WRI MÉXICO

A BRIEF ON THE SAFE AND WALKABLE ENVIRONMENTS GUIDEBOOK

Urban design guidelines for the access to urban facilities and public transport in Mexican cities

ABOUT THIS GUIDE

The aim is to provide urban design recommendations for Mexican cities, with a focus on creating pedestrian-friendly and safe public spaces to enhance access to urban facilities. Spatial analysis is conducted for schools, parks, markets, and health centers to identify essential urban design elements and accessibility requirements for people. Subsequently, existing urban design guidelines are reviewed to extract, compile, and customize the primary guidelines about pedestrian infrastructure, green infrastructure, cycling infrastructure, public transportation, and traffic calming measures. Throughout this process, gender and social inclusion considerations are incorporated.

The guide provides general and introductory information for a non-specialized audience and is aimed at local decision-makers in the fields of urban development, public works, public space management, and mobility.

The guide was developed in coordination with the Government of the State of Jalisco, through the Ministry of Infrastructure and Public Works (SIOP), specifically through the Division of Architecture and Urbanism. They collaborated in defining this document, drawing on the expertise of personnel from the Research and Development Department and the Department of Streets and Maintenance of Metropolitan Works to create specific technical criteria and a comprehensive urban design perspective.

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EXECUTIVE SUMMARY

- The street is the essential public space for urban mobility, and its design determines the conditions for accessing and utilizing urban amenities and the city itself. Emphasis is placed on the sidewalk for promoting walking, connectivity to and from public transportation, and the incorporation of green spaces.
- The guide presents a proposal for walkable urban environments based on the concept of transit-oriented development, which promotes active mobility and public transportation, in conjunction with a focus on road safety and a perspective that considers gender and social inclusion.
- The environments around essential facilities such as schools, markets, parks, and hospitals are critical public spaces for accessing their respective services. Analyzing these spaces allows for an understanding of spatial dynamics and the specific needs of people, particularly in Mexican cities.
- By drawing from other urban design guides and the experience of WRI (World Resources Institute), there is an update and adaptation of pedestrian, green, cycling, public transportation, and traffic calming infrastructure design included in the guide.
- The guide provides basic information for individuals involved in the planning, construction, and maintenance of streets and public spaces

CONTEXT

In Mexico, urban development has been predominantly driven by road-oriented criteria that prioritize vehicular efficiency and speed. It is crucial to shift the paradigm of viewing streets as conduits for traffic flows towards seeing them as central public spaces in urban life, spaces for construction, and the exercise of citizenship (Delgado 2014). Understanding streets as spaces that also include bike lanes, sidewalks, public squares, and greenery leads to considering them as integrative elements for accessing goods and services and facilitating mobility at both the local and regional levels. Thus, having walkable urban environments promotes accessibility to amenities and the city as a whole.

INTRODUCTION

Cities are dialogues between elements of infrastructure (streets, buildings) and social dynamics (with diverse activities and people). Recently, there has been a growing interest in urban public spaces as key elements for democratization and equality in cities, in conjunction with the emergence of mechanisms to manage water and natural resources. Thus, they are nodal points where urban, social, and environmental challenges converge.

Globally, cities are currently undergoing significant processes of change. On one hand, there is a shift away from an expansive, disconnected, and gray infrastructure-oriented model of urban development that prioritizes individual motorized mobility, towards a people-centered vision. This includes a focus on improving quality of life, facilitating the use of sustainable transportation modes, and integrating green infrastructure to address current and future social and environmental challenges. On the other hand, urban populations worldwide increasingly recognize their diversity. This is evident in policies aimed at the inclusion of traditionally marginalized populations and changes in social discourse that incorporate issues of accessibility, poverty, and inequality.

In this regard, the transformation of cities is reflected in the design of public spaces, necessitating a review and update of existing urban design guidelines to enhance the mentioned changes and promote connectivity, accessibility, and inclusion. Additionally, in light of the COVID-19 pandemic, the need for open public spaces that allow for outdoor activities, both in productive and sustainable mobility senses, as well as recreational activities, has become even more essential.

CROSS-CUTTING CRITERIA

In this context, the following criteria are cross-cutting, signifying a responsibility and obligation on the part of individuals overseeing urban planning and the provision of mobility services within cities (Figure 1):

1. Transit-oriented development
2. Road safety
3. Environmental sustainability
4. Universal accesibility
5. Gender-based approach

Figure 1 | Cross-cutting criteria

Source: Authors.

STREET ELEMENTS

Streets require a systemic vision that ensures road safety for all. The shape of a city determines both the demand and supply of mobility, so it is necessary to generate joint processes of city planning and mobility. Therefore, when designing or redesigning streets and public spaces, it is essential to consider both current use and the medium and long-term objectives.

ROAD HIERARCHY

To manage speed, it is necessary to establish a road hierarchy associated with the function and context of the roads (Table 2). Roads with higher speed limits are typically used for long-distance transportation of people and goods. In local roads with more diverse usage dynamics and higher pedestrian traffic, speed limits are lower to ensure the safety of all road users, especially cyclists and pedestrians (Bogotá Mayor's Office 2019).

TURNING RADII

The maximum turning radius of a vehicle is defined by the radius of the corner in the curb and the number of lanes in both streets (SEDATU 2019). Likewise, the function and speed of operation in both streets (Table 3). "The basic principle of speed management when turning a corner is that the smaller the turning radius, the lower the vehicle's speed when entering a street, increasing pedestrian safety" (ITDP, 2011b).

Table 2| Classification of the road hierarchy associated with its function, maximum recommended speed and lane considerations

ROAD HIERARCHY	FUNCTION	GUIDELINES
Local street	Access to residential areas or local neighborhood streets, such as neighborhood shops or local commerce streets.	▪ 1 - 2 total lanes ▪ 2.8 - 3 m width; <=30 km/h
Connector street	Local road links to the primary road system. Lateral roads of controlled access highways or primary roads.	▪ 2 lanes per direction - 4 total lanes ▪ 3 a 3.5 m width; 30 km/h
Main street	Connection between regions and regional roads.	▪ 4 - 6 total lanes ▪ 3 a 3.5 m width; 50 km/h
Highways with continuous	They are the largest roadways, do not have traffic lights or speed bumps, and do not allow the circulation of motorcycles below 250cc.	▪ 4 - 6 total lanes ▪ 3 a 3.5 m width; 80 km/h

Source: Authors.

Table 3 | Recommended turning radii by type of use

TURNING RADIUS	USE
< 1.50 m	It should be used only when there is no turn at the corner.
3.0 m	Low-speed turns by private cars.
6.0 a 9.0 m	Moderate-speed turn by private cars; low-speed turn by medium trucks.
12.0 m	High-speed turn by private cars; moderate-speed turn by medium trucks.
15.0 m	Moderate-speed turns by heavy trucks

Source: ITDP (2011).

TRAVEL LANES

The street consists of longitudinal strips of the sidewalk and the roadway, and the latter is made up of lanes that are designed for the circulation of vehicles (SEDATU 2019). Below, we provide a reference table to identify the types of lanes with their use and associated guidelines (Table 4).

STREET LIGHTING

It is a fundamental public service as it allows people to move through public spaces at night, whether it is for commuting to work, school, shopping, leisure, socializing, or any activity that involves enjoying and using the streets (Buen et al. 2019). Therefore, the importance of having not only street lighting but also pedestrian lighting that illuminates the sidewalks is emphasized.

In December 2020, when identifying some type of problem in their city, Mexicans ranked insufficient public lighting second with 59.2 percent, according to data from the National Institute of Statistics, Geography, and Informatics (INEGI 2019).

Table 5 presents criteria for the spacing of pedestrian street lighting on sidewalks) and road lighting (for cyclists and vehicles):

Table 4 | Use and general guidelines by lane type

TYPE	USE	GUIDELINES
Travel lane	Circulation of all types of vehicles and modes.	▪ Width of 2.8 to 3.5 meters.
Bike lane	Bike lanes are protected from vehicular traffic by a raised buffer for the circulation of non-motorized or light vehicles.	▪ 1.80 m unidirectional. ▪ Buffer area of 0.6 m.
Shared cycle lane	Located on the far right, cyclists and drivers share the lane. It is wide enough to allow safe overtaking of cyclists by motorists.	▪ Width of 3.9 to 4.30 m ▪ 20 - 40 km/hr.
Priority cycle lane	Far-right lane that, due to its width, does not allow motorists to overtake cyclists.	▪ Less than 3.0 m of width. ▪ 20 - 30 km/hr.
Shared bus-bike lane	E xclusive lane on the far right with sufficient width for the simultaneous and/or passing circulation of buses and cyclists traveling in the same direction. Its implementation should be in corridors with low speed and frequencies (with intervals greater than 3 minutes).	▪ Minimum width of 5.0 m (3.5 m + 1.5m). ▪ Consider an additional 0.60 m of buffer. ▪ 30 km/hr.
Exclusive public transport	Located on the far right (does not include central BRT lane).	▪ 3.5 m minimum width. ▪ Recommended width of 4.0 m

Source: Authors, based on SEDATU (2019).

Table 5| Recommendation of public lighting installation by type of luminaire and number of lanes

TYPE	NUMBER OF LANES	HEIGHT	DISTANCE BETWEEN POLES	DISPOSITION
Pedestrian	Sidewalk	5 m	10 m	Alternating pattern
Vehicular	1 a 3	9 m	30 m	Unilateral
Vehicular	4 a 6	12 m	36 m	Bilateral

Source: Authors.

Costa Alegre, Jalisco

Guadalajara, Jalisco

STRATEGIC APPROACH:
USERS, SCALE OF STUDY AND FUNCTIONALITIES OF THE URBAN FACILITIES

Planning walkable urban environments involves recognizing and analyzing two relevant factors (Table 1): spatial scales and functionalities of the urban facilities.

Table 1 | General considerations for the planning and design of urban facilities considering the people as the center of the design process

CONSIDERATIONS FOR PLANNING AND DESIGN		KEY FACTORS THAT PRIORITIZE PEOPLE IN THE DESIGN PROCESS
DYNAMICS OF SPATIAL UTILIZATION AT VARIOUS LEVELS OF SCALE	**The facility**	▪ People who operate, manage, supply and maintain the facility. They travel to the facility permanently. ▪ Each facility has users with different age groups and frequencies of use. The most vulnerable population groups in terms of road safety are priority.
	Access and sidewalk	▪ The users of the facility, entering and leaving or occupying the street as a meeting place. ▪ Non-facility users such as merchants or police officers.
	The street	▪ Road users (transport, pedestrians, cyclists, motorists, taxi drivers, goods transporters, etc.). ▪ Other people related or not to the facility and who use the street for their various activities.
	The neighborhood	▪ Fixed or floating population. The composition, diversity and degree of mixing people largely determine the environment and identity of the locality.
FACILITY FUNCTIONS	**Users**	▪ People with different age groups and activities. They also vary in their frequent or constant users, and sporadic or random users. ▪ Workers and public authorities involved in the operation and management of different facilities also participate.
	Use and schedule	▪ Schedules during the day or days of the week when the facility and its surroundings have greater intensity of use.
	Transportation	▪ The types of activities and services offered in the area have a high influence on the dominant mode of transport for arrivals and departures.
	Safety	▪ Depending on the majority of users by type of facility, their level of vulnerability and need for both road and personal safety varies.
	Integration	▪ The facility generates influence on uses and activities in its surroundings, therefore it is important to maintain active spaces and functions in adjacent uses.
	Particularities	▪ The functions of the facility in some cases require considerations related to handling material, logistical operations and/or aspects of access or protection of users.

Source: Authors.

SCHOOLS

They vary from compact typologies located in high land-use areas (such as historic or town centers) to distributed organizational typologies (like campuses) with multiple buildings and intermediate open spaces.

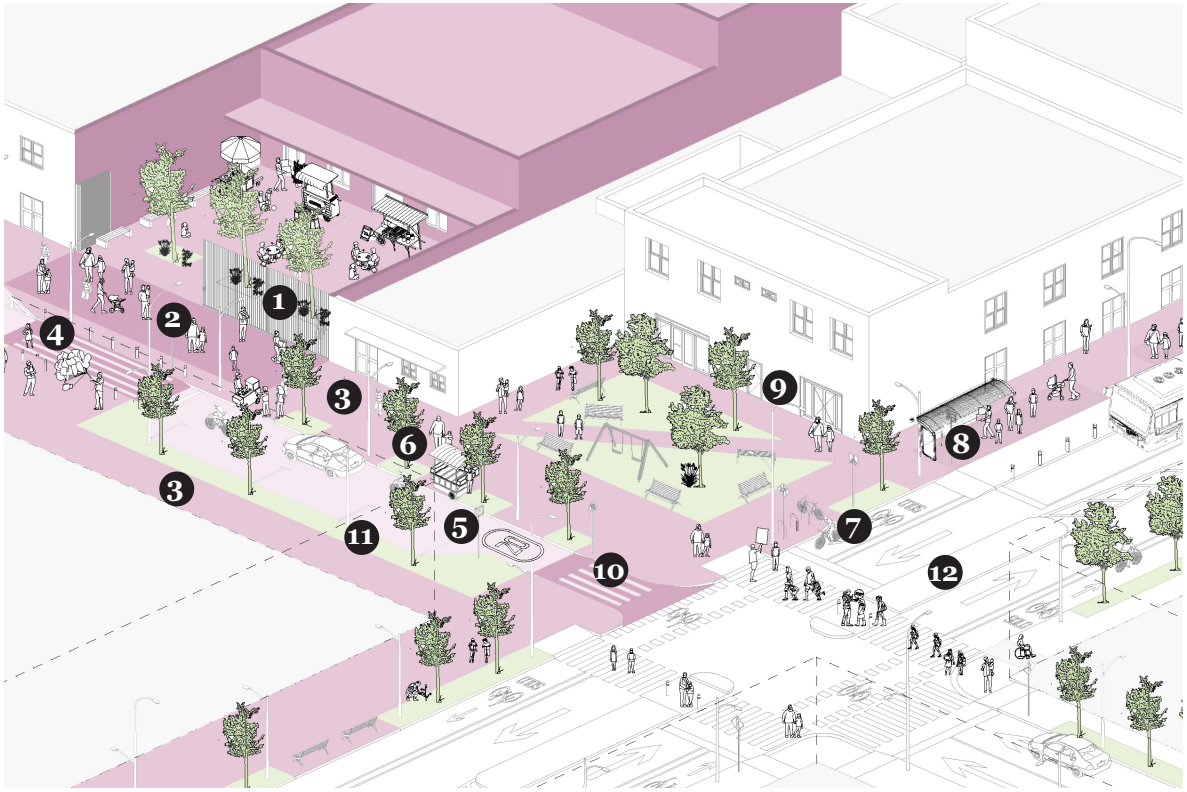
Design considerations:

- Schools typically have morning, afternoon, and evening shifts with established entry and exit times, which are moments of concentrated people at the entrances.
- Consider students of different ages, teachers, administrative and security staff, and cleaning personnel. In schools for young children, also consider the parents, or guardians of the students.
- Elementary schools typically serve the local neighborhood population, so many people arrive on foot. Middle or high schools often serve a regional community, so many people will arrive by public transportation or car.
- School bays go nearby the access but without obstructing pedestrian crossings.

SCENARIO AFTER INTERVENTION (FIGURE 2)

1. **A permeable facade:** allows for the identification of the building as a school.
2. **Obstacle-free and shaded access:** as a waiting area and for bike parking.
3. **Widening of sidewalks:** in the proximity of the school, at least up to the nearest public transport stop.

Figure 2| Urban design proposal for a safe school environment



Source: Authors.

4. **Raised pedestrian crossing and pinchpoint:** if there is a parking lane.
5. **Signage and pavement markings:** for controlling vehicular traffic at a maximum speed of 20 km/h.
6. **An area designated for commerce:** in the sidewalk's furniture and vegetation zone, interspersed with trees.
7. **Cycling infrastructure:** protected or shared lanes.
8. **Transit stops:** with clearly marked areas that provide safety during the day and night.
9. **Active ground floors:** with uses that cater to the needs of school users.
10. **Raised crossings:** to reduce speed.
11. **Continuous tree strip:** to prevent pedestrian crossings in sections not designed for it.
12. **Traffic calming infrastructure:** at intersections within a buffer zone around the school.

PARKS

Parks are often located at street corners or occupy entire blocks and their design allows access from multiple points.

Design considerations:

- A wide range of users, including children, youth, adults, vendors, tourists, and people with pets, frequent the park. It is regularly used by older individuals, as well as children who have flexible leisure time; both groups may face difficulties in access. Women accompanying these groups are also frequent users. Despite their widespread use, parks are often not adapted for people with disabilities. The immediate environment significantly influences its daily use (office workers, vendors), and its level of attraction can generate local or regional tourism.
- The are facilities with the highest accessibility and flexibility of use, and most of them are open 24 hours. Typically, their usage increases after office hours or on weekends.
- Neighborhood parks are typically visited on foot. However, there will be parks that are visited by tourists or people from other regions, making their connectivity with the rest of the city important

SCENARIO AFTER INTERVENTION (FIGURE 3)

1. **Shared sidewalk-level streets** in front of the park to enhance the flow of people between different destinations around the park
2. **Widening of sidewalks:** surrounding the park for to accommodate functional zones and reorganization of commerce.
3. **Public bus bays:** near the park that ensure the main pedestrian crossings remain unobstructed.
4. **Signage, surface, and pavement markings:** that communicate the presence of the park and the maximum allowed speed.
5. **Road diet:** that discourages vehicular flow and lowers vehicular speed.
6. **A wayfinding system:** that promotes walking between different destinations in the neighborhood.
7. **Vegetation:** both inside and around, enhancing pedestrian conditions for all.
8. **Cycle share station:** to promote active mobility for both residents and visitors.
9. **Pedestrian-scaled lightning:** along with urban amenities such as garbage bins, benches, and water fountains.

Figure 3 | Urban design proposal for a safe park environment

Source: Authors.

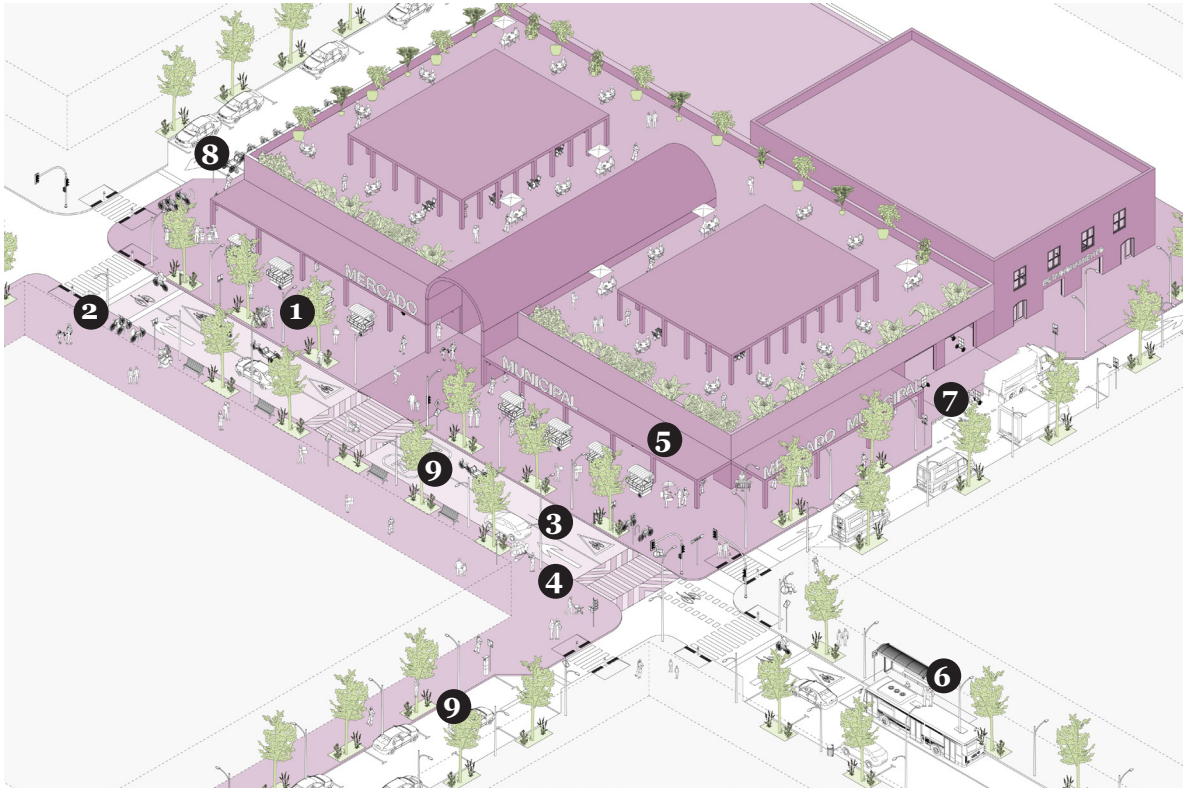
PUBLIC MARKETS

Public markets are typically open every day of the week and are buildings that occupy an entire block or a significant portion of it.

Design considerations:

- They are often close to other businesses, thus they depend on their logistical efficiency for loading and unloading products.
- Traders, suppliers, and consumers, who engage in their activities in addition to local workers, tourists, or merchants from other businesses who source their goods.
- Activities and operations occur daily, with more visitors during the weekends. The supply of goods typically takes place in the early morning hours.
- In neighborhood markets, many users arrive by foot or transit. When purchases are larger than what one person can carry, the use of a car is preferred. Since the majority of users are adults, they have a high level of navigational and environmental interpretation skills. However, carrying purchases, as well as for elderly individuals, can affect agility.
- There is a significant flow of goods transported by bicycle between the market and its surroundings.
- They are a cultural space in the city, and the historical identity and the type of goods-sold in each market are fundamental to its operation.

Figure 4 | Urban design proposal for a safe public market environment



Source: Authors.

SCENARIO AFTER INTERVENTION (FIGURE 4)

1. **Conversion of parking into access areas and free pedestrian circulation.**
2. **Bicycle racks for parking.**
3. **Pedestrian and cyclist priority street:** with mixed traffic and a maximum vehicle speed of 20 km/h.
4. **Sidewalk extensions and raised crossings:** for a prioritized pedestrian crossing and speed reduction around the market.
5. **Weather protection for pedestrians.**
6. **Public transportation stops near the market.**
7. **Side street with areas designated for loading and unloading goods and unloading bays.**
8. **Exclusive bays:** for bicycles, tricycles or cargo devils and cargo motorcycles.
9. **Public parking:** on nearby streets.

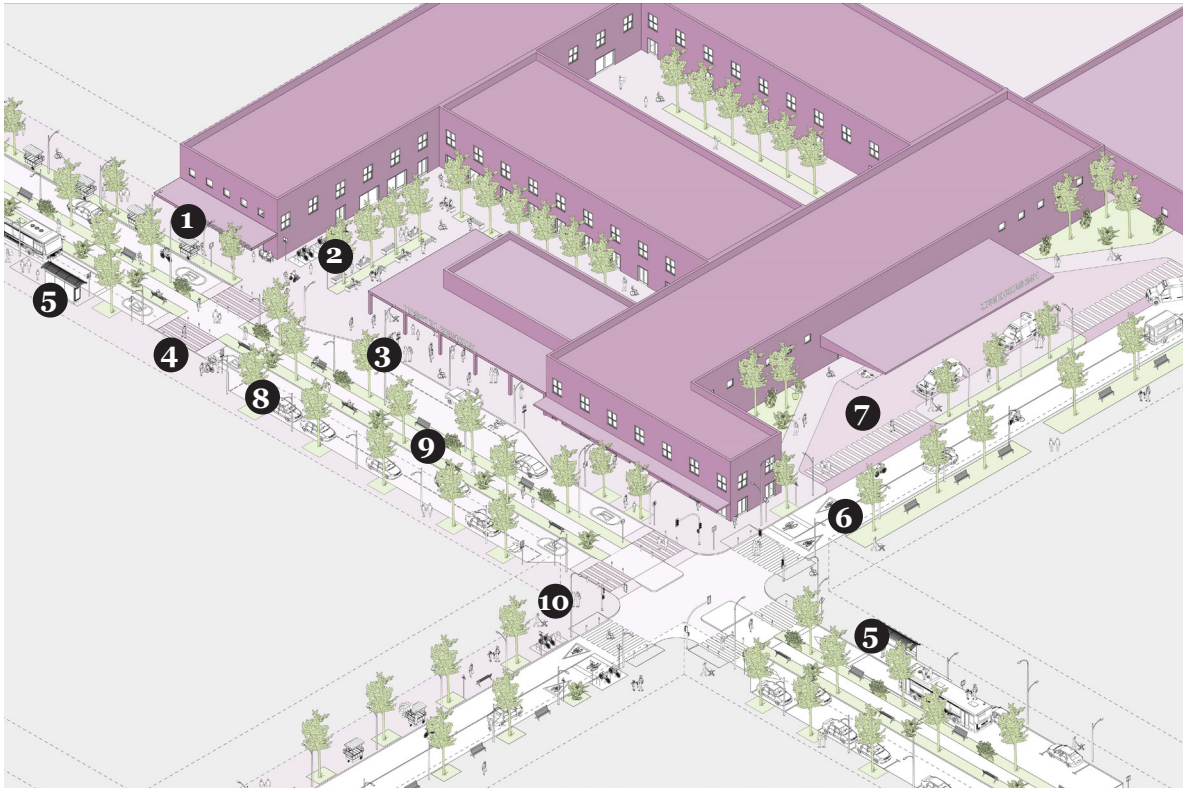
HEALTH CENTERS

They consist of administrative areas, consultation rooms, treatment facilities, and storage areas. Typically, their perimeters become waiting or gathering zones and generate activity on sidewalks and adjacent areas.

Design considerations:

- They serve people of all ages, with some having physical or mental illnesses or disabilities. It is common to find individuals in wheelchairs, using crutches, older adults with canes, or mothers with babies or children. They are attended by medical and healthcare personnel, administrative staff, cleaning personnel, and security personnel, many of whom spend long hours in these facilities.
- Typically, there is activity every day of the week and around the clock.
- Users of emergency services often arrive by vehicle (private, public, or ambulance). Patients coming for consultations or treatment use public transportation, private vehicles, or taxis. Staff members normally use public transportation or private vehicles, and there may be incentives to encourage walking or biking to the facility.
- They typically offer differentiated access to outpatient services, emergency care, staff, supplies. There are also loading and unloading areas for maintenance vehicles, specialized equipment and handling substances.

Figure 5 | Urban design proposal for a safe health center environment



Source: Authors.

SCENARIO AFTER INTERVENTION (FIGURE 5)

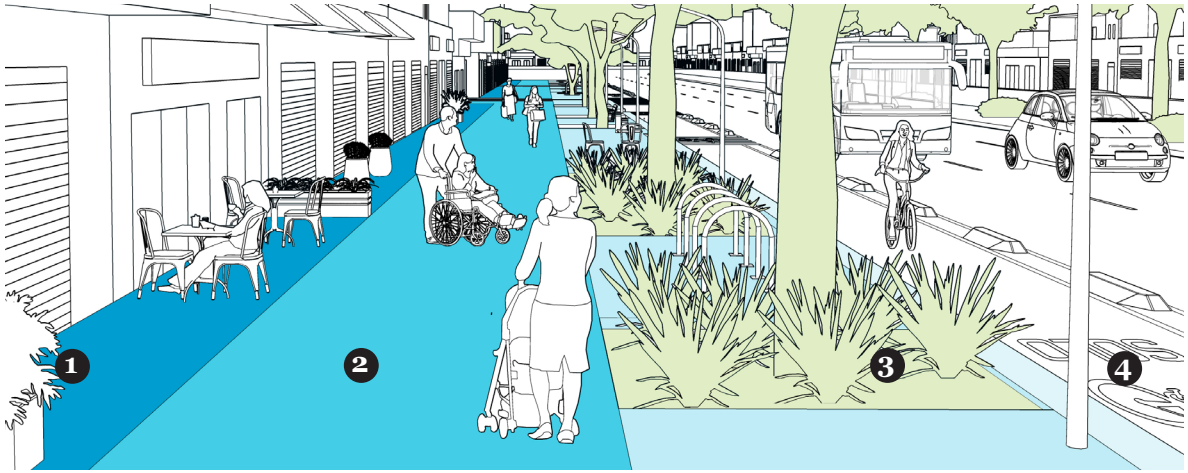
1. **Sidewalk widening:** commerce only in the street furniture/vegetation zone.
2. **Permeable facade and public square.**
3. **Bay for patient drop-off and pick-up**
4. **Raised pedestrian crossing.**
5. **Public transport stops.**
6. **Cycle facilities, protected or shared.**
7. **Exclusive ambulance access:** with vehicle access ramps only on the furniture zone.
8. **Curb extension and dedicated taxi parking:** combined with road narrowing.
9. **Road diet and reorganization of median as linear park:** along with improved-crossings at intersections.
10. **Universal accessibility:** with ramps and a pedestrian crossing width suitable for the hospital's heavy foot traffic.

SIDEWALK ZONES

The sidewalk is made up of longitudinal zones (Figure 6) and minimum dimensions must be considered for quality (Table 6).

1. **Frontage zone:** gives access to properties, to place vegetation, to operate doors or windows; it can also accommodate furniture for business operations.
2. **Pedestrian through zone:** for the continuous, obstacle-free pedestrian circulation.
3. **Street furniture and vegetation zone:**
   - **Vegetation:** sections without pavement are maintained for their growth and for the absorption of rainwater (SEDATU 2019).
   - **Street furniture:** and for public transport stops (SEDATU 2019).
   - **Infrastructure:** it houses lighting, electricity cables, internet, traffic control devices, among others (SEDATU 2019).
4. **Curb:** construction element that delimits and creates a difference in level between the sidewalk and road (SEDATU 2019).

Figure 6 | A complete sidewalk with all sidewalk zones



Source: Authors.

Table 6| Minimum sidewalk sections by sidewalk zone

SIDEWALK WIDTH	FRONTAGE (M)	PEDESTRIAN THROUGH ZONE (M)	STREET FURNITURE AND VEGETATION (M)	CURB (M)
Minimum	Does not apply	1.80	0.80	0.15
Average	0.45 – 1.60	2.40 – 3.00	1.50 or more	0.15 – 0.30
Width	3.00	3.20 or more	1.50, 3.00 or more	0.15 – 0.40

Source: Authors, adapted from Global Street Design Guide, NACTO, 2021 and from the Ministry of Infrastructure and Public Works of Jalisco, 2021.

SLOPES, VEHICLE ACCESS, PEDESTRIAN RAMPS, SIGNAGE, REST AND COMMERCIAL FURNITURE

DESIGN GUIDELINES

1. Only straight ramps with a minimum width of 1.80 m and slopes between 6 and 8 percent will be used (SEDATU 2019); with a 0.30 x 1.20 m tactile warning strip or textured pavement (GDF 2016). Layed out according to the pedestrian desire line whenever possible, or as close to the corner, based on the turning radius (GDF 2016).

2. Maximum cross slope of 2 percent for storm drainage (Government of the Federal District - GDF 2016).

3. Maximum longitudinal slope between 4 and 8 percent to solve unevenness (GDF 2016).

4. Spacing of 3.0 m between successive commercial stalls.

5. The stalls must not obstruct corners and intersections, so they should be placed 15.0 m from the building wall corners if they are large stalls or 3.0 m if they are small (Welle et al. 2015).

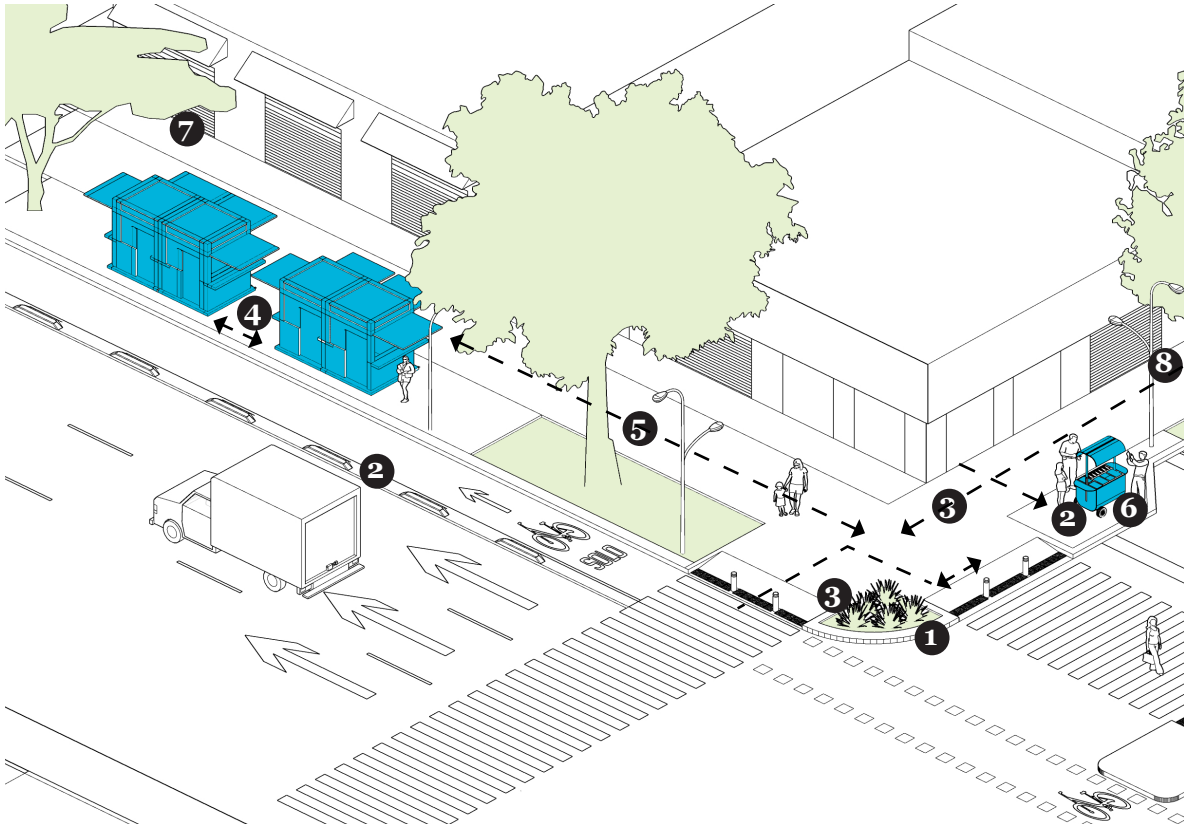
6. When there is not enough space on the furniture strip and and conditions do not allow to expand the sidewalk, a parking space can be taken to locate businesses.

7. Vehicular ramps with a maximum slope of 12 percent. They are placed only in the furniture and/or frontage zones or at a maximum of one third when there are narrow sidewalks (GDF 2016).

8. Directional signage with a height of 2.5 m below the sign; directory with neighborhood information at a height of 0.90 m and 1.80 m to achieve legibility for a small person, in a wheelchair or a person standing up (SEDATU 2019); maps with information on relevant points within a walking distance radius expressed in 5, 10 and 15 minutes.

Figure 7 graphically shows the application of the recommended guidelines.

Figure 7 | Design guidelines of pedestrian infrastructure



Source: Authors, adapted from Welle (2018).

PEDESTRIAN AND SHARED STREETS

Pedestrian streets prohibit vehicular traffic, except for emergency vehicles and delivery trucks, which can travel very early or at night (Welle et al. 2015).

Shared streets are pedestrian or semi-pedestrian priority. They form a section at the same level and achieve vehicle speeds of 15 km/h. Fixed objects such as flower pots or bollards are used, with the option of forming a zigzag (Welle et al. 2015).

Both types function as "pedestrian shopping centers" and must be attractive, safe and convenient. To this end, activities on the ground floor of buildings are encouraged. They are applicable in areas of intense pedestrian activity, such as commercial or mixed-use corridors, access corridors to stops or transport stations with high demand, along the seashore, river or lake, parks, baseboards or schools (Welle et al. 2015).

CONSIDERATIONS

- Aim for speeds of 15 km/h (Welle et al. 2015).
- Clusters of benches and small gardens increase appeal and experience (Welle et al. 2015).
- 2% slopes for stormwater drainage.
- Design elements can be used to improve the pedestrian environment such as street furniture, vegetation, pavement texture, material and pattern, and street lighting (Welle et al. 2015).
- Residue recolection.
- Removal of obsolete furniture and/or obstructions.
- Maintenance of green areas.
- Surveillance cameras and panic buttons.
- Rehabilitation of facades.

DESIGN GUIDELINES

- Leave 3.2 m to 3.5 m free for the passage of cargo vehicles, services and emergencies.
- Separation between bollards of 1.50 m.
- For pedestrian streets, a raised pedestrian crossing which crosses intersecting streets allows for the continuity of pedestrian circulation and reduces vehicle speeds.
- In shared streets, it is recommended to change the material, texture or color in the separation strip between the shared lane and pedestrian circulation to indicate the change of zones.

Box 1 | Inclusion and gendered perspective

Keeping the different uses of the space at the same level promotes accessibility for people with disabilities and caregivers – generally women – with luggage, strollers, etc. (Judge 2011; Alamdari and Habib 2012).

Source: Authors.

Guadalajara, Jalisco

Guadalajara, Jalisco

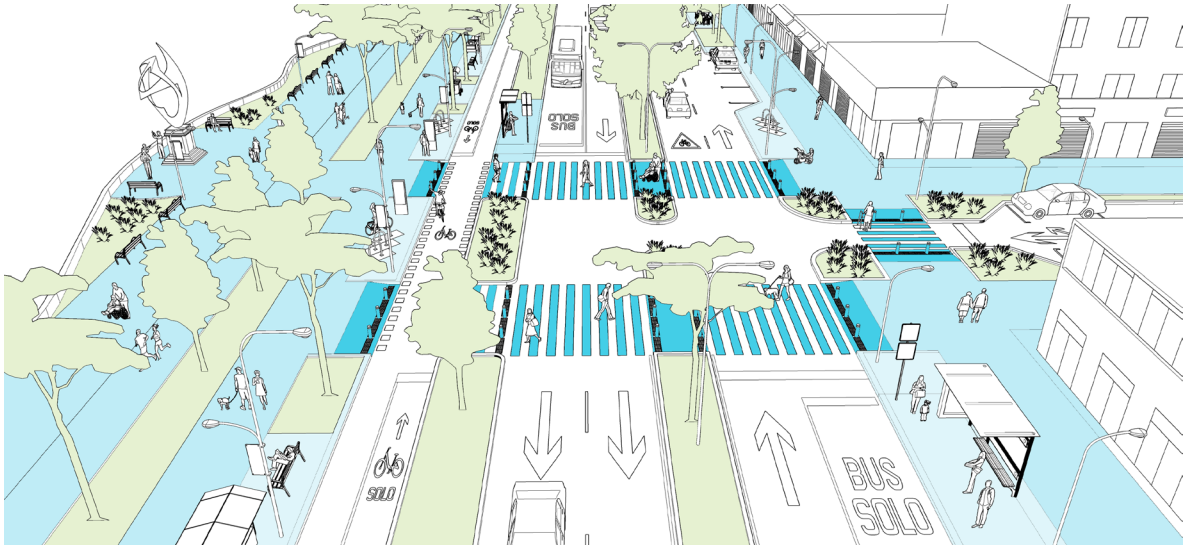
WATERFRONTS

Waterfronts have retaining walls that are built along the coast and there is a pedestrian circulation along it. Considering the design of adjacent streets permeates their area of influence and the visibility of the public space to the adjacent neighborhoods, inviting more people to use it and enjoy it (NACTO 2021).

DESIGN GUIDELINES (FIGURE 8)

- According to the context, milestones should be designed to reinforce the identity and enjoyment of the boardwalk. They can be monuments, children's games, amphitheaters, exercise equipment, among others.
- Continuous pedestrian walkway, minimum 9.0 m wide, but may vary depending on expected demand and local conditions (NACTO 2021). Paved sections will consider the use of permeable materials to reduce the need for storm drainage (NACTO 2021).
- Include pedestrian lighting with a mounting height of 5.0 m. Consider the use of informative signs about events, traditional festivals or information about the tide and preservation of the area (NACTO 2021).
- Rest furniture facing the water with materials that prevent excessive conduction of heat or cold.
- Tartan running track 1.20 m wide.
- Minimum 1.50 m of continuous strip of trees, which helps define circulations, in addition to providing shade, comfort and a barrier against winds. Consider the use of rainwater collection techniques.
- 2.10 m strip of trees and furniture for various services, such as bicycle parking, pedestrian signage systems and stalls, interspersed with trees.
- Bidirectional recreational cycle path with a width of 2.40 m. It must be differentiated from the pedestrian section by material, texture or color.
- Median or pedestrian islands between the cycle path and the vehicular lanes (NACTO 2021). This median can accommodate space for transport stops.
- Signposted pedestrian crossings. They can be solved with straight ramps at the level of the vehicular stream; with an elevated speed bump at one of the intersections (at an intersection or in the middle of a block) or as an elevated intersection.
- Minimum 2.5 m median with landscaping that calms traffic and allows pedestrian crossing at parts. Consider the use of rainwater collection techniques.
- Pick-up and drop-off and/or parking bays along the boardwalk.
- The sidewalks are expected to have high commercial activity. Consider a minimum of 3.60 m width of the pedestrian circulation strip, plus a minimum of 1.50 m of tree strip.

Figure 8 | Waterfront design example



Source: Authors.

Guadalajara, Jalisco

Guadalajara, Jalisco

GREEN INFRASTRUCTURE

ROAD VEGETATION

The tree strip must be kept unpaved to facilitate its growth and allow the absorption of rainwater (SEDATU 2019).

- Individual planter: individual planters should be as large as possible, with recommended dimensions of 1.5 m by 3.0 m to ensure tree health (City of Boston 2013). Minimum width is of 0.08 m.
- Continuous planter: allows the vegetation strip to be unpaved, interrupted only by vehicular accesses and other eventualities. The minimum optimal width is 1.5 m, but it increases considerably according to the road hierarchy of the site.
- The combined planting of trees, shrubs and herbaceous plants is desirable.
- 1 tree every 8 meters is desirable for healthy growth.

PERMEABLE PAVEMENTS

It is an important technique for capturing and infiltrating rainwater and for increasing the permeable surface in cities. Infiltrating rainwater crucially reduces flooding.

- Some pavements that are applicable are: ecocrete for vehicular sections, adopasto for parking lots and modular paving stone or cobblestones for local or historical center roads.

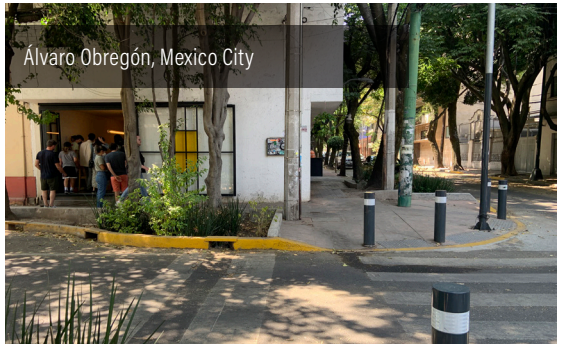
RAIN GARDEN

They are gardens with cavities with the aim of "forming a lower level than that of the adjacent surfaces to capture and infiltrate rainwater" (IMPLAN Hermosillo 2019).

- The selection of vegetation should consider native species and water tolerance.
- Consider water inlet and outlet; sediment filter; filter strip; mulch; micro-basin; substrate layer; drainage layer and geotextile.
- Other green infrastructure techniques that can be applied to the roads are bioswales, flow-through planters and pervious strips; these can be applied in curb extensions, chicanes, pinchppints, medians and along the vegetation zone in the sidewalk.


Guadalajara, Jalisco


Benito Juárez, Mexico City


Álvaro Obregón, Mexico City

CYCLING INFRASTRUCTURE

Four key components of cycling infrastructure are:

- **Segregated one-way cycle lanes with segregation elements:** This is an exclusive street section marked on the pavement and buffered with confinement elements.
- **Segregated one-way cycle lane defined by parking:** This is an exclusive lane physically separated from vehicular traffic by a parking lane.
- **Intersections:** these are spaces where road users in different modes of transportation or opposing directions meet. The goal is to regulate and organize these encounters to prevent traffic incidents and reduce conflict .
- **Bicycle parking:** urban furniture that secures the frame of a bicycle and at least one or both wheels. They are permanently located on the roadway, sidewalk, or access area of a property. They are essential for promoting and facilitating the use of this mode of transportation.

CONSIDERATIONS

- Bicycle lanes should be for exclusive use and located on the right side.
- Driving on medians is not recommended.
- Driving against the flow of traffic is not recommended.
- Vertical signage is important, with informative elements to indicate the existence of bike lanes, as well as restrictive elements that prohibit vehicle parking or motorcycle traffic (Cancino et al. 2018).
- Consider a network design and connectivity with other bike lanes and modes of transportation.
- Consider the lighting along the routes to ensure road and personal safety.

Box 2 | Inclusion and gendered perspective

- Consider the minimum width of 1.8 m to allow the circulation of a greater variety of bicycles and suitable passing conditions.
- It is also important to include rest stops that are strategically located, covered and with signage along the cycling routes.
- To encourage travel planning, it is suggested to make information available about routes with segregated infrastructure and other relevant data in an open, free, and accessible, for example, in GBFS format.

Source: Authors.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DESIGN GUIDELINES

1. **Preferential start:** the bike-box is the area where bycycles stop when there is a red light, is a rectangle with a length of 4.0 m and the width being the first two lanes of circulation.

2. **Motorist right turn and cyclist crossing:** when there is a segregated bike lane, the cyclist crossing is marked. The length is from one side to the other at intersections; and in the case of parking entry, the width of the vehicular access is plus 1.5 m. When the crossing is more than 5.0 m, consider using road studs.

3. **Left turn cyclist:** as cyclists travel on the right side of the road, it is difficult to move to the far left lane to turn. A smaller bike box can fit in the existing space after the pedestrian crossing to achieve a two-movement waiting area for left turns.

4. Visibility and eye contact at corners between cyclists and motorists is allowed if ground cover and/or vegetation with a maximum height of 0.60 m is placed.

5. Unidirectional lane width of 1.80 m plus 0.60 m of buffer area.

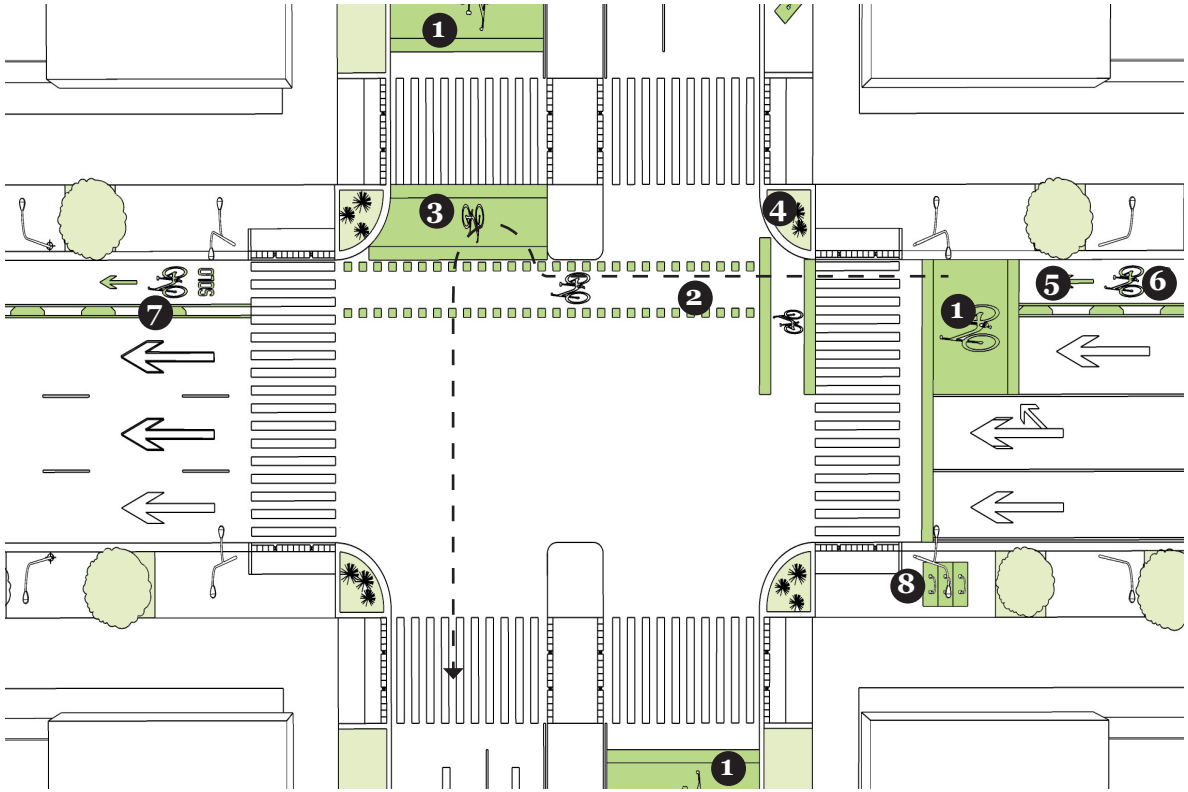
6. The optimal segregating element is the trapezoidal one of 1.80 m long, by 0.40 m wide and 0.13 m high (height can vary depending on the hierarchy of the road). The inclined part is placed towards the bike lane and the straight one towards the road. The segregating element is placed from the stop line and with a separation of 2.0 m (SEDATU 2019).

7. The confinement element is placed up to 3.50 m before and after the intersection from the building's walls; it can be combined with a folding bollard to achieve the dimensions (SEDATU 2019).

8. Bike parking should consider an area of 0.80 m x 2.0 m (ITDP 2011b); be placed 3.0 m from corners and walls, vehicular accesses and buildings (GDF 2016); and 1.5m from other urban furniture, and 1.0 m from registers and trees (ITDP 2011b). The location can be perpendicular or parallel to the sidewalk, as well as at 30 or 45 degrees (ITDP 2011b) and 0.8 m from the curb.

Figure 9 graphically shows the application of the design guidelines for cycling infrastructure.

Figure 9 | Design guidelines for traffic light-regulated Intersections



Source: Authors adapted from ITDP (2011b).

BUS INFRASTRUCTURE

The bus stops must have vertical and horizontal signage, with parking restrictions for vehicules (Figure 10).

- The boarding and alighting platforms on the sidewalk must be free of any obstruction, covering at least each bus door.
- They must not obstruct the pedestrian circulation strip of minimum 1.8 m wide.
- The vertical signage must have the bus pictogram, name of the stop, origin and destination of the route, fare and a contact number for attention or complaints.
- Provide a bench for resting and a roof to cover from the sun or rain. It is ideal to place the bus stop near trees to reinforce climatic protection.
- It is ideal to provide transparency in the backrest, have adjacent or own lighting, and have a panic button.
- If there is perpendicular advertising, place it in the opposite direction of the bus approach.

BUS STOP TYPE 1

Vertical signage at 0.30 m from the curb.

BUS STOP TYPE 2

They are a good option on narrow sidewalks. In case of advertising, install parallel to the street.

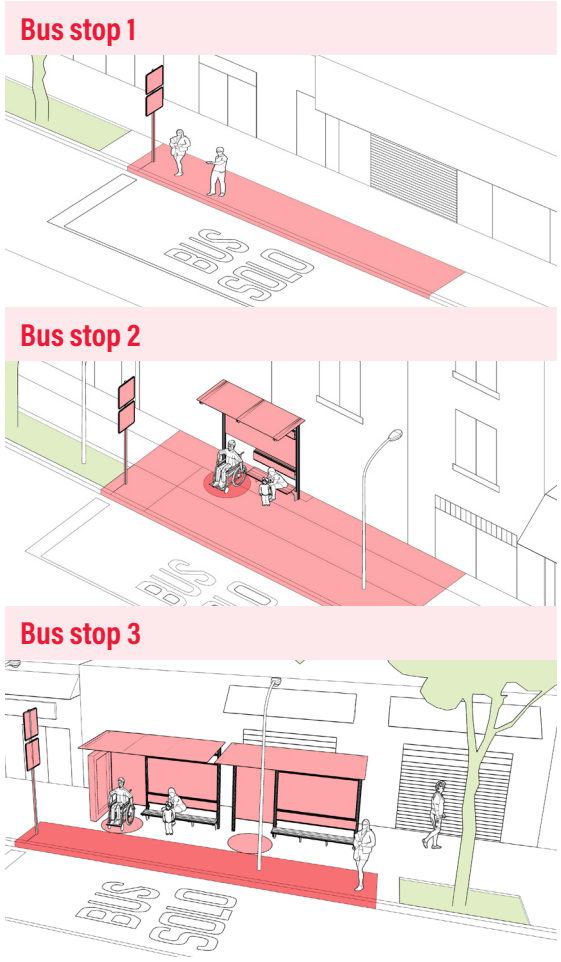
- Roof width in cantilever of 1.50 m; length of 3.0 m and height of 2.50 m.
- Bench with length of 1.50 m by 0.45 m wide and free space of 1.50 m for waiting area for people in wheelchairs. Recharge: 1.50 m long, 0.25 m wide and 0.75 m high at the lowest part, and 0.90 m at the highest, with an inclination of 30 degrees.
- Leave 0.30 m free towards the facade strip for cleaning and maintenance.

BUS STOP TYPE 3

Two or the necessary bus stops can be placed according to the expected demand.

1. Parabus with width 1.50 m; height of 2.50 m and length of 4.20 to 4.50 m.

Figure 10| Types of bus stops



Source: Authors.

BUS BULB

Curb extensions are applicable for public transportation stops when there is on-street parking. The platforms must cover the pick-up and drop-off areas, which correspond to the bus doors.

BUS STOP WITH ADJACENT CYCLING LANE

These are applicable on roads where public transport service is offered and there is cycling infrastructure. A geometric solution to these convergences of users is that of a public transport stop with a shared pedestrian-cyclist area; this is achieved by raising the cycle lane to the level of the sidewalk, thus creating a curb extension for the loading and unloading of passengers (ITDP 2011b).

BUS BAYS

They are implemented in places where buses are required to leave the traffic lane, usually on high-speed avenues (NACTO 2016), (Table 7).

- **Closed bay:** for stops in the middle of the block. It is formed by a includes a stop area for buses and a deceleration and acceleration area (Transport for London).
- **Open bay:** placed before or after an intersection, so that the side lane functions as a deceleration area and becomes the bay itself (Transport for London).

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Table 7 | Bus bay dimensions by vehicle type

BUS STOP LOCATION	12 m	12 m x2	18 m	18 m x2
Before the intersection	30.5 m	44 m	36.5 m	56 m
After the intersection	27.5 m	38 m	30.5 m	50 m
After the intersection (with turn to the right)	42.6 m	42.6 m	49 m	70 m
At mid block	36.5 m	56 m	45 m	64 m

Source: Authors based on NACTO (2013).

BUS STOP LOCATION (FIGURE 8)

BEFORE THE INTERSECTION

- Locating a stop before the intersection allows the boarding and alighting of passengers near the pedestrian crossings. It should be considered when the destinations of interest to users are closer to this location.
- It allows people to get on and off while the bus stops at a red light (Secretaría de Movilidad, s. f.).
- Consider the case of right turns to leave enough space for the types of vehicles that pass through.
- However, when buses stop, conflicts with vehicles' right turns increase.
- Stopped buses can block the view of crossing pedestrians.
- They can block the flow when it stops and subsequently stops at the traffic light and when there are more than two buses in line.
- Consider the stopping platform from 3.0 m from the pedestrian crossings to have visibility at the intersection (NACTO 2013).

AT MID BLOCK

The mid-block stop location is applicable if the block is very long and warrants an intermediate stop or if important destinations are located in the middle section (City of Boston 2013).

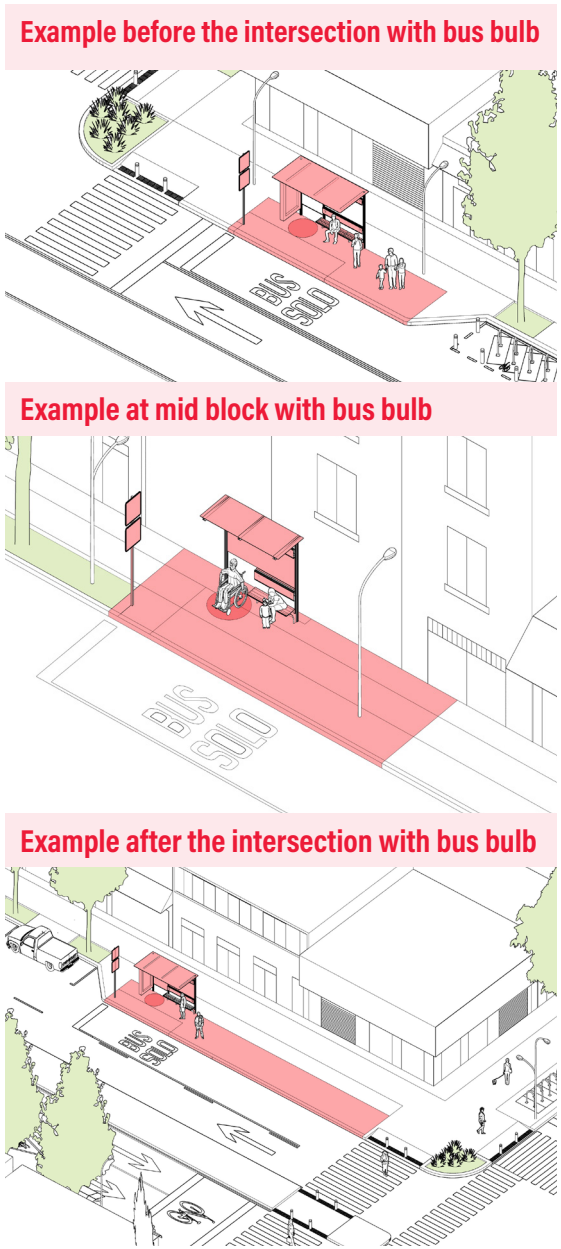
- It is applicable when there is a stop with medium or high demand and there may be several buses in line (City of Boston 2013).
- Place horizontal pedestrian crossing signage, as it encourages pedestrians to cross in the middle of the block. Combine with median on four-lane roads or two-lane arterial roads (Welle et al. 2018).

AFTER THE INTERSECTION

It allows pedestrians to cross more safely behind the bus, which is safer than crossing in front (NACTO 2013).

- Minimizes traffic conflicts at intersections with right turns.
- Makes the crosswalk visible to motorists waiting before the intersection (City of Boston 2013).
- However, points where there are several passing routes are not recommended, because it would require more space.
- They can block the intersection at rush hour, with buses lining up for the stop (City of Boston 2013)
- They can cause conflicts, as drivers do not expect buses to stop again after a red light (City of Boston 2013).

Figure 8 | Bus stops at diferent locations



Source: Authors based onCity of Boston (2013) and NACTO (2013).

TRAFFIC CALMING INFRASTRUCTURE

In the design and redesign of streets, it is important to change the paradigm from moving vehicles to moving people. This is a priority for the equitable redistribution of space.

ROAD DIET

It seeks to eliminate or reduce the width of vehicle or parking lanes to make room for segregated cycling infrastructure, medians, widen sidewalks or for an exclusive public transport lane. Applicable on any road hierarchy.

MEDIAN

"The medians are barriers in the central part of the roads that separate the directions of traffic" (Welle et al. 2018). The width and design vary, and it is possible to find everything from minimal sections to boulevards with vegetation (Welle et al. 2018).

- It is possible to incorporate pedestrian walkways, with special attention to the design of intersections (Welle et al. 2018).
- Consider the inclusion of vegetation and stormwater management techniques (Welle et al. 2018).
- Minimum recommended dimension of 2.5 m, although it is always better to include a median than not to include it.
- Solve level changes through same-level crossings or straight ramps."

SPEED HUMPS AND RAISED PEDESTRIAN CROSSINGS

They are trapezoidal-shaped road elevations that allow for the reduction of vehicular speed (Welle et al. 2018) and are leveled with the adjacent sidewalk (Table 9).

- It's necessary to contemplate a water evacuation system, which can be small gutters on the sides that will have to be covered with metal grids if pedestrian crossings are expected.
- Do not apply on roads with more than 2 percent flow of heavy freight and/or passenger vehicles" (CONASET 2010).

Table 9 | Guidelines for trapezoidal speed reducers

SPEED LIMIT	20 km/ hr	30 km/ hr	40 KM/ HR	50 KM/ HR
Development	4.00 m	4.00 m	4.60 m	5.20 m
Ramp	1.07 m	1.50 m	2.50 m	3.00 m
Height	0.15 m	0.15 m	0.15 m	0.15 m
Ramp slope	14%	10%	6%	5%

Source: Authors, adapted from Technical Street Design Standard for the Municipality of Morelia (2018).

CROSSWALKS

Crossings mark the area where pedestrians are exposed to vehicular traffic. Ideally, pedestrians should not cross more than three lanes continuously.

- Optimal width of 4.0 m but consider increasing according to pedestrian capacity.
- Vehicle stop line 1.20 m before the pedestrian crossing with a width of 0.60 m.
- Install vertical signage and place adjacent or nearby lighting.
- Install audible traffic signals.

PEDESTRIAN SAFETY ISLANDS

"Pedestrian refuge islands are short medians in the middle of the road section to provide a safe space for pedestrians crossing at intersections or halfway through a block" (Welle et al. 2018). This is so that people do not cross more than three lanes in one movement.

- It is recommended to use reflective materials, as well as horizontal and vertical signage of pedestrian crossings and warning signs.
- They can be complemented with chicanes, pinchpoints and other traffic calming measures (Welle et al. 2018).
- Recommended for pedestrian crossings without traffic lights (Welle et al. 2018).
- The "nose" is essential in a pedestrian island, which protects pedestrians. Its radius is associated with the turning radius of the site.
- The optimal minimum width is 2.5 m and a total length of 12.0 m.
- Consider a minimum pedestrian crossing width of 3.0 m and bollards at 1.5 m between them.
- Green infrastructure elements can be included for rainwater management.

ROUNDABOUT

They are central islands located in the middle of an intersection that generate a change in the previously straight trajectory of vehicles, creating a circular flow in one direction. They are useful in intersections without traffic lights with four or more arms, with the need for left turns, to reduce speeds, or to locate turning points.

- In single-lane roundabouts, leave 4.6 m from the corner to the tangent of the central island (NACTO 2013).
- They must include signage to indicate the approach to a mini-roundabout (Welle et al. 2018).
- In single-lane roundabouts, the lane is shared with all modes, so it does not require special treatment for bicycle traffic.
- It allows for the integration of vegetation and/or rainwater retention techniques.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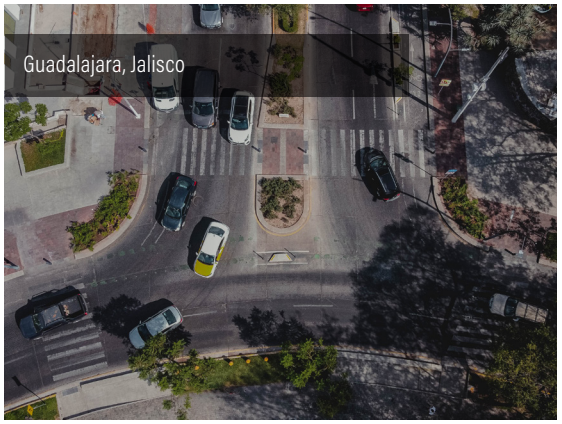
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CURB EXTENSIONS

GATEWAY

The shorter the pedestrian crossing distance, the less exposure to road events. In parking lanes, the curb extensions allow this, making pedestrians more visible without reducing or affecting vehicular traffic lanes. In addition, the speed of turning vehicles is reduced.

- Consider the dimensions of the road at the beginning and end of the movement to determine the turning radii (Sanz 2008).
- Width of the parking lane (2.5 m). 3.5 m straight from the end of the pedestrian crossing or bike box and then an inflection point begins at 45 degrees.
- Allows the integration of rain garden retention techniques with vegetation with a maximum height of 0.60 m

PINCHPOINT OR CHOKERS

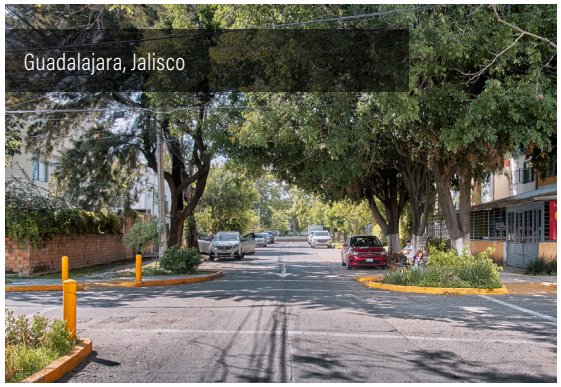
They are placed in parking lanes, and reduce speeds due to the perception of narrowing of the road, without necessarily affecting the traffic lanes.

- They are appropriate on streets with little traffic where vehicular circulation is moderate or low (Welle et al. 2018).
- Its design can be with extension of only one or both sides (Welle et al. 2018).
- If there is a segregated bike lane, locate the bike path between the road narrowing and the sidewalk (Welle et al. 2018).
- 45 degree angle with parking lane width (normally 2.5 m).
- Minimum length (road side) of 3.0 m or 5.0 m if there is pedestrian crossing. If there is no pedestrian crossing, landscaping elements such as trees, rainwater management techniques or urban furniture can be used.
- Can be combined with elevated crosses (Welle et al. 2018).

CHICANE

Offset curb extension that form zig-zag lanes (Welle et al. 2018). “A simple approach is to alternate parking spaces one side and then the other on single-lane streets” (Welle et al. 2018).

- 30 degree entry angle; length (road side) from 1.0 to 6.0 meters; length (sidewalk side) equals the length of the road side plus the angles of entry and exit; exit angle of 45 degrees.
- Circulation lane of 3.5 m.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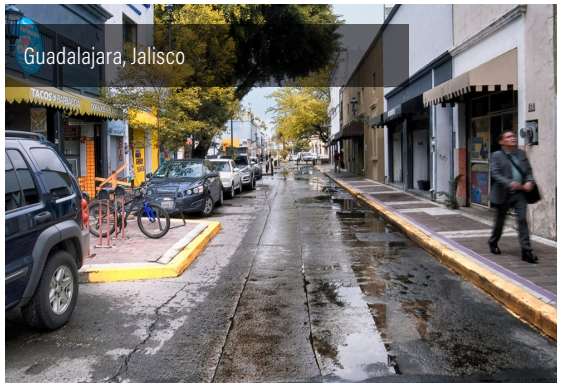
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CONCLUSIONS

The guide to walkable environments presents recommendations from the perspective of pedestrians and cyclists, recognizing the importance of the street as an articulating axis of public life and urban traffic. The following are central approaches and important reflections product of the development of this document:

- The public budget for urban mobility is mainly intended for roadways, and for this reason, it is important to consider both motor vehicle traffic (cars, public transportation, services, and cargo) and people who use active modes of transportation (walking and cycling).
- Although the habitability perspective has been gaining ground, there is a need to disseminate these criteria throughout the territory, particularly in medium-sized and small municipalities.
- Addressing of the issue from public policy perspective, budget considerations, binding mechanisms for local adoption, culture, and the context of administrations that often change is still pending.
- It is the duty of planners and implementers to reposition walking as a neighborhood-scale mode of transportation, key to accessibility to facilities.
- Sidewalks should be considered priority infrastructure in streets, with longitudinal design free of obstacles and that includes a vegetation strip.
- The street network can also allocate space for green infrastructure that will enable cities to face present and future environmental challenges. Urban heat islands can be tackled with permeable surfaces and vegetation that retains humidity.
- Cycling infrastructure is the most lagging in Mexico; however, our cities have the possibility of transforming transportation paradigms, decision-makers, and citizens to incorporate it and create more equitable, healthy, and sustainable cities."
- Standardizing public transport stop design guidelines can greatly dignify the service. Factors such as the walking distance and physical condition to the stop, geometric and conditions of a stop, the existence or condition of a bus shelter, materials used, or access to information contribute to generating user confidence and encouraging their preference for public transport.
- The budget dedicated to road infrastructure is a great opportunity to change the shape of cities. Reducing speeds, as well as dealing with intersections and crossings on arterial roads, is essential to increase the habitability of urban environments and preserve the lives of all people.

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