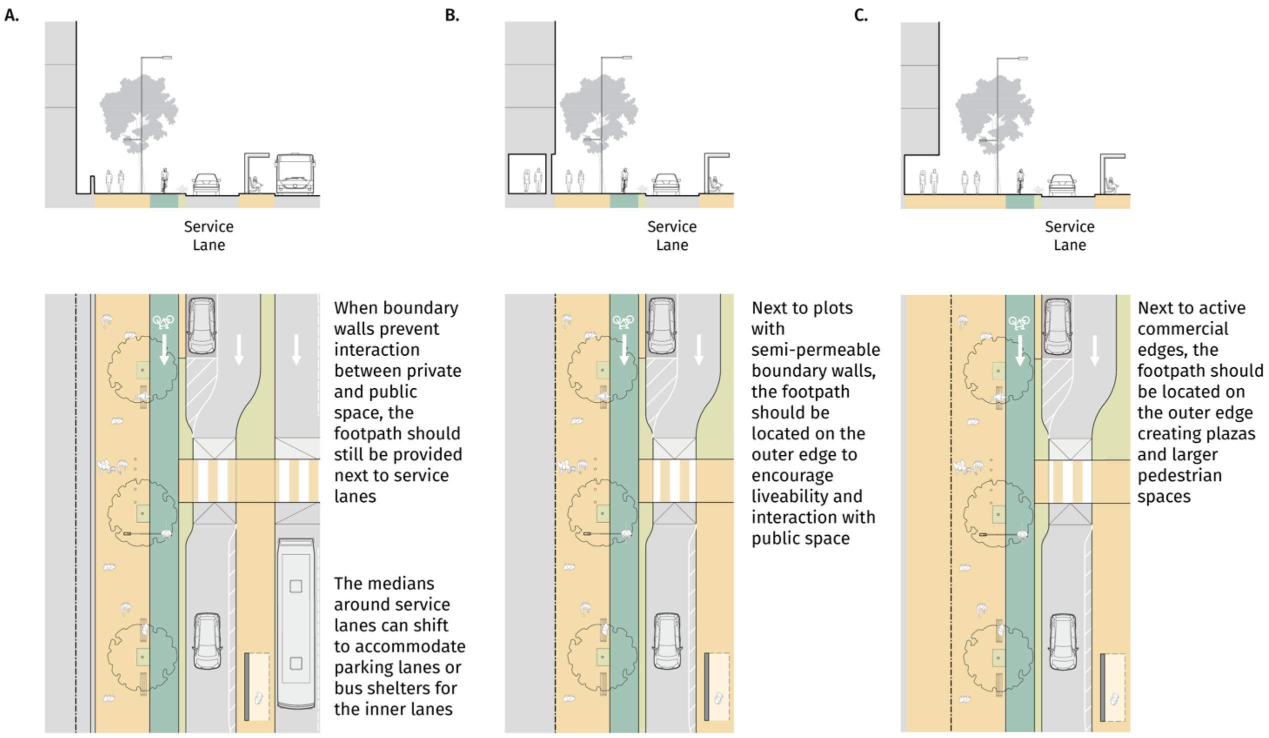


Figure 45. Intersection with service lanes.

4.15 ON STREET PARKING

In general, valuable street space should be used for wider walkways, trees, cycle tracks, cycle parking, vending, and social gathering space rather than parking. On-street parking may be allowed on streets where all the other requirements for public transport and NMT have been met. Bike parking racks should be provided on each block in commercial areas. Some parking spaces can be designated for moto parking.

DESIGN STANDARDS

- Parking areas should be allotted after providing ample space for pedestrians, cyclists, trees, and street vending.
- Parking bay width of 2.0 m width for taxi stands and 2.2 m in commercial areas.
- Tree pits can be integrated in a parking stretch to provide shade. Otherwise, shaded street elements, such as footpaths, may be encroached by parked vehicles.
- Within 10 m of intersections, parking lanes should be discontinued to reduce conflict and to give additional vehicle queueing space.
- Dedicated cycle parking should be provided at regular intervals in commercial districts. The rack should support the frame and should allow the cyclist to secure one wheel and the frame with a U-lock. The rack should be placed in the furniture zone of the footpath to avoid obstructing pedestrian flow.
- Provide designated parking spaces for boda bodas at established stage locations

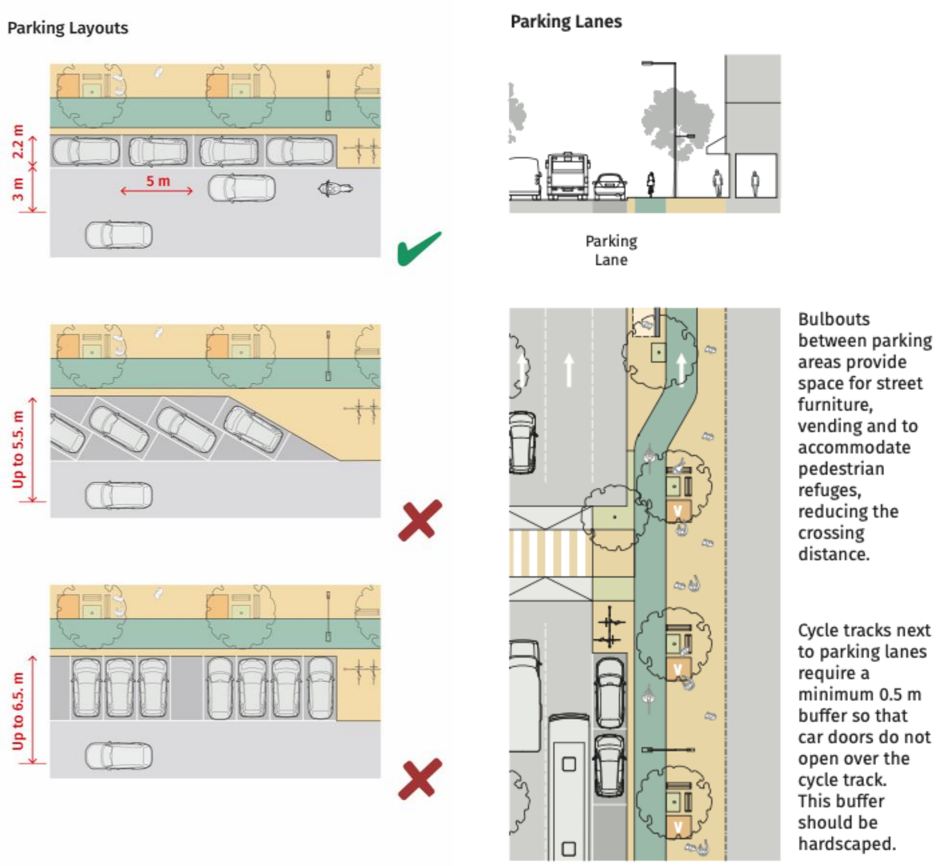


Figure 46. On-street parking layout, (left) and Parallel parking for cars is the most efficient parking layout in terms of the number of vehicles relative to the area occupied. The same parking lane can be used as perpendicular parking for two-wheelers, (right)

4.16 UTILITIES

Streets are the conduits for major services, including electricity, water, sewage, communication, and gas. The physical infrastructure may occur in the form of pipelines, telephone and fibre optic cables, ducts, and poles. Some utilities, such as telecommunications cables, require frequent access for expansion and maintenance. The placement of above- and below-ground utilities at the appropriate location in the right-of-way ensures unconstrained movement as well as easy access for maintenance.

DESIGN STANDARDS

- Underground utilities are ideally placed below the parking area or service lane, if present, which can be dug up easily without causing major inconvenience. Where this is not possible, underground utilities can be placed at the outer edge of the right-of-way.
- Utility boxes should be sited in the furniture zone or in easements just off the right-of-way to reduce conflicts with pedestrian movement. If it is necessary to locate utility access points in the footpath, a clear width of at least 2 m should be

maintained for pedestrian movement. Similarly, utility boxes should never constrain the clear width of a cycle track.

- Though it is possible to accommodate underground utilities even below a tree line, this may lead to the destruction of the trees and a deterioration in liveability if the utilities need to be uncovered.
- To minimise disruptions, utilities should be installed with proper maintenance infrastructure. For example, telecommunication lines should be placed in ducts that can be accessed at frequent service points.

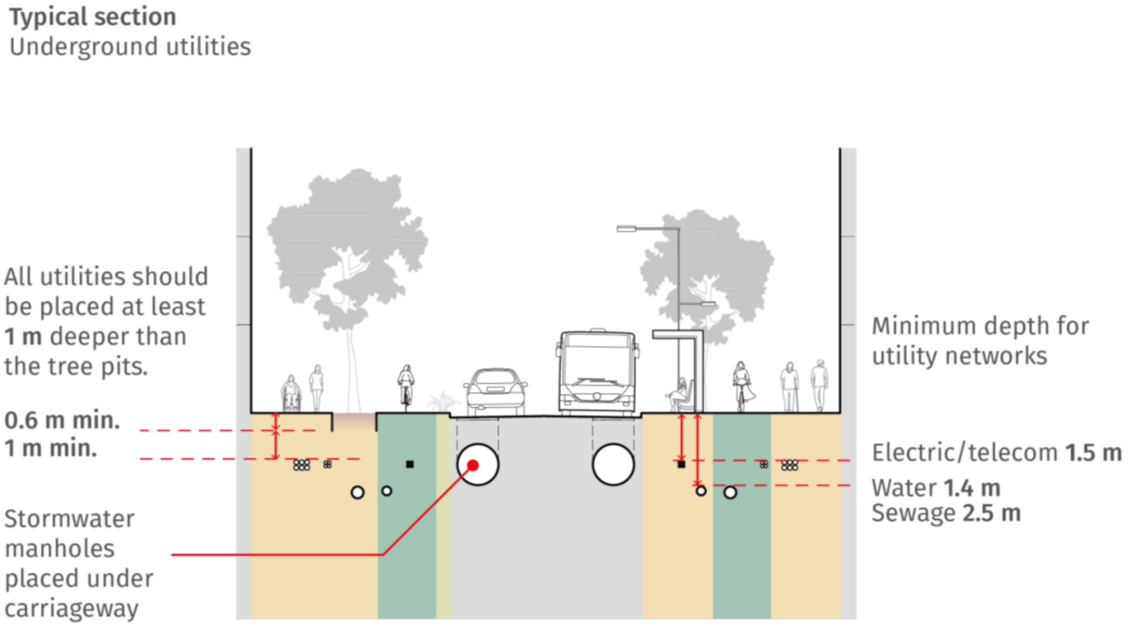
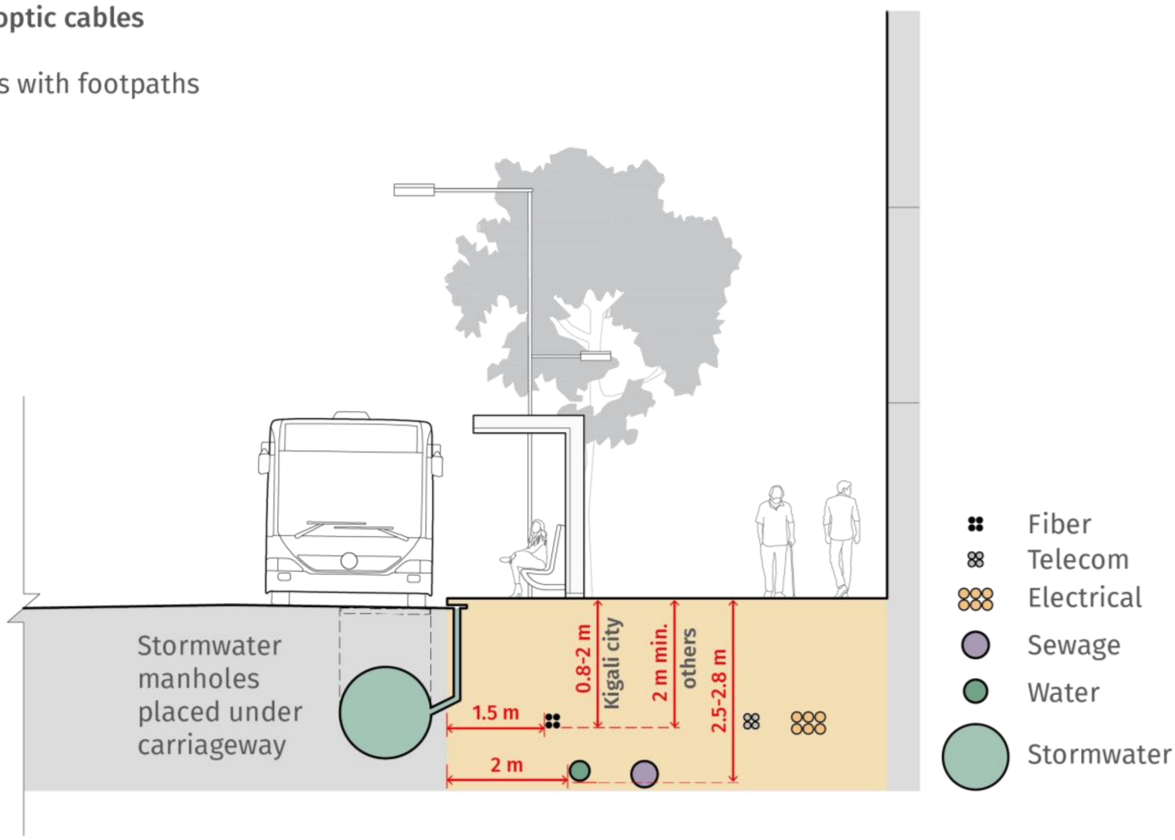


Figure 47. Appropriate placement of underground utilities can improve ease of access and minimise interruptions of the walking and cycling facilities.

Fiber optic cables
Water
Streets with footpaths



Fiber optic cables
Water
Residential/shared streets

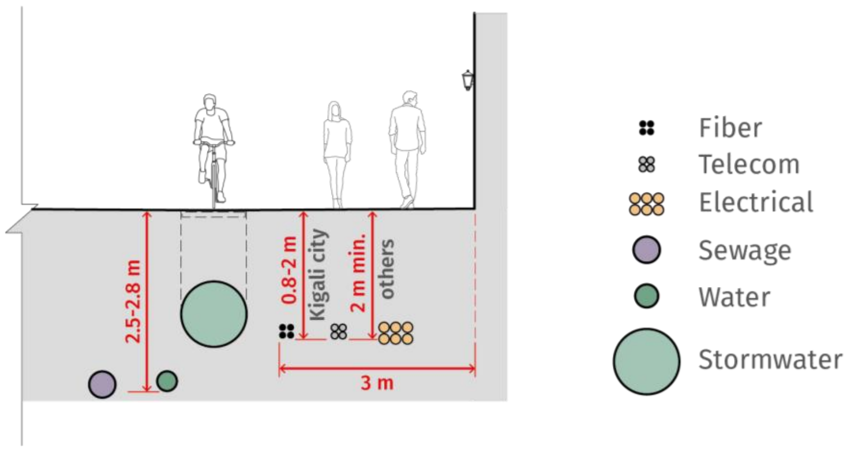


Figure 48. Utilities on a shared street.

Table 9. Underground utility specifications.

Type	*Element*	*Diameter (m)*
Water main	Milled steel/ductile iron pipe	0.15-0.3
Electricity: Low-tension	HDPE DWC	0.15-0.3
Electricity: High-tension	RCC	0.3-0.45
Street lighting	HDPE	0.1-0.3
Sewage: Trunk	RCC hume pipe	0.3-0.45
Sewage: Rider	RCC hume pipe	0.5-1.0
Telecom: Copper cables	HDPE	0.1-0.3
Telecom: Optic fibre	HDPE	0.1-0.3
Storm water main	RCC	0.5-1.2
Type of utilities	Elements	Diameter
Water main	Milled steel/ductile iron pipe	0.15-0.3

4.17 TRAFFIC CALMING

Well-designed traffic calming improves safety by reducing the speed and potentially also the volume of motor vehicles. Traffic calming elements are particularly important in places where large numbers of children are present, such as schools, parks, and residential areas. Some traffic calming elements, such as speed humps and speed tables, are easy to implement, and can be deployed quickly as a solution to road safety challenges.

Traffic calming slows down vehicles through one of the following mechanisms: vertical displacement, horizontal displacement, real or perceived narrowing of the carriageway, material/colour changes that signal conflict points, or the complete closure of a street. Traffic calming can take different forms depending on the context and is most effective where two or more mechanisms are combined. Typical forms of traffic calming include speed humps and raised pedestrian crossings, both of which rely on vertical displacement to reduce speeds.

DESIGN STANDARDS

- Traffic calming can take different forms depending on the context and is most effective where two or more mechanisms are combined. Traffic calming can be applied near intersections or every 80-120 m in stretches where speeds need to be controlled, such as school zones (streets within 100 m of schools), residential areas, or locations with high foot traffic.
- Vertical-deflection devices include raised crossings, speed humps, and raised intersections.
- Speed humps should follow a sinusoidal shape to improve comfort for cyclists.

- Raised pedestrian crossings should match the level of the adjacent footpath—typically 150 mm. A flat top design is preferred, with allowances for drainage at the kerb. The critical dimension is the ramp slope:
    - 1:6 yields 10 km/h
    - 1:8 yields 15 km/h
    - 1:10 yields 20 km/h
    - 1:12 yields 25 km/h
    - 1:14 yields 30 km/h
- Rumble strips are uncomfortable for cyclists and should be avoided on urban streets.
- Horizontal-deflection devices include mini-roundabouts, chicanes, and islands.

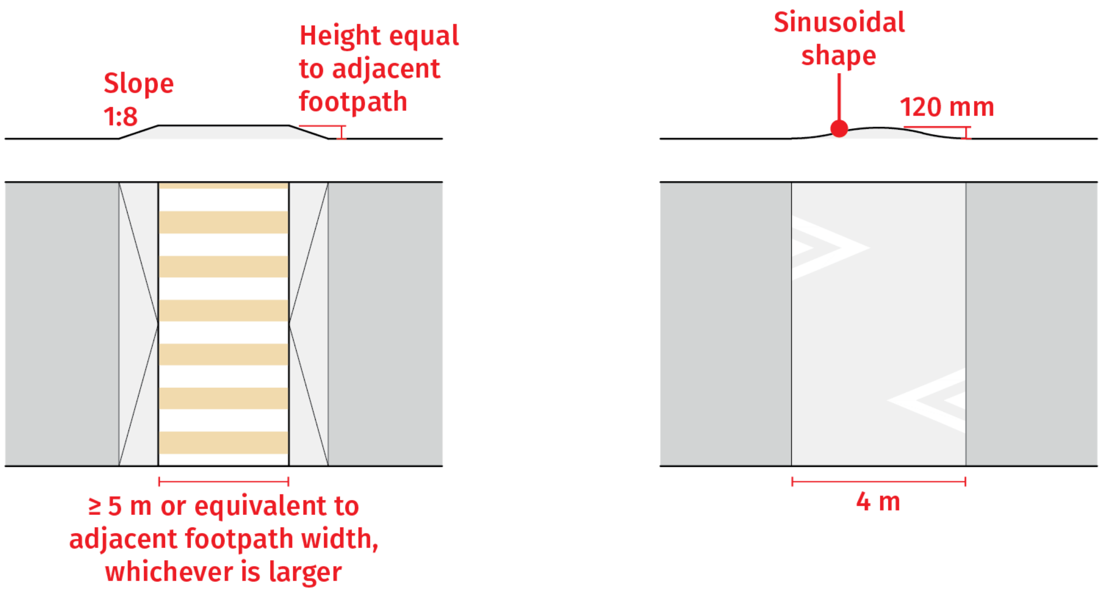


Figure 49. Vertical deflection devices include raised crossings (left) and speed humps (right).

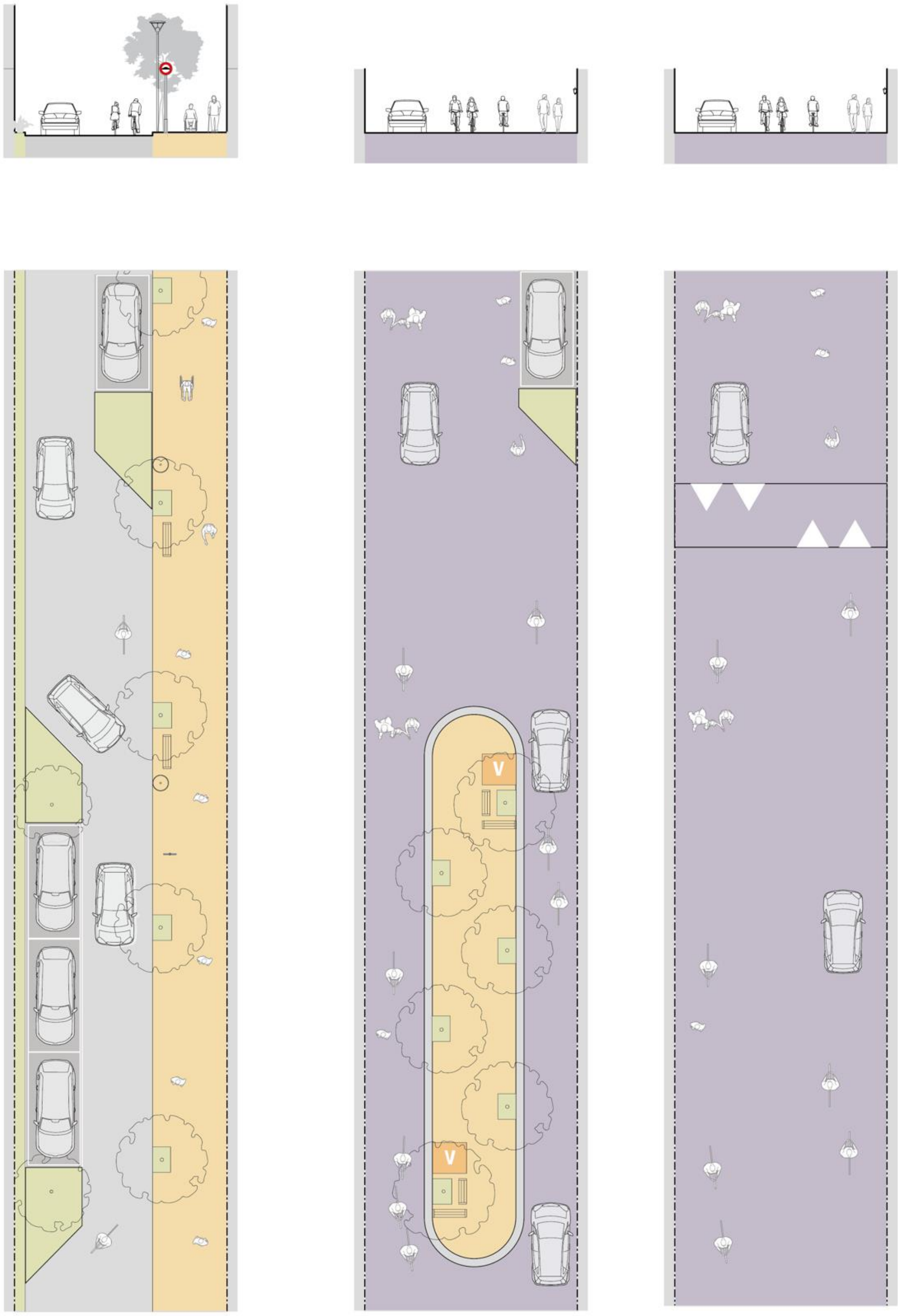


Figure 50. Traffic calming options include horizontal displacement through a meandering carriageway (left) or shared space (middle) and vertical displacement in the form of a speed hump (right).

Figure 51. Raised crossings compel vehicles to reduce their speeds, thereby increasing pedestrian safety.

4.18 GREENWAYS

Greenways are multipurpose urban transport corridors for cyclists and pedestrians, often located alongside rivers, waterbodies, or wetlands. They offer continuous, safe, unobstructed, and universally accessible facilities for non-motorised traffic, complementing the street network. They also serve as beautiful and vibrant public spaces. Waterways can be cleaned through interception sewers.

DESIGN STANDARDS

- Connectivity to existing pedestrian networks, cycle networks, and open spaces.
- Exclusive access for pedestrians and cyclists. Bollards to prevent encroachment by vehicles.
- Effective width of at least 3.0 m to serve as a shared space for pedestrians and cyclists. Increase effective width to 4.0 m where there are more than 25 people walking or 250 people cycling (both directions, per hour). Provide separate paths for each mode where there are more than 50 people walking or 500 people cycling (both directions, per hour).
- Tabletop crossings where the greenway crosses the street network.

- Organised spaces for street vending.

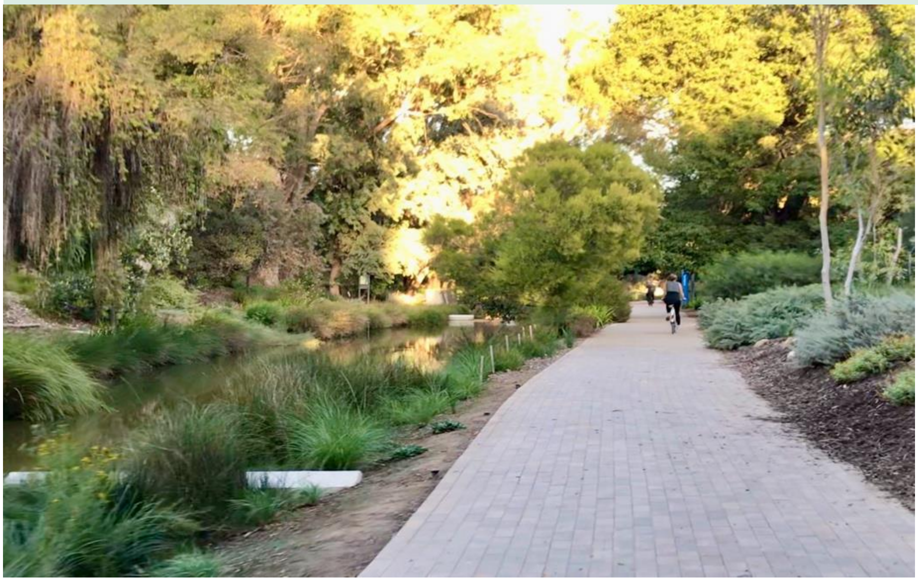


Figure 52. Greenways can transform open spaces along clean waterways, creating beautiful public spaces with high-quality pedestrian and cycling facilities.

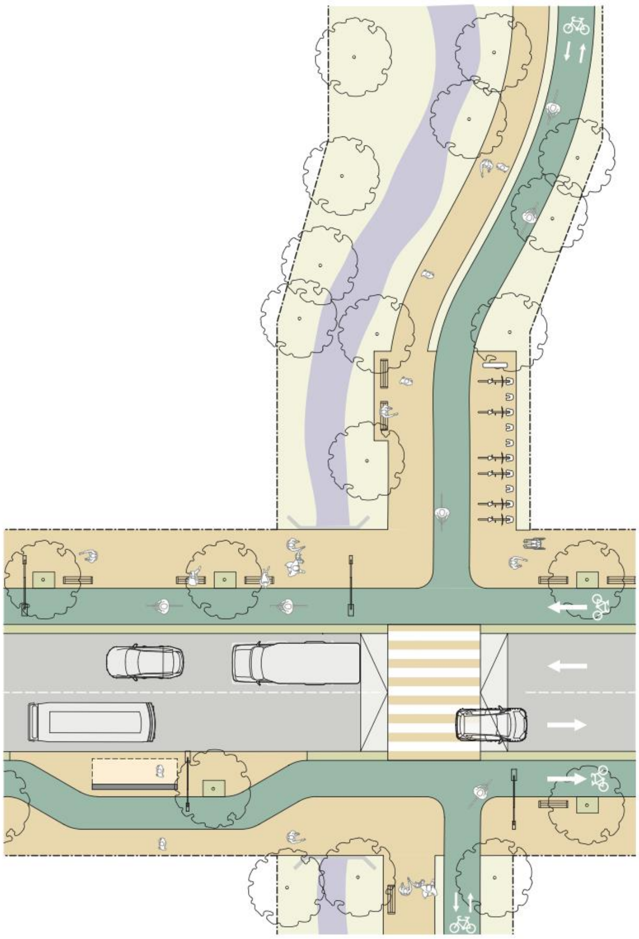


Figure 53. Possible greenway configuration offering space for cyclist and pedestrians. At the interface with the street network, a wide, traffic calmed crossing ensures safe passage for greenway users.

4.19 INFORMAL SETTLEMENT

Informal settlements, while vibrant and densely populated, often lack adequate infrastructure and urban services, contributing to poor living conditions for their residents. Improving mobility infrastructure within these areas is a critical step towards enhancing access to opportunities, services, and public amenities. Streets in informal neighbourhoods serve not only as transportation corridors but also as communal spaces that support social, economic, and cultural life. Therefore, well-designed and inclusive street interventions can significantly improve the quality of life, resilience, and dignity of residents.

Upgrading streets in informal settlements will enhance physical access for residents and service providers, particularly in terms of public spaces, mobility, sanitation, and emergency services. Improving walkability and road conditions enables safer and more equitable movement, especially for vulnerable groups such as women, children, the elderly, and persons with disabilities. The design of these streets should incorporate climate-resilient approaches, including proper drainage systems and erosion control, to reduce the vulnerability of these neighbourhoods to flooding and other environmental risks. Infrastructure should ensure all-season accessibility for residents, economic operators, and emergency response vehicles.

In many informal settlements in Kigali, street widths commonly range from 2 to 4 metres, as seen in Kagugu and Rwezamenyo. These narrow streets do not provide sufficient space for pedestrian and vehicular mobility, primarily serving for walking and cycling within the neighbourhoods. In such cases, the concept of single-direction vehicle access within a shared-space layout is encouraged, where feasible, to facilitate local mobility. Traffic calming measures and reduced speed limits should be prioritised to enhance safety. Pedestrian priority should be central to the design approach, ensuring safe, continuous, and universally accessible pathways, particularly for individuals with disabilities or limited mobility.

Drainage and stormwater management should also be considered essential components of resilient street design in these settings. Upgraded streets should include the construction or rehabilitation of drainage systems to minimise the impact of heavy rainfall and prevent flooding. Integrating green infrastructure, such as permeable surfaces or vegetation where feasible, can further contribute to climate adaptation while improving the overall street environment.

5. STREET TEMPLATES

This chapter presents a collection of street templates that demonstrate how the elements discussed in the previous chapter can be combined to create streets with varying levels of liveability and mobility. These templates align with the street classification outlined in the Kigali Master plan 2050 (Transport Plan) (2020). Each template includes a ground plan and section at a scale of 1:500. In cases where the cross section of a street varies, such as having two variations of BRT layout, they are labelled as 'A' and 'B'. Additionally, to accommodate different urban contexts as cities urbanize, the streets are identified as part of either a brownfield (BF) or greenfield (GF) area. Brownfield (BF) areas are sections within an already established urban environment that have undergone prior development or significant industrial and commercial activity. Greenfield (GF) areas, on the other hand, refer to undeveloped or minimally developed regions typically found on the outskirts of a city.

The templates are then shown in order of increasing street width 2 ,3, 4, 8, 10, 12.5, 15, 15, 15.5, 18, 21, 21.6, 26, 26.6, 27, 27.6, 29.4, 37, 37.5, 53.4, 58. Each template can be adjusted for a slightly wider right-of-way by increasing the width of any element except the carriageway and parking lanes.

Table 10. Guide to the templates.

Street type	*Template*		*Shared space*	*Footpath*	*Cycle Track*	*Dual carriage way*	*BRT*
	Brownfield (m)	Greenfield (m)					
Local Street (BF): Informal Settlement Area	2			√			
Local Street (BF): Informal Settlement Area	3		√				
Local Street (BF): Informal Settlement Area	4		√				
Local Road (BF): Green field	4			√			
Local Road (BF): Brown field	8A			√		√	

Residential Street A							
Local Road (GF): Residential Street B		8B	√				
Local Road (GF): Greenway		10		√	√		
Local Road (GF): Residential Street		12.5		√		√	
Collector Road (BF): Urban	15A			√	√	√	
Minor Arterial (BF): Commercial Street	15B			√		√	
Minor Arterial (BF): Main Bus Routes	15C			√		√	
Minor Arterial (BF): Commercial Street	15.5A			√	√	√	
Minor Arterial (BF): Commercial Street	15.5B			√			
Major Arterial (BF): BRT	18A			√			√
Major Arterial (BF): BRT at station	18B			√			√
Collector Road (BF): Rural	21			√	√	√	
Major Arterial (BF): Link Road	21.6			√	√	√	

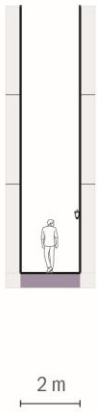
Collector Road (GF): Urban		26		√	√	√	
Minor Arterial (GF): Commercial Street		26.6		√	√	√	
Major Arterial (BF): Trunk Road	27			√	√	√	
Minor Arterial (GF): Main Bus Routes		27.6		√	√	√	
Major Arterial (BF): BRT	29.4A			√		√	√
Major Arterial (BF): BRT at station	29.4B			√		√	√
Collector Road (GF): Rural		37		√	√	√	
Major Arterial (GF): Link Road		37.5		√	√	√	
Major Arterial (GF): BRT		53.4 A		√	√	√	√
Major Arterial (GF): BRT at station		53.4 B		√	√	√	√
Major Arterial (GF): Trunk Road		58		√	√	√	

Local Street - Informal Settlement Area

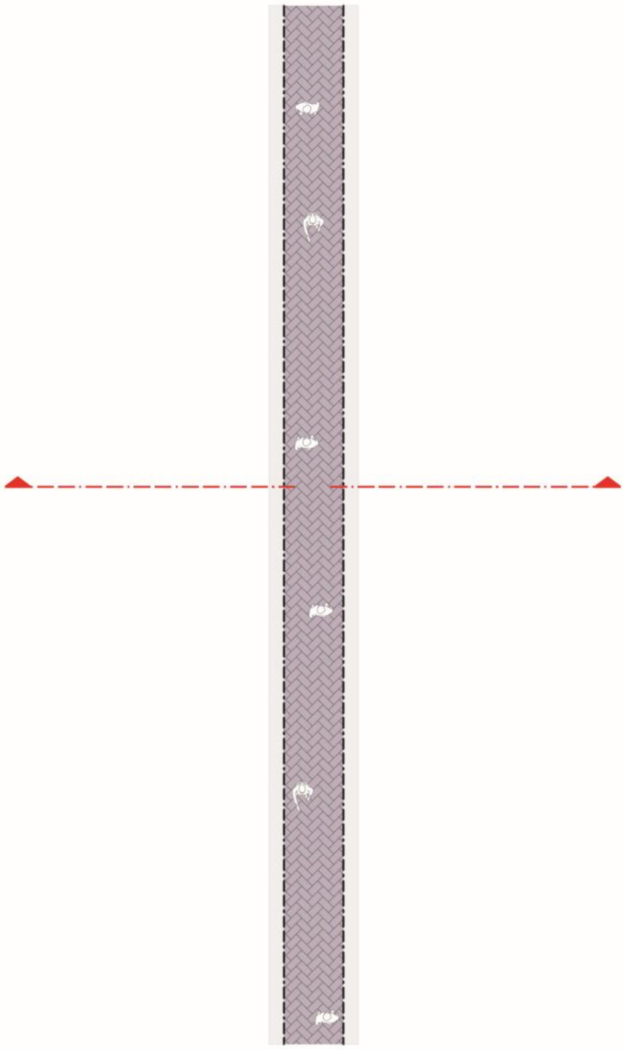
Brownfield (BF)

2 m

Section



Plan



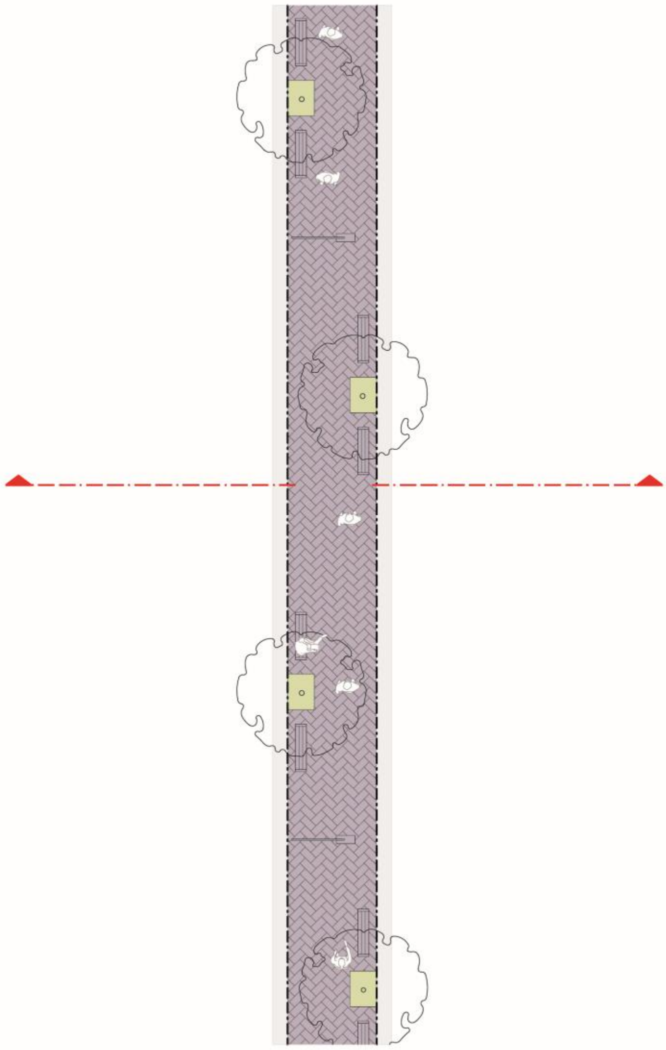
Local Street - Informal Settlement Area

Brownfield (BF)

3 m

Section

Plan



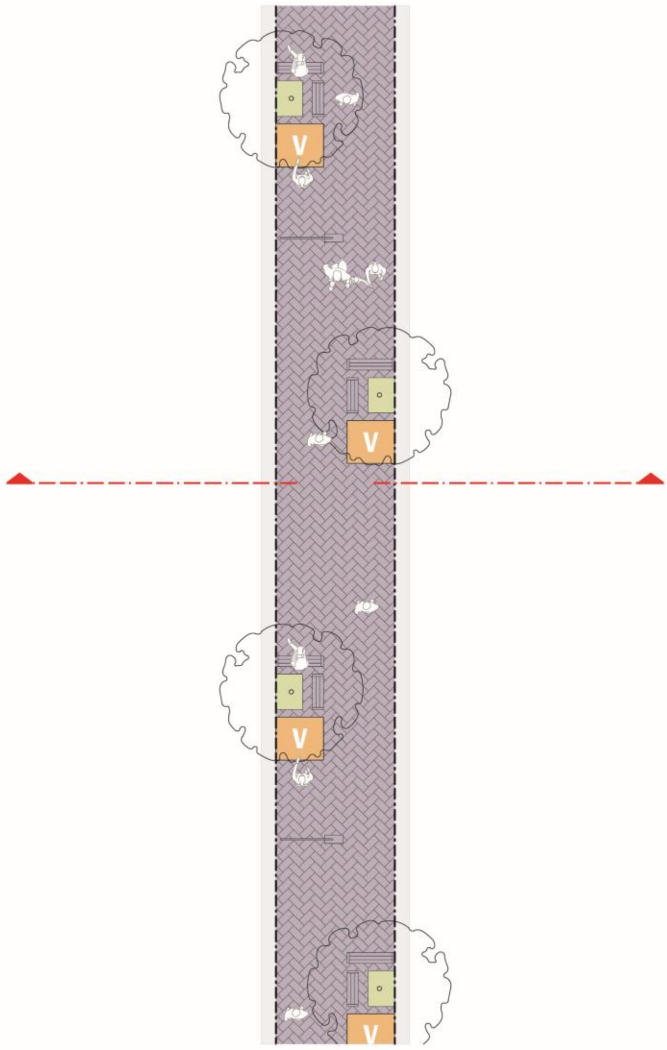
Local Street - Informal Settlement Area

Brownfield (BF)

4 m

Section

Plan

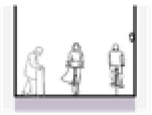


Local Street (BF)

Greenway

4 m

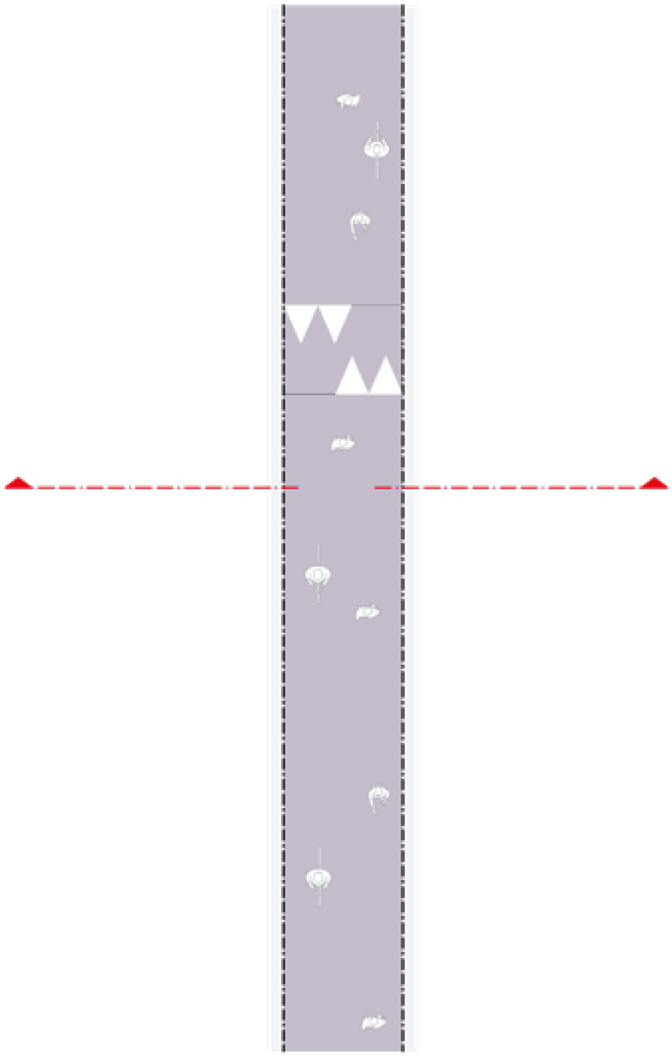
Section



Shared space

4 m

Plan

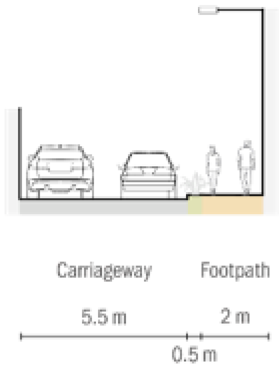


Local Street (BF)

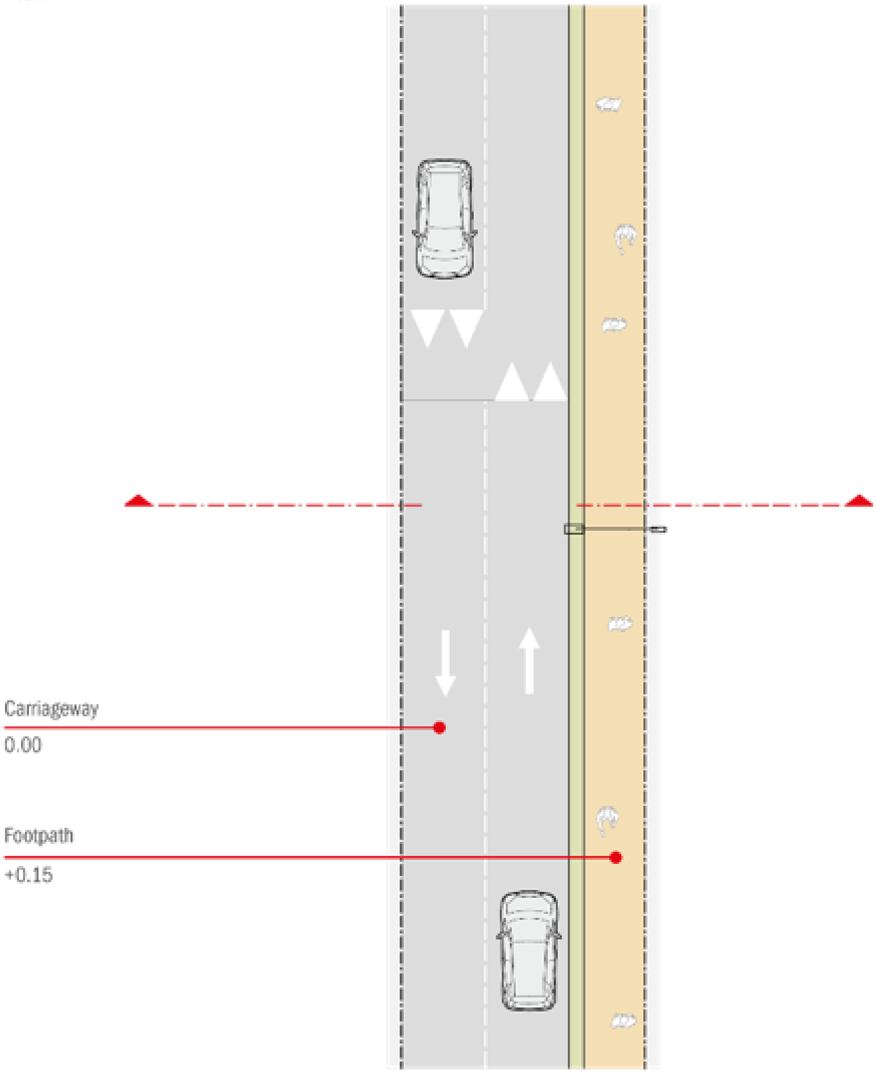
Residential Street A

8 m

Section



Plan

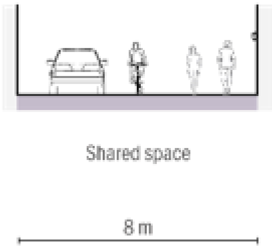


Local Street (BF)

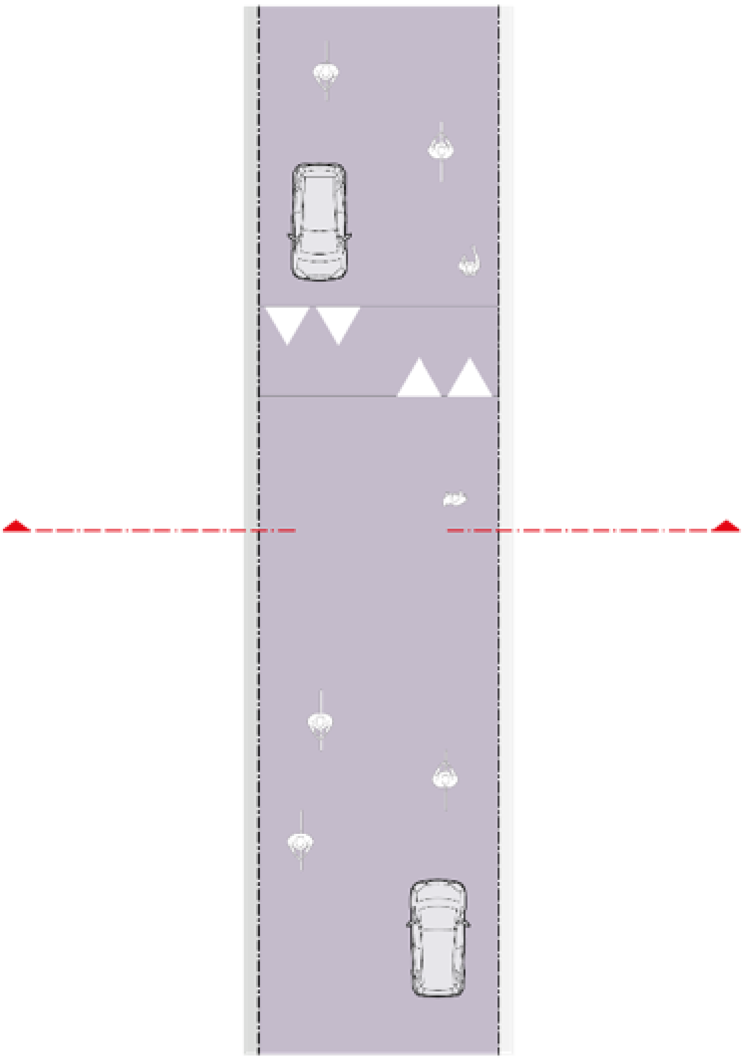
Residential Street B

8 m

Section



Plan

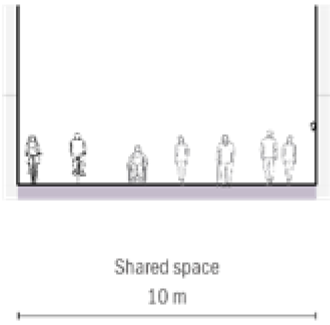


Local Street (BF)

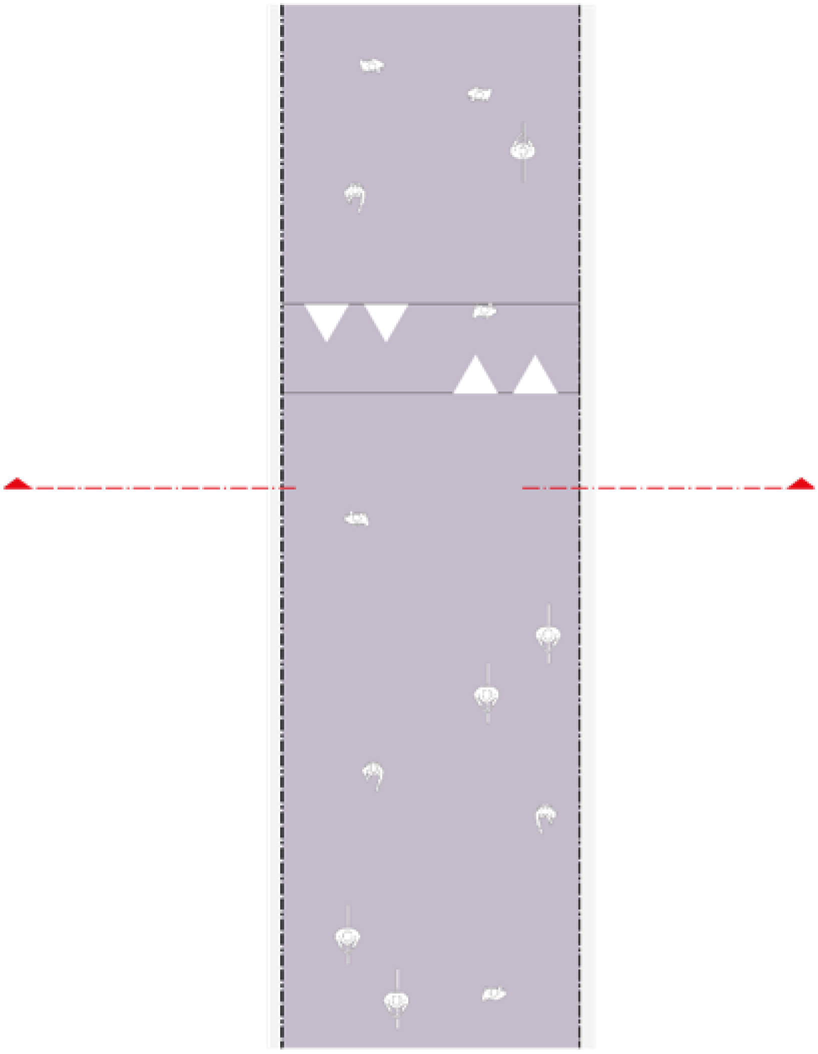
Greenway

10 m

Section



Plan

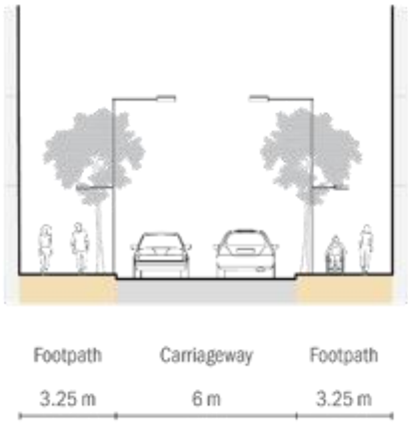


Local Street (GF)

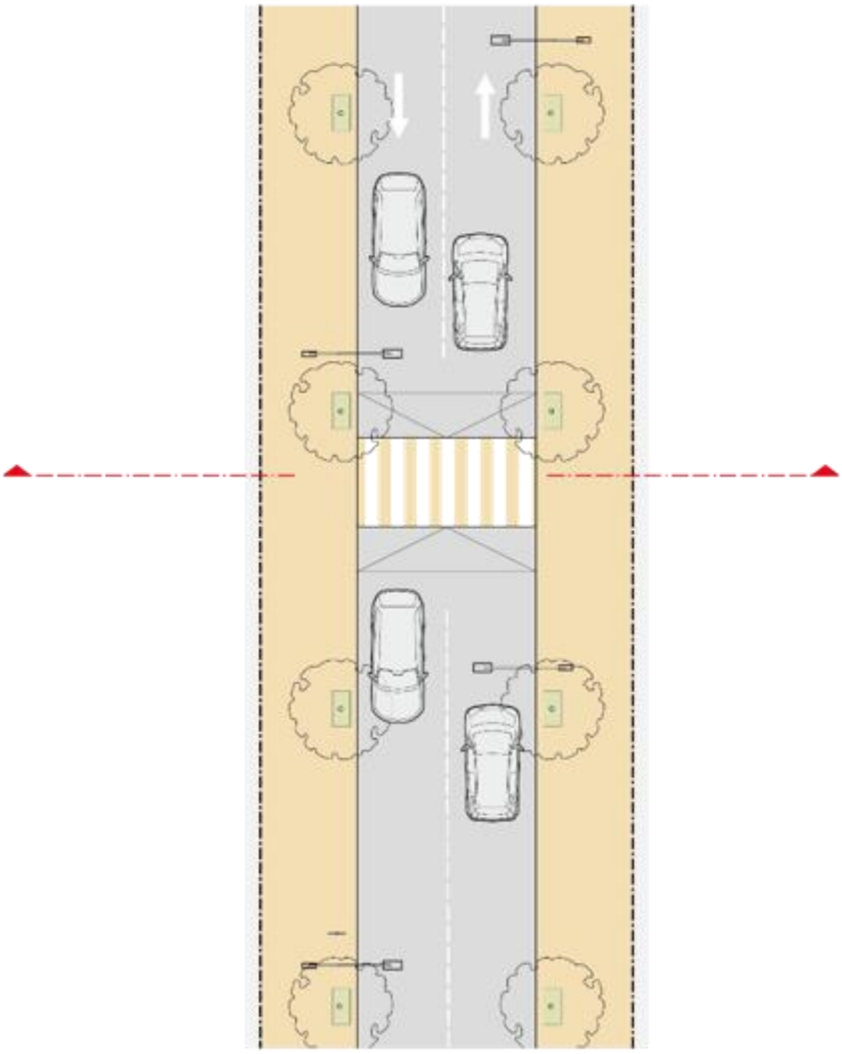
Residential Street

12.5 m

Section



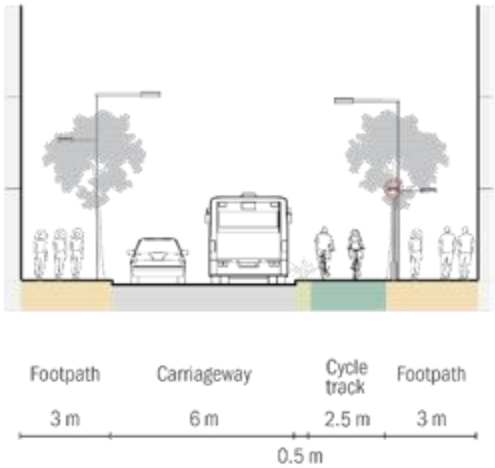
Plan



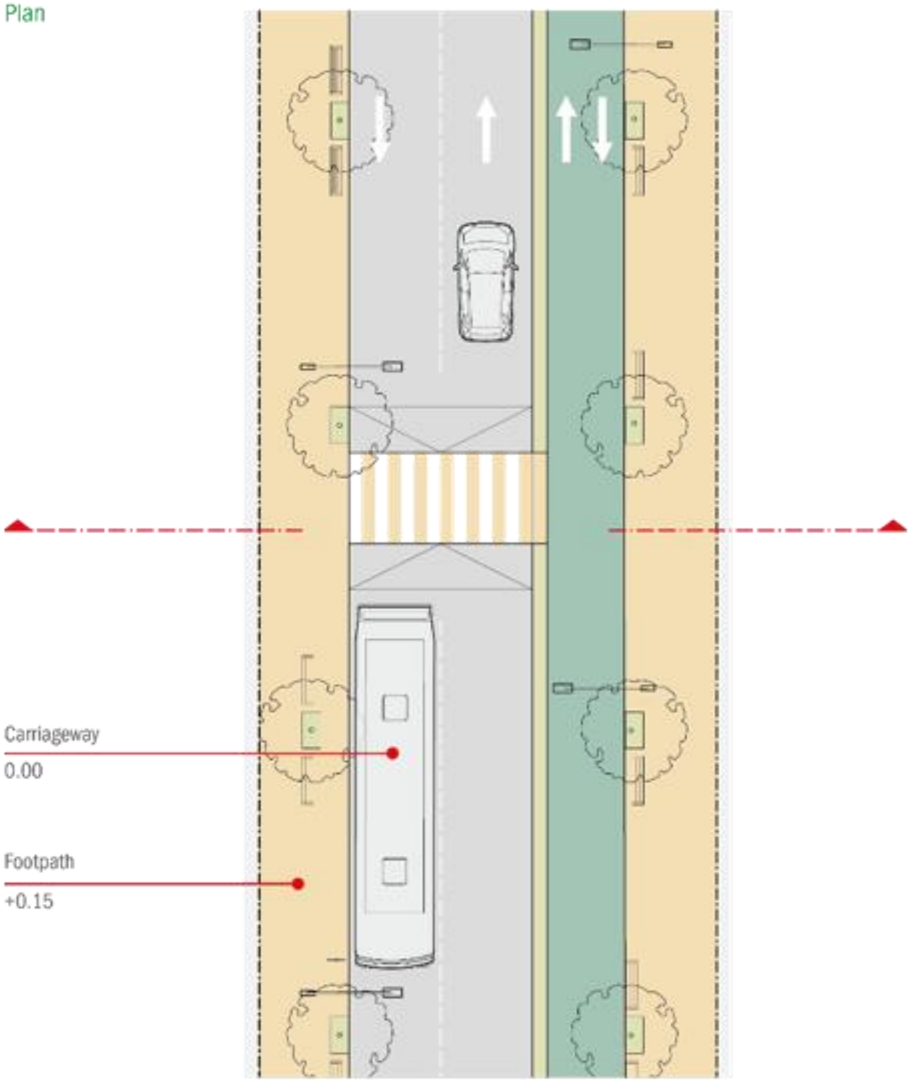
Collector Street (BF)

Urban

15 m



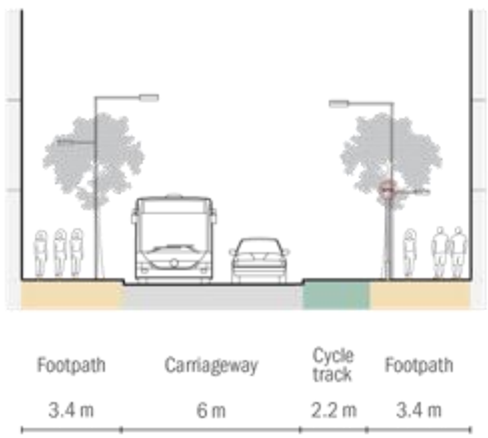
Plan

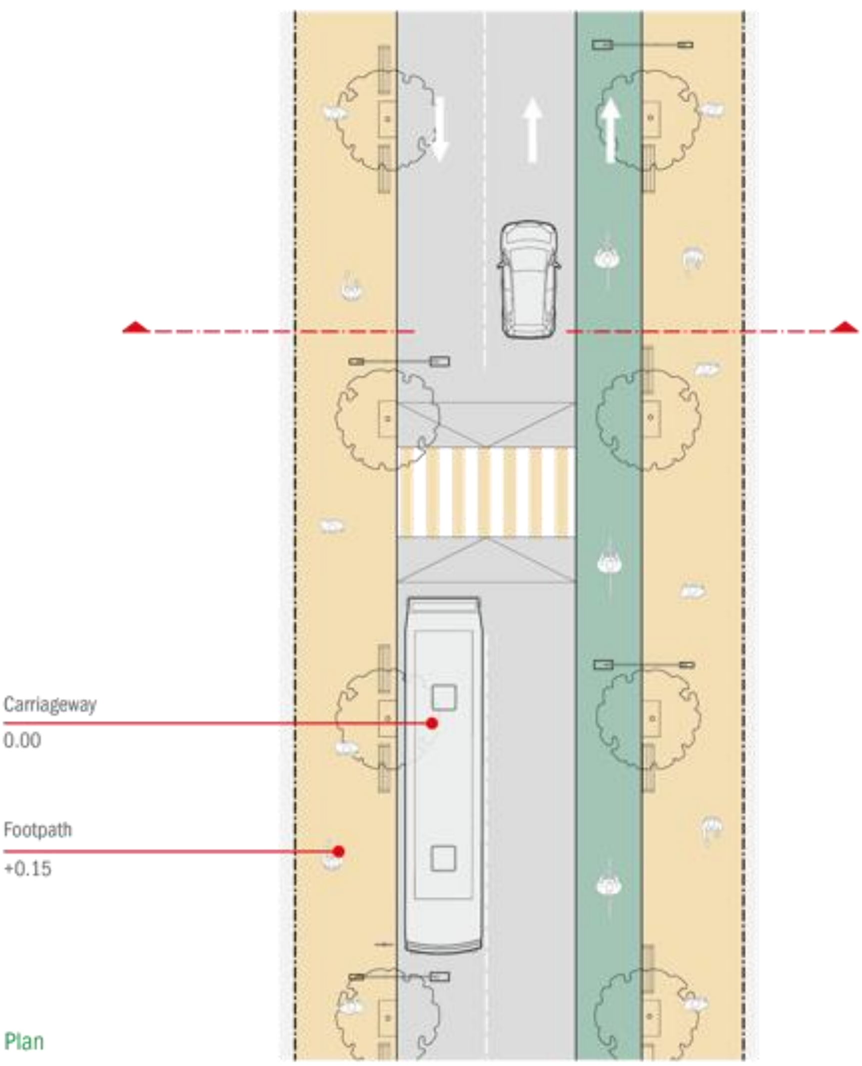


Minor Arterial (BF)
Commercial Street

15 m

Section



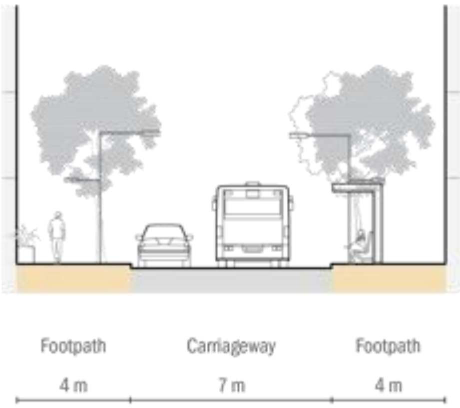


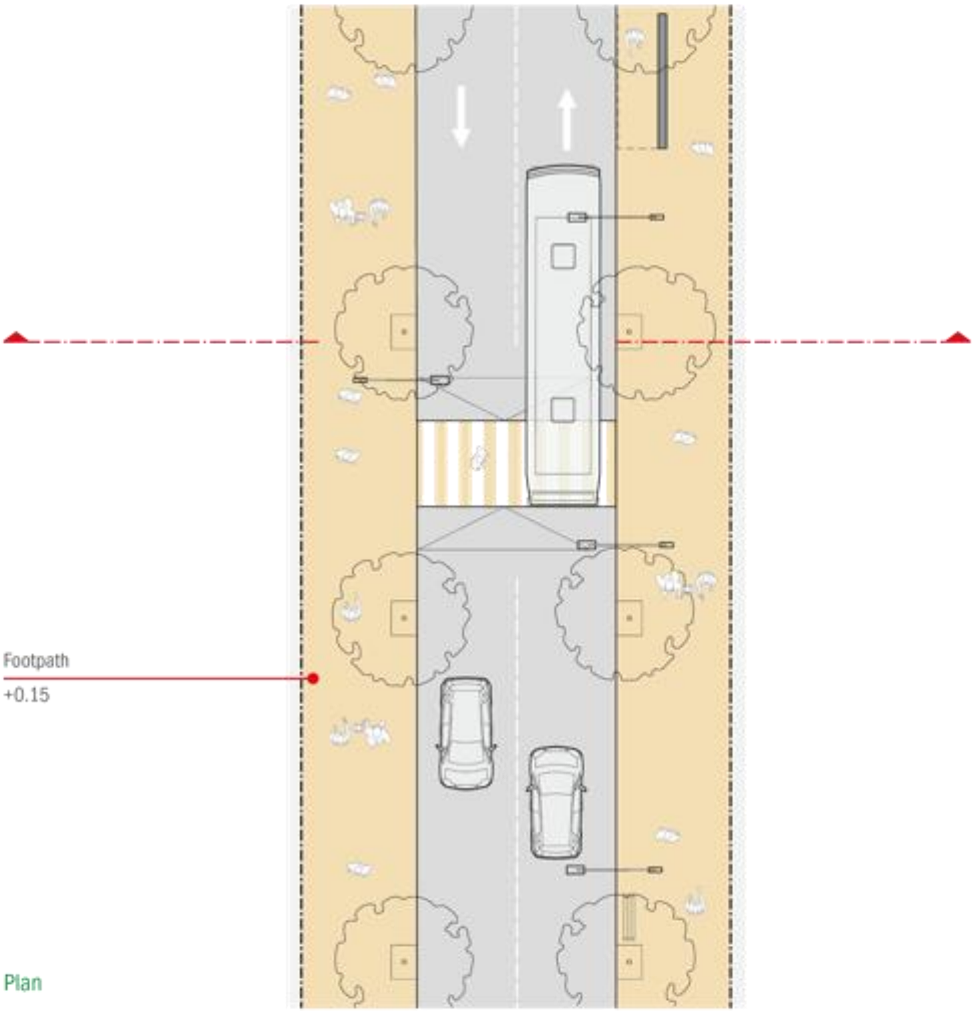
Plan

Minor Arterial (BF)
Main Bus Route

15 m

Section





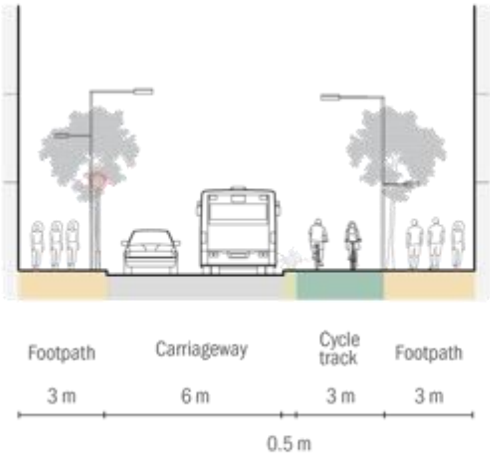
Plan

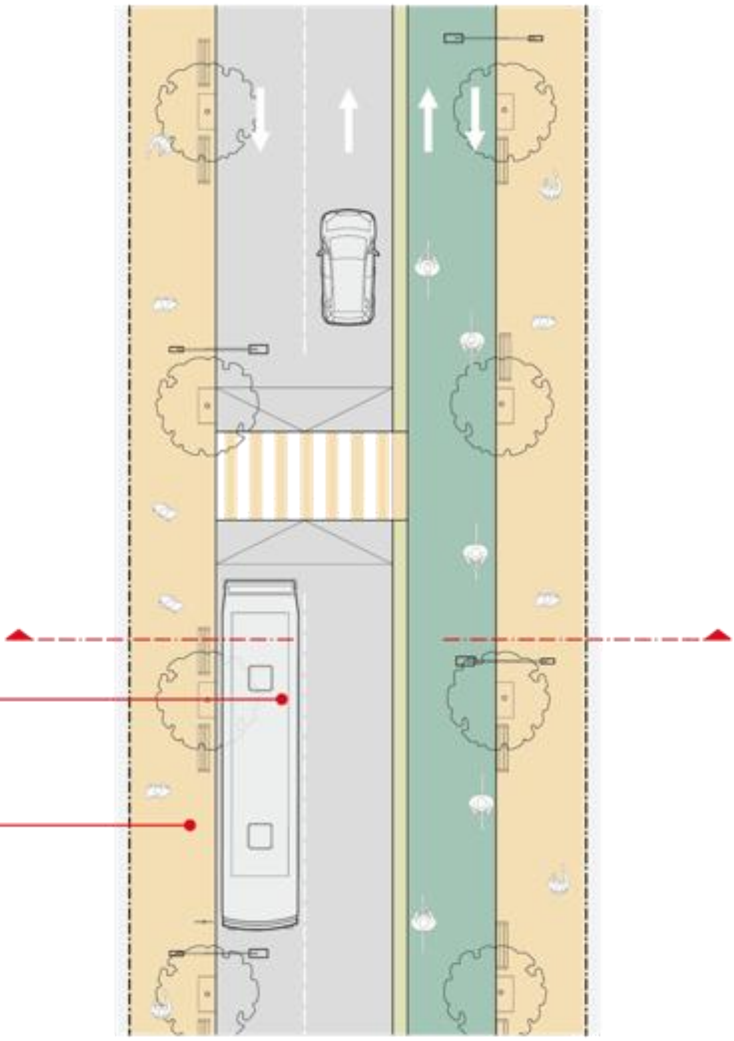
Minor Arterial (BF)

Commercial Street

15.5 m

Section



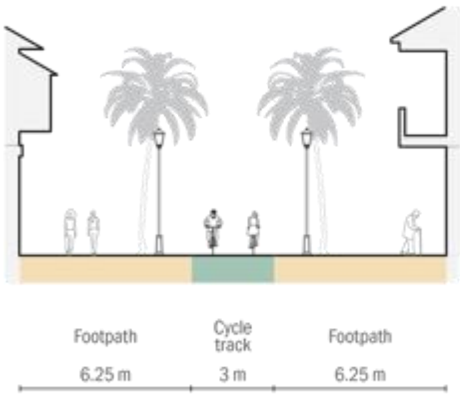


Plan

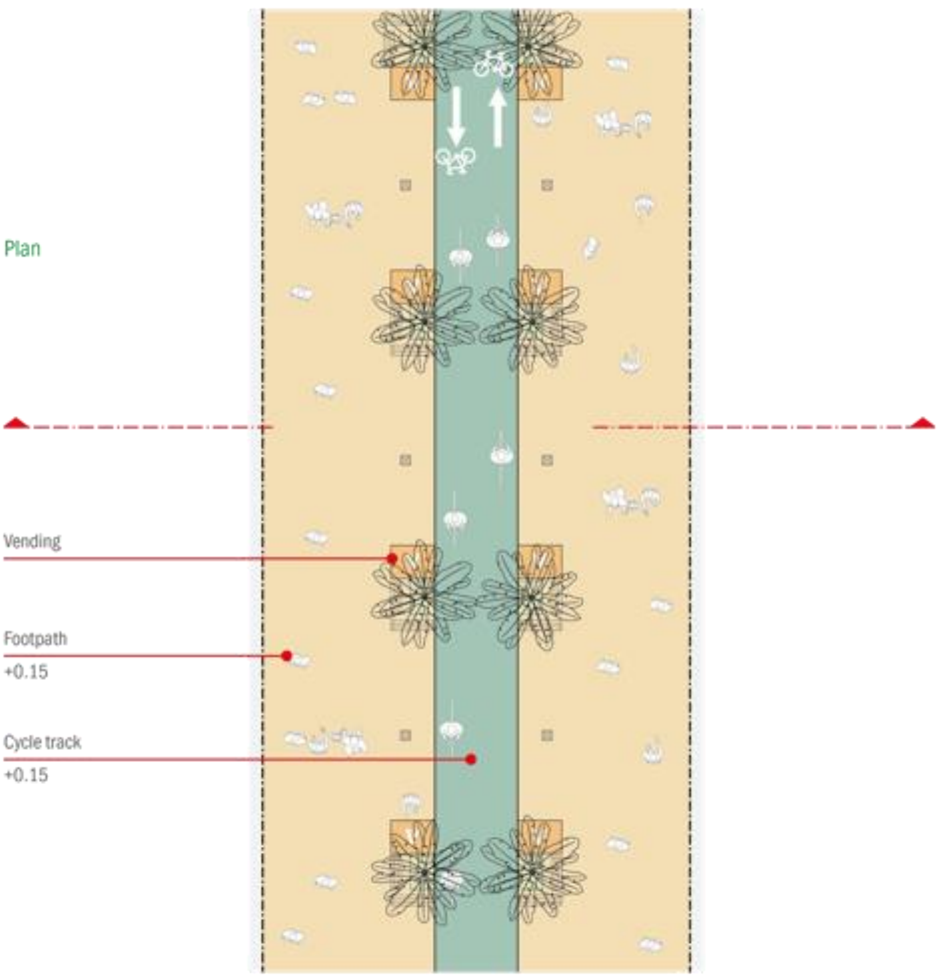
Minor Arterial (BF)
Commercial Street

15.5 m

Section



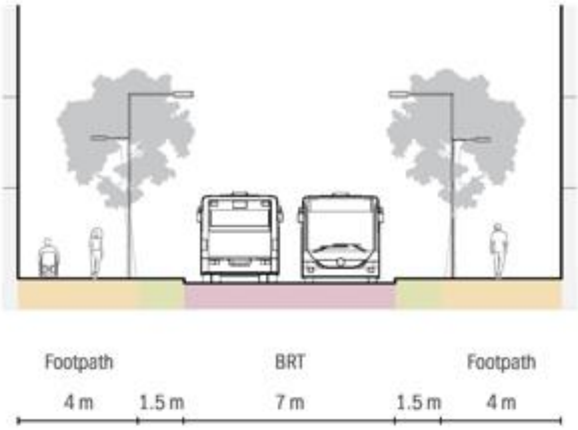
Plan

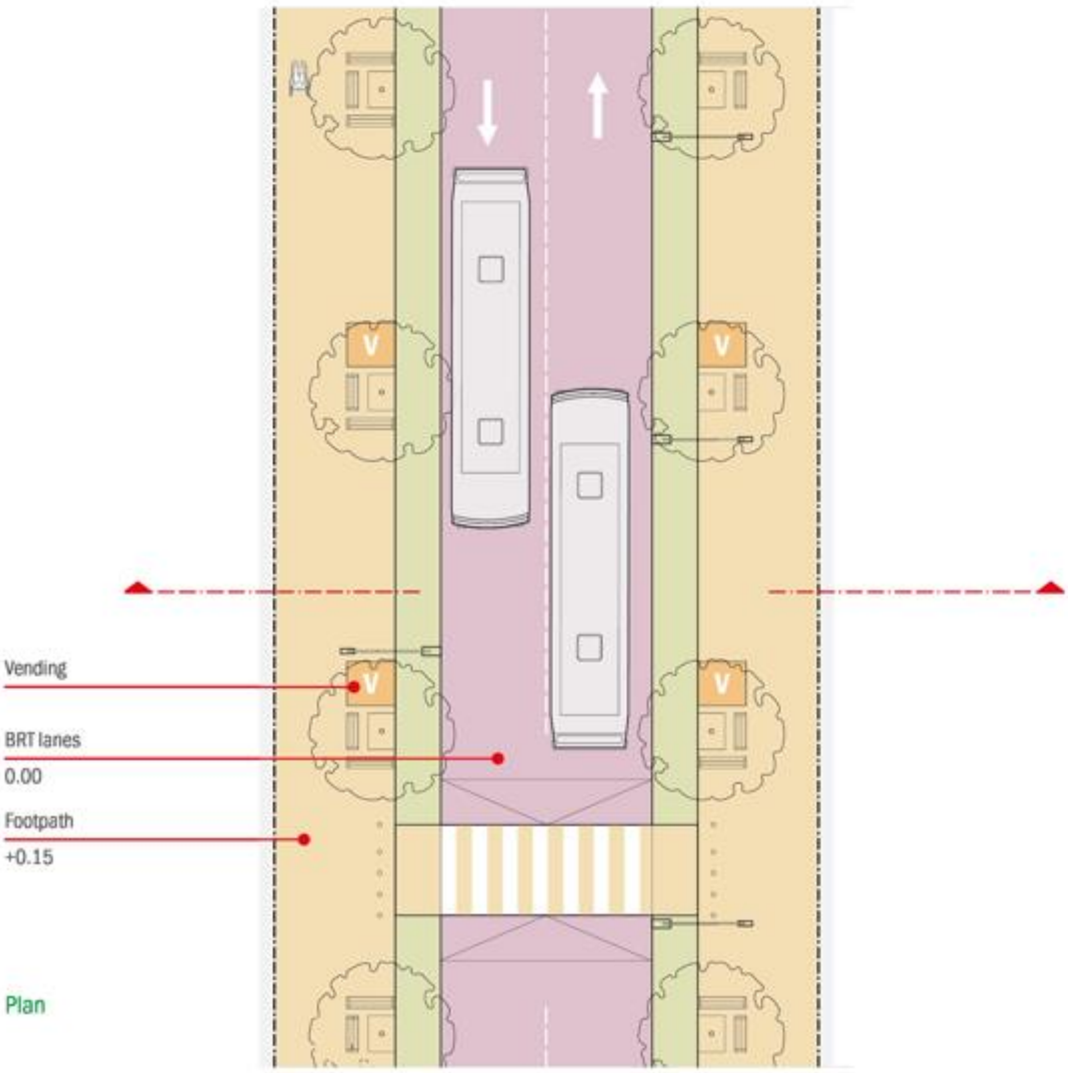


Major Arterial (BF)
BRT

18 m

Section



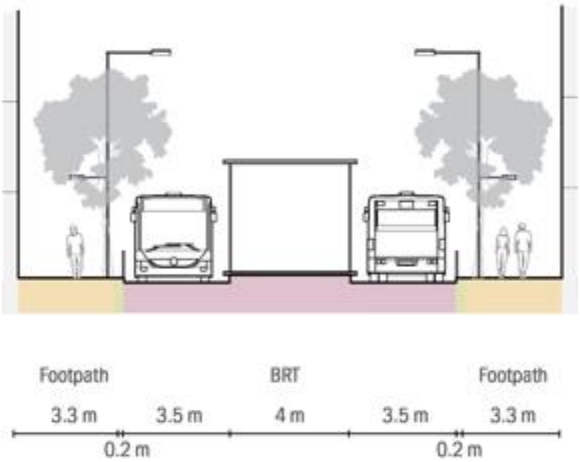


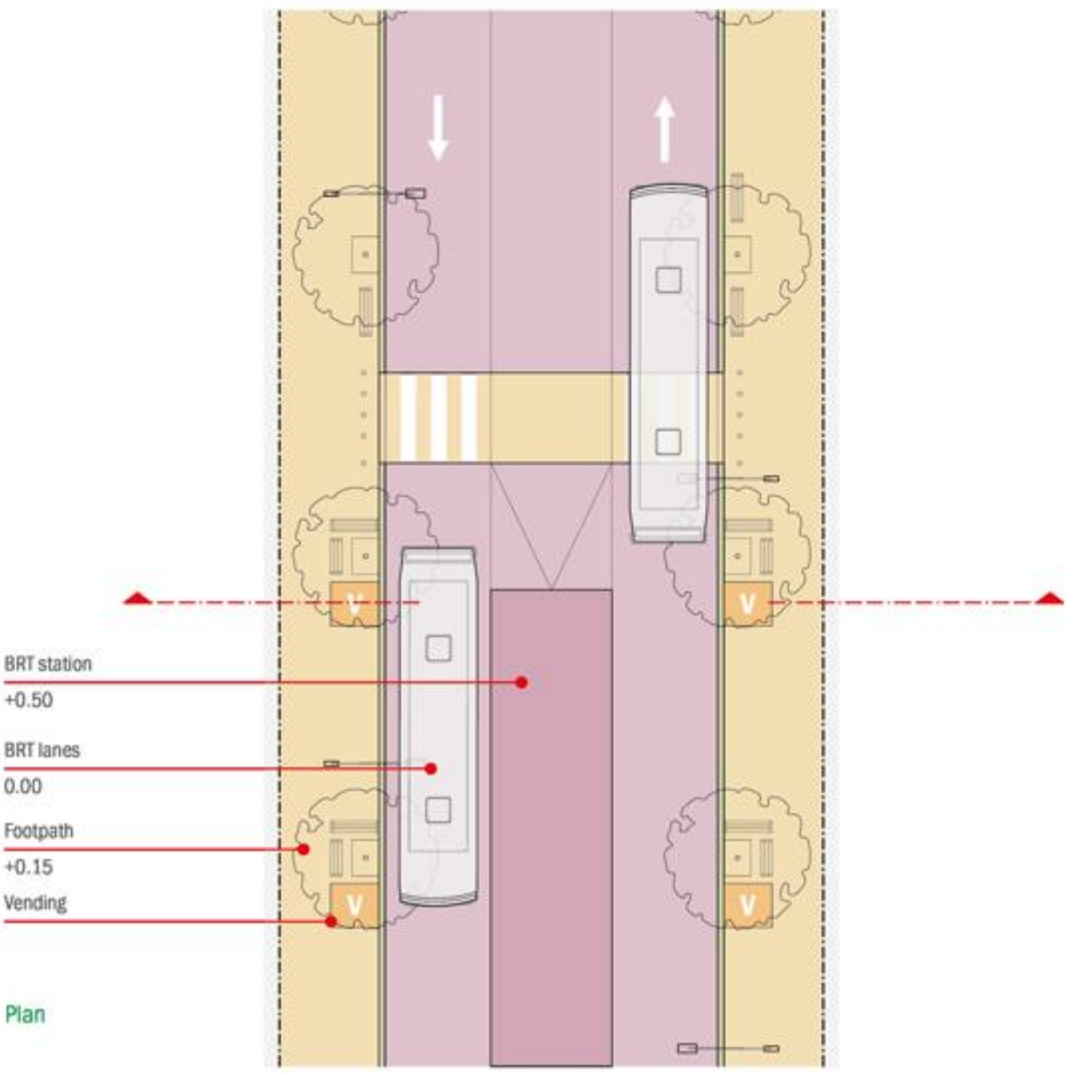
Plan

Major Arterial (BF)
BRT at station

18 m

Section





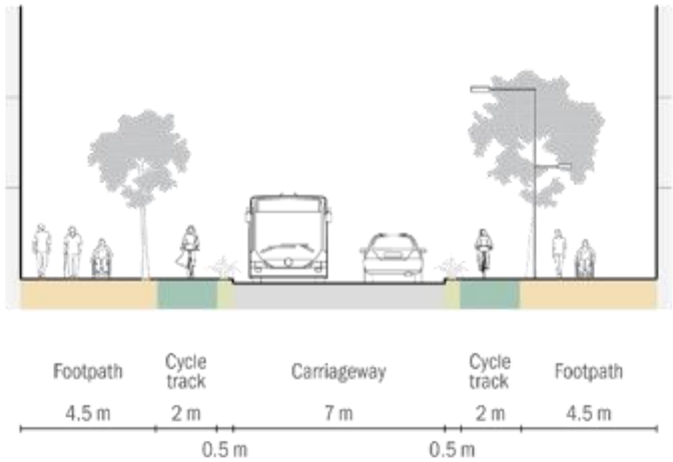
Plan

Collector Street (BF)

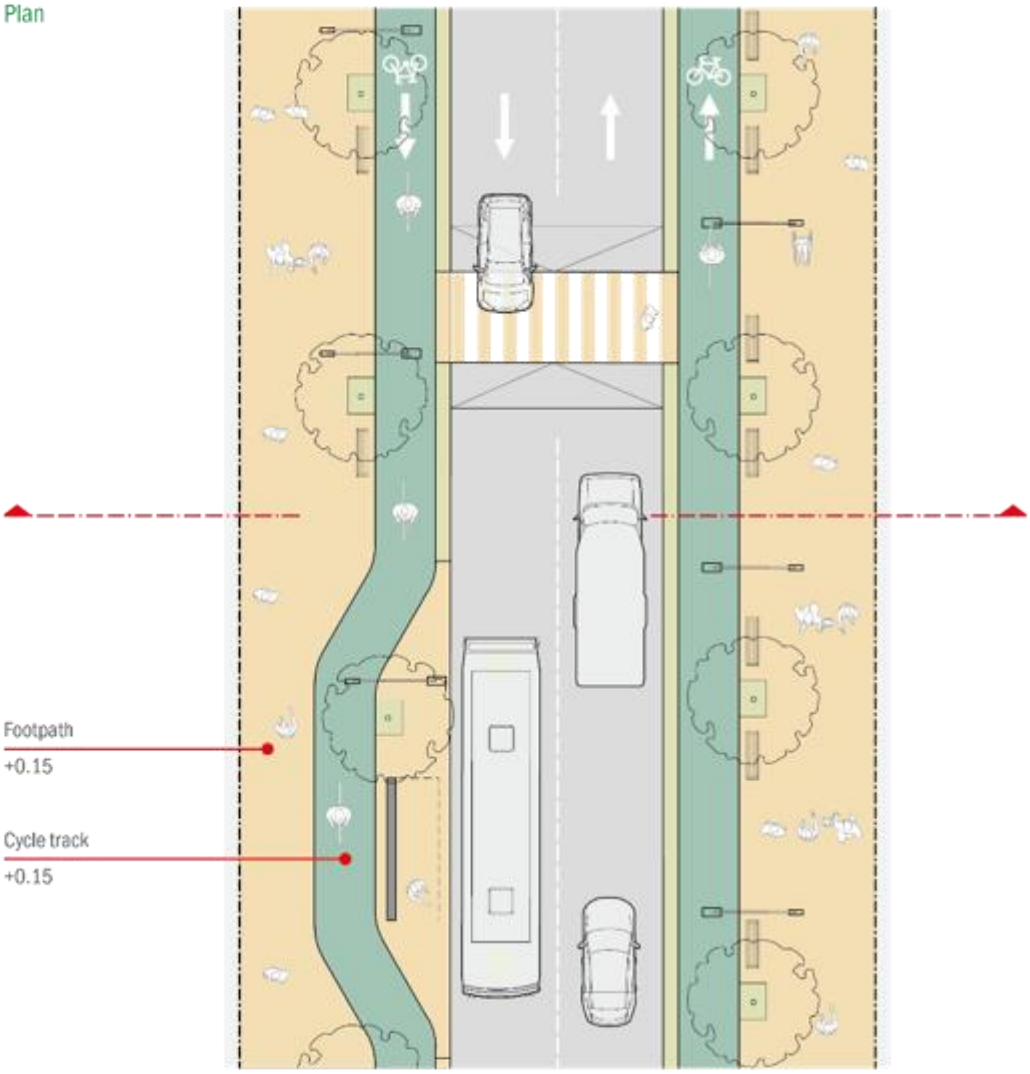
Rural

21 m

Section



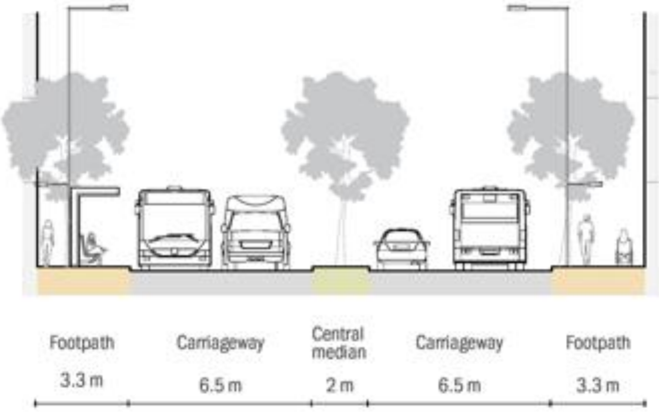
Plan



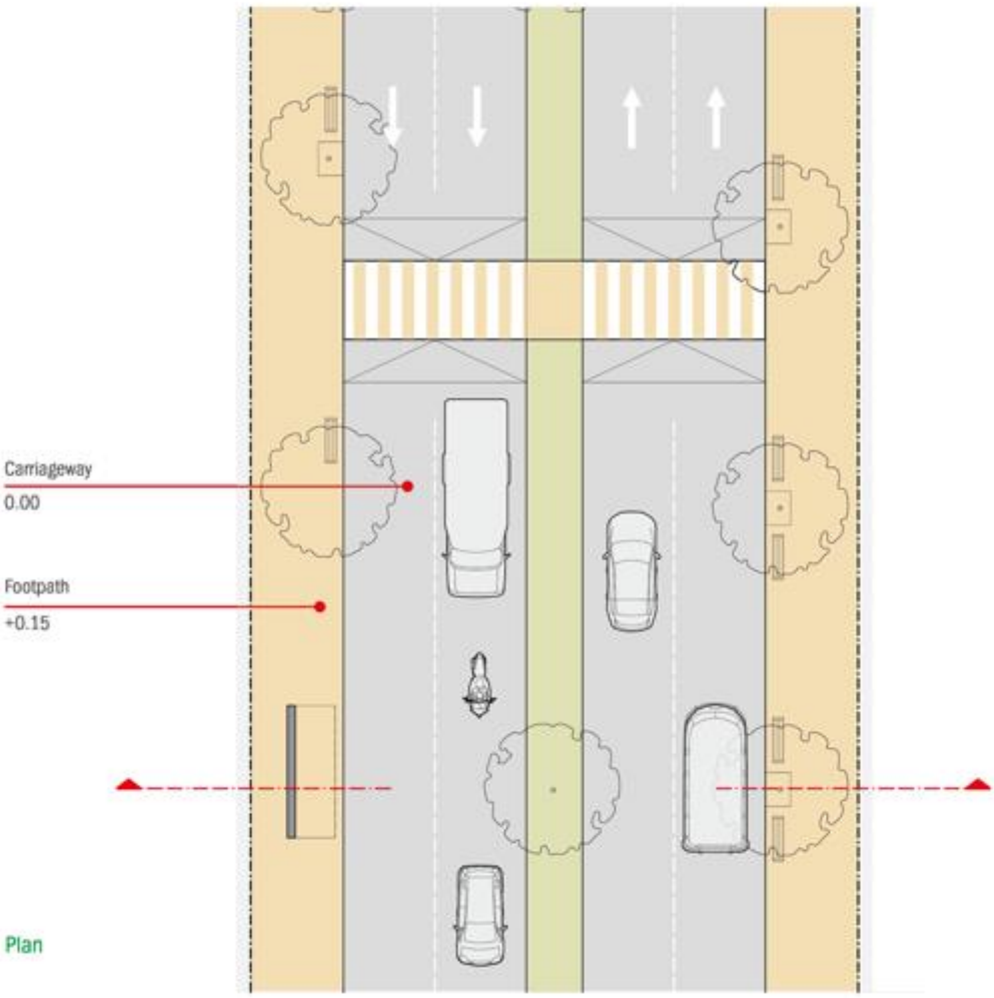
Major Arterial (BF)
Link Road

21.6 m

Section



Plan

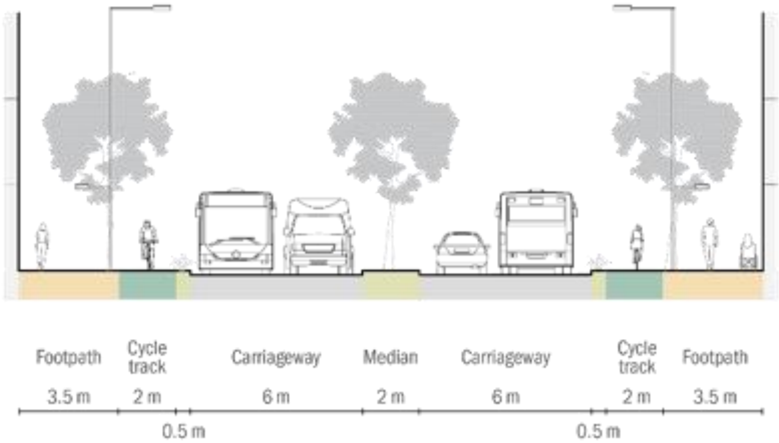


Collector Street (BF)

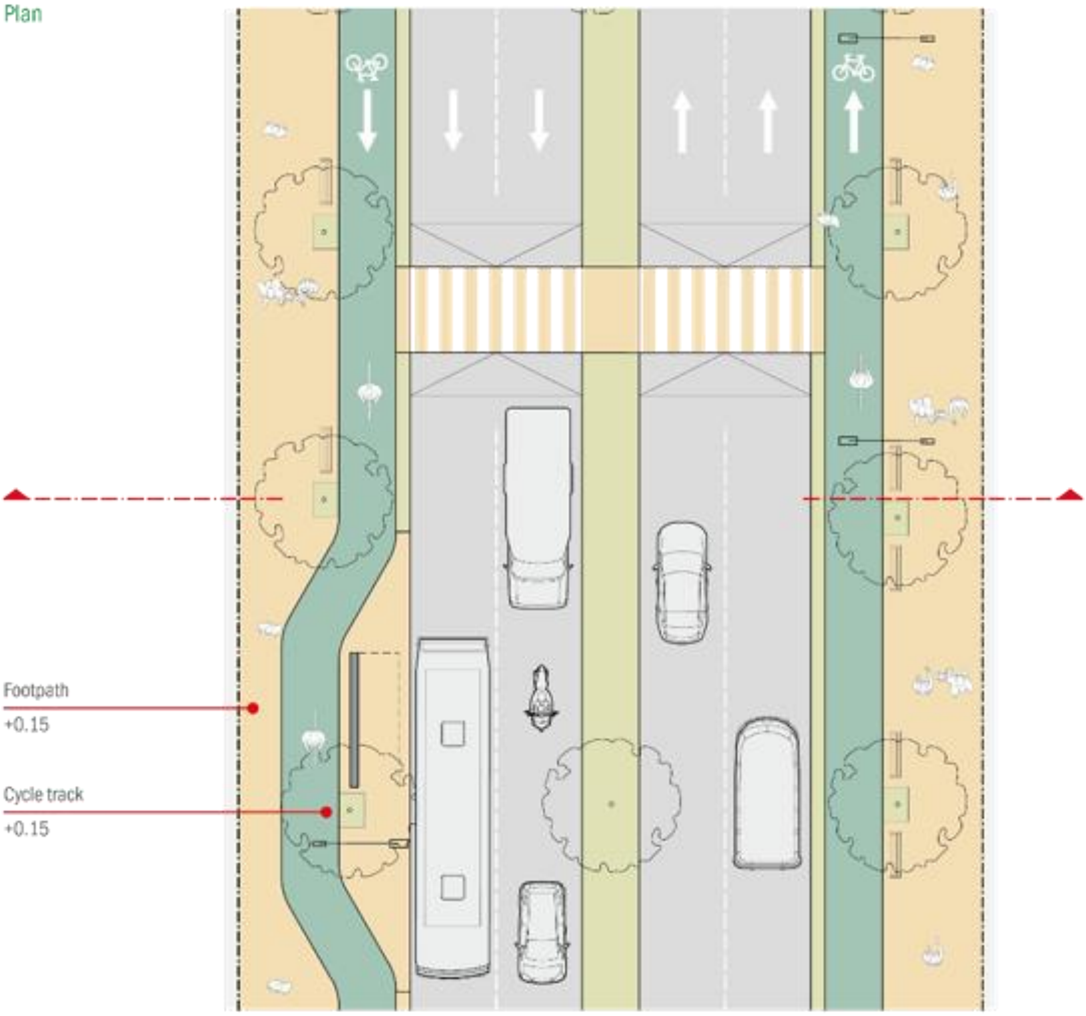
Rural

26 m

Section

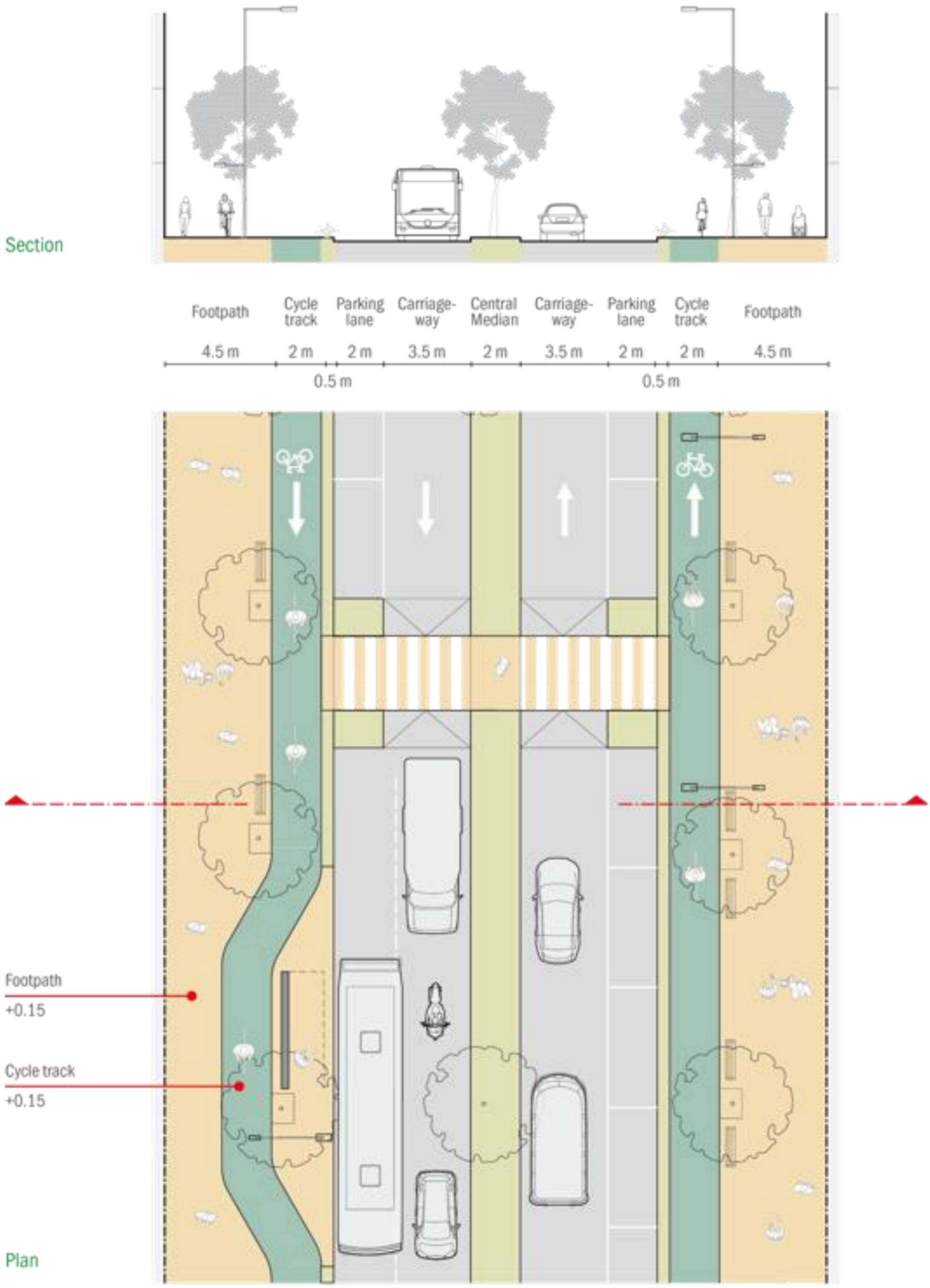


Plan



Minor Arterial (GF)
Commercial Street

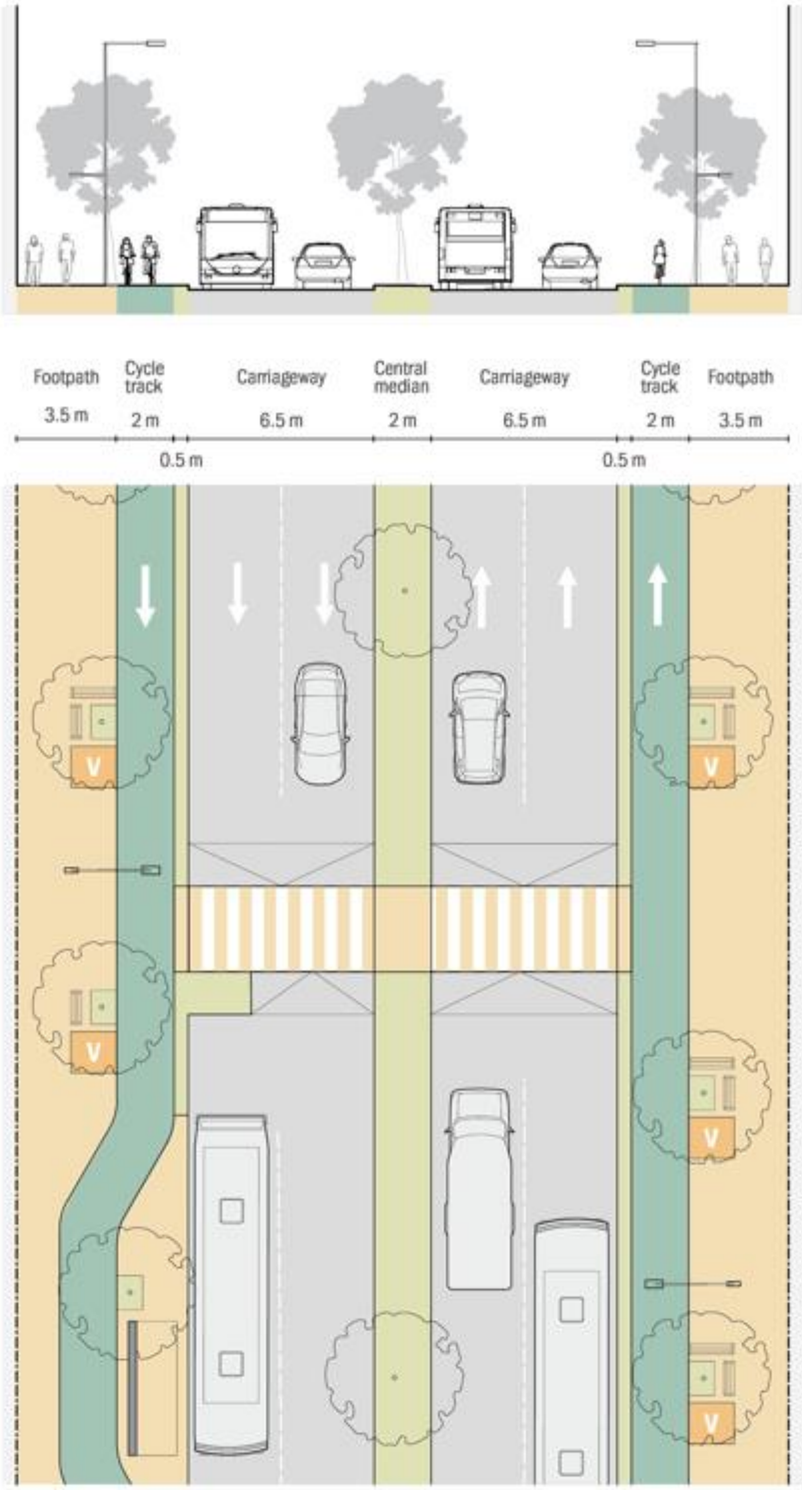
26.6 m



Major Arterial (BF)
Trunk Road

27 m

Section

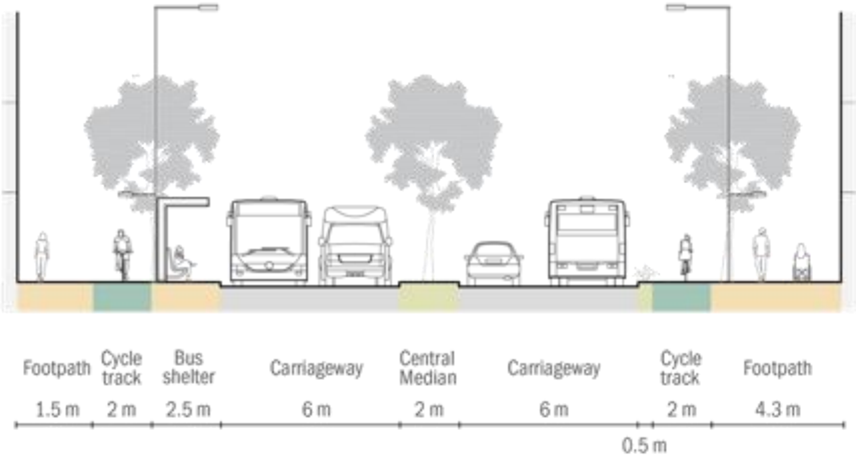


Plan

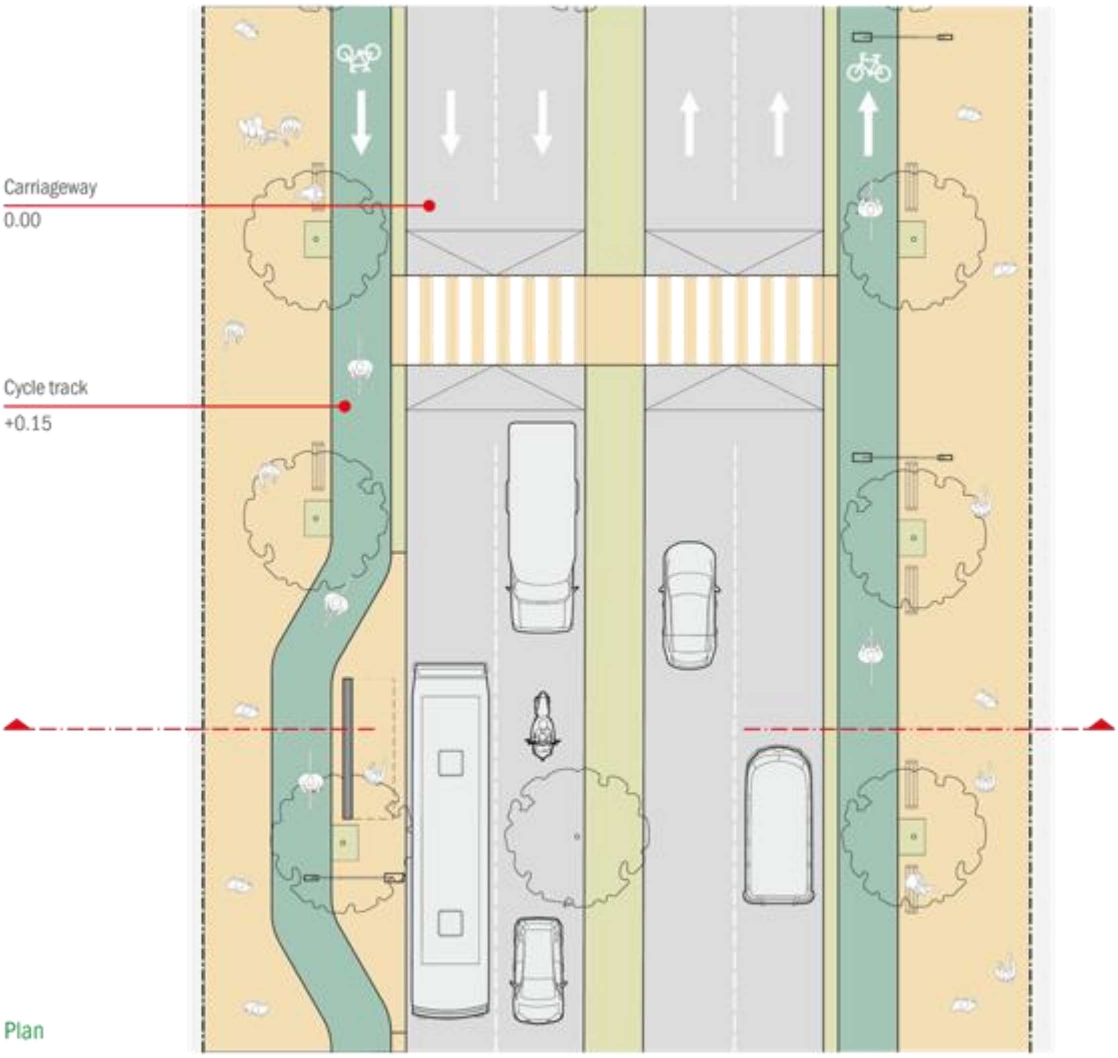
Minor Arterial (GF)
Main Bus Route

27.6 m

Section



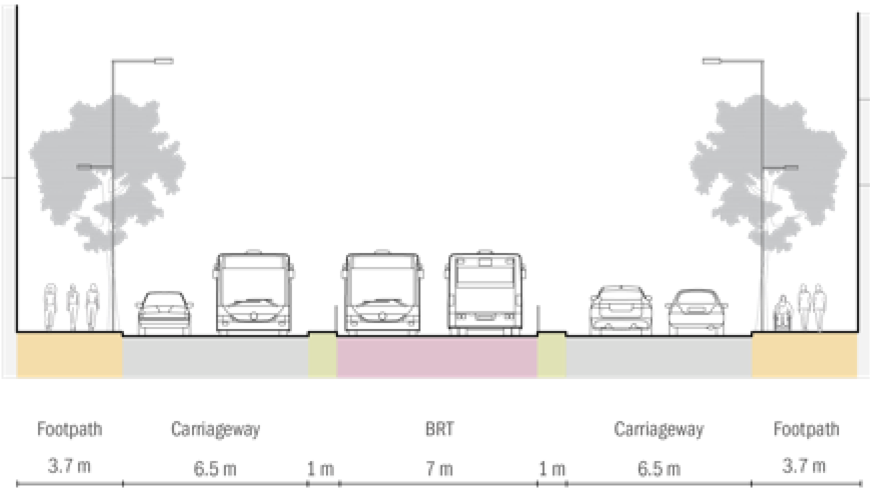
Plan

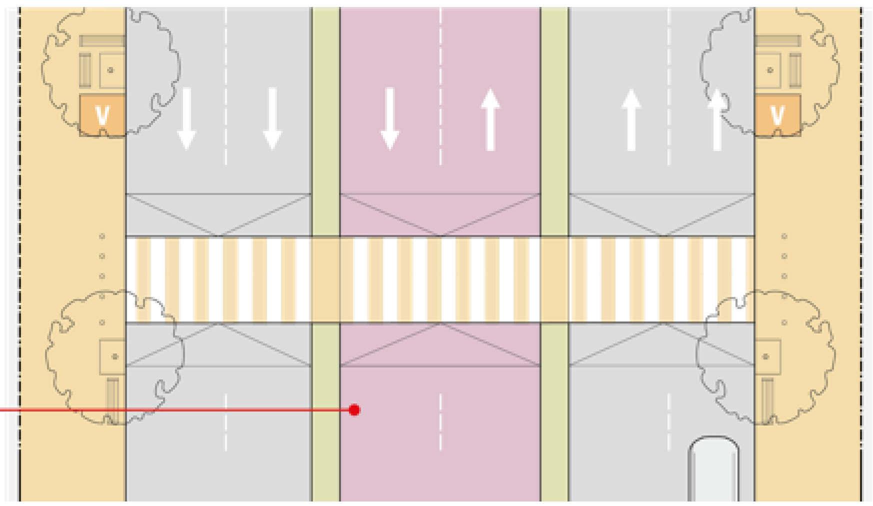


Major Arterial (BF)
BRT

29.4 m

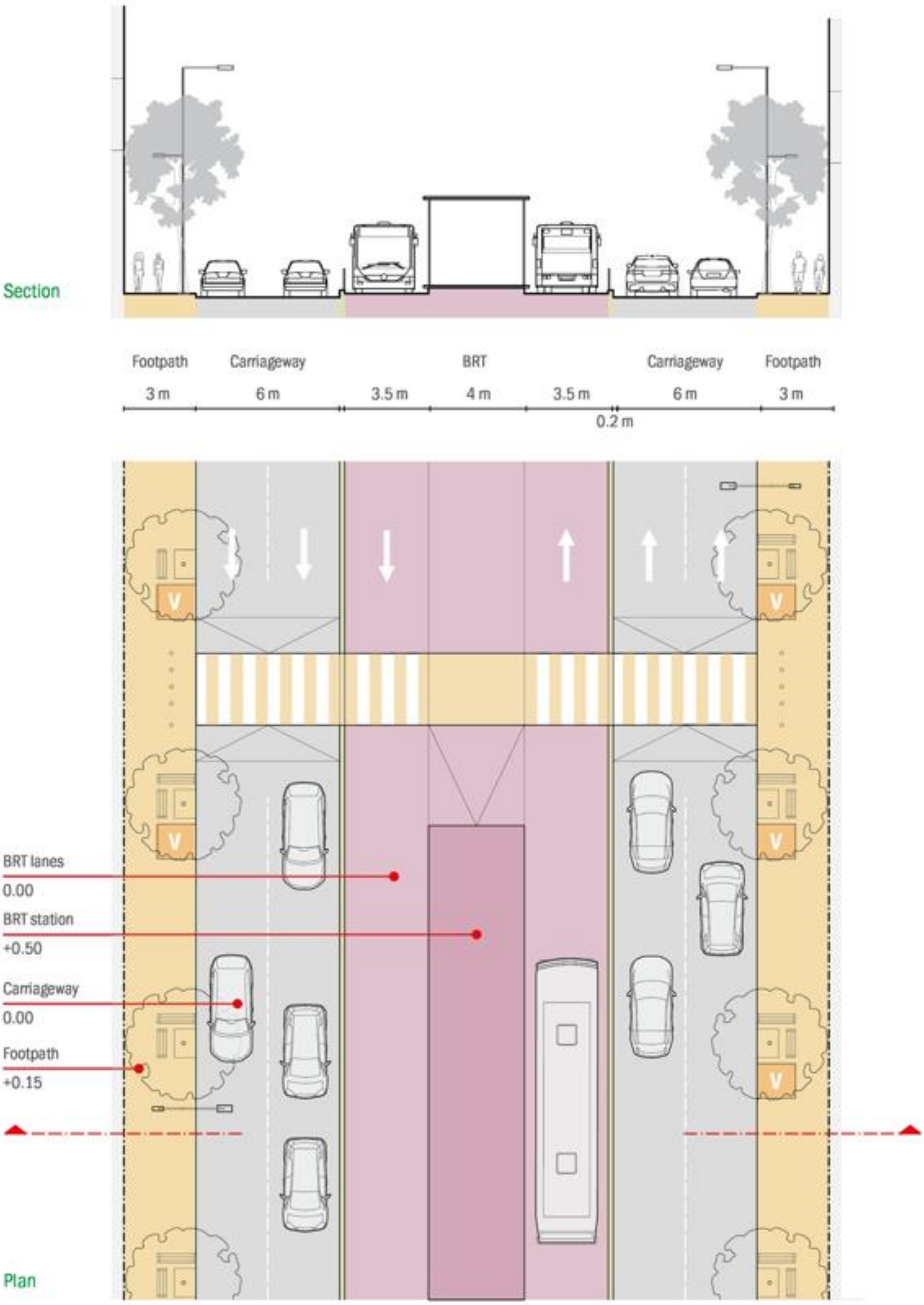
Section





Major Arterial (BF)
BRT at station

29.4 m

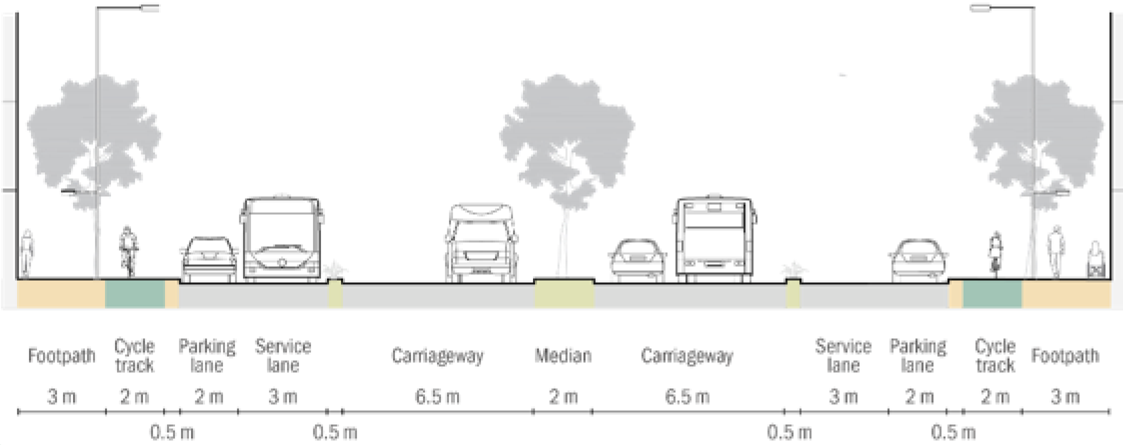


Collector Street (GF)

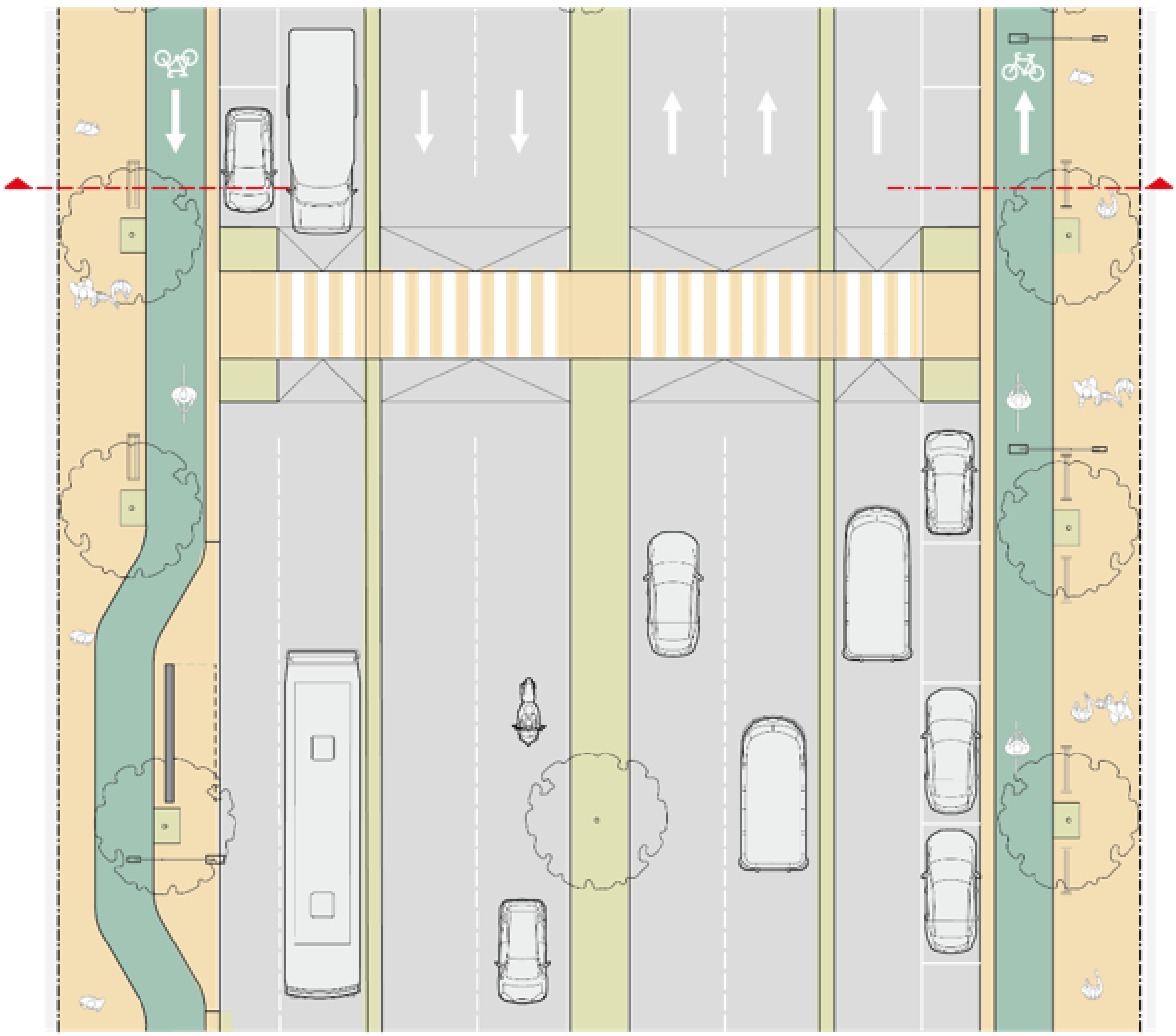
Urban

37 m

Section

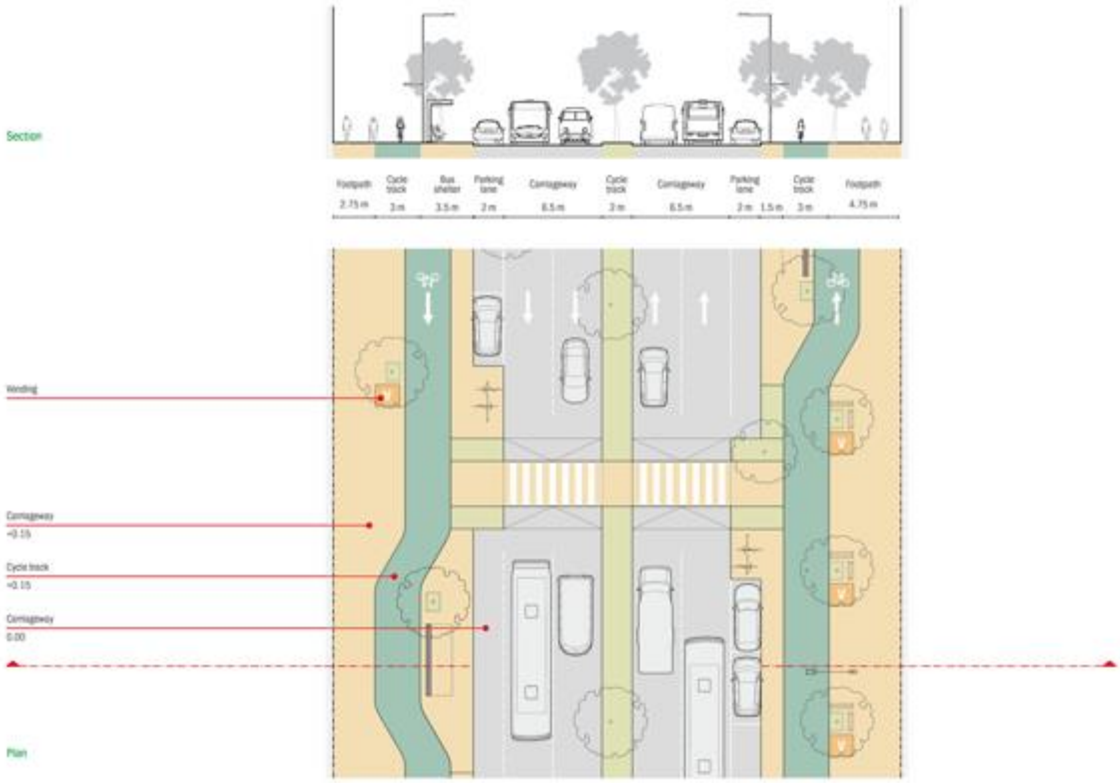


Plan



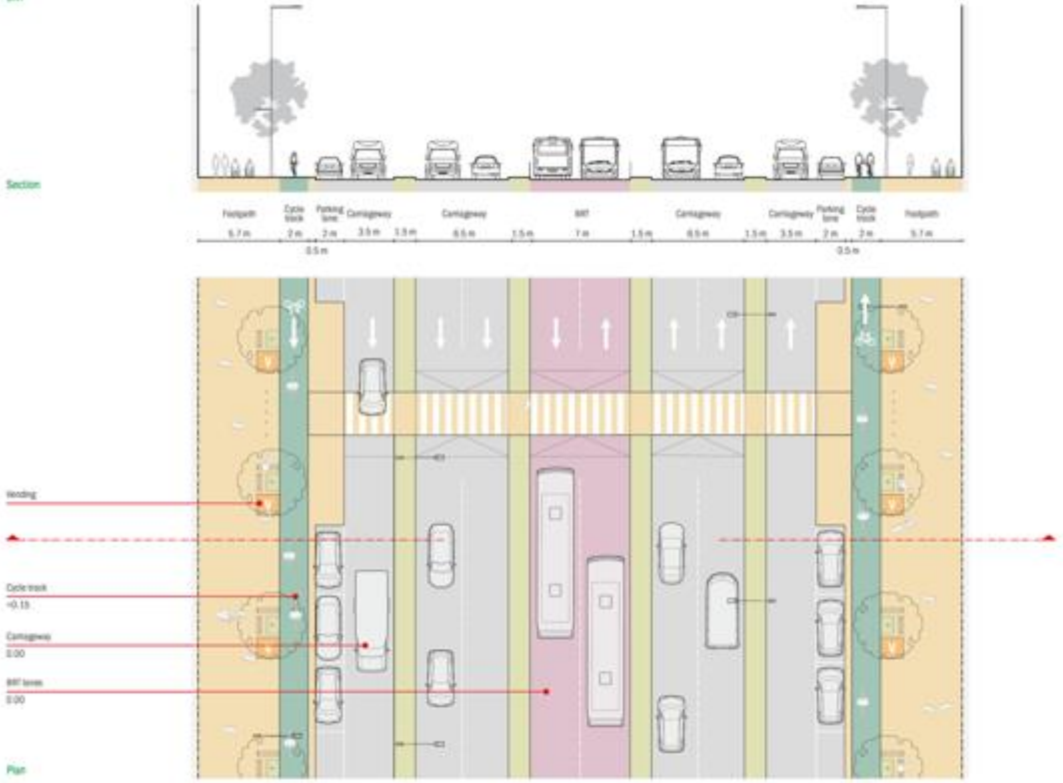
Major Arterial (GF)
Link Road

37.5 m



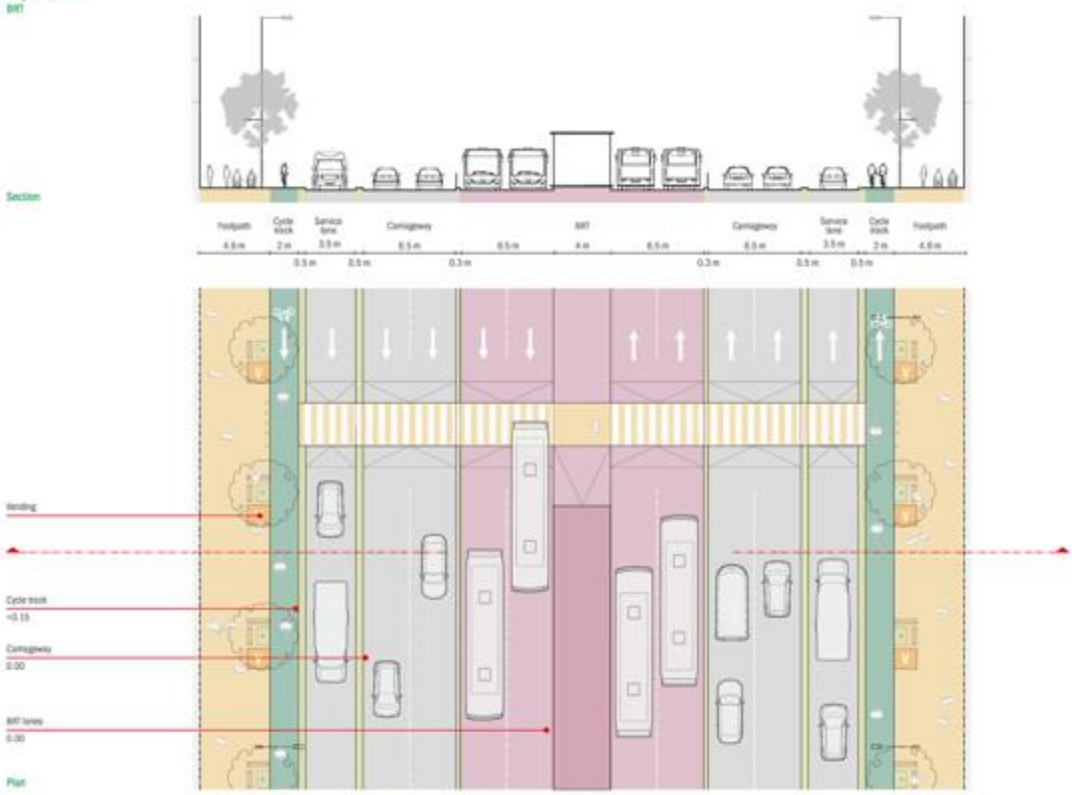
Major Arterial
BRT

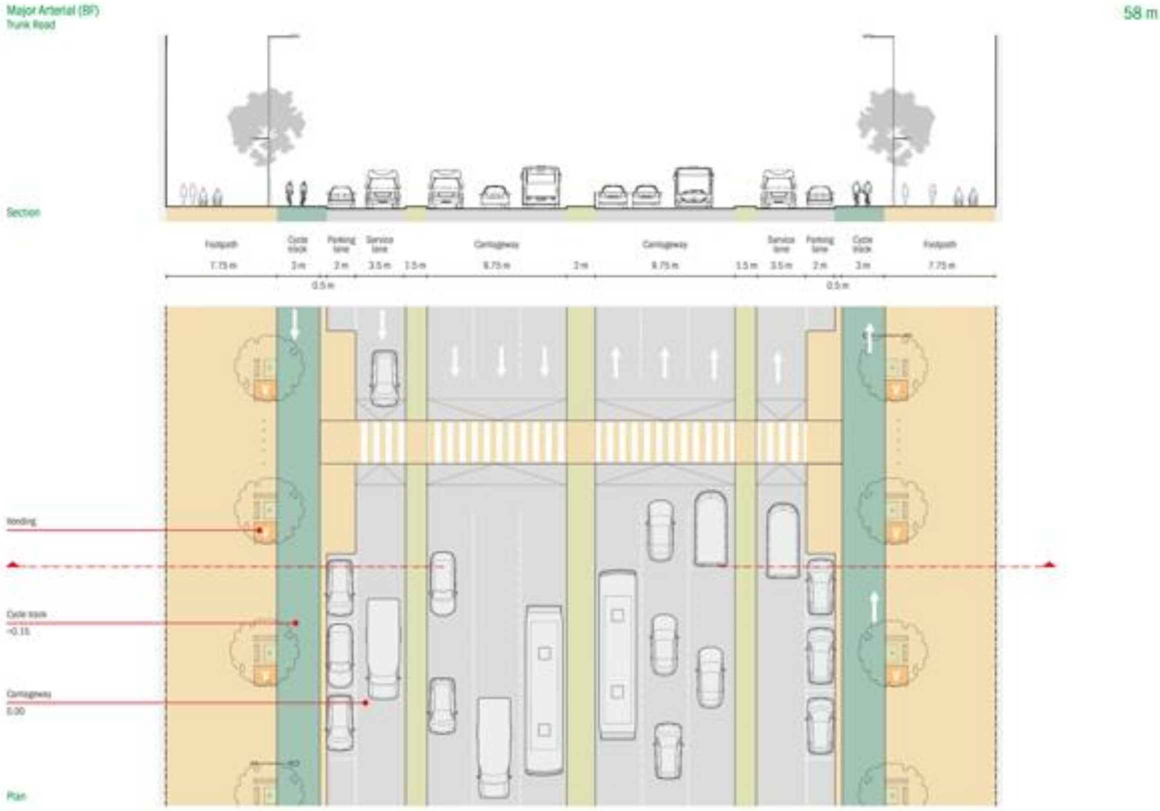
53.4 m



Major Arterial
BRT

53.4 m




Major Arterial (BF)
Trunk Road
58 m
Section
Footpath
Cycle track
Parking lane
Service lane
Carriageway
Carriageway
Service lane
Parking lane
Cycle track
Footpath
7.75 m
3 m
2 m
3.5 m
1.5 m
8.75 m
2 m
8.75 m
1.5 m
3.5 m
2 m
3 m
7.75 m
0.5 m
0.5 m
Vending
Cycle track
+0.15
Carriageway
0.00
Plan

6. INTERSECTIONS

Intersection design has undergone a fundamental shift in recent decades. What was once perceived as simply optimizing the flow of vehicles has now been redefined as a focus on safety. Intersections, by their very nature, are points of conflict. Experience has shown that the most effective way to reduce the consequences of these conflicts is through speed management, rather than solely assigning priority through traditional traffic control devices. The quality of an intersection environment can vary significantly based on factors such as turning radii, the presence of refuge islands, the continuity of cycle tracks, and other design features.

Intersections, rather than the standard sections of a street, are the determining factor in vehicle capacity. Therefore, intersection design must carefully consider the impact of design choices on mobility. However, this emphasis on mobility should not be misconstrued as prioritizing private Motorised traffic. Instead, it may be preferable to design intersections in a way that prioritizes the smooth flow of public transport, bicycles, and pedestrians.

6.1 INTERSECTION TYPOLOGIES

Intersections can take a variety of forms depending on the level of pedestrian activity, bicycle traffic, vehicle volume, presence of BRT, and street cross sections:

- ***Signalised intersections*** are the preferred configuration for urban intersections of major streets with large volumes of pedestrians and cyclists. All legs are controlled by traffic signals. Signalised intersections provide discrete crossing opportunities for pedestrians and cyclists.
- ***Roundabouts*** improve safety for vehicles by simplifying the interactions among vehicles at unsignalised intersections. However, they present challenges for pedestrians and cyclists because they increase the size of the intersection and divert NMT movements from their desire lines. Roundabouts are warranted at locations with moderate traffic volumes: up to 15,000 annual average daily traffic (AADT) for a mini roundabout, 25,000 AADT for a single-lane roundabout, and 45,000 AADT for a two-lane roundabout. With higher volumes, roundabouts should be converted to compact signalised intersections without the central traffic circle. Such conversions will reduce delay for vehicle and NMT users alike.
- ***Squareabouts*** are a means of managing left-turning traffic at large intersections while minimising signal cycle time. Squareabouts make the left-turn phase obsolete by creating left-turn queuing space within the intersection itself. Vehicles queue in this space during one phase and exit during the next phase. Squareabouts are a valuable option on BRT corridors. While the BRT would require the addition of extra phases to a typical four-phase signal cycle, the squareabout accommodates all turning movements in only two phases.
- ***Stop-controlled intersections*** are appropriate for smaller with low to moderate traffic volumes. Stop lines should be provided.
- ***Mini roundabouts*** are the safest type of intersection on smaller streets.

6.2 OPERATIONS

The capacity of a road facility is the rate at which persons, cyclists, or vehicles can traverse a section of street during a given period of time under prevailing infrastructure, traffic, and control conditions. Delays for NMT users, public transport, and mixed traffic can be minimised through optimal signal phases, determined by the relative volumes of the various movements taking place at an intersection. Use of information technology systems (ITS) can enhance the management of intersections by adjusting signal timings in response to current traffic conditions and prioritising movement of buses.

The simplification of signal cycles through the elimination of turning movements can help reduce delay at intersections, particularly along BRT corridors. As described later in this section, squareabouts combine straight and turning movements, allowing for a two-phase cycle. Signal cycles also can be simplified through changes at the network level. For example, a left turn can be substituted by three right turns.

DESIGN STANDARDS

- Signal timing should be optimised according to traffic volumes on different legs of the intersection. Pedestrians should be given priority, followed by bicyclists, public transport, and other vehicles in that order.
- Provide leading pedestrian signals allowing pedestrians to begin crossing before the signals for vehicles along the same leg turn green.
- The minimum phase duration is determined by the time pedestrians need to cross the street, assuming a walking speed of 1 m/s.
- Adopt two-phase signal cycles and intersection designs along BRT corridors. Intersections where BRT corridors cross roundabouts should be signalised.
- Phasing sequences ensure that the final vehicles from each phase are in a different part of the junction from the starting vehicles in the next phase. For example, for four straight-plus-left phases, a counter-clockwise sequence is preferred.
- Signalised intersections should be fitted with audible pedestrian signals in at least one local language and in English.

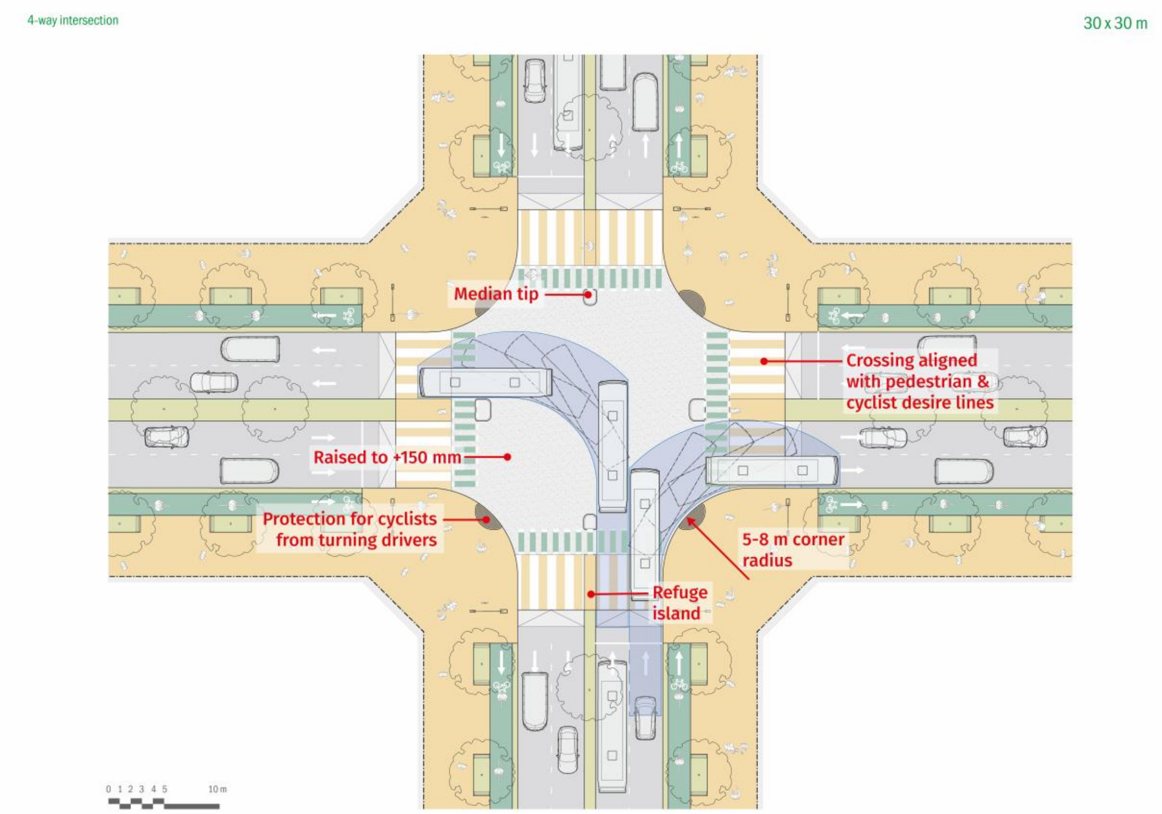


Figure 54. Design elements for a signalised intersection

6.3 GEOMETRIC DESIGN

The physical layout of an intersection must be designed in conjunction with the signal phasing. The layout is also influenced by the design vehicle, the kind of vehicle that predominantly uses a given street (as opposed to the control vehicle). The design vehicle should be as small as possible, typically a passenger car or small delivery van.

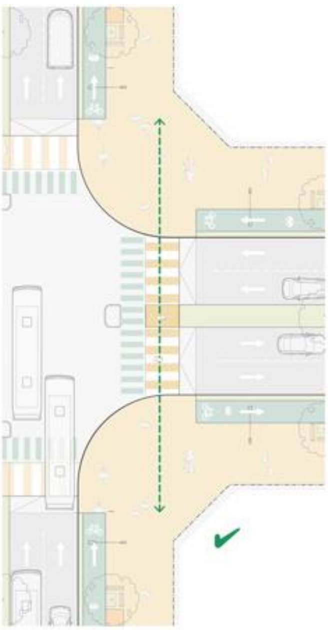
The choice of design vehicle is influenced by the functional classification of a street and by the proportions of the various types and sizes of vehicles expected to use the facility. The control vehicle on the other hand is the largest vehicle that is expected to operate on a given roadway segment at low frequencies. When control vehicles are making turns at an intersection, they can be allowed to encroach to the adjacent lanes to enable them to make the turn movement.

6.3.1 CROSSINGS

Crosswalks delineate an area that is reserved for pedestrian and cycle movement while perpendicular traffic is stopped. They should only be marked where vehicles are required to stop, such as at signalled intersections. At unsignalised intersections, painted crosswalks do not necessarily improve pedestrian safety unless accompanied by a physical measure such as a speed bump or speed table. Stop or yield lines for drivers should be located prior to painted crosswalks.

DESIGN STANDARDS

- Zebra crossings at all legs of all signalised intersections.
- Pedestrian crossings aligned with desire lines. People will cross the street using the shortest route, so it is best to accommodate movements along desire lines. Align crossing elements (zebra crossings, median refuges, and kerb ramps) in a straight line and maintain the same width.
- 5 m wide pedestrian crossings (3m minimum) and 2 m wide cycle track crossings.
- Raised crosswalks (tabletop crossings) at +150 mm at unsignalised zebra crossings. This applies to crossings of smaller streets along a corridor, slip lanes, and elsewhere. Signalised crossings may be raised as well. The entire intersection may be raised.
- Pedestrian refuge islands separate conflicts, so pedestrians can judge whether it is safe to cross by looking at and analysing fewer travel lanes and directions of traffic at a time. Provide refuge islands where there are more than three lanes total to cross.
- Provide bicycle facilities through intersections. Protect cyclists from drivers, especially turning drivers. Direct cyclists through pedestrian areas. Include slow, shared zones where modes and directions interact.
- "Median tips" where there is a zebra crossing and a median at an intersection
- Stop lines perpendicular to the travel lane and set back at least 3 m from the zebra crossings.
- Tall, bushy plants should be avoided immediately adjacent to refuge islands because they obstruct pedestrian visibility. In the case of triangular islands adjacent to free right turn lanes, the island must remain free of landscaping and fencing in order to serve as a refuge for pedestrians.



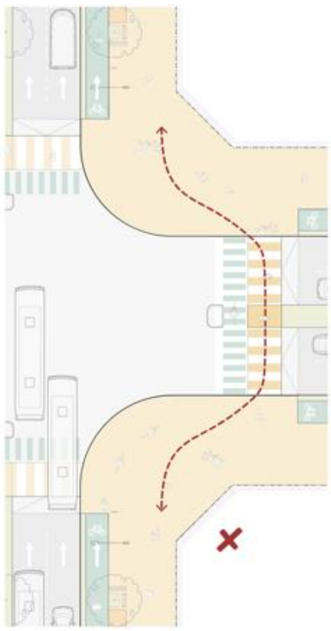


Figure 55. Pedestrian crossings at intersections should be located such that there is minimum deviation from the path of travel defined by the pedestrian zone in the footpath.

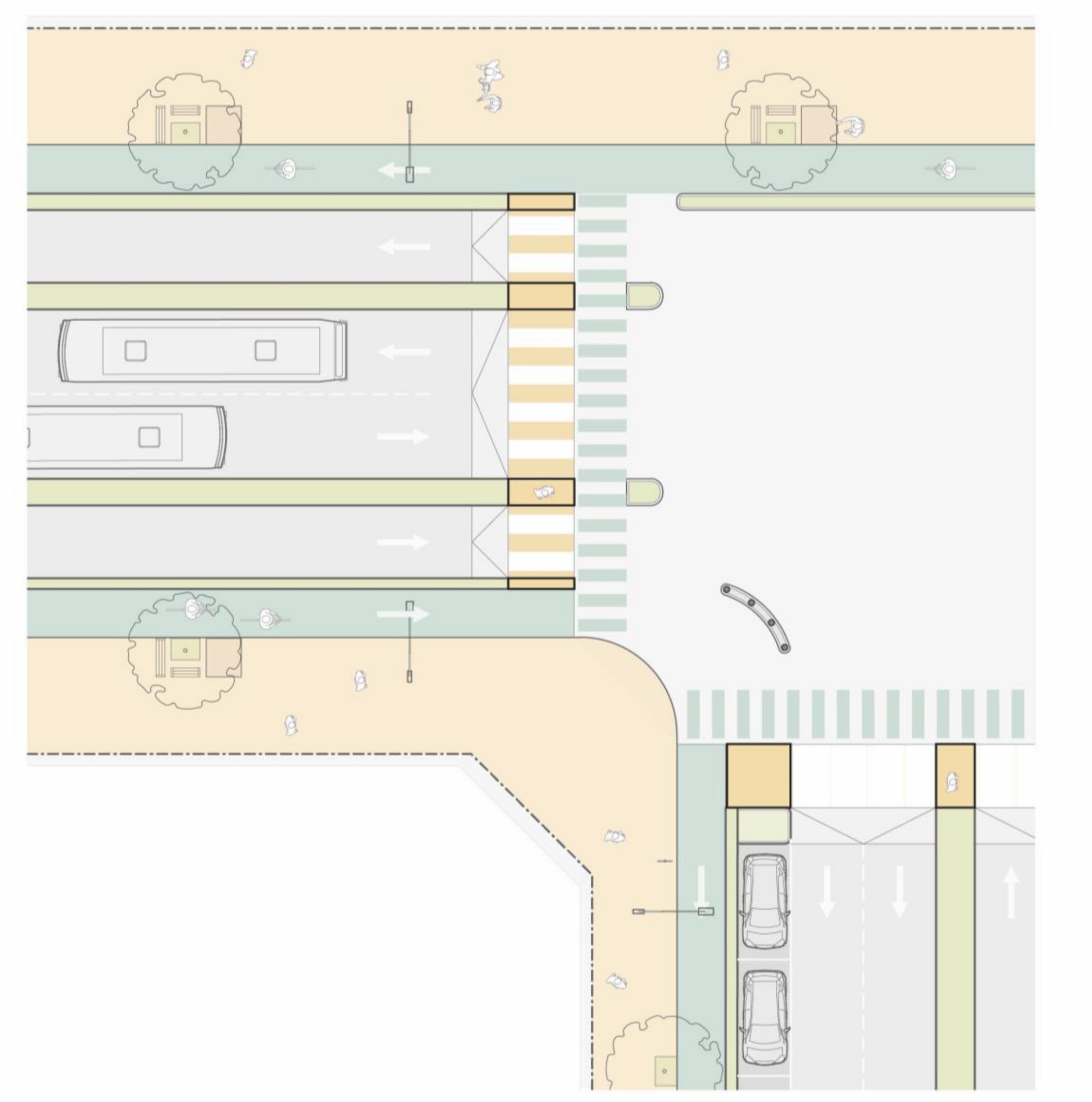


Figure 56. Pedestrian refuge islands and medians improve safety by allowing pedestrians to cross different streams of traffic in separate stages.

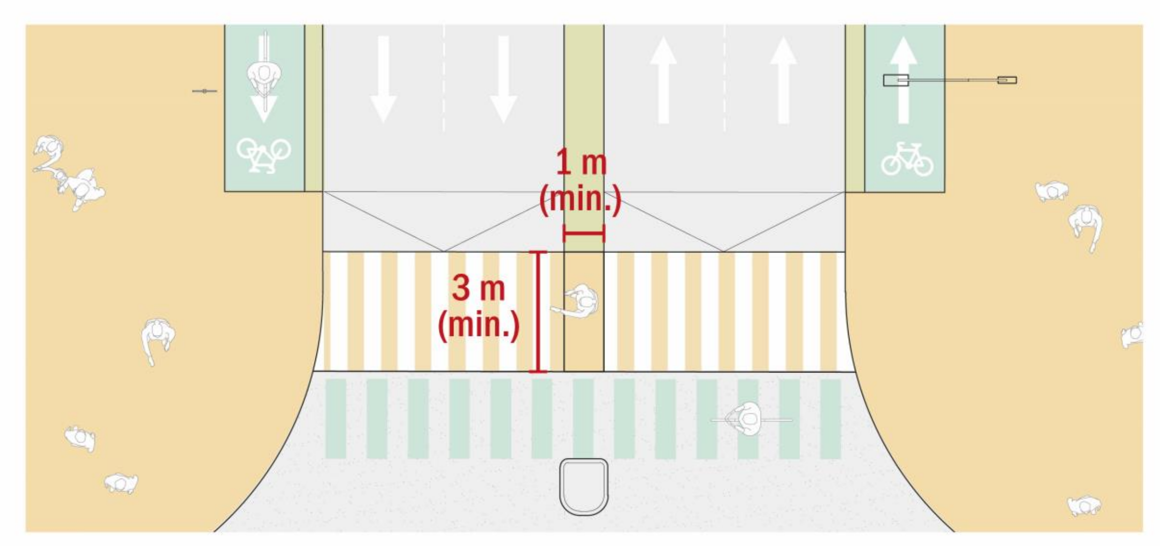


Figure 57. Pedestrian refuge island dimensions.

6.3.2 TURNING RADIUS

The concept of the turning radius is relevant in the context of designing street corners and right turn pockets. Larger vehicles require more space in order to take a turn, so intersection designs need to consider the size of vehicles that are expected to pass through an intersection.

Since larger turning radii encourage faster vehicle speeds, tighter corners are preferred because they improve safety for pedestrians and cyclists. Smaller radii reduce vehicle speeds, minimise crossing distances, and encourage driver yield behaviour.

While larger streets need to consider the turning radius requirements of buses and trucks, the effective turning radius is often much larger than the radius of the built kerb. The design of the kerb should assume that vehicles make the largest turn possible. The corner radii listed below can be adjusted in the case of skewed intersections.

DESIGN STANDARDS

- For local streets that cater to light vehicles, as well as intersections of major streets with local streets, a 3 m kerb radius is appropriate.
- For streets with large vehicles, use an 8 m radius when turning into one lane and a 5 m radius when turning into more than one lane. In some particular cases, with special authorization from the relevant institution, the turning radius may exceed 8 m and reach up to 13.1 m
- Protected configuration of the cycle track at locations where vehicles turn.

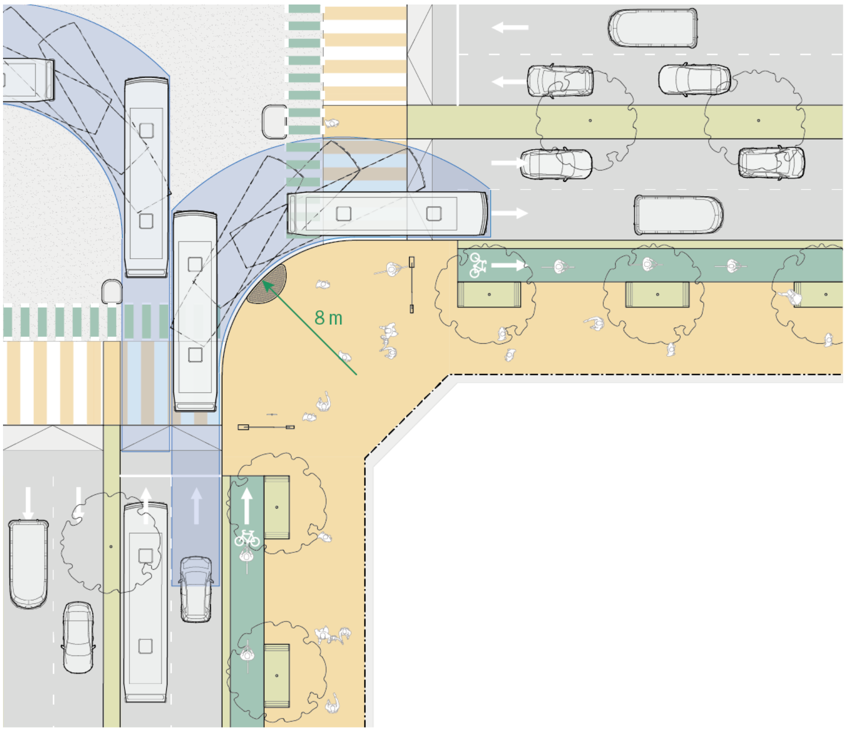


Figure 58. An intersection should be sized to minimise pedestrian crossing distances while accommodating right turns of a design vehicle—in this case, a bus.

6.3.3 BOLLARDS

Bollards help define refuge islands and other pedestrian spaces and prevent vehicles from driving over these spaces. Bollards are especially helpful when a pedestrian area is at the same level as the surrounding street surface. Possible shapes range from slender posts to larger and heavier obstacles that can double as seats.

DESIGN STANDARDS

- A minimum width of 900 mm between at least one set of bollards is required for the passage of wheelchairs at pedestrian crossings.
- At entrances to cycle tracks, 1.2 m is preferred between bollards. A width of 1.5 m is required for 3-wheelers and trailers.

6.3.4 INTERSECTION ALIGNMENT

The carriageway can be widened at intersections to provide additional queuing space for vehicles, which reduces overall signal time. Where the additional space is provided, the street's cross section usually becomes asymmetrical—even if the regular street section is symmetrical—in order to claim the additional space evenly from both sides of the cross section instead of eating deeply into the pedestrian/cycle space only on one side. The number of straight-bound lanes entering an intersection should equal the number of outgoing lanes in the same direction. Otherwise, the intersection may become congested as vehicles try to merge into the narrower outgoing carriageway.

DESIGN STANDARDS

- The physical layout of signalised intersections must be designed in conjunction with traffic signal timing and phasing for users.
- Equal number of straight-bound lanes entering an intersection and outgoing lanes in the same direction.
- Streets at an intersection should join at right angles, or as near to a right angle as possible.
- If more than four legs join at the intersection, explore solutions to reduce the number of intersecting legs.
- One receiving lane at a T-junction as there will ever only be one driver turning into it at a time.
- 1:2 transition when a turn lane is added.
- The entire intersection can be raised to the level of the footpath (typically +150 mm) to improve safety. Vehicles from all directions pass over a ramp as they enter the intersection, causing them to slow down.

6.3.5 RIGHT TURN POCKETS

Right turn pockets can increase intersection capacity by allowing vehicles to make free right turns. However, if not designed appropriately, they can compromise pedestrian safety. Traditionally, right turn lanes have been designed with a circular geometry. However, such a design is unsafe for pedestrians because it allows for fast vehicle movements. The preferred design incorporates a 30° angle of approach. Since vehicles enter the outgoing leg at a more abrupt angle, they are compelled to reduce their speeds.

The design should assume that a large vehicle completes the turn in the outermost lane of the exit leg but may enter the central lane while completing the turn. Otherwise, the right turn pocket becomes so large that smaller vehicles are able to travel at full speed around the corner.

DESIGN STANDARDS

- 30° angle of approach to encourage moderate vehicle speeds, with a 20 m entry radius and 8 m exit radius.
- 4 m vehicle lane.

- Tabletop crossing for pedestrians and cyclists, with ramps for vehicles.

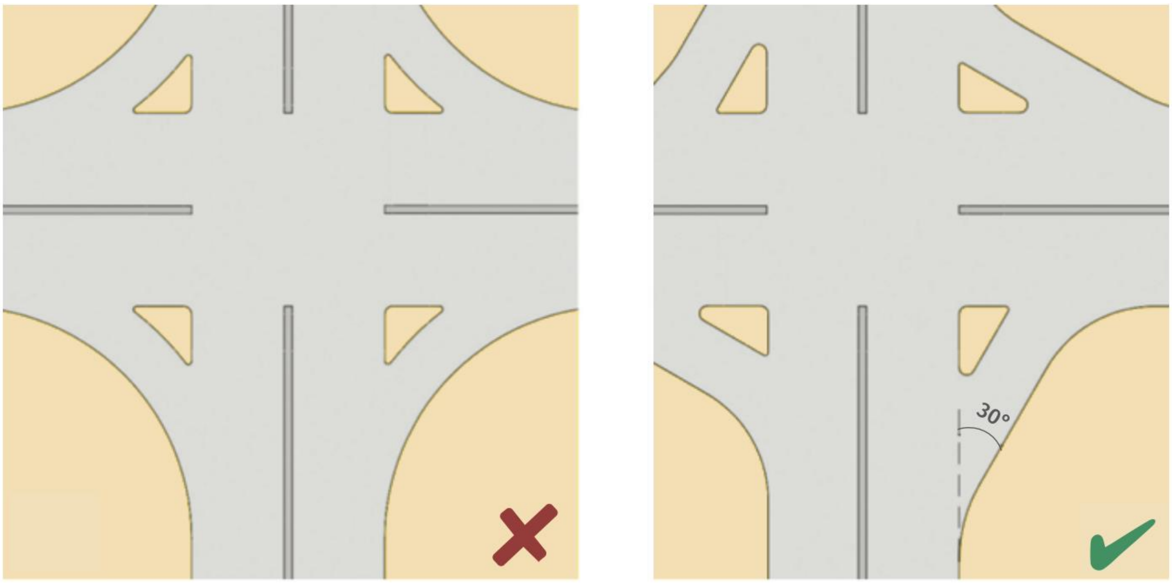


Figure 59. An intersection should be sized to minimise pedestrian crossing distances while accommodating right turns of a design vehicle.

6.3.6 ROUNDABOUTS

Roundabouts can improve safety for vehicles at unsignalised intersections with moderate vehicle volumes. Roundabouts increase walking and cycling distances and should be avoided where NMT volumes are high. Roundabouts need to include safety elements for pedestrians and cyclists. The cycle lane should be protected from motorised traffic in the roundabout through the provision of a buffer zone. Since the intersection is unsignalised, pedestrian and cycle crossings should be raised to the level of the footpath, with ramps for vehicles.

DESIGN STANDARDS

- Inner circle radius as large as possible.
- No more than two approach lanes per direction. If there are three or more lanes, use a signalised intersection design. The number of circulating lanes should be equal to the number of lanes per direction on the largest carriageway of the intersecting legs.
- Adopt a maximum of 2 lanes circulating the roundabout.
- Circulating lane width of 4 m.
- 5 m offset between the circulating lanes and the crossing to allow a vehicle to stop for pedestrians and cyclists on the exit leg without blocking the roundabout.
- Raised pedestrian and cycle crossings at +150 mm.

- Roundabouts can be applied in areas where the volume of pedestrians is low and where there is sufficient space to accommodate vehicle and NMT elements in the roundabout design.

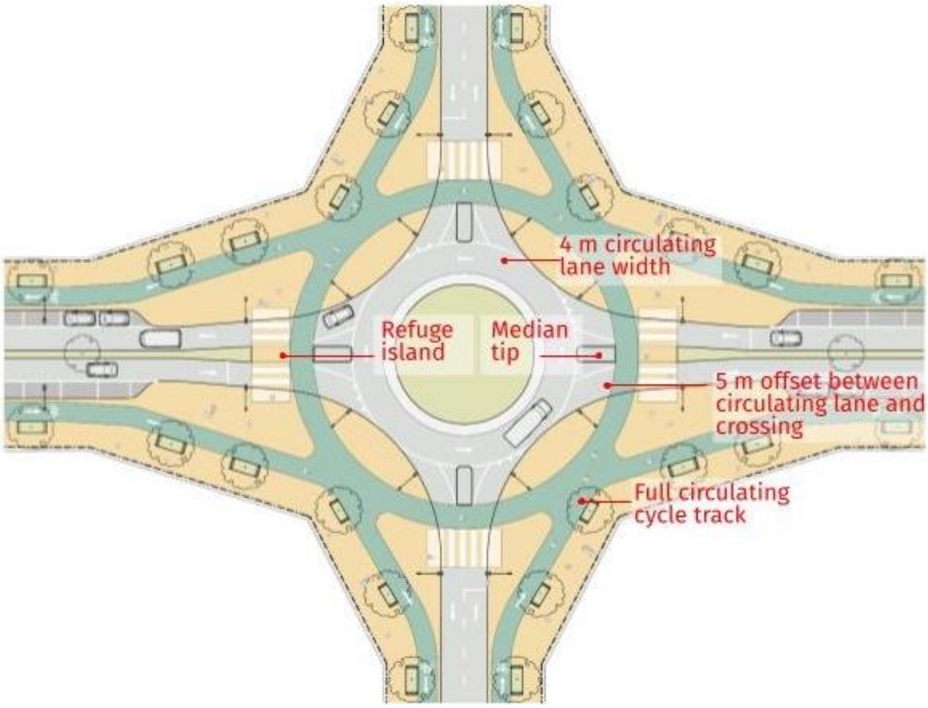


Figure 60. Design elements of a roundabout intersection.

6.3.7 INTERSECTIONS WITH BRT

BRT intersections should be designed to operate with two-phase signal cycles, reducing delays for buses and mixed traffic alike. Turns along BRT corridors can be managed through the following approaches:

- Two-phase signal cycles combine straight-bound BRT and mixed traffic movement. Left turns are accomplished through the network (e.g., three right turns).
- Signalised U-turns allow vehicles to reach the opposite side of the corridor. They also accommodate left turning vehicles (e.g., U-turn plus right turn).
- Squareabouts make the left-turn phase obsolete by creating left-turn queuing space within the intersection itself. Vehicles queue in this space during one phase and exit during the next phase. BRT buses merge with the mixed traffic when moving around the central island.

DESIGN STANDARDS

- Adopt two-phase signals at BRT intersections. Eliminate left turns across the BRT lanes. Additional phases may be provided where BRT buses need to turn.
- In squareabout intersections, size the queueing space per expected turn volumes. Use corner radii of 8 m for the central island.
- Position U-turn lanes on the outer side of the carriageway to improve visibility of turning vehicles for bus drivers and allow for an adequate U-turn radius.

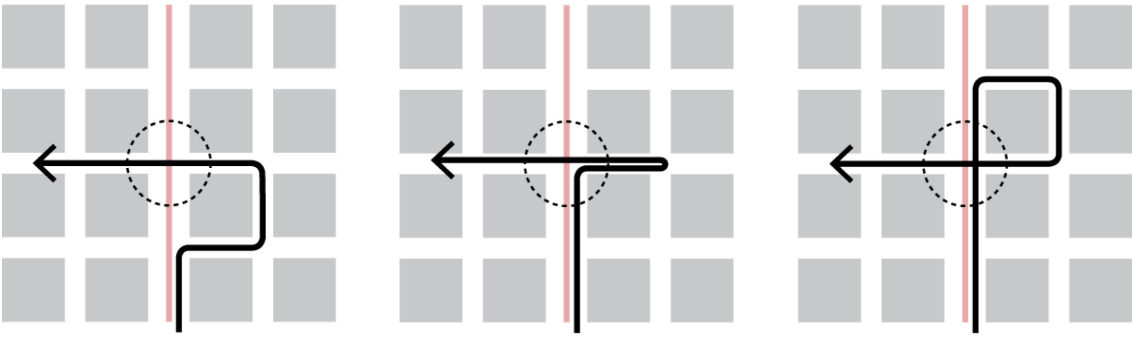


Figure 61. In order to reduce intersection delay along a BRT corridor, intersections can be simplified by prohibiting left turns across the BRT corridor and providing alternatives through the network.

6.3.8 GRADE SEPARATION

In general, urban intersections should be at-grade so as not to disrupt the urban fabric, public space, and socioeconomic activities. Grade separation is not justified to facilitate vehicle flow. This simply induces more traffic and increases speed at the overpass, which decreases safety.

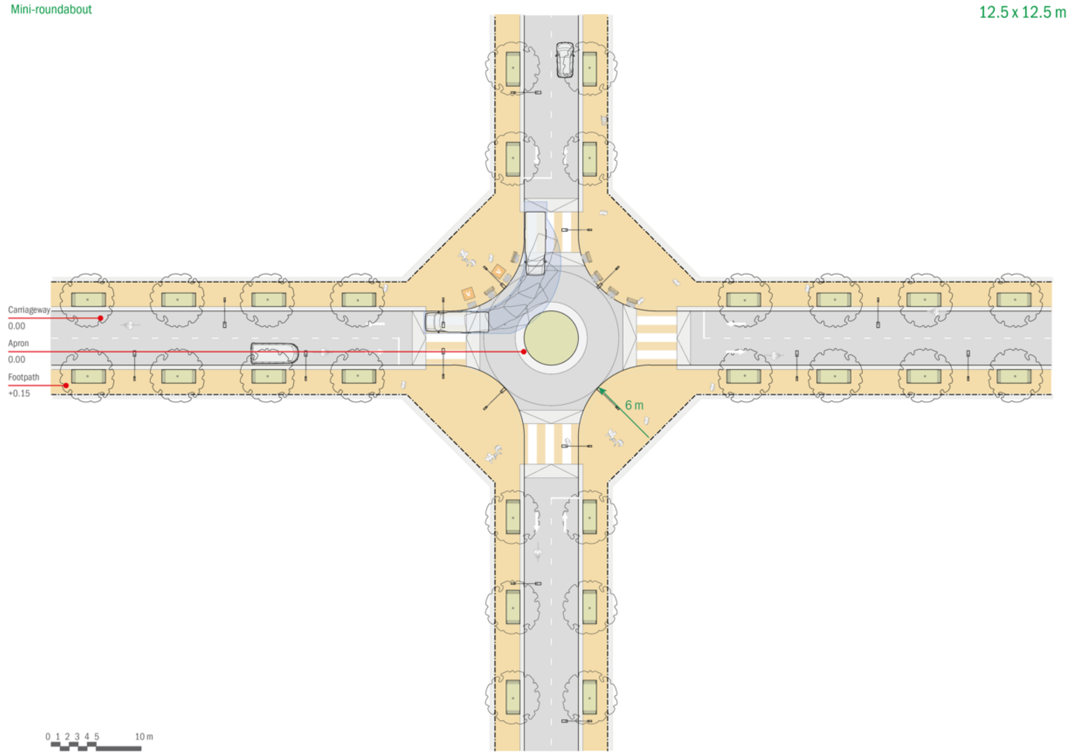
Cases where grade separation may be justified include BRT-only flyover to give priority to BRT buses, NMT-only bridge or tunnel connecting parks and greenways, and changes in elevations where people already go up or down.

DESIGN STANDARDS

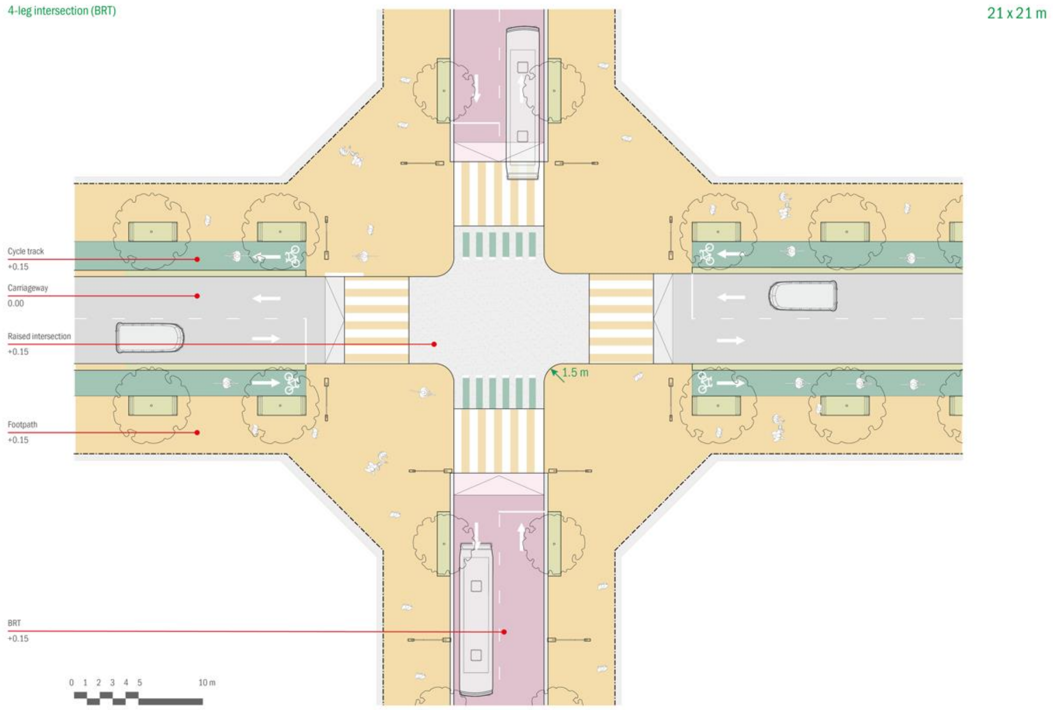
- The clear height under the grade separator shall be at least 5.5 m.

6.4 INTERSECTION TEMPLATES

6.4.1 4-WAY INTERSECTION 12.5 M X 12.5 M



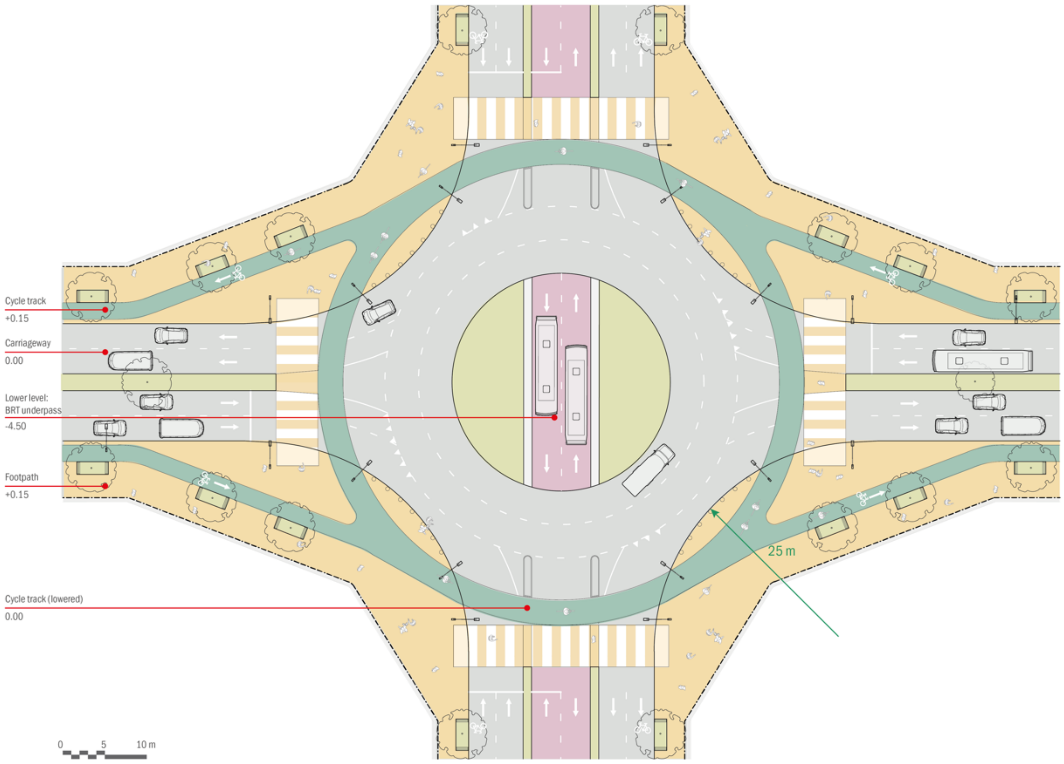
6.4.2 4-WAY INTERSECTION 21 M X 21 M



6.4.3 ROUNDABOUT 27.6 M X 27.6 M

Roundabout (BRT)

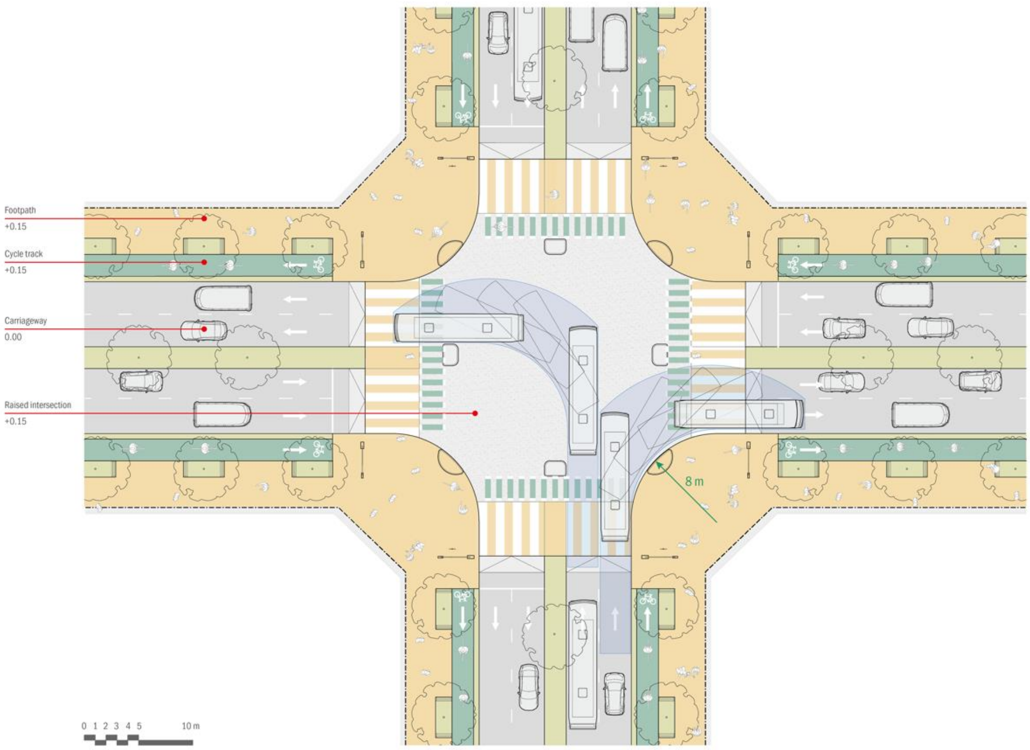
27.6 x 27.6 m



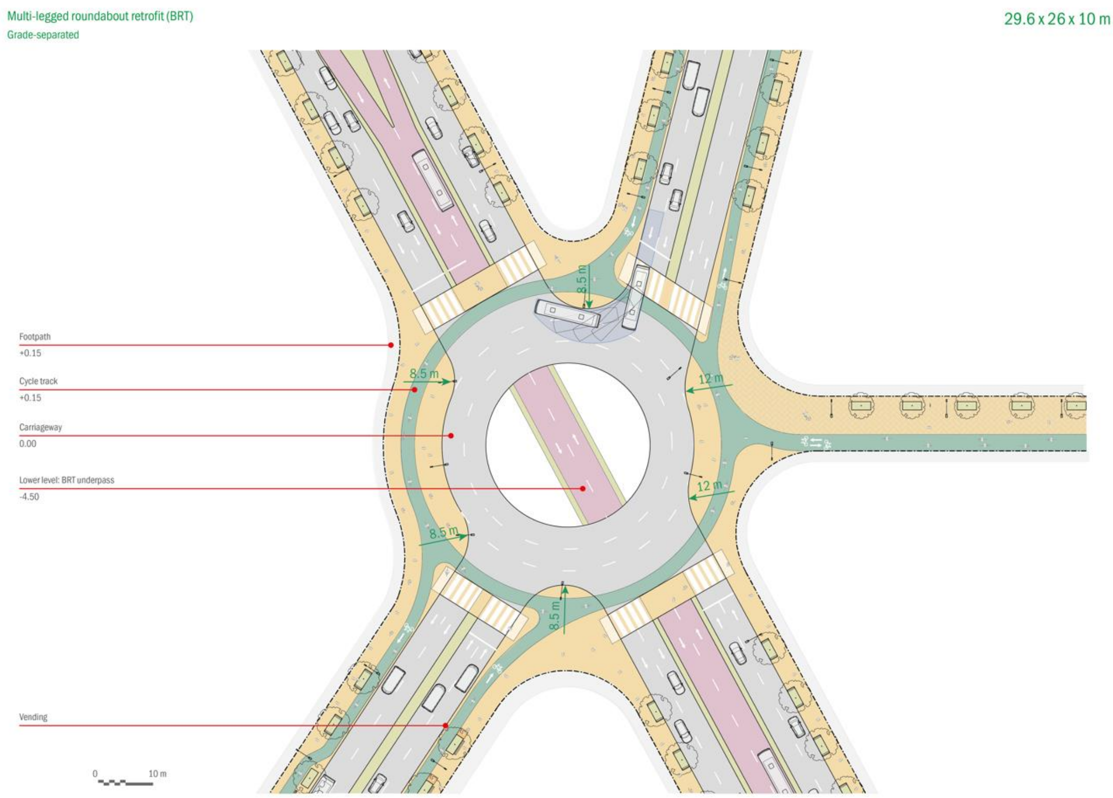
6.4.4 4-WAY INTERSECTION: 27.6 M X 27.6 M

4-leg intersection

27.6 x 27.6 m



6.4.5 MULTI-LEG INTERSECTION RETROFIT: 29.6 M X 26 M X 10 M



7. PLANNING, DESIGN AND APPROVAL PROCESS FOR STREETS

This chapter describes the process of designing streets in an urban environment. Connectivity and safety are key aspects to consider during a street design process. Creating an effective design involves analysing the existing conditions in the project area and then identifying design solutions to suit the local conditions.

The process of street design involves the following stages:

- Stage 1: Data collection.
- Stage 2: Concept designs.
- Stage 3: Design review and approval process.
- Stage 4: Final designs.
- Stage 5: Bills of quantities.

Figure 62. Stages of the design process.

7.1 DATA COLLECTION

At the onset of the design process, it is key that the designer consult relevant government agencies and gather data about street conditions. Such information may include the following.

City vision. It is useful to have a brainstorming session with city officials to understand their vision for the city. A workshop can be held to explore the best suited options to achieve the city vision while at the same time aiming for a comfortable, safe, and user-friendly street environment.

Review of existing transport and land use plans. The designer is required to compile spatial information existing transport plans, including master plans, BRT and public transport networks, cycle networks, pedestrian networks, and pedestrian zones Transport master plans provide a comprehensive framework for planning, development methods, challenges as well as suitable location for key developments. The designer should identify transport system goals that are stated in these reports.

Topographic survey. The purpose of a topographic survey is to collect data on the project site including all the existing features. The designer should supplement the topographic survey with information on underground utility networks obtained from the client.

Underground utility survey. It is necessary to conduct detailed surveys of underground utilities to establish the location of specific utility lines and determine whether relocation is necessary. These utilities may include lines for telecommunication, electricity, natural gas, water, and sewage.

Survey of land uses. The designer should compile land use information to help inform street design decisions. A land use survey must be carried out for every building in the study area. The land use analysis should note important activity generators, such as shopping areas, theatres, and housing developments. All land use data should be recorded using a GIS platform.

Stakeholder participation. Public participation is a requirement under the Constitution of Rwanda aimed at promoting transparency in decision making, facilitating public awareness, promoting public ownership of projects, and encouraging collaboration in governance processes. Public participation is, therefore, a key step in the street design process. The project team should inform the stakeholders of the planned developments and to seek their input into the designs. It is important to engage all key stakeholders including:

- Ministry of Infrastructure (MININFRA)
- Rwanda Transport Development Agency (RTDA)
- Local Administrative Entities Development Agency (LODA)
- Rwanda National Police (RNP): Traffic Police
- City of Kigali: City Engineering Department
- City of Kigali: Urban Planning Department
- Rwanda Environmental Management Authority (REMA)
- Rwanda Water Resources Board (RWB)
- Public transport operators
- Street vendors
- Business community
- Persons with disabilities
- Donor agencies and development partners
- NGOs
- Utility providers (e.g., water, electricity, telecommunications)
- Cycling community

NMT condition survey. Key to designing quality and effective NMT network is to have an in-depth understanding of the existing walking and cycling environment, and the extent to which it provides safe, convenient access for users. Street conditions can be captured using the smartphone application that records street characteristics. The designer can then clean, map, and analyse data from these surveys to inform street improvements.

Survey of NMT user movements. Information on NMT volumes on each street can help inform the design and sizing of pedestrian and cycle facilities. There are range applications available online which can be used for NMT counts, including Multiple Counter. NMT surveys should be disaggregated by gender, age, and disability.

Traffic counts. Data obtained through a traffic survey are necessary for intersection design and signal timing optimisation. The traffic survey quantifies vehicle movements, including non-motorised user movements. Classified volume counts should be conducted at mid-block locations and intersections, for a period of 24 hours for at least a typical weekday, Sunday, and Saturday. At least the following should be collected:

- Classified link counts (LCs) including pedestrians and cyclists on street links.
- Classified turning counts (TCs) including pedestrians and cyclists at intersections.

Counts can be conducted manually on site or by using video recording using cameras. The count should be categorised by vehicle type. To minimise the need for new data collection, existing classified traffic count data should be obtained from COK, RTDA, and other relevant agencies.

Origin-destination surveys. OD surveys for all street users including pedestrians can inform street designs. OD surveys can illustrate how improvements in the network can relieve pressure on specific street links and improve the efficiency of the overall transport system.

Parking survey. In most urban areas in Rwanda, parking appears crowded and chaotic in some areas, creating the impression of an overall shortage, yet there are often unused parking spaces within a reasonable walking distance. A parking survey reveals such imbalances, and appropriate measures can be included in the street design to improve parking efficiency on the street. A parking survey seeks to quantify current parking patterns in the project area by collecting data on the existing parking capacity and demand. The designer should conduct the following surveys:

- Parking inventory survey: The first step involves recording the number of parking spaces in on- and off-street facilities.
- Occupancy survey: The second step involves counting the number of vehicles parked on each street segment or off-street parking facility over the course of the day. These counts can be used along with the supply data gathered in the first step to calculate occupancy rates.
- Turnover survey: Turnover data can help determine what types of users are parking in a particular facility (e.g., all-day parking by officegoers, short-term parking by shoppers, etc.).

Street vending and related activities survey. The designer must document existing vending activity, including the type of vending and the physical typology of the vending structure (i.e., permanent or temporary structure). The location and characteristics of each vendor should be recorded using GIS. The survey also should capture social gathering spaces in the study area. This information will inform the placement of street furniture and other elements in the final design.

Analysis of crash data. The designer should obtain data from the police on traffic crashes over the past 3 years. The crash location, type, and users involved (i.e., pedestrian, cyclist, moto, car, bus, etc) should be mapped using a GIS platform. This information will enable the designer to identify major traffic safety "black spots" and suggest traffic calming, intersection modifications, and other interventions to improve safety for vulnerable street users.

Right-of-way. City management or relevant transport authorities (RTDA and MININFRA) may be in a position to provide the available right-of-way (ROW) widths.

Documentation of public transport and moto services. To document existing public transport routes and services, data on the public transport services within the project area should be collected and mapped. For Kigali, the bus routes are available from city authorities. All commercial motorcycle stands within the project area also should be mapped. The designer should gather additional information on planned public transport projects within the project area from relevant bodies, such as RURA and RTDA.

Consultation with utility providers. Any existing utilities within the project area should be identified during the early stages of design. Utility providers may have information on existing utility networks. Discussions with relevant utility providers should be held to agree on any necessary relocations or on the installation of a service duct. It is advisable to maintain communication with the providers as the design progresses and during project implementation. The designer should obtain any necessary approvals from utility providers for planned relocations.

7.2 TOPOGRAPHIC SURVEY

The surveys must cover all streets in the project area plus any intersecting streets up to a distance of 100 m from the intersection with the study area street. The survey should locate the following elements, each geocoded with X, Y, and Z coordinates. Each type of element should be on a different layer in AutoCAD:

- Main roads, sub-roads, and service lanes, as applicable
- Signals /road marks
- Intersection elements
- Roundabouts
- Medians / bollards /permanent barricades
- Compound walls and each access point/gate
- All utility (electricity, telephone etc.) poles/boxes
- Overhead high-tension lines
- Trees: to be indicated in 2 categories: above and below 30 cm of main trunk circumference
- Front facade of existing buildings/structures
- Footpaths/pathways including all kerbs and level differences.
- Kerbs
- Manholes

- Drains (covered and uncovered)
- Signboards/markings
- Service lines/cable ducts
- The difference in levels wherever it occurs.
- Establishing true/magnetic north point with respect to each location
- Establishing reduced/relative level for each item

Each map should be georeferenced with latitude, longitude, and height coordinates so that it can be combined with other maps on a GIS platform. Each element should be in a separate layer.

Figure 63. Sample topographic survey drawing.

7.3 TRAVEL DEMAND FORECAST

Traffic forecasts often overestimate traffic growth based on an assumption that future growth in the use of private motor vehicles is inevitable. However, urban travel demand patterns can be influenced through transport policies and investments. Public transport improvements, high-quality walking and cycling facilities, and parking management measures can all help to encourage a shift from personal vehicles to sustainable modes, thereby offsetting future growth in traffic volumes.

In Kigali, the 2020 Master Plan calls for measures to encourage the use of NMT and public transport. The City of Kigali aims to establish efficient public transport, integrated NMT infrastructure, and a network of green and pedestrian friendly streets. Through these measures, the Master Plan aims to achieve a 70:30 ratio of public transport to personal vehicle trips. Therefore, street designs should be consistent with these plans to prioritise public transport, walking, and cycling transport.

Travel demand forecasts should consider the following factors:

- ***Population growth***: Estimates of future population growth are available in master plans or from the National Institute of Statistics of Rwanda.
- ***Trip rate:*** The number of daily trips per capita is typically derived from household survey data and can be found in master plans or transport studies. The trip rate typically increases over time as incomes rise but is also affected by changing labour patterns, such as work-from-home arrangements.
- ***Mode split:*** Existing and future mode splits can be found in the urban mobility plan or master plan for the respective urban area.

Improvements in public transport and NMT facilities, a reduction in trip lengths due to transit-oriented development, and travel demand measures can all contribute to a reduction in the mode share for personal motor vehicles. Changes in the mode split can offset possible increases in travel resulting from growth in population and incomes.

The methodology for calculating the traffic growth is as follows:

1. Determine the initial traffic volume for each traffic class (m) using the results of the traffic survey and any other recent traffic count information.
2. Estimate the annual growth rate, i, expressed as a decimal fraction. The growth rate will be influenced by the following factors:
    a. Population growth
    b. Trip rate
    c. Mode shift changes, as outlined in the city's master plan.
3. For each vehicle class, estimate the traffic in the first year that the road is opened to traffic. For normal traffic this is given by

   $AADT_{m,1} = AADT_{m,0} \times (1+i)^n$
4. For each vehicle class, add the estimate for diverted traffic and for generated traffic if any are anticipated.

Example: Kigali travel demand. The population of Kigali is expected to increase from 1.5m to 3.8m by 2050, a 3.3 percent annual increase. Meanwhile, the ratio of public to private motorised modes is expected to change from 35:65 at present to 70:30 in the future. The corresponding mode share scenarios are shown in the table below.

Table 11. Mode split scenarios for Kigali (based on 70:30 public-private split for motorised modes per the Master Plan).

Mode share	*2021*	*2050*
NMT	52%	52%
Public transport	17%	34%
Moto taxi	16%	7%
Car	15%	7%

The trip rate is expected to increase at a rate of 1% per year. As a result, daily trips are expected to increase as shown in the table below.

Table 12. Daily trips in Kigali.

Mode	*2021*	*2050*
NMT	1,560,000	5,273,959
Public transport	510,000	3,407,789
Moto taxi	480,000	753,797
Car	450,000	706,684
Total	3,000,000	10,142,229

The resulting growth rates through 2050 are as follows:

- Total trips: 4.3 percent per year
- Public transport: 6.8 percent per year
- Private modes: 1.6 percent per year

These growth rates can be applied to traffic counts to determine future traffic volumes.

7.4 CONCEPTUAL DESIGNS

The designer should prepare detailed street designs for all streets in the Project Area. The design must be consistent with relevant plans, including plans for BRT networks, cycling networks, pedestrian networks, and pedestrian zones.

Street designs should offer easy and quick access to key public facilities such as schools, hospitals, bus stops, and markets. Adequate footpath space should be provided close to areas generating high pedestrian traffic volumes. Information on land uses in the project area and NMT user flows will inform the designer's decisions on the width of footpaths, location and sizing of pedestrian crossings, and other design elements. Junction designs and the width of the lanes should facilitate speed control for motorised traffic to enhance NMT user safety. Cycle tracks should be provided along axes identified in the city's cycle network plan. Facilities such as stations, or bus stops, necessary to support projected public transport passengers should be established and included in the designs.

Once typical cross sections are assigned, the various street elements should be captured in the concept layout plan. All street elements should be included in the conceptual plan, including mixed traffic lanes, public transport, pedestrian facilities, cycle tracks, bus stops, BRT stations (if applicable), vending kiosks, and landscaping. The concept design should be discussed with the city/district management and relevant national agencies for concurrence.

7.5 DESIGN REVIEW

For quality control and to ensure that the standards outlined in this manual are achieved in the design, the concept street designs should be submitted to the municipality/district or RTDA, which will share the designs with members of a street design review committee for comments. Concept street designs will be reviewed by the committee to confirm that they are aligned with city goals, street design principles, and design standards. Street design review committees should be comprised of the following members:

- Representative from MININFRA
- Representative from RTDA
- Representative from RNP
- City Engineer from the concerned municipality
- Chief of Urban Planning from the concerned municipality
- Representative from the social development unit of the concerned municipality
- Representative from REMA

The designer may be required to present the plans at a public stakeholder meeting. The designer should revise the conceptual design based on the feedback received from the Review Committee and other stakeholders. The revised conceptual designs must be submitted to the client for approval. Most of the reviews should be done at the conceptual stage.

7.6 FINAL DESIGNS

Following approval by the client of the conceptual designs, the designer will prepare detailed construction drawings. The designs should include geometric and vertical profiles and should incorporate drainage designs. The final working drawings must be submitted to the client for approval.

7.7 TENDERING

The final stage of the process is to prepare specifications, bills of quantities, cost estimates, and bid documents for the implementation of the proposed street improvements, including pavements, furniture, street lighting, landscaping, and other components. The designer should work with the Client to include appropriate mechanisms in the bid documents to facilitate long-term maintenance, such as annuity-based compensation of contractors.

Bill of quantities. To achieve complete street designs, the BOQ should incorporate the following items that are not conventionally included in road improvement BOQs:

- Footpaths

- Tabletop pedestrian crossings
- Cycle tracks
- Bicycle parking
- Street furniture
- Streetlights
- Bus stops and bus shelters
- Public toilets
- Landscaping

Cost estimates. The designer should prepare a detailed cost estimate for the project to guide the government during the tendering process.

7.8 INSTITUTIONAL ROLES AND RESPONSIBILITIES

Street design projects require input from multiple agencies, as outlined in the table below.

Table 13. Institutional roles in planning, design, and implementation of urban streets.

Agency	*Responsibility*
Ministry of Infrastructure	• Develop rules, regulations, and standards for the transport sector. • Manage the overall operations of transport sector agencies. • Allocate funding from the road maintenance fund and other sources to support urban street improvement projects.
Rwanda Transport Development Agency (RTDA)	• Regulate and maintain the national road network. • Provide capacity building to equip the sector.
Ministry of Local Government (MINALOC)	• Plan, develop, and maintain transport infrastructure and services within local authorities.
Rwanda Utilities Regulatory Authority (RURA)	• Regulate public utilities including transport of goods and persons by all modes of transport. • Ensure fair competition in the market. • Improve the standard of services offered to consumers. • Ensure that transport operators comply with applicable laws and regulations.
City Administrations / Districts	• Manage city-/district-specific functions related to transport planning and procurement and traffic management.
Ministry of Environment (MoE)	• Facilitate the introduction of environmentally friendly transport.
Road Maintenance Fund (RMF)	• Manage and distribute funds for maintenance of public roads.

Agency	*Responsibility*
Ministry of Interior (MININTER)	• Through the Rwanda National Police, enforce traffic laws and regulations and collect road traffic crash data.
Rwanda Development Board (RDB)	• Facilitate the involvement of the private sector in the provision of transport services.
Ministry of Information Communication Technology and Innovation	• Facilitate the integration and application of ICT in the transport sector.

8. DESIGN CHECKLIST

8.1 KEY DESIGN ELEMENTS AND APPLICABLE STANDARDS

Element	*Design standards*
Footpath	• Height of 150 mm above the carriageway. • Minimum 2 m clear width in all locations. • Wheelchair kerb ramps have a maximum slope of 1:12. • Bollards installed along the edge of the footpath to prevent driving and parking on the footpath. • At least one set of bollards with spacing of 1,200 mm. • The footpath surface is uniform and non-slippery, with slope of 1:100 to avoid water stagnation. • Tactile warning are strips located at transition points (e.g., mid-block crossings, intersections).
Cycle track	• Physically separated from the carriageway. • Elevated 100 mm above the carriageway. • Clear width ≥ 2 m for one-way movement; ≥ 2.5 m for two-way movement.
Property entrances	• The footpath remains at the same level through property entrances. • Bollards are installed on either side of each entrance to prevent driving and parking. • Property access is provided at a discrete location for each plot, with a maximum entrance width of 6 m
Mid-block crossings	• Pedestrian crossings at intervals of 100-150 m. • Crossings are raised to the level of the footpath with ramps for vehicles (minimum slope of 1:15) OR have kerb ramps at each end of the crossing. • Median refuge islands are provided at crossing points, with minimum dimensions of 2 m by 1 m.
Intersection	• Kerb ramps on all corners of intersections to provide wheelchair access to the footpath. • Median refuge islands with minimum dimensions of 2 m by 1 m on all arms with more than 2 lanes to cross. • Signalisation if any arm has more than 2 lanes to cross. • Pedestrian crossings are located along desire lines. • Turning radii are no more than 5 m.
Shade	• Tree pits least every 20 m.
Lighting	• No dark spots on footpath or carriageway.
On-street parking	• Parking is provided in parallel orientation rather than angled or perpendicular parking. • Car parking bay size is no more than 5.0 m x 2.2 m
Street vending	• The design includes designated spaces for organised street vending

8.2 KEY BASELINE DATA REQUIREMENTS FOR STREET IMPROVEMENT

8.2.1 EXISTING CONDITIONS ON SELECTED STREETS

Land use survey: Land use information should be compiled to assist in making informed decisions regarding street design. A land use survey must be conducted for every building adjoining the selected streets. If the ground floor use differs from the upper floors, this should be noted. The number of floors per structure should also be recorded. It is important to identify key activity generators such as shopping areas, theatres, and housing developments adjacent to the selected streets. All land use data should be recorded and documented using a GIS platform.

Survey of pedestrian facilities: The quality of existing pedestrian infrastructure should be documented for all streets in the study area. Key attributes to record include the clear width of the footpath on each side at intervals of every 200 meters (where present) and the presence of shade at 14:00 (from buildings or trees). These data should be geo-referenced and stored using a GIS platform. If cycle tracks are present, a similar assessment should be carried out to evaluate their condition and usability.

Parking survey: On-street parking surveys should be conducted to identify parking patterns and occupancy rates. Vehicle counts must be disaggregated by type and should cover both the selected streets and a buffer zone of 300–500 meters to either side. Surveys should be conducted during one morning peak hour and one evening peak hour on a typical weekday. The focus should be on on-street parking areas.

Street lighting survey: The level of night-time illumination should be assessed on each street, with lighting levels recorded at intervals of every 200 meters. This information is important for evaluating user safety and comfort during nighttime hours.

Survey of street vending and related activities: All vendors along the selected streets should be recorded. Information collected should include the type of vending activity, the physical typology of the vending structure (e.g. permanent or temporary), and whether the vendor causes obstruction to pedestrian or cycling movement. Additionally, the survey should capture informal social gathering areas and other public activities occurring within the right-of-way. The location and characteristics of each vendor and activity should be documented using GIS, including the number of people engaged. This data will support appropriate placement of street furniture and other public elements in the final design.

8.2.2 TRAFFIC COUNTS

Non-Motorised and Motorised traffic counts: Traffic count surveys should be carried out on each selected street to assess user flows during the morning and evening peak periods (three hours each) on a typical weekday. Survey locations should be carefully selected to capture the accumulation of pedestrian traffic, particularly at points where last-mile access routes connect to main corridors. Counts must include the number of pedestrians using and walking off the footpath (if available), as well as other NMT and Motorised vehicle flows. Prior approval of survey points is recommended to ensure comprehensive coverage.

8.2.3 TOPOGRAPHIC SURVEY

To support informed street-improvement interventions, a topographic survey should be conducted. All datasets should be clearly labeled, logically structured for efficient processing, and organized to allow rapid retrieval of relevant information. Each record must be georeferenced with latitude, longitude, and elevation coordinates to ensure full compatibility with GIS platforms and other design software.

- Roadway classification: Classification of road/street types, such as main streets, secondary streets, and service lanes.
- Intersection and junction features: Design elements including roundabouts and adjoining streets surveyed up to 50 meters from each junction.
- Medians and barriers: Includes medians, bollards, and permanent barricades.
- Right-of-way: Measurements taken at 15-meter intervals.
- Carriageway width: Recorded at 15-meter intervals.
- Footpath dimensions: Footpath width measured at 15-meter intervals.
- Paved surface width: Width of existing bituminous or concrete road surfaces.
- Bus stop infrastructure: Bus shelters, captured as polygon features.
- Traffic control and markings: All signals, signage, and surface markings
- Kerbs and boundaries: Includes kerbs and physical boundary demarcations.
- Access features: Compound walls and access points such as gates and entrances.
- Utility infrastructure: Above-ground (poles, cabinets, boxes) and underground elements (cable ducts, service lines for electricity, telecom, etc.).
- Power lines: High-tension overhead electrical lines.
- Landscaping elements: Trees categorized by main trunk circumference (≥ 30 cm and < 30 cm)
- Building frontages: Existing building facades and structures facing the street.
- Drainage infrastructure: Includes manholes and drains (covered and uncovered).
- Natural waterways: Adjacent features such as rivers, streams, or other natural channels.
- Bridges and culverts: Includes vehicle and pedestrian bridges, culverts, and underpasses/overpasses.
- Roadside ditches: Includes open drainage ditches and roadside stormwater channels.
- Elevation data: Relative or reduced levels (RL) and vertical differences for all surveyed items.
- Orientation reference: Establishment of magnetic or true north for mapping accuracy.

9. DEFINITIONS

Accessibility: Facilities offered to people to reach social and economic opportunities, measured in terms of the time, money, comfort, and safety that is associated with reaching such opportunities.

Average trip length: The average distance covered by a transport mode for a trip, measured in kilometres.

Bus rapid transit (BRT): High-quality bus-based mass transit system that delivers fast, comfortable, reliable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service.

Complete streets: Streets that are designed for all users, including pedestrians, cyclists, public transport passengers, and personal motor vehicles, including all modes of mobility as well as street vending, trees, street furniture, and other elements.

Greenway: A waterway or strip of land with exclusive facilities for cycling and walking.

Mobility: Conditions under which an individual can move in the urban environment.

Mode share: The share of total trips carried out by a particular mode of urban transport, such as walking, cycling, bus, moto, or car.

Non-motorised transport (NMT): Human-powered transport such as walking and cycling.

Nationally Determined Contribution (NDC): National pledge to reduce greenhouse gas emissions per the provisions of the 2015 United Nations Framework Convention on Climate Change Conference of the Parties in Paris.

Paratransit: Service operated by the private sector on a shared or per seat basis along informally organised routes with intermediate stops. The service may or may not have a predefined fare structure.

Public transport (PT): Shared passenger vehicles that are publicly available for multiple users. In this document, the term "public transport" is used to refer to paratransit and formal road-based public transport services.

Parking management: Pricing, enforcement, and other mechanisms used to guide parking operations to ensure the efficient use of street space.

Right-of-way (ROW): The width of the road, taken from the compound wall/property edge on one side of the road to the compound wall/property edge on the other side of the road.

School zone: All streets and greenways within a 200 m radius of a school.

Sustainable transport modes: The following modes are categorized as "sustainable modes" of urban transport because when compared with personal motor vehicles, they consume the least amount of road space and fuel per person-km and also entail lower infrastructure costs: walking, cycling, and public transport (including a regular bus service as well as BRT systems).

Traffic calming: Traffic calming measures ensure pedestrian safety by reducing speed and potentially also the volume of motor vehicles. Traffic calming slows down vehicles through vertical displacement, horizontal displacement, real or perceived narrowing of the carriageway, material/colour changes that signal conflict points, or the complete closure of a street.

Vehicle kilometres travelled (VKT): Vehicle kilometres travelled by all the personal motor vehicles (in a city) in one day.

10. ACRONYMS

AADT	Annual average daily traffic
ADT	Average daily traffic
BRT	Bus Rapid Transit
CoK	City of Kigali
REMA	Rwanda Environment Development Agency
RNP	Rwanda National Police
RTDA	Rwanda Transport Development Agency
RURA	Rwanda utilities regulatory agency
MININFRA	Ministry of Infrastructure
MRT	Mass rapid transit
NMT	Non-motorised transport
ROW	Right of way
RUSDM	Rwanda Urban Street Design Manual
VKT	Vehicle kilometres travelled

11. BIBLIOGRAPHY

City of Kigali. (2018). *Rwanda National Transport Policy.* City of Kigali. Retrieved from http://airqualityandmobility.org/STR/NMTStrategy_Rwanda_200402.pdf

City of Kigali. (2020). *Transport Plan.* Retrieved from https://bpmis.gov.rw/asset_uplds/kigali_master_plan/3_Kigali%20Master%20Plan_Transport%20PlanLowRes.pdf

GDCI. (2016). *Global Street Design Guide.* Retrieved from https://globaldesigningcities.org/publication/global-street-design-guide/

MININFRA. (2012). *Public Transport Policy and Strategy for Rwanda.* Kigali. Retrieved from https://rura.rw/fileadmin/Documents/transport/laws%20and%20order/Public_Transport_Policy_and_strategy_for_Rwanda_02.pdf

MININFRA. (2021). *National Transport Policy and Strategy for Rwanda.* Ministry of Infrastructure. Retrieved from https://www.mininfra.gov.rw/fileadmin/user_upload/Mininfra/Publications/Policies/Transport/NATIONAL_TRANSPORT_POLICY_AND_STRATEGY_APRIL_2021.pdf

NACTO. (2014). *Urban Bikeway Design Guide, Second Edition.* Island Press.

Paulo, S. (2015). *Municipality Technical Manual.* Retrieved from https://www.prefeitura.sp.gov.br/cidade/secretarias/meio_ambiente/publicacoes_svma/index.php?p=188452

Republic of Rwanda. (2012). *Official Gazette nº 04 of 23/01/2012.* Retrieved from https://www.rtda.gov.rw/fileadmin/templates/publications/Rwanda_Road_Act.pdf

Republic of Rwanda. (2015). *Official Gazette n◦ 20 bis of 18/05/2015.* Retrieved from https://gazettes.africa/archive/rw/2015/rw-government-gazette-dated-2015-05-18-no-20%20bis.pdf

Republic of Rwanda. (2017). *7 Years Government Programme: National Strategy for Transformation (NST1) 2017-2027.* Retrieved from https://www.nirda.gov.rw/uploads/tx_dce/National_Strategy_For_Trsansformation_-NST1-min.pdf

Republic of Rwanda. (2020). *National Land Use and Development Master Plan (NLUDMP).* Retrieved from https://www.environment.gov.rw/index.php?eID=dumpFile&t=f&f=10551&token=ef94f9c2e05dfb6b5e43acfdaaefa0dfe0071380

Republic of Rwanda. (2023). *2023 Rwanda Voluntary National Review.* Retrieved from https://hlpf.un.org/sites/default/files/vnrs/2023/VNR%20Rwanda%20Report.pdf

UNEP. (2018). *Kigali City Air Quality Policy and Regulatory Situational Analysis.* Retrieved from https://www.eci-africa.org/wp-content/uploads/2019/05/Final-Kigali_AQ-policy-situational-assessment_ECI_31.12.2018rev.pdf

World Bank Blogs. (2022, January 05). *Cutting Global Carbon Emissions: Where Do Cities Stand?* Retrieved from World Bank Blogs: https://blogs.worldbank.org/sustainablecities/cutting-global-carbon-emissions-where-do-cities-stand#:~:text=Cities%20account%20for%20over%2070,constructed%20with%20carbon%2Dintensive%20materials.