



Safer Streets, Safer Cities in Bihar

Street design guidance to mainstream women's mobility and access



Acknowledgements

We would like to thank Advait Jani, Senior Manager-Road Safety at World Resources Institute, Christopher Kost, Director-Africa Programs at the Institute for Transportation and Development Policy and Michael King, Progenitor-Traffic Calmer for reviewing the street design guidelines. We are indebted to the C3 team and especially Madhu Joshi, Devaki Singh and Gunjan Bihari for their time, regular reviews, engaging discussions, field work support and encouragement throughout the study.

Authors: Sonal Shah and Rithvika Rajiv

Contents

Context.....	1
Principles.....	5
Street network.....	7
Street network and location of amenities.....	10
Street typologies and the land-use context.....	12
Street elements.....	19
Footpaths.....	20
Cycling infrastructure.....	22
Carriageway, speeds and traffic calming elements.....	25
Pedestrian crossings.....	29
Bus stops.....	31
IPT Stands.....	33
Street vendors.....	34
On-street parking.....	36
Street lighting.....	38
Utilities.....	38
Trees and other shading devices.....	40



Storm water drainage	41
Dust bins	43
Seating.....	44
Bollards.....	45
Signage.....	47
Advertising.....	48
Compound wall	50
Blind corners and dead spaces	51
Public toilets and nursing (breast-feeding) rooms	52
Role of the Police.....	53
Street design templates	54
ROW 9 (one way)	54
ROW 12.....	55
ROW 15.....	56
ROW 18.....	57
ROW 24.....	58
ROW 30.....	59
ROW 36.....	60
Intersections.....	61
Signal phasing.....	62
Street design process	63
Street design cell.....	65
Reference publications.....	65

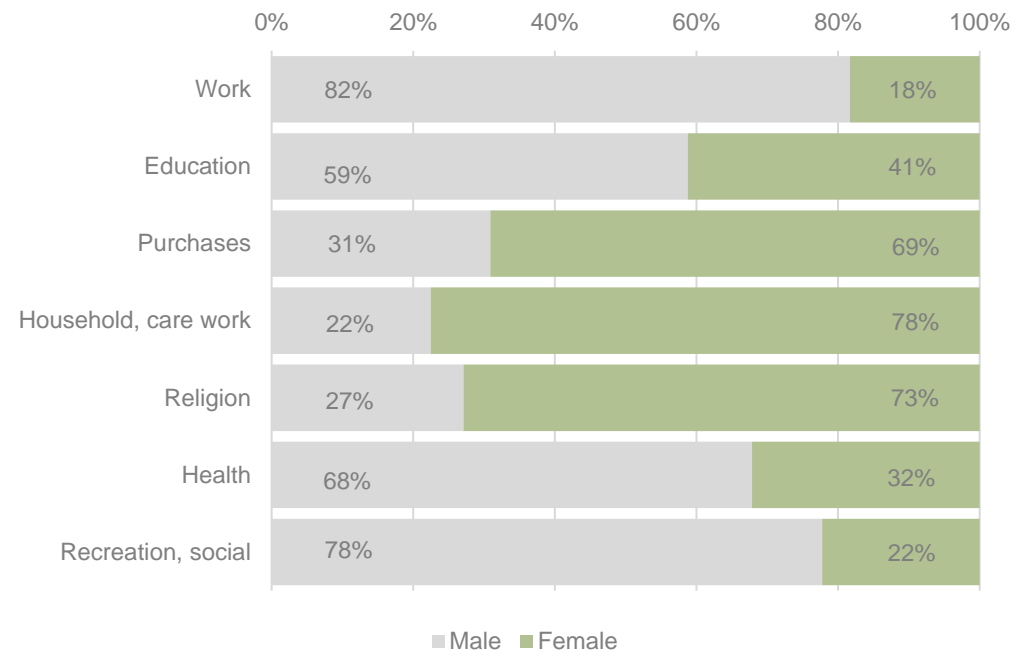
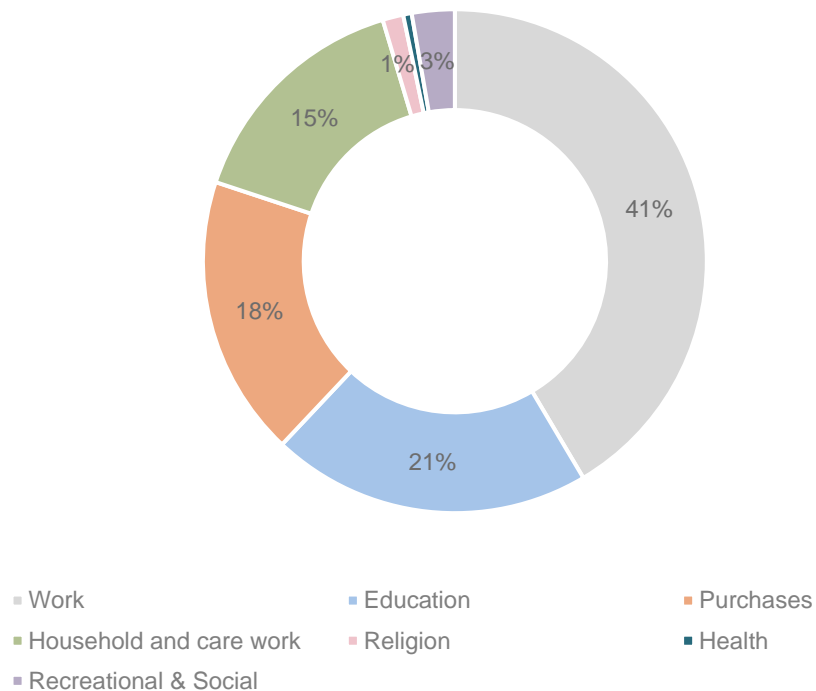


Context

In 2011, 11.75 million (11.3%) of Bihar's residents lived in cities and towns. The urban agglomerations of Patna, Gaya and Muzaffarpur constituted 25% of these residents. Patna is characterized by an old city core and a new administrative and business centre, whereas Gaya and Muzaffarpur are cities with mixed use cores and agricultural activity within the municipal corporation boundaries. In 2017-18, women's labour force participation in urban Bihar was 6.9% compared to 69% for men. A study was undertaken in the cities of Patna, Gaya and Muzaffarpur to understand the role of transportation on women's access to educational and work opportunities.

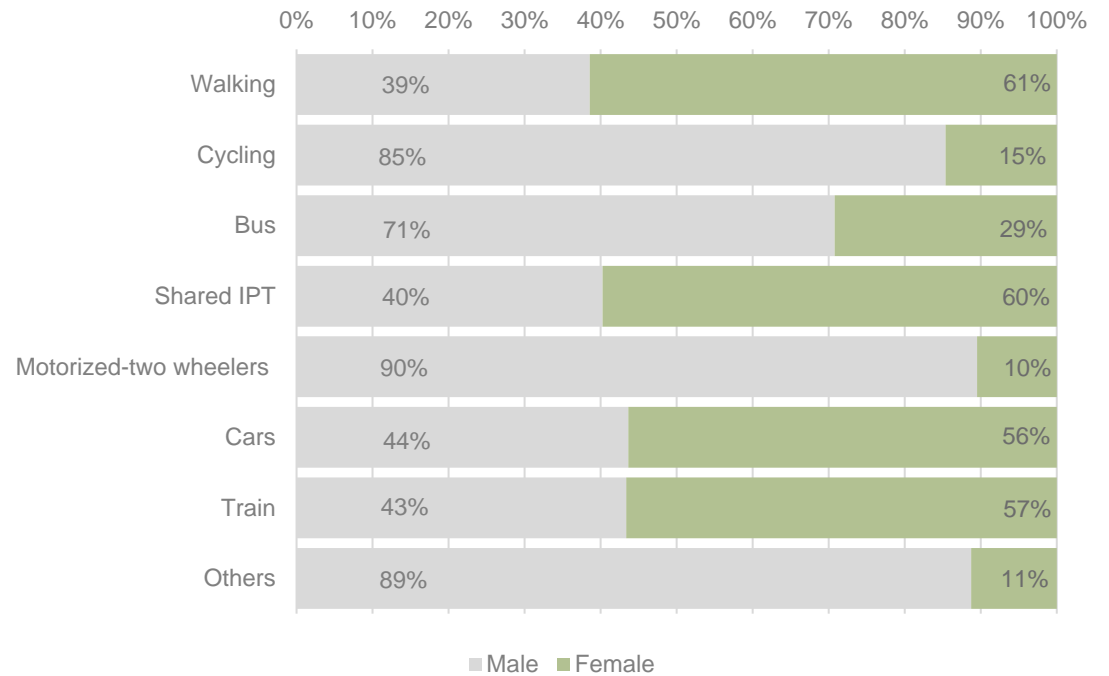
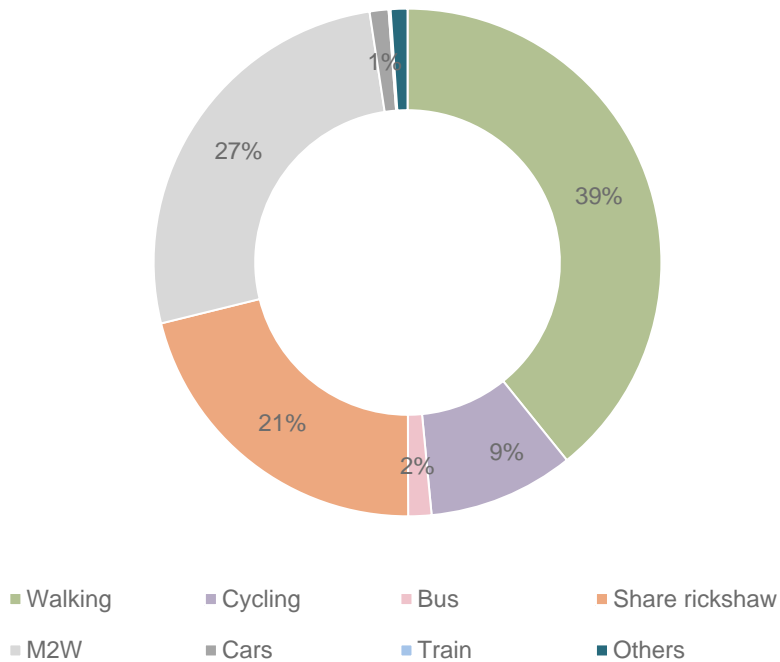
The survey revealed that women in the cities of Bihar make 37% fewer trips than men, with those in Patna and Gaya making 30% and 29% fewer trips than men. While work constituted 41% of all trips, only 18% of these were by women. Therefore, transport planning that predominantly focuses on work-trips will not account for women's daily travel. 33% of all trips are for household, care work and purchases with women constituting 73% of these trips.

Travel purpose (L), travel purpose by sex (R)

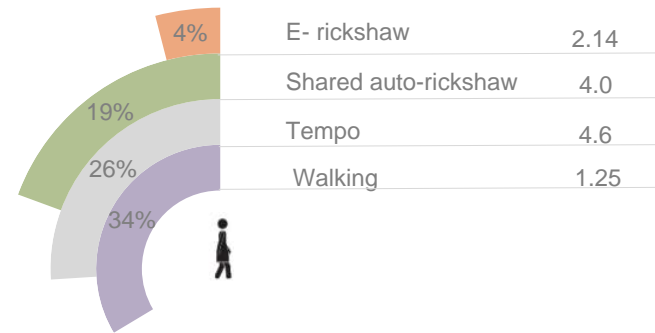
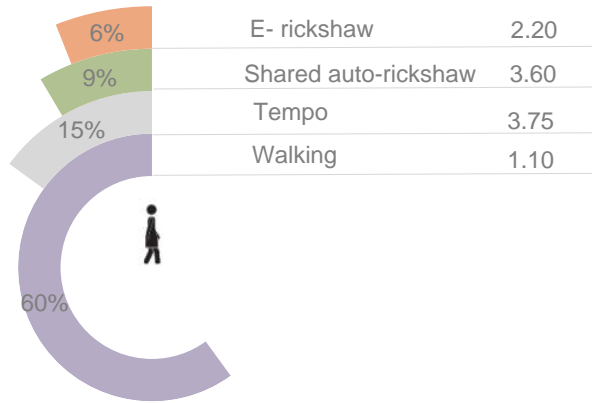


Travel modes: 39% of all trips are by walking, followed by motorized two-wheelers and shared intermediate public transport (IPT). Cars only constitute 1% of all trips. Women make 61% of all walk trips and 60% of all trips by shared IPT, making these two modes critical for their access and mobility. While there is no travel distance difference for education, women travel 45% shorter distances for work. The major issues with the walking environment are inadequate, unshaded footpaths, waterlogged streets, high speed vehicles and intentional rash driving, presence of groups of men on street corners/ shops and fear of anti-social elements. At night, deserted streets and unlit footpaths further deteriorate the quality of the walking environment.

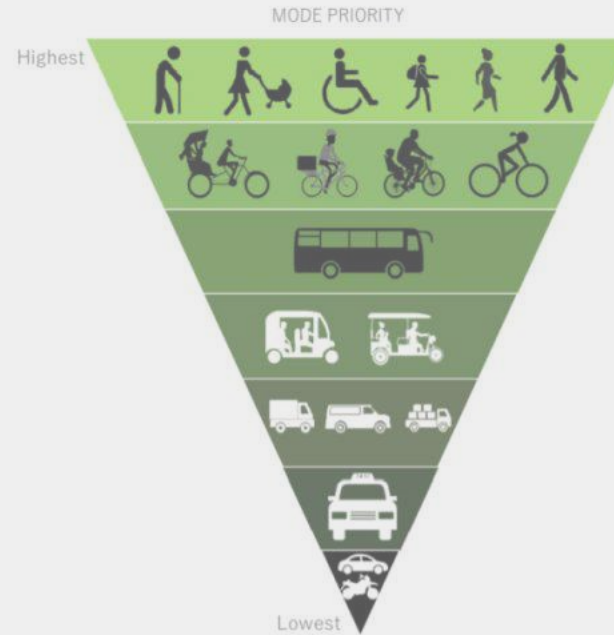
Travel modes (L) and travel modes by sex (R)



Average travel distance (km) and modes for household, purchase, care trips (L) and education trips (R) by women



These street design guidelines are created within the context of the National Urban Transport Policy 2006, which aims to **create streets for people, and not cars**. While there are numerous street design guidelines for Indian cities such as the Indian Roads Congress, Delhi and Pune, these guidelines are specific to the urbanizing context of Bihar, informal employment; targeted towards small and medium scale cities, recognize the role of land uses in the use of streets and mainstream women’s mobility and access. In addition to infrastructure standards, guidance is provided on information, awareness and human behavior messages in creating safer streets for women and girls. They are targeted towards road development agencies, Public Works Department, Urban Development and Housing Department, Municipal Corporations in Bihar, transportation practitioners and groups advocating for women’s mobility and safety.





NOW OPEN

SARYODAYA KHADI BHAVAN

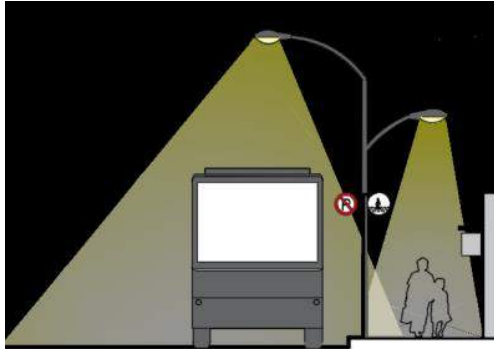
SARASWATI

युवा वक

युवा वक

युवा वक

Principles



Safety and security

Streets ensure road safety, actual and cognitive sense of security in the day and in the night, safety from crime, theft and hygiene.



Universal accessibility

Streets promote universal access with a focus on care givers, elderly and persons with disabilities.



Environment sustainability

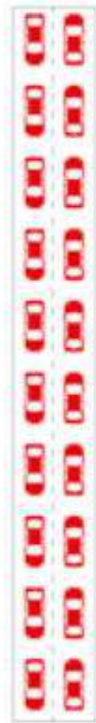
Streets preserve trees and other natural elements in the design process.



Informal economy

Streets provide spaces for workers in the informal economy like street vendors.





30 people
in 20 cars

(1.5 average)



30 people
on 30 bicycles

(3.5m bike lane)



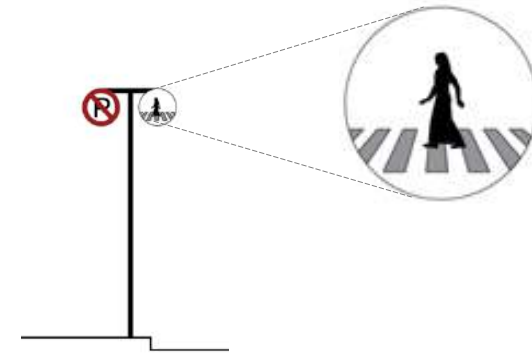
30 people
In 1 bus

(75% full)

Source: TUMI

Efficiency

Streets allocate road space efficiently to enable movement of people over personal motor vehicles.



Behavior change

Signage, information, advertising and communication messages create a gender positive environment.



Mobility and proximity of care

Street network and design, location of amenities cater to the mobility and proximity of care trips.



Street network

Cities in Bihar lack a secondary road network resulting in large block sizes, and the right of way varies significantly along the length of the road. There is a need to improve street network connectivity to reduce travel distances, especially for pedestrians and ensure a consistent right of way. In Gaya and Muzaffarpur, narrow streets often serve as major roads causing traffic congestion. The perimeter of blocks in the city core in Patna, Gaya and Muzaffarpur vary from 1.7km to 3km, against benchmarks of 400m-600m. The block sizes can be reduced through pedestrian or NMT-priority streets, thereby reducing walking and cycling distances.

Street network in Patna, Gaya and Muzaffarpur

Road category	Patna	Right of way (m)	Gaya	Muzaffarpur	Right of way (m)
Major roads	Danapur-Khagaul Road and Bailey Road	24-36	Gaya Shergati Road, Jail Road	Brahmapura Main Road, Station Road	15-23
Intermediate roads	Kankarbagh Road, Fraser Road, Patliputra Kurji Road	13-23	Civil Lines, Rajendra Path Road, Church Road, Station Road, Tekari Road	Kalambagh Road, Sadpura Road	8-22
Access/ local streets	Gola Road, Patliputra Housing Colony etc.	<12	Dangi Nagar Road, Old Kareem Ganj Roads etc.	Khabra Road, Majhaulia Road	<9



Patna

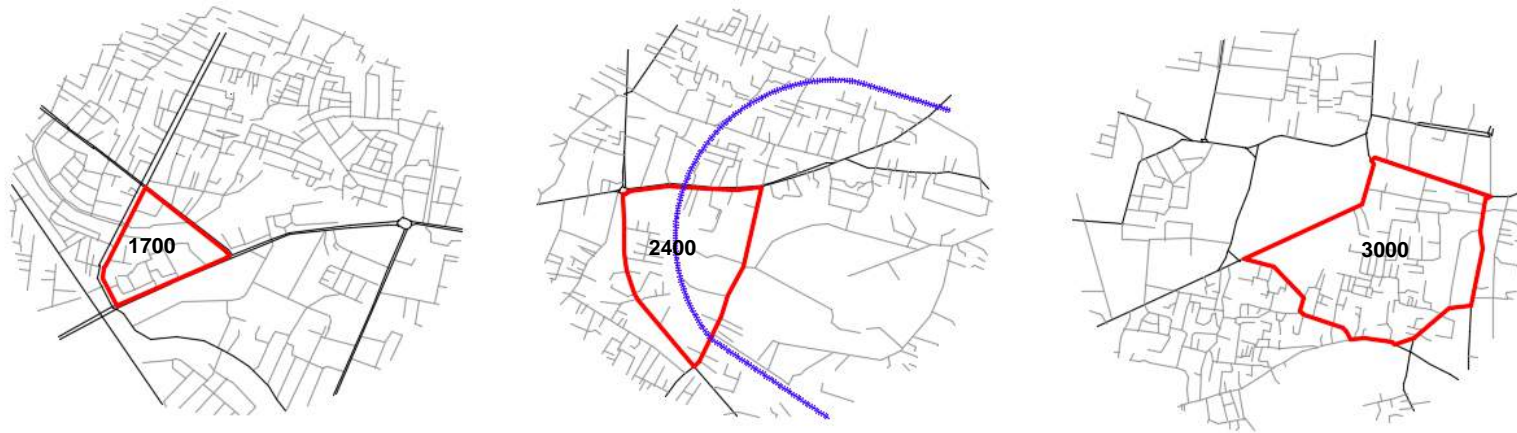


Muzaffarpur



Gaya

Street network in neighborhoods in Patna (L), Gaya (C) and Muzaffarpur (R) with existing block size perimeters in metres



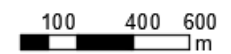
Proposed perimeter of block sizes (less than 600m) in Patna, Gaya and Muzaffarpur



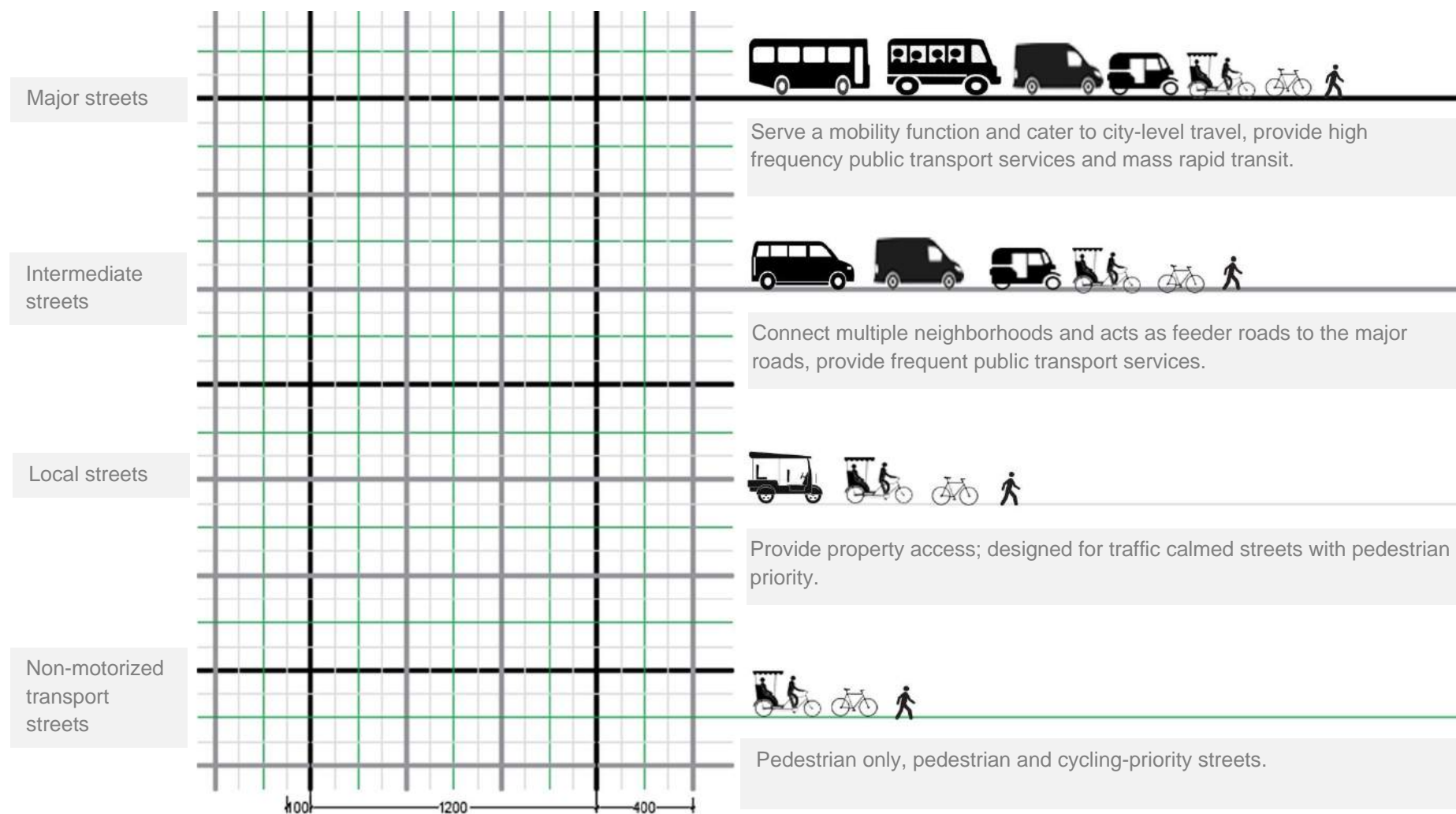
Existing block size

Proposed NMT connectors

Railway line



A functional hierarchy of streets is proposed, based on their mobility and access functions. (All dimensions are in metres)



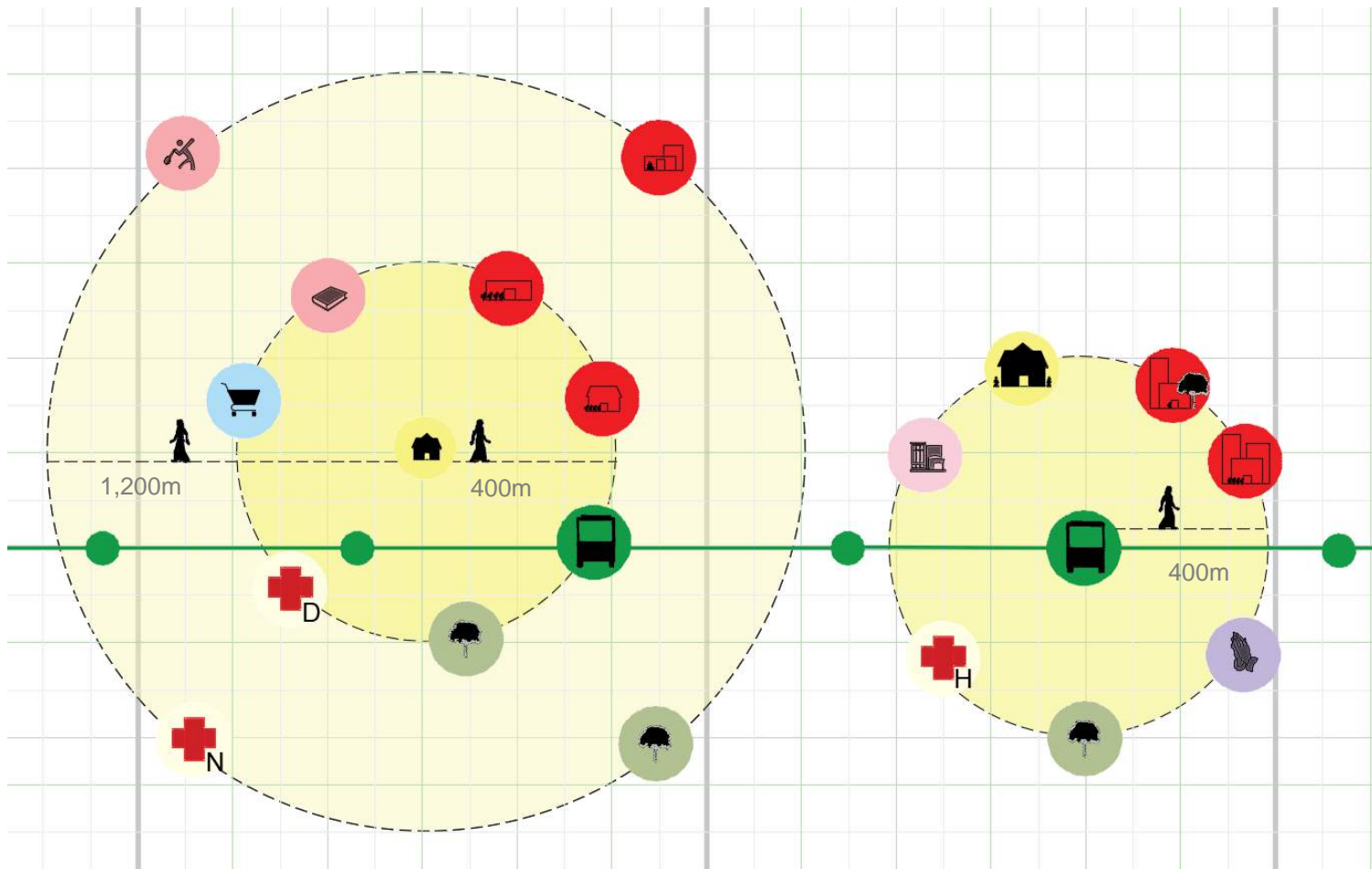
Special streets

Urban highways are special streets, as they cater to longer distance trips. They connect the city to nearby settlements and other cities. By-pass road in Patna and SH 22 in Muzaffarpur are some examples. Existing highways within urban areas should be redesigned as major streets.



Street network and location of amenities

While the Urban and Regional Development Plan Formulation and Implementation (2015) guidelines recommend the number and area of each amenity relative to the population, it does not specify their location. These guidelines recommend 3 influence zones: amenities that are accessed daily should be located within short walking distances of 5 minutes or less (400m), whereas those which are visited periodically are located within a 15-minute (1.20km) walking distance. City/ regional level amenities are recommended within a 5-minute walking distance of frequent public transport.



 Anganwadi
 Secondary school
 Dispensary
 Neighborhood park
 Community hall/library
 Local market
 Public transport
Amenities within 5 minutes walking distance

 Integrated school
 Nursing home, poly clinic
 Community park
 Recreation club
Amenities within 15 minutes walking distance






 College
 University
 Hospital
 District park
 Convention center
 Religious center
 Working womens hostel
Amenities within 5 minutes walking distance of frequent public transport





Street typologies and the land-use context

Streets vary in character and use depending on the adjoining land uses in Patna, Gaya and Muzaffarpur. The cities are characterized by five different types of land uses. Therefore, the network design, management, and street design needs to respond to these contexts.

Land use	Description	Image	Design approach
City core	<ul style="list-style-type: none"> • Old city-dense and narrow street network • Commercial and residential land uses • High pedestrian activity 		<ul style="list-style-type: none"> • Neighbourhood level approach • Traffic and onstreet parking management, one-way street loops • Traffic-calmed shared streets and NMT-priority streets
Central administrative and/or business area	<ul style="list-style-type: none"> • Mixed land use. In Gaya and Muzaffarpur, the city core is the retail centre • High pedestrian activity • Demand for on street parking 		<ul style="list-style-type: none"> • Equitable distribution of road space • Traffic and on-street parking management • Consider one-way street loops • NMTonly and NMT priority streets
Predominantly commercial areas	<ul style="list-style-type: none"> • Shopping and service activities • High pedestrian activity • Demand for street vending and on street parking 		<ul style="list-style-type: none"> • Equitable distribution of road space • Space for street vendors • On-street parking management • Public toilets and nursing spaces
Predominantly residential areas	<ul style="list-style-type: none"> • Varies from low and medium-rise dense settlements, multi-storey buildings and detached houses 		<ul style="list-style-type: none"> • Equitable distribution of road space • Traffic-calmed pedestrian priority local streets and shared streets
Peri-urban areas	<ul style="list-style-type: none"> • Undeveloped right of way • High vehicular speeds 		<ul style="list-style-type: none"> • Road surfacing, provision of services • Equitable distribution of road space

Patna

The total length of surfaced roads in Patna Urban Agglomeration (PUA) is 1,500 km, out of which nearly 90 percent are municipal roads while 10 percent are state level roads (UDHD 2010). The road network constitutes less than 10 percent of the overall area and Patna lacks a hierarchy of roads, especially a secondary network (UDHD 2010). There is a lack of sufficient, shaded pedestrian infrastructure throughout the city, except for the central administrative area. Settlements like Danapur are outside the city, with thriving markets and undeveloped roads. Street vendors are omnipresent in the central administrative area, commercial nodes, and under flyovers.

Land-use context and hierarchy of streets in Patna

Streets	Right of way	Predominant land-use context			
		Central administrative area	Commercial	Residential	Peri-urban context
Major streets	24-36m				
Intermediate streets	13-23m				
Access streets	12m and below				















Gaya and Muzaffarpur

Cities like Gaya and Muzaffarpur with a population of less than 0.5 million residents have retail and administrative nodes. Streets are narrow with mixed-use, and agricultural activity is observed within the city limits. There are three road typologies. National and state highways are connected to major roads, intermediate roads and a network of local or access streets.

Gaya: Some important roads in Gaya are Station Road, Jail Road, Tekari Road. Some of the major intersections include Sikaria More, Collectorate Chowk and Manpur Chowk. Gaya has three bus stands located at Sikaria More, Gandhi Maidan and on Gaya College Road. In 2010, only 39 percent of the roads had streetlights, and a lack of maintenance was observed. The City Development Plan prioritized improvement of the roads and providing adequate, safe and user-friendly public transportation in Gaya (UDHD 2010).

Muzaffarpur: Muzaffarpur is connected by NH-28, NH-57, NH-77 and NH-102. It has a total road length of 72 km, jointly managed by MMC (38 km), Public Works Department (17 km) and the District Council (17 km). The City Development Plan observed a shortage of streetlights, with most of the peripheral areas having no provision for street lighting (UDHD 2010). The streets do not have a signaling system for traffic management, footpaths for pedestrians (MMC 2018).

Land use context and hierarchy of roads in Gaya and Muzaffarpur




Streets	Right of way	Predominant land-use context				
		City core	Central business area	Commercial	Residential	City outskirts
Major roads	15m and above					
Intermediate roads	9-22m					
Access/ local streets	9m and below					





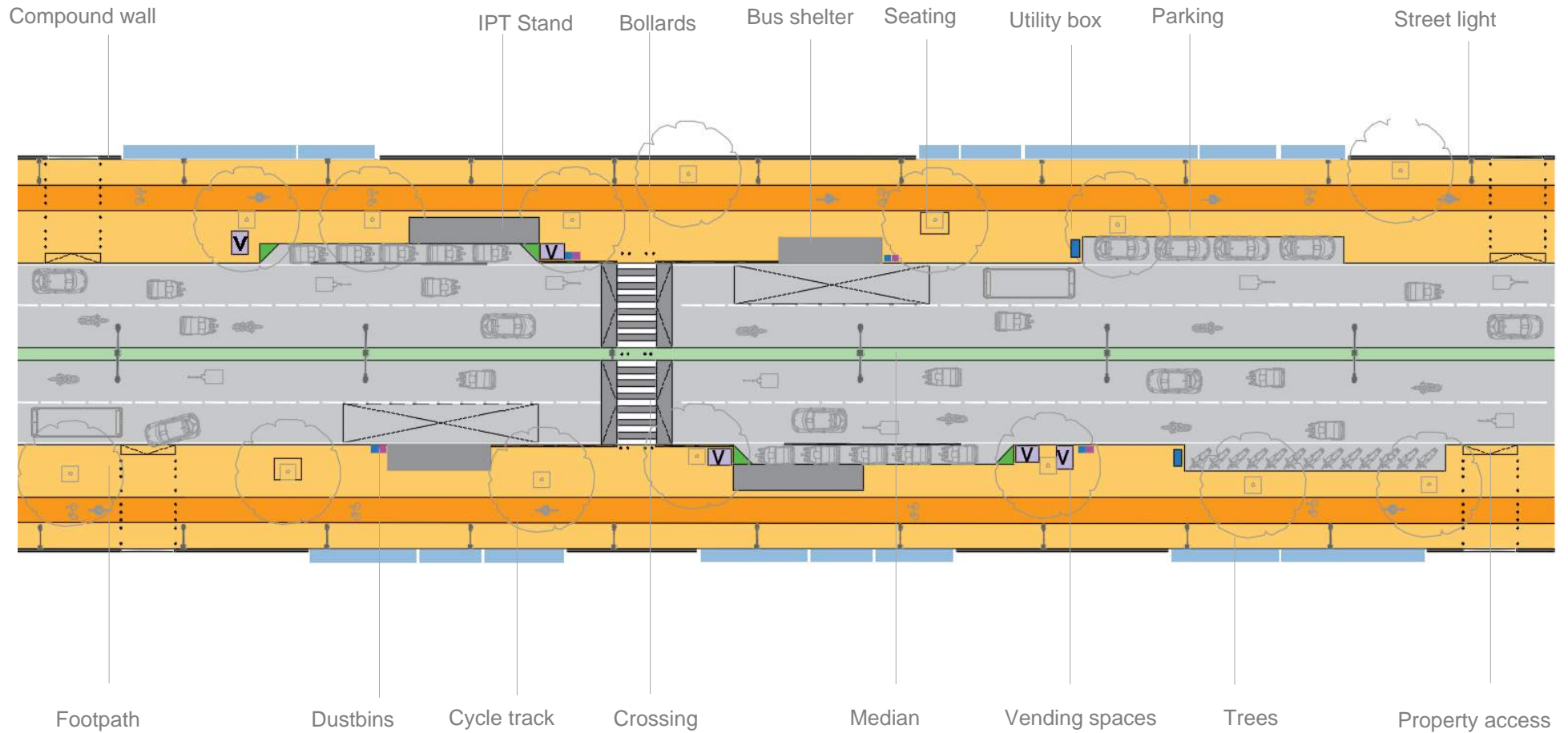
Special neighborhoods

Informal settlements, organic settlements (such as Danapur) and transit nodes (such as terminals, railway stations) are characterized as special neighbourhoods due to narrow streets, high intensity of traffic and pedestrian movement. Neighbourhood level approaches are recommended over corridor-level improvements.

Typology	Description	Design approach
Organic settlements	<ul style="list-style-type: none"> • Dense network with narrow streets • Active street edges and no compound walls 	 <ul style="list-style-type: none"> • Traffic and on-street parking management plan at the neighborhood level • Upgradation of basic services • Traffic calmed shared streets
Informal settlements	<ul style="list-style-type: none"> • Absence of basic services • Narrow shared streets catering to pedestrians, cyclists and two wheelers 	 <ul style="list-style-type: none"> • Upgrade street surfaces • Provision of basic services, including electricity, water supply, sewage and solid waste management • Traffic calmed shared streets
Transit nodes	<ul style="list-style-type: none"> • Dense and congested nodes • Transit point with associated ancillary facilities 	 <ul style="list-style-type: none"> • Traffic and parking management plan at the neighborhood level • Multi-modal integration plans • High quality public realm



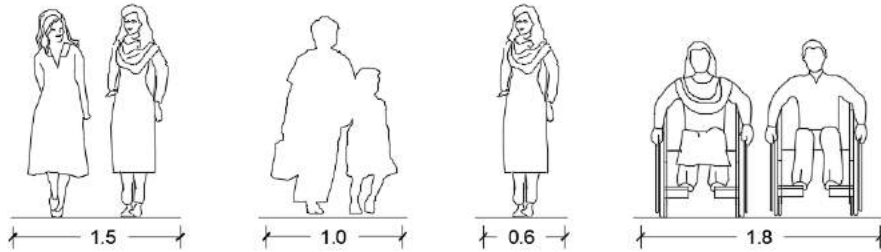
Street elements



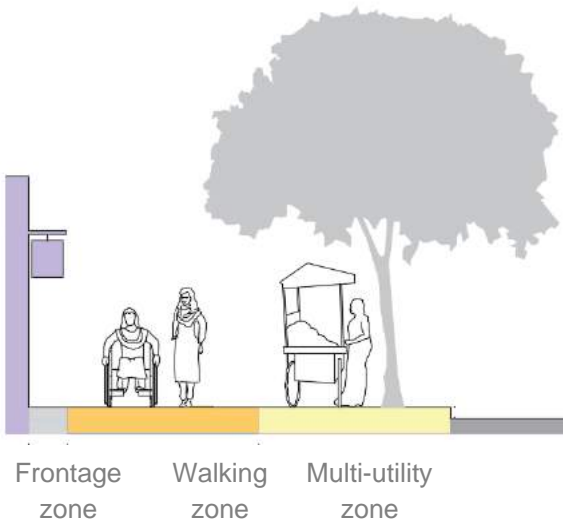
Footpaths

Walking is the most affordable and sustainable mode of transport. 39% of trips in cities in Bihar are by walking with women constituting 57% of the trips.

Dimensions



Zones within a footpath

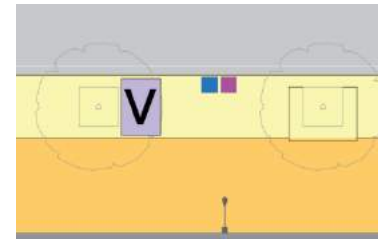


Frontage zone provides a buffer between the property boundary and the walking zone, as pedestrians are unlikely to walk along the edge.

Walking zone provides an unobstructed and continuous space for walking.

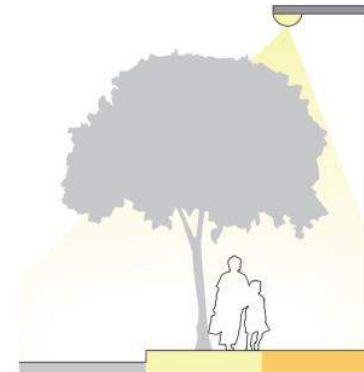
Multi-utility zone provides space for essential street infrastructure such as vendors, trees, street lighting, street furniture, bus stops, auto/ taxi stops, utility boxes, fire hydrants, landscape, to avoid any obstruction in the walking zone.

Unobstructed footpaths



Utilities, street furniture and vending spaces to be located within the MUZ.

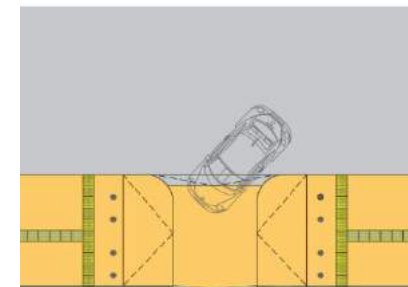
Safety and thermal comfort



Anti-skid surfaces, consistency should be maintained by color, texture and level.

Cross fall of 1:50.

Streetlights and shade promote safety and comfort.



Height of footpath is 0.15m above carriageway.

Tactile guiding and warning pavers for persons with visual impairments.

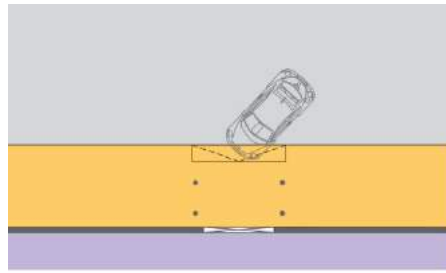
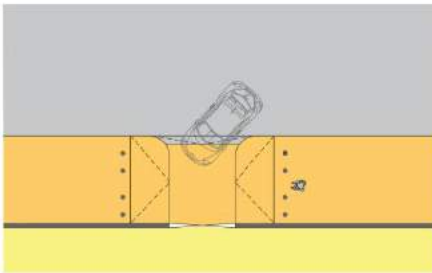


Continuous and accessible footpaths

Footpaths must be continuous at property entrances, or slope half-way down.

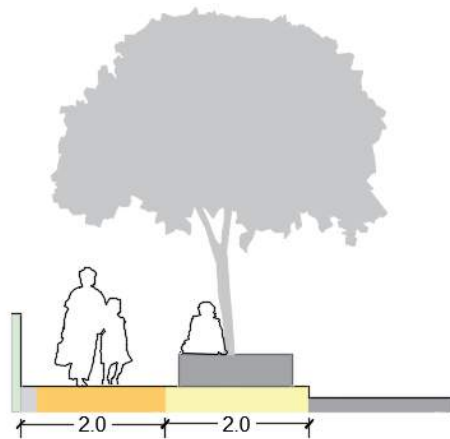
Pedestrian ramp 1:12

Vehicular ramp 1:5

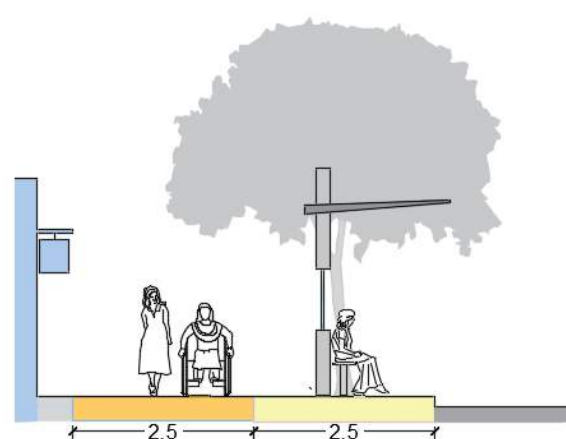


PLOS B as per IRC:103-2012 Guidelines for Pedestrian Facilities. Minimum footpath widths are provided in this table.

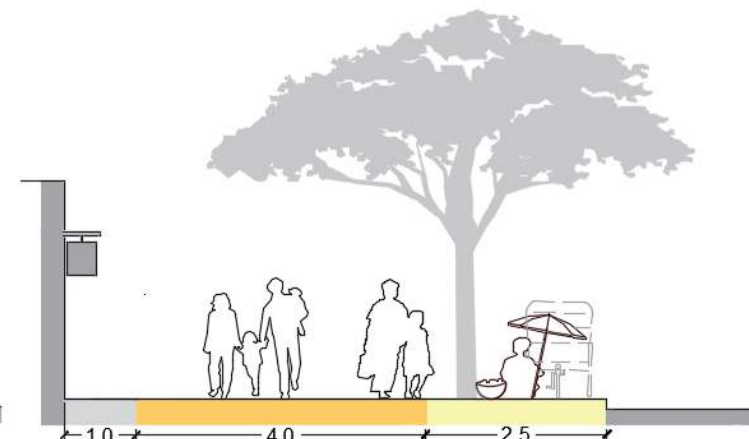
Land-use context	Total footpath	Minimum width (in metres)		
		Frontage	Walking zone	Multi-utility zone
Low-intensity areas	3.0	Combined width of 3.0		
Predominantly residential	4.0	0.2	1.8	2.0
Predominantly commercial	5.5	0.5	2.5	2.5
High-intensity areas	7.5	1.0	4.0	2.5



Residential area



Commercial area



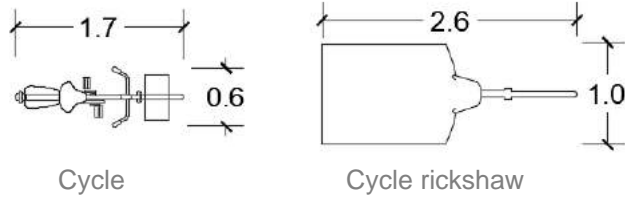
High intensity area



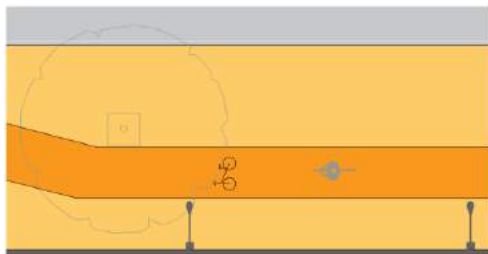
Cycling infrastructure

Cycle track or providing a dedicated space for cyclists is recommended. Improving the quality of cycling infrastructure is imperative for providing respect, encouragement and safety to cyclists.

Dimensions



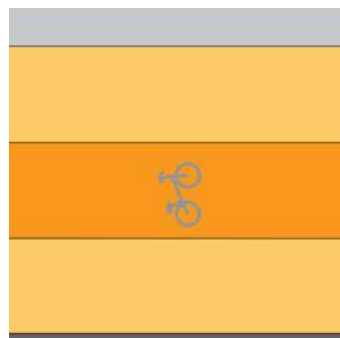
Dedicated space



Cycle tracks on streets of 24m and above

- Single lane: 2m min
- Two lanes, same direction: 2.5m min
- Two lanes, two-way: 3.0m min

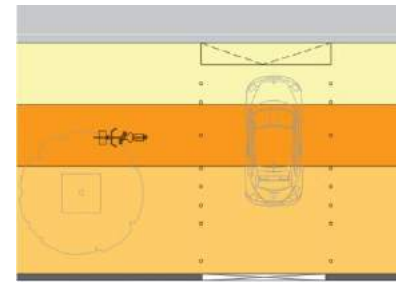
Lane demarcation and surface



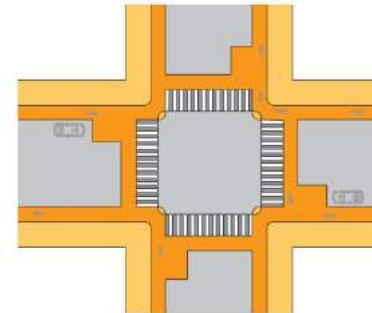
Unobstructed and continuous with a gradient of 1:12 – 1:20.

Coloured cycle tracks to distinguish them and lane markings on tracks.

Continuity

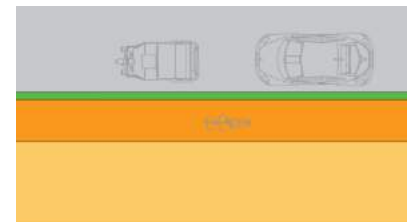


Cycle tracks must be continuous at property entrances.



Cycle tracks must be continuous at intersections.

Bicycle boxes at crossings, signal priority and lead time at signals.



Minimum buffer between cycle track and carriageway.

- Width of 1m near parking.
- Width of 0.25m near motorised vehicle lane.

Safety and comfort



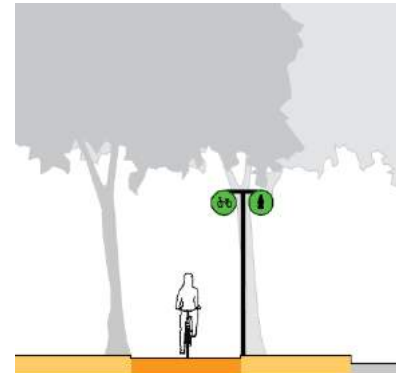
Vertical clearance of 2.4m.

Protected from traffic by footpath.

Sufficient shade and adequate street lighting.

Height of +50mm-100mm from the carriageway.

Surface and signage



Skid resistant, asphalt or concrete.

Levelled, without obstructions.

Avoid paver blocks.

Gender-balanced representation of cyclists.



To increase women and girls' mode share in cycling, the following initiatives are recommended:

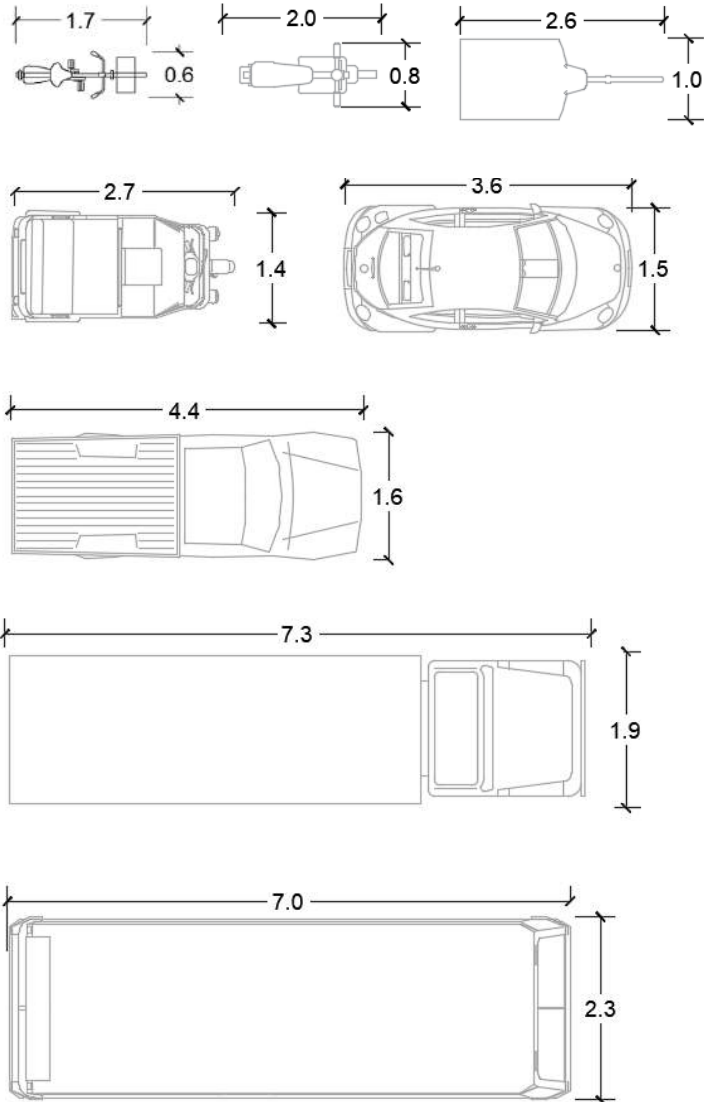
- Enable access to bicycles in urban areas by expanding schemes such as Mukhyamantri Balika Cycle Yojana to urban areas.
- In public bicycling schemes, reduce registration fee, enable text message-based registration and usage, locate stands in areas visited by women and girls. Cycle stands and surrounding areas must be safe and well lit.
- Training for women and girls to learn bicycling, maintenance and repair of bicycles.
- Redesign bicycles so that bags and other carry-ons can be kept.



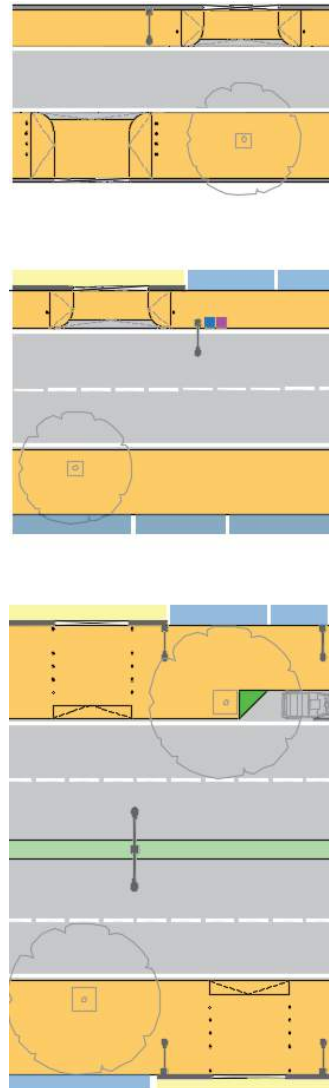
Carriageway, speeds and traffic calming elements

The primary role of carriageway is to facilitate efficient movement of people and travel of motorized vehicles at safe speeds.

Dimensions



Width of carriageway lanes



Single lane: 2.75- 3.0m with shyness.

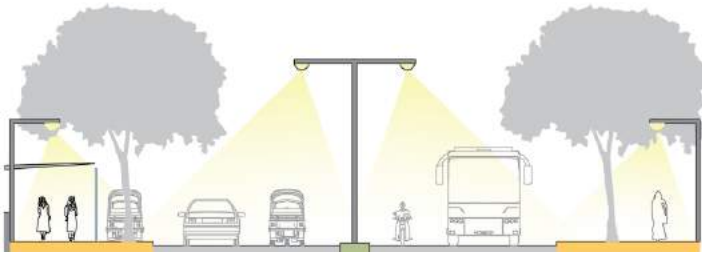
Undivided: 2.5- 3.5 m per lane with shyness. Consider 3.5m only if standard buses ply on the road.

Divided: 3.0m maximum per lane with shyness.

The ROW in Bihar is inconsistent with varying widths leading to bottlenecks in traffic. The carriageway must be consistent to avoid bottlenecks.

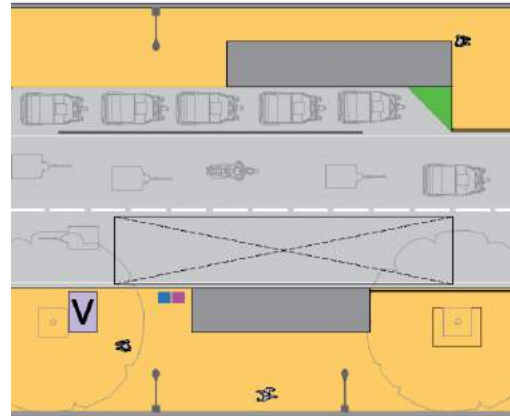


Median

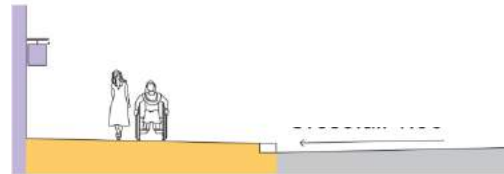


Median must have a minimum width of 1m, at +150mm from carriageway. At crossings, it must be level with the road surface for universal access. Trees and other vegetation may be grown if the width of median is greater than 2m, however, sightlines of vehicles must not be disturbed.

Lane surface



Defined through kerbs and material difference, lane markings (Refer IRC 035:2015).



Cross fall of 1:50 must be provided for drainage.



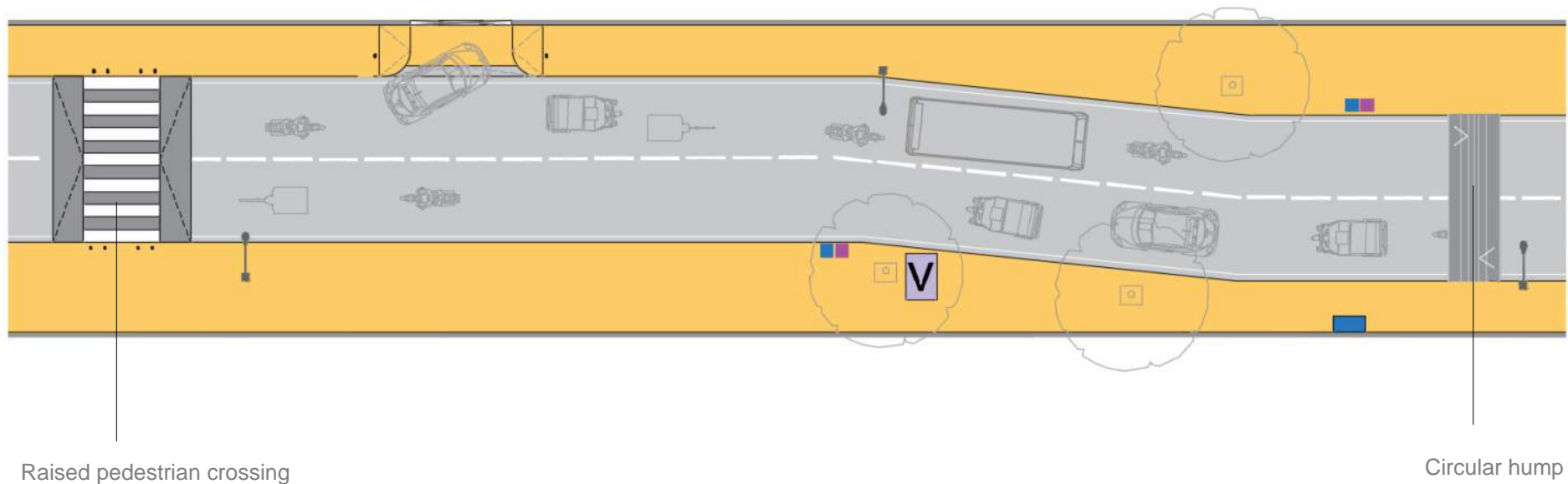
Design speeds

The design speeds should adjust to the predominant land use to create a safe street realm. Traffic calming strategies such as road humps, raised crossings, chicanes (on local streets) can be explored. Other traffic calming mechanisms include markings (IRC 35) which convey information to drivers and signs (IRC 67) for visual indication of speed reduction.

Design speeds in different land use contexts

Streets	City core	Central administrative area	Land-use context Predominantly commercial	Predominantly residential	Peri-urban
Urban highways	30	50	30	40	50
Major roads	30	40	30	40	40
Intermediate/ feeder roads	20	30	30	30	30
Access/ local streets	15-20	15-20	15-20	15-20	15-20

Traffic calming strategies





Speed bump



Raised pedestrian crossing



Circular hump

Chicane

- Offset curb extensions.
- Angle of 45 degrees or more.
- Used for residential or low volume streets.
- Increases public space and can be landscaped.

Raised pedestrian crossing/ trapezoidal humps

- Profile is flat with ramps on either side.
- For a desired speed of 20kmph, the slope must be 1:7.
- Minimum width: 3m.
- At left turns in high activity pedestrian zones.
- Not to be placed in front of access points.
- To be spaced at distances less than 150m to achieve desired speed.

Circular hump

- Profile of hump is circular.
- Rise: 0.10m.
- For a desired speed of 20kmph- radius of 11m and chord length of 3m.
- At left turns in high activity pedestrian zones.
- Not to be placed in front of access points.
- To be spaced at distances less than 150m to achieve desired speed.



Pedestrian crossings

Dimensions

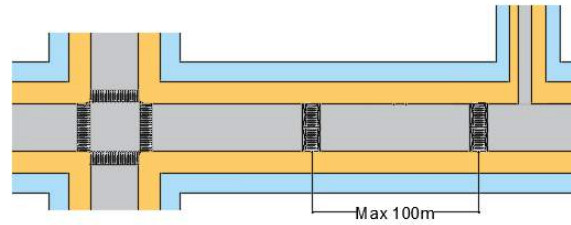


Pedestrians walk at speeds ranging from 1.25-1.4m/second.

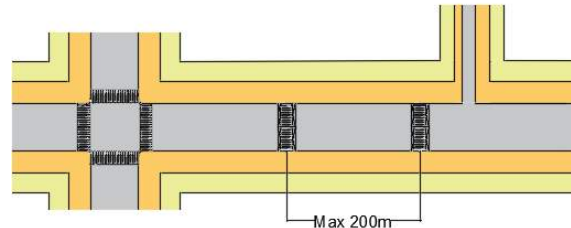


Caregivers, elderly walk at speeds of 0.40m/ second.

Spacing of crossings based on pedestrian desire lines and access points

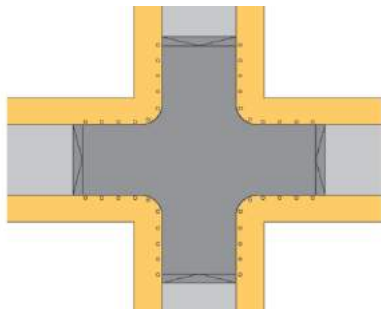


Predominantly commercial land-uses



Predominantly residential land-uses

Intersections



Raised intersections at non-signalized junctions.
Flushed with the sidewalk.
Bollards provide protection to pedestrians.

Types of mid-block crossing

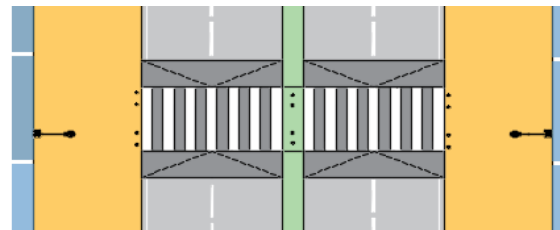
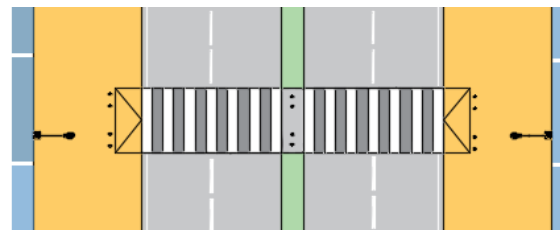


Table-top at non-signalized crossing, minimum 3m width.

Near bus stops, IPT stops, retail streets.

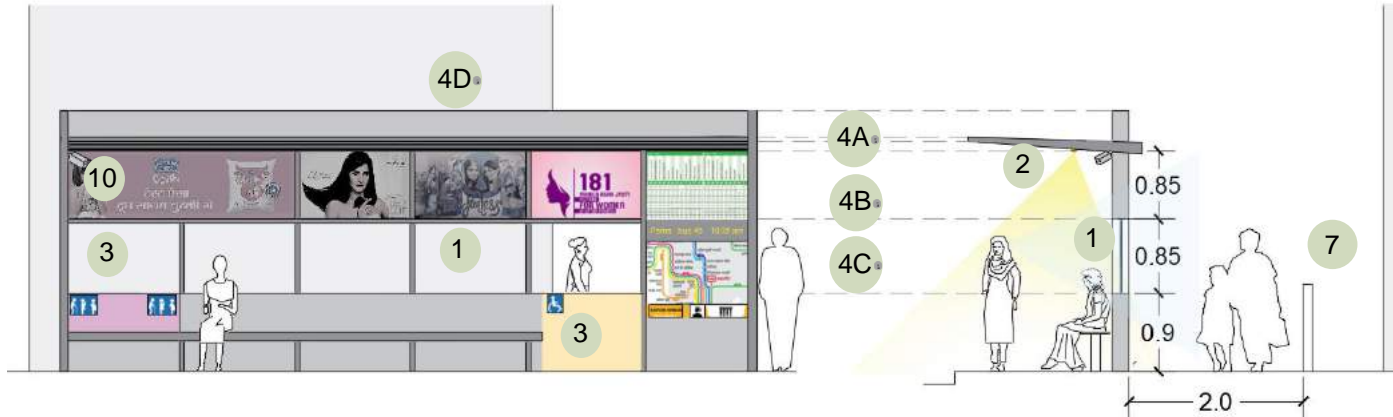


Zebra markings at signalized crossings, minimum 3m width.



Bus stops

Bus stops provide shaded comfortable waiting spaces for commuters. They may be placed within the MUZ and can extend over the width of the footpath when walking space of 2m is unavailable, however they must not obstruct pedestrian or cycle movements.



1. Transparent panel

2. Lighting

3. Priority seating

Reserved seating for the differently abled, pregnant woman, women with children and elderly.

4. Signage

4A: Bus stop name and schedule
 4B: PIS board
 4C: Map of surrounding area
 4D: Helpline numbers and gender positive images, space for advertisements.

5. Vendors

Located adjacent to the bus stop with shade and seating.

6. Dustbins

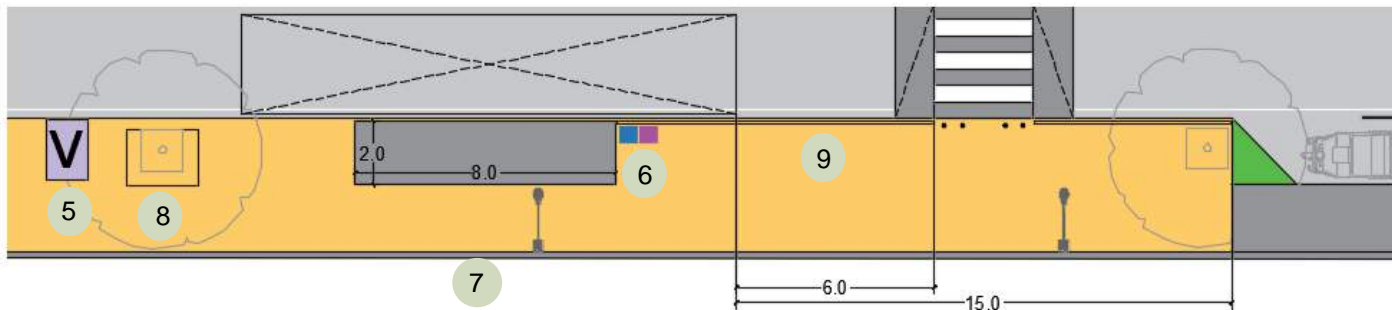
7. Low compound wall

8. Additional seating

9. Guard rail

10. CCTV cameras

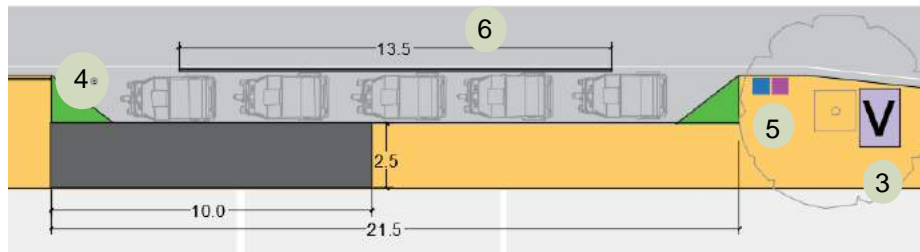
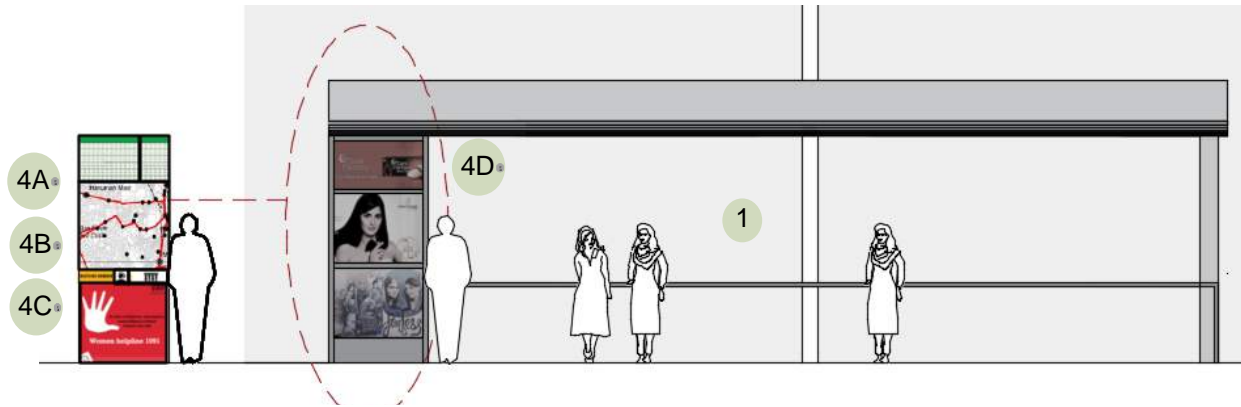
To be placed at the top corners



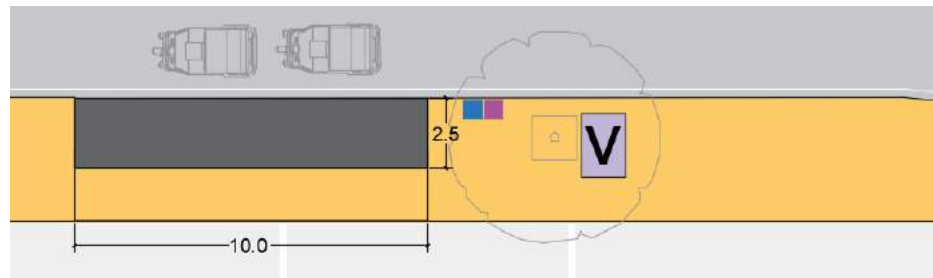


IPT Stands

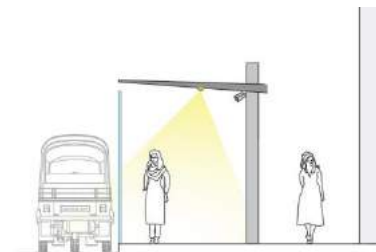
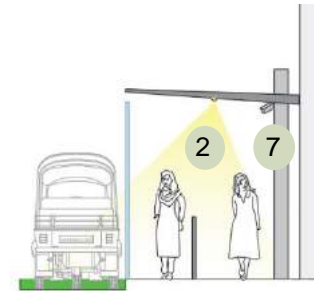
As the connectivity of bus transit in Bihar is limited, a considerable percentage of the population depends on IPT, especially women. Two types of IPT stands are proposed: Terminal stands where the vehicle waits for passengers; and stop and go stands where the vehicle stops momentarily at a designated place on the carriage way to pick up passengers.



Terminal IPT stands



Stop and go IPT stands



1. Transparency

2. Lighting

3. Vendors

4..Signage

4A: IPT routes and stops
 4B: Route maps
 4C: Helpline numbers
 4D: Gender positive images along with space for advertisements

5. Dustbins

6. Curb

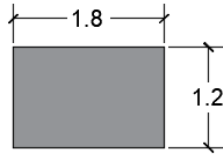
7. CCTV cameras



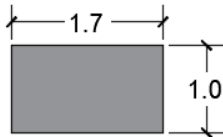
Street vendors

Street vendors enable easier access to goods and services, thus reducing trip distances and time poverty. They provide affordable goods and services and promote safety on streets.

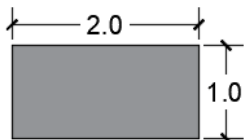
Dimensions



Vending on ground



Mobile vendor



Stationary vendor

Retention of existing markets



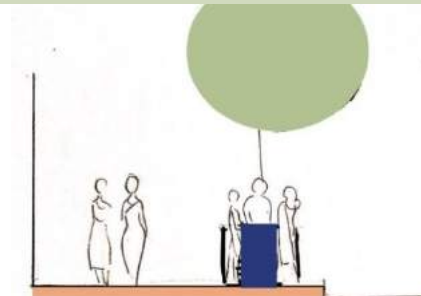
Natural markets must be retained and upgraded into pedestrian priority streets.

Provision of shaded spaces



Provide garbage bins, access to water and electricity, public toilets.

Located within the MUZ



Street vendors are positioned within the MUZ.

Designated space for female vendors



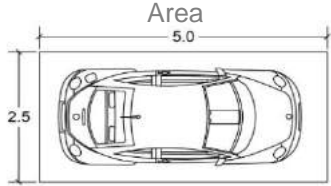
Allocate 1/3rd of all street vending spaces for women. Give priority to widows and female headed households, as well as subsidies in monthly fees.

Liminal spaces

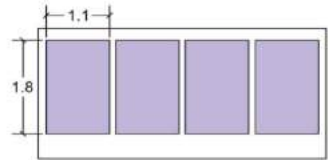


Spaces under flyovers such as in Patna railway station may be designed as vending zones with seating and amenities.

Benefits of street vending over street parking



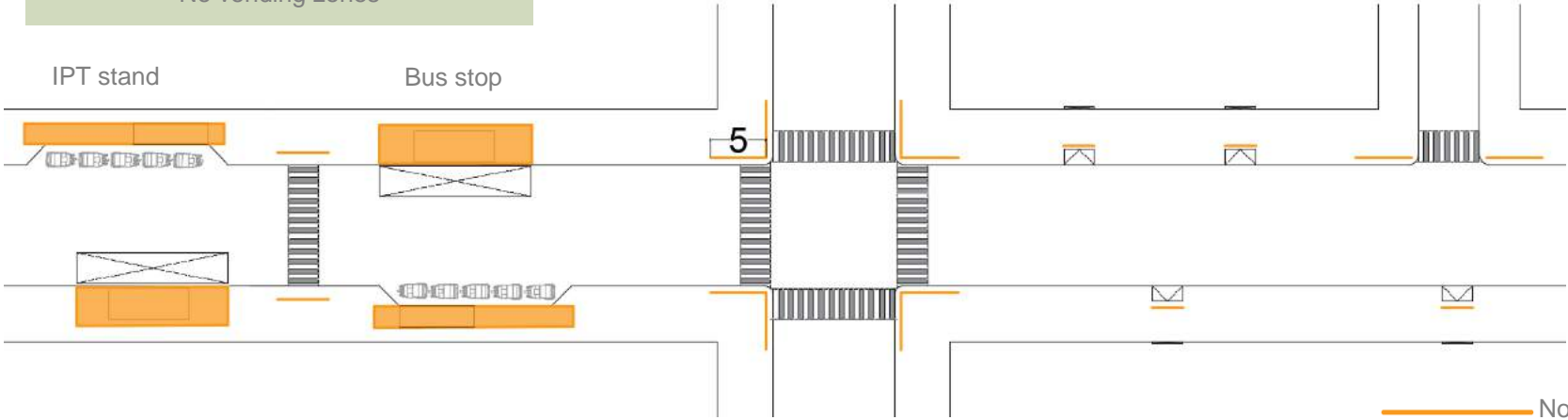
People served/ day
~3 persons
(2 trips/ day, occupancy of 1.5)



20-50 persons

One parking space, if repurposed can generate livelihoods for 4 vendors. It can cater to 20-50 persons per day, thereby increasing street eyes.

No vending zones

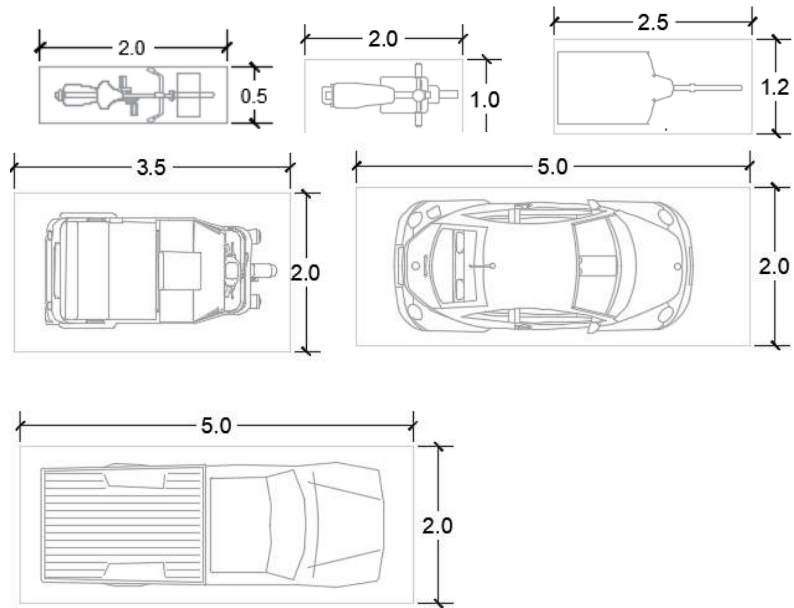


— No vending zones
(Subject to approval from the town vending committee).

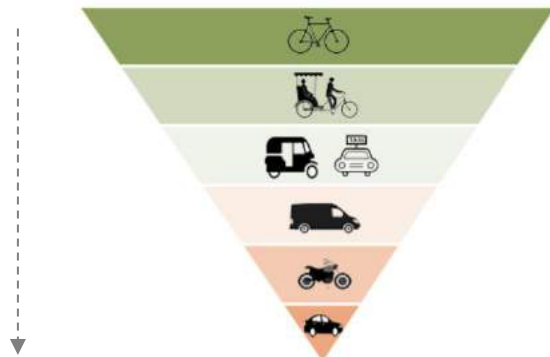


On-street parking

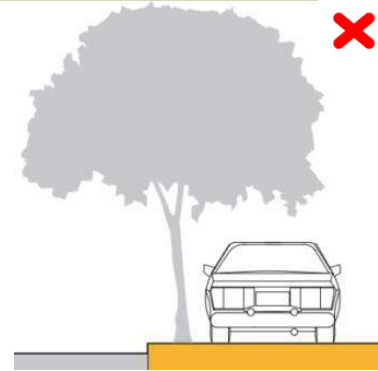
Dimensions



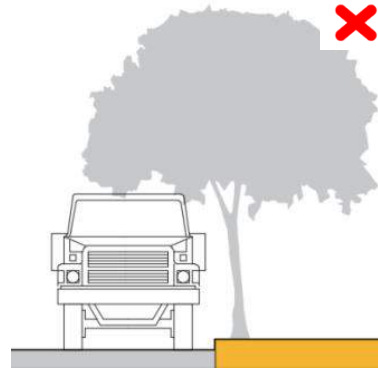
Priority of parking



Location

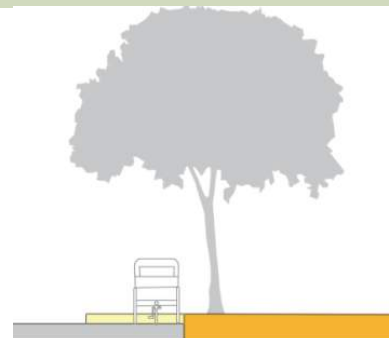


No parking on footpaths
Discourage long term parking
along retail stretches.



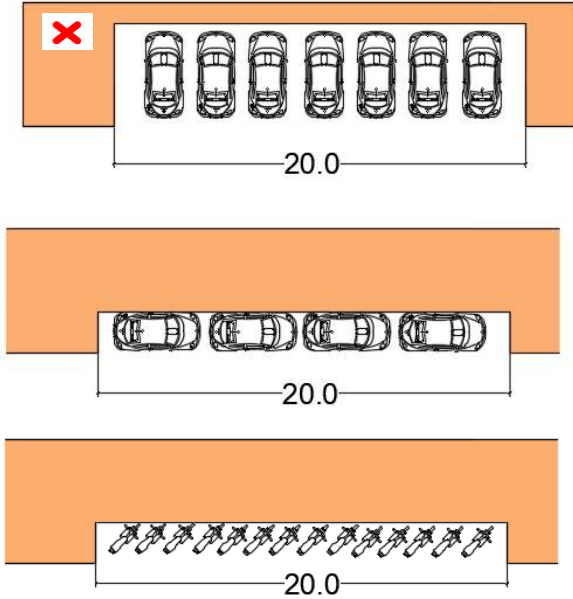
Provide dedicated off-street
spaces for long-term parking for
light and heavy commercial
vehicles. This will prevent dead
spaces along footpaths.

Parking turnover

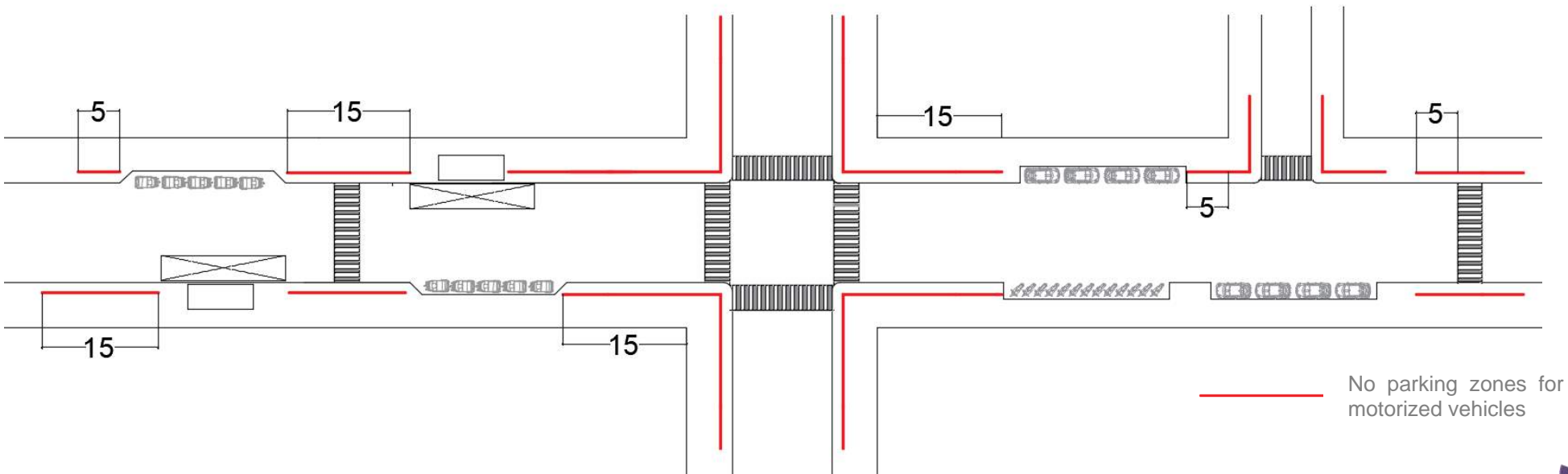


Encourage turnover of on-street
parked vehicles. Free parking for
bicycles and cycle rickshaws.

Parking configuration



Parallel parking is the best configuration for maximum space utilization. On-street parking should be defined. Parking more than 20m at one stretch is not recommended as it makes footpaths inaccessible.



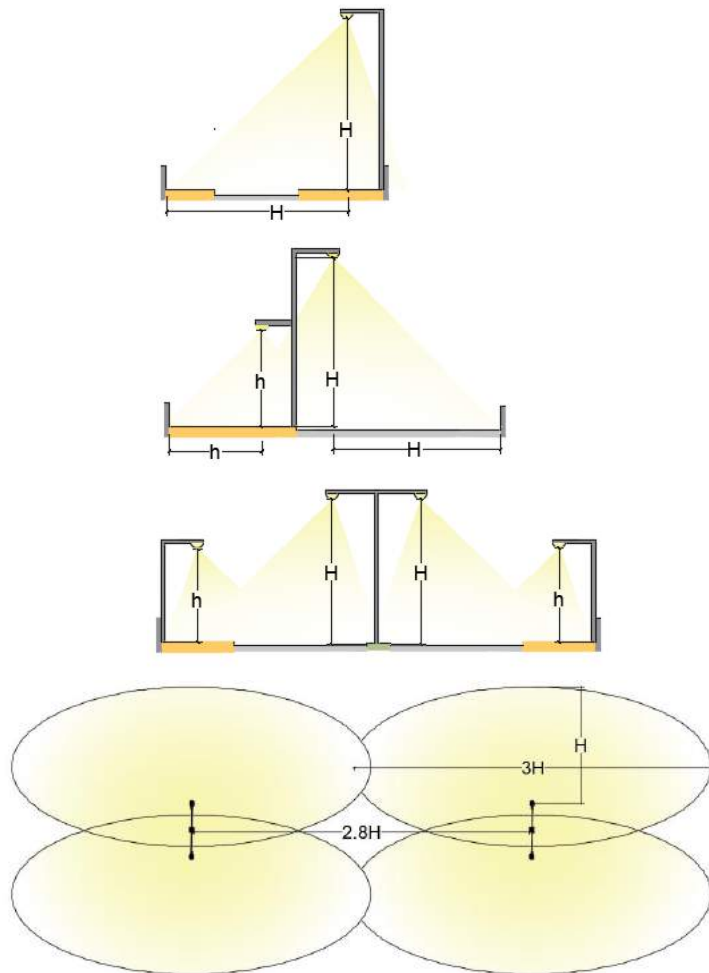
— No parking zones for motorized vehicles



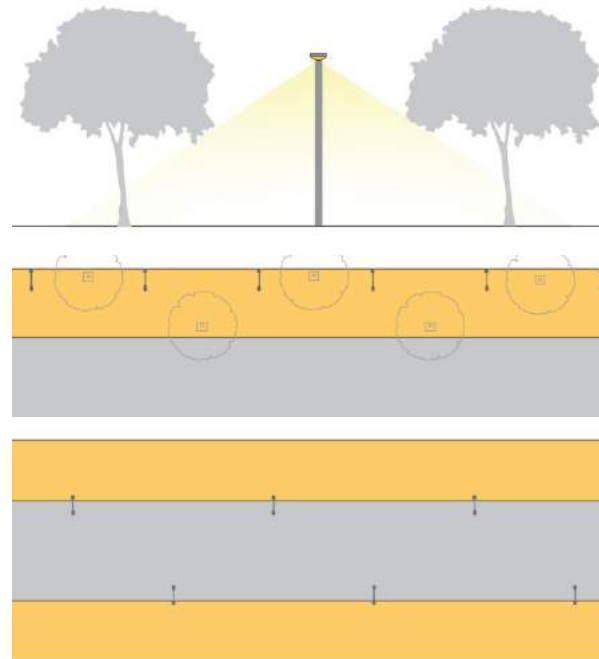
Street lighting

The comfort and confidence of all age and gender minorities in streets is heavily influenced by the presence of street lighting. It reduces the perception of threats and provides a sense of safety. The design and placement of streetlights must ensure that all areas receive illumination and the elimination of dark spots. The national street lighting scheme proposes to retrofit all existing streetlights with LED bulbs. This will reduce the electricity load as the energy efficiency of LED is high. Solar lighting should be encouraged.

Dimensions



Unobstructed street lighting



Streetlights can be staggered with trees to avoid dark spots.

Streetlights must be spaced to prevent dark spots or over illumination.

Spacing and lux levels

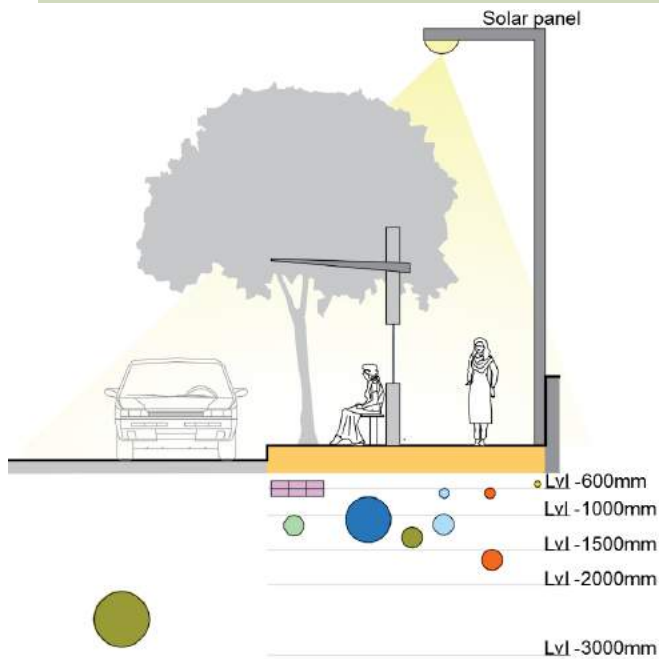
Street type	Pole height	Pole spacing	Street Element	Lux levels
Footpath or cycle track	4-6	11-16	Footpath or cycle track	30-40
Access streets	8-10	22-28	Carriageway	30-40
Major, intermediate streets	10-12	28-33	Intersection	50



Utilities

Utilities are an essential component of streets and must be designed such that the footpath surface is not hampered during maintenance of utilities.

Location of underground utilities





ICT lines may be placed within a duct that can be easily accessed at service points.

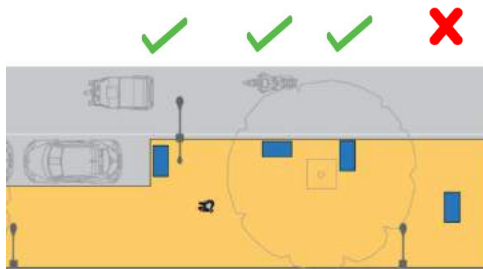
Pressure run utilities to be placed above gravity run pipes.

Gas lines and electrical lines are to be placed at sufficient distance from each other to ensure safety.

Maintain a minimum distance of 300mm between utilities.

Utility	Diameter	
	Street lighting	200mm
	Water service line	150mm
	Water trunk line	300mm
	Electrical LT	150mm
	Electrical HT	300mm
	ICT cable/fiber	300mm
	Storm water	1000mm
	Rider sewer	300mm
	Trunk sewer	800mm
	Gas	300mm

Location of access boxes

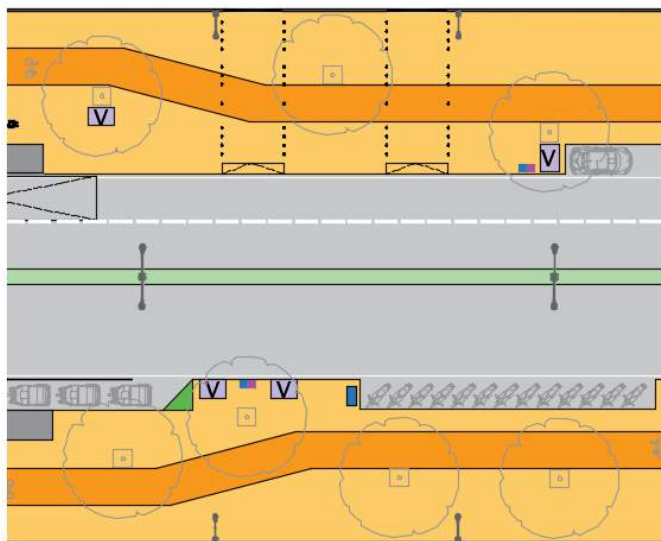


Access boxes must be placed in the MUZ and must not impede pedestrian traffic flow.

Manhole covers must be flush with the surface so as to not cause disturbance to the pedestrians.

Trees and other shading devices

Trees



Canopy size must differ across varying ROW to provide appropriate shade. Narrower ROW may have smaller canopies and wider ROW will have larger canopies.

The placement of trees may be staggered to provide uniform shade.

Trees native to Bihar that may be included in the streetscape are Golden Shower, Flame of the Forest and Peepal.

Tree pit must have gratings perpendicular to the direction of movement of wheelchair.

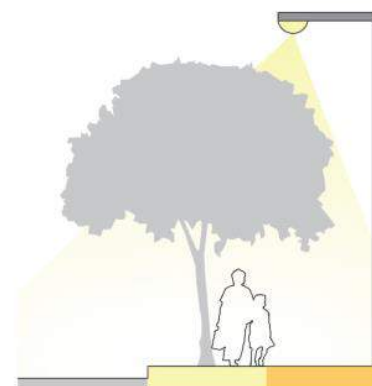
Temporary shading



In the absence of trees, more informal shading devices such as canopies may be explored.

Canopies can add color and vitality to streets, provide shade and protection from the rains.

Vertical clearance



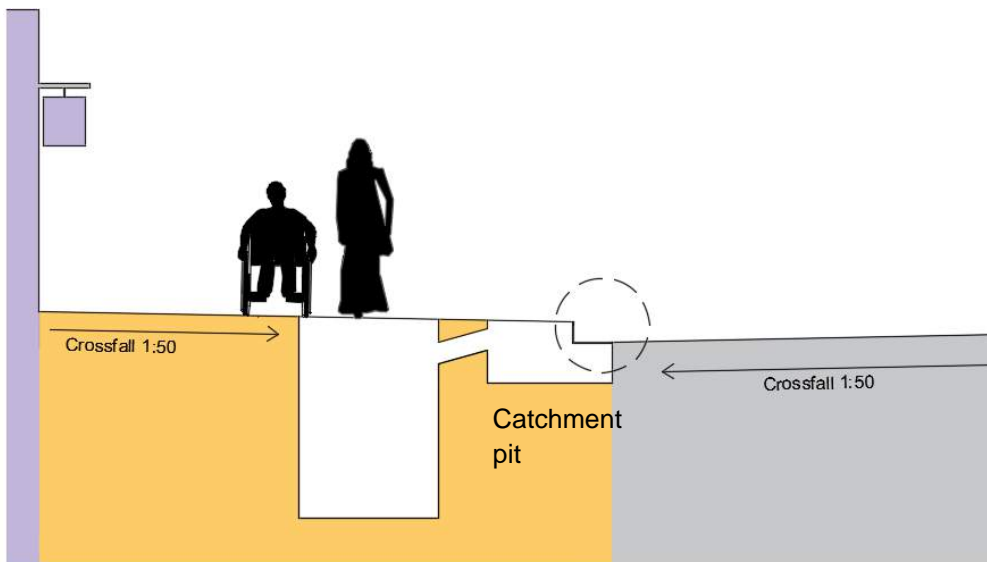
2.4m vertical clearance at a minimum.



Storm water drainage

Water logging is a persistent issue in cities in Bihar. On one hand, proper cross fall, spacing of inlets and maintenance of catchment pits must be ensured to facilitate drainage. Simultaneously, ground water recharge is recommended through permeable pavements, tree pits, swales, recharge wells.

Placement



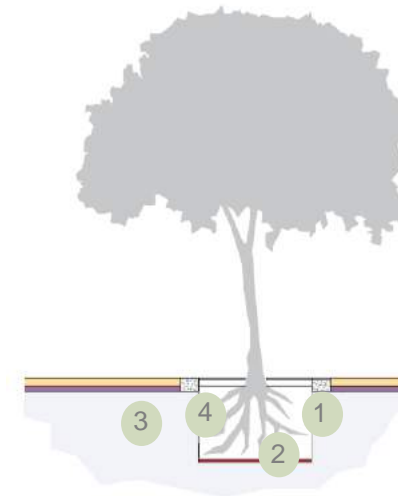
Combination inlet includes horizontal grates along a channel drain and vertical grates along the kerb. Inlet grating must be perpendicular to the movement of bicycles.

Infrastructure	Dimensions	Recommendations for
Inlet	0.6m 15m	Width Maximum spacing
Catchment pit	1.2m 0.6	Width Depth

Tree pit

Tree pits allow water to seep into the soil, thus recharging the ground water table.

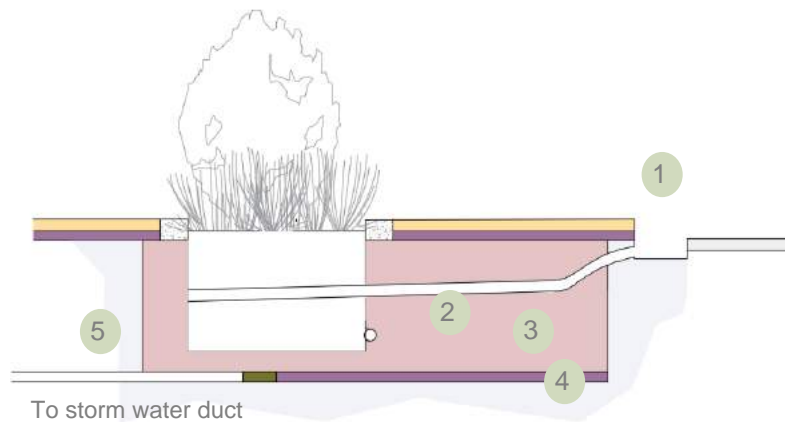
Tree pits must have root barriers to encourage downward growth of roots.



- | | | | |
|---|------------|---|--------------|
| 1 | Loamy sand | 3 | Earth |
| 2 | Gravel | 4 | Root barrier |

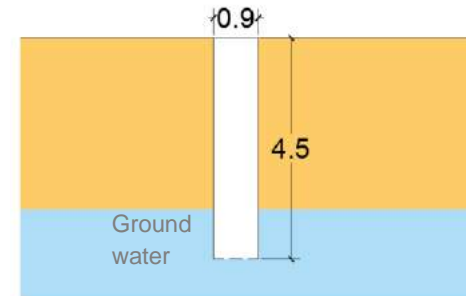
Raingarden pit

Landscaping can act as pervious catchment pits to absorb and clean water. It is connected to drains so that during times of overflow, water is siphoned to the storm water duct. Swales can be explored for wide streets.

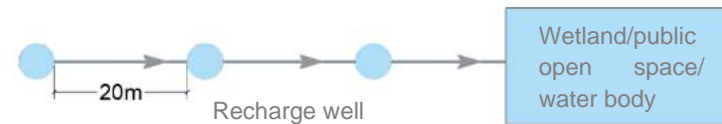


- 1 Drain inlet
- 2 Slotted AG pipe
- 3 Structural soil
- 4 Compacted depth FCR
- 5 Non slotted corrugated pipe

Recharge Wells



- Located within MUZ.
- Prevents urban flooding.
- Improves water security.



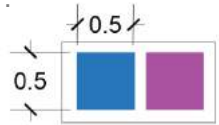
Recharge wells are a cost-effective method of managing storm water drainage. The recharge wells can also be connected to each other and linked to a nearby public open space to harvest water along with recharging groundwater.



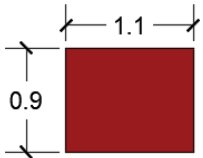
Dust bins

The disposal of waste along streets poses a threat to public health and hygiene. Dust bins provide a space to dispose of waste in an organized manner.

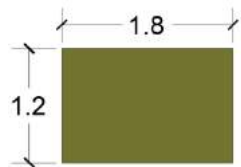
Dimensions



The area for dustbins must not exceed 1sqm.

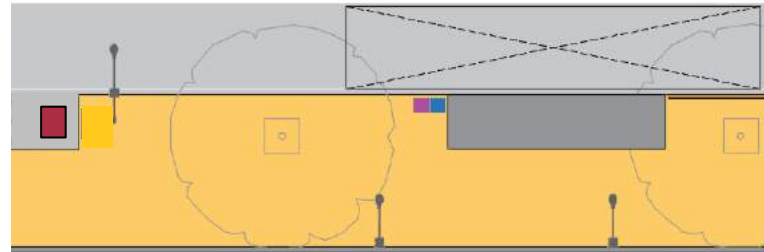


Community waste bins must hold waste of weight 500kg.



Feeding troughs for animals.

Location



Provide dust bins in the MUZ in areas with high pedestrian footfall such as near bus stops, IPT stands, market areas.

Community waste bins may be located as per the guidelines of the municipal solid waste department.

Types of dustbins



Two bins are recommended for dry waste and wet waste to promote recycling.

Dedicated space for feeding animals



Provide feeding troughs for animals on local streets.

Seating

Seating should be provided such that they are shaded and do not obstruct pedestrian movement. Ledges around trees may serve as seating as can compound walls. Park lets are also viable seating spaces.

Location

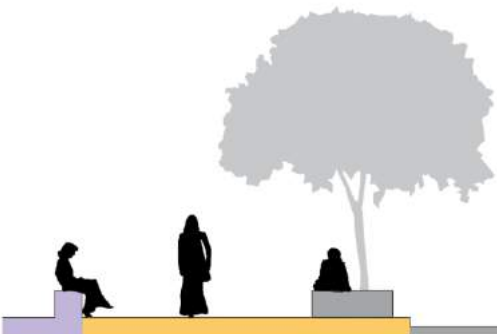


In areas with high pedestrian footfalls, near street vendors, around bus and IPT stops, and at regular intervals. These should be visually accessible.

Provide priority seating for elderly, differently-abled and caregivers and indicate it with signage.

An ideal distance between seating points is less than 50m, with a maximum distance of 150m.

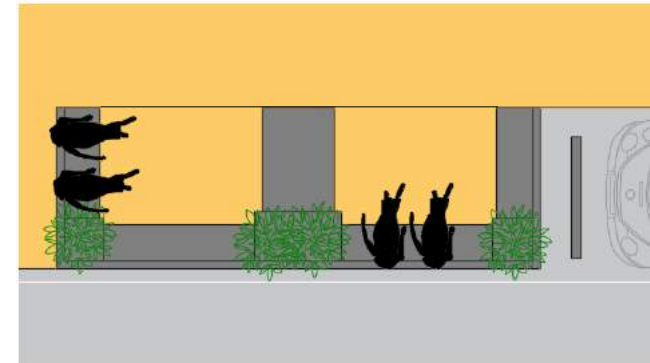
Comfort and safety



Shading, lighting, visual access, and protection from traffic.

Compound walls of height and width of 0.45m can double up as seating.

Accessibility



Parklets are bulb outs into the parking lane



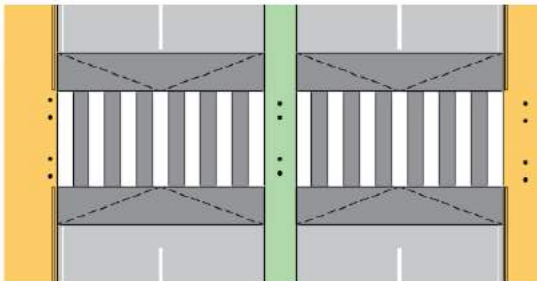
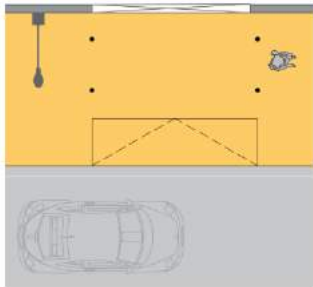
Priority seating must be provided with appropriate signage.



Bollards

Bollards are separation elements that prevent the incursion of vehicles onto pedestrian zones. While they serve the purpose of physical and visual segregation, they should be designed so as not to obstruct visibility.

Location



Bollards are located at property entrances, crossings, medians to prevent vehicles from entering the footpath.

They should not block movement for persons on wheelchairs.

Seating



Bollards of sufficient height and width may be utilised for seating where short waiting time is prevalent.

Infrastructure	Dimensions (in metres)	Recommendations
Width	0.10	0.45m when used as seating
Height	0.5-0.7	0.45m when used as seating
Spacing	0.50 1.20	Clear width for pedestrians Clear width for wheelchair users





Chandni Chowk, Delhi

Signage

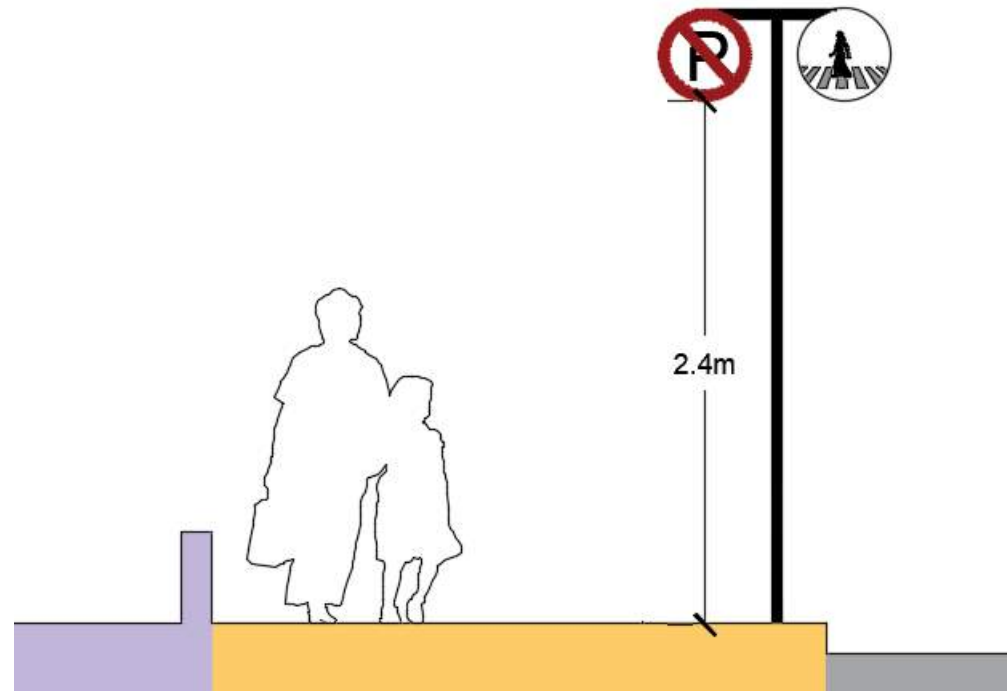
Signage communicates important information to pedestrians and motorists. Thus, legibility and inclusivity are important characteristics of signage. Traffic and pedestrian signage in IRC 67-2001 should be reviewed to ensure gender balance in representation.

Gender inclusive signage



Gender inclusive representation in traffic signals, signage and road construction works will help create gender balance in representation in public spaces.

Legibility



Signage can be combined to improve legibility.
Signage must be placed perpendicular to oncoming traffic.



Advertising

Any signage that objectifies women to sell a product or conveys sexist messages should not be permitted. Public service messages highlighting women's achievements, conveying zero tolerance to sexual harassment on streets, buses and IPT must be encouraged.

Gender positive advertisement



Zero tolerance for sexual harassment



Gender etiquette



**Dude...
Stop the Spread,
Please**

It's a space issue.

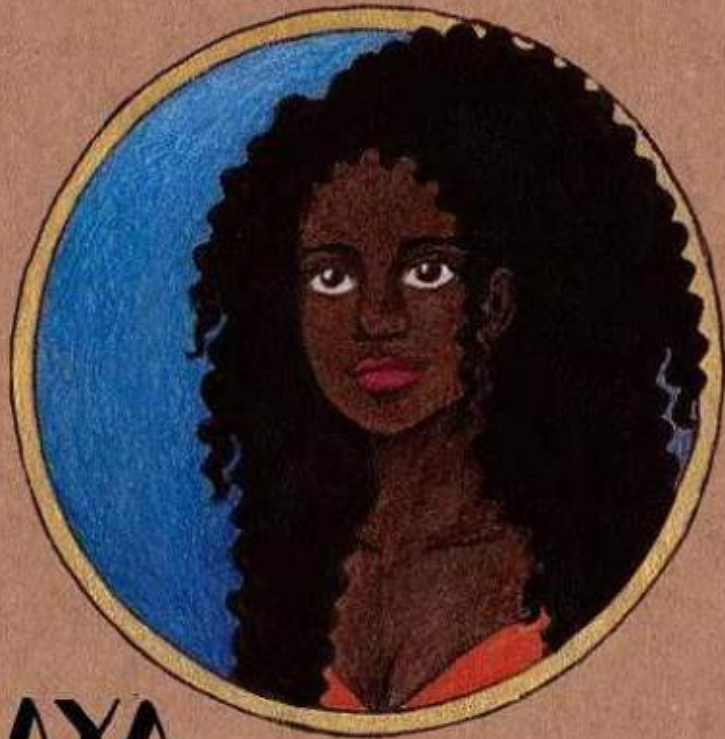
Encourage women to report



Source: Imgur.com, Vagabomb.com, Republicworld Dude, Stop the Spread' sticker Madrid Public Transportation Edmonton Transit's 'Safe Ride' campaign TARC's #WeBelieveYou campaign, Louisville, USA



MAYA HAS BEEN TOLD THAT SHE WOULD BE **GORGEOUS** IF HER **SKIN** WASN'T SO **DARK**.



MAYA,
SKIN TONE DOESN'T DEFINE **BEAUTY** OR **UGLYNESS**, BUT CAN SURELY **REVEAL RACISM** IN SOME PEOPLE. **YOU ARE BEAUTIFUL** JUST THE WAY YOU ARE /

SOME PEOPLE SAID THAT **THAIS** SHOULD **GIVE UP** HER **DREAM** BECAUSE SOME JOBS ARE REALLY MEANT **"JUST, FOR MEN."**



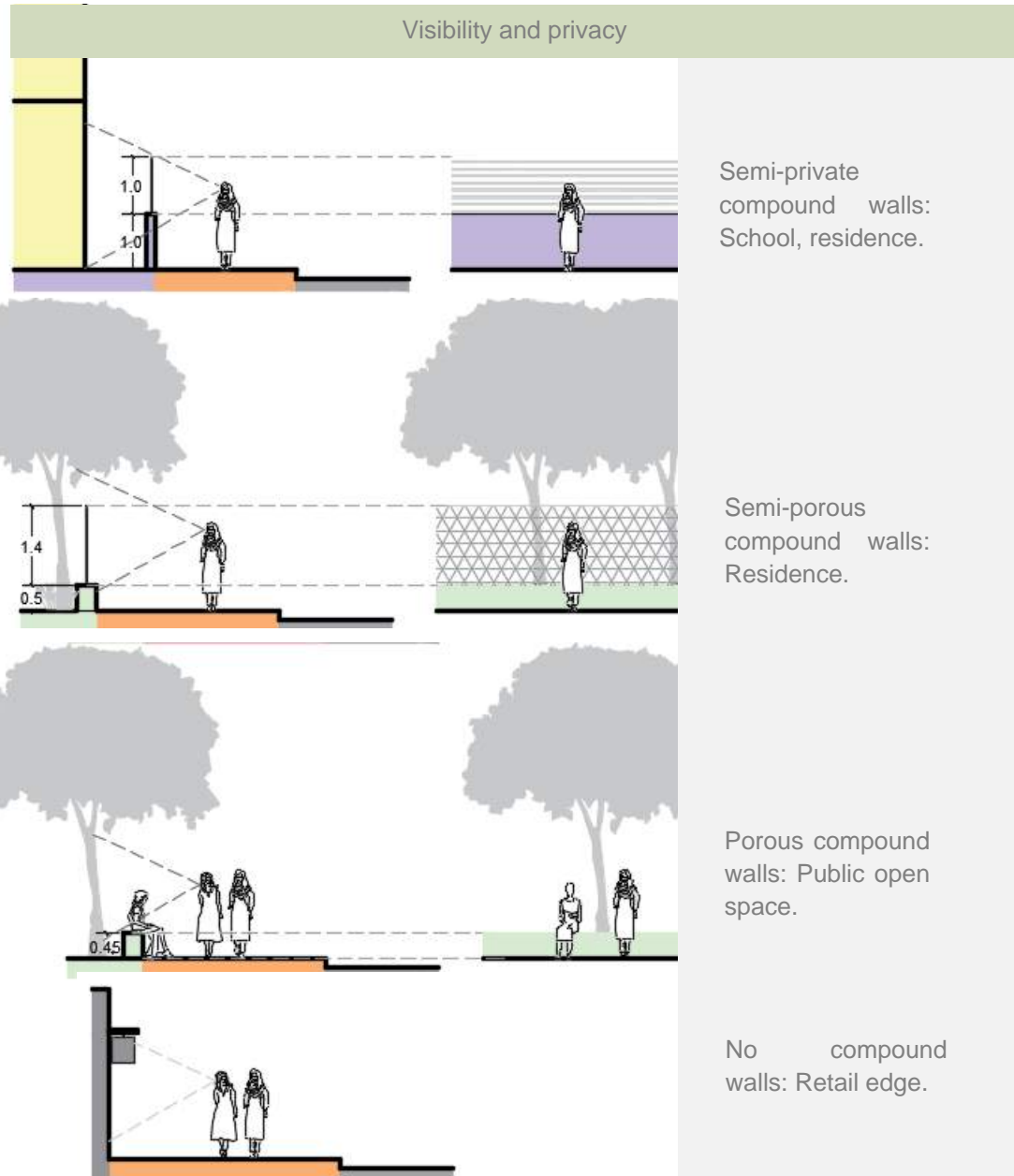
THAIS WAS THE FIRST **WOMAN** IN HER TOWN TO BECOME AN **AIRPLANE PILOT** AND DOESN'T REGRET IGNORING THE **BAD ADVICE** /

Compound wall

Compound walls influence the perception of safety, by enabling or inhibiting visibility. Different types of compound walls are recommended, depending on the adjoining land-use, to encourage street visibility.



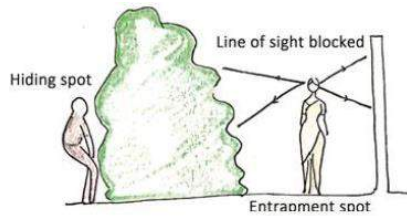
Wall art on public space edges such as compound walls can be encouraged. They can serve an aesthetic value and communicate social messages. Madhubani art can be used in cities of Bihar.



Blind corners and dead spaces

Blind corners create fear and a sense of insecurity. Street mirrors can improve visual access and connectivity, thus enabling safer streets. A gender violence map can be created at the neighborhood level to document unsafe spaces and to ensure mitigation actions can be initiated.

Clear sightlines



Landscape and high compound walls create blind spots especially in residential streets.

Surveillance



Dead spaces have less pedestrian activity. CCTV cameras, regular police patrols are recommended to improve safety.

Off street parking for goods vehicles



On-street parking of goods vehicles reduce visibility. Existing off-street parking facilities can be utilized for goods vehicles in the night.

Visibility



Enable visibility through porous compound walls, vertical clearance, street mirrors at corners.

Gender violence map

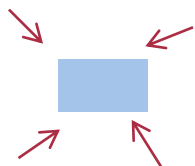


Participatory gender violence maps can be created for streets and neighborhoods to document unsafe spaces and prioritize action.

Public toilets and nursing (breast-feeding) rooms



Visibility and safety



Public toilets and nursing rooms must be easily identifiable and provide safe, well-lit access to pedestrians.



Access

Location

Public toilets and nursing rooms should be located within a 5 minute-walk from public and intermediate public transport stops and denoted in maps at these stops. They should also be provided in markets, parks and commercial establishments open to the public.

Mobile toilets

Buses about to be scrapped can be repurposed as mobile public toilets as in the case of Ti Toilet in Pune.

Maintenance



Public toilets and nursing rooms must be well equipped and maintained with periodic cleaning schedules.

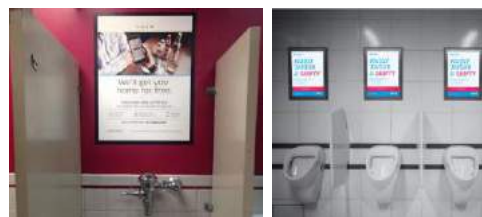
Self-financing

Designed to reduce operating costs

- Use of solar panels and water recycling.

Revenue sources

- Advertisements and marginal user fees.

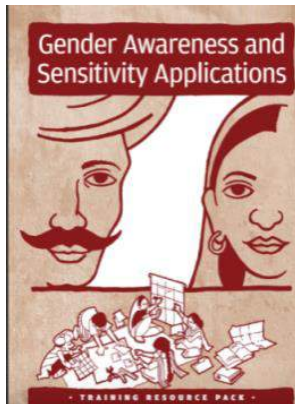


Role of the Police

Street design programs should also include the involvement of the Police to create safer streets for women and girls.

Train the Traffic Police

Traffic police should undergo gender sensitization trainings, so that women feel comfortable in approaching them, when experiencing sexual harassment.



Community Police Scheme

Community Police initiatives, taking cues from the Janamaithri scheme in Kerala can build a relationship between the community and the Police. This can address women's daily experience of harassment at the neighbourhood level.

Female police patrols in the night

Frequent women police patrols along public and intermediate public transport corridors in the day and night are recommended to address women's safety.



Mahila Police Volunteers

The Mahila Police Volunteer reports incidents concerning women and children to the police, while also raising awareness of the existing schemes available for women and children.

Train Nirbhaya volunteers

Women in the age groups of 25-55 years can be trained to address women's safety. The NVs can provide legal assistance, serve as a bridge between women and the Police.



Street vendors as Street Marshals

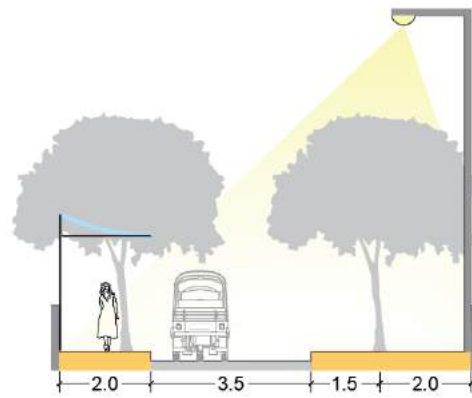
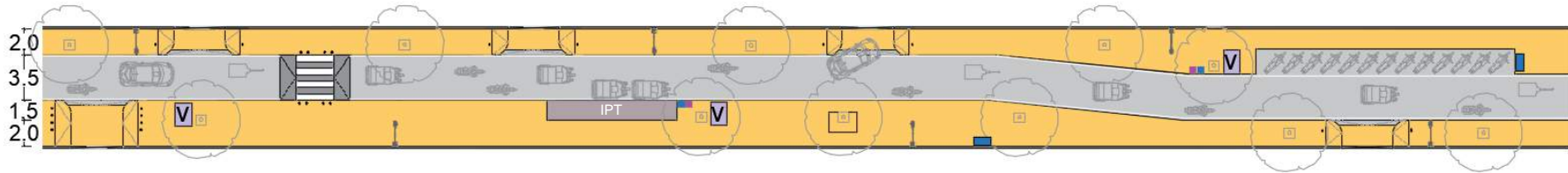
Since vendors also provide natural surveillance on streets, they can be trained to support and assist women facing harassment. This will also improve the perception of street vendors as safety enablers for women.



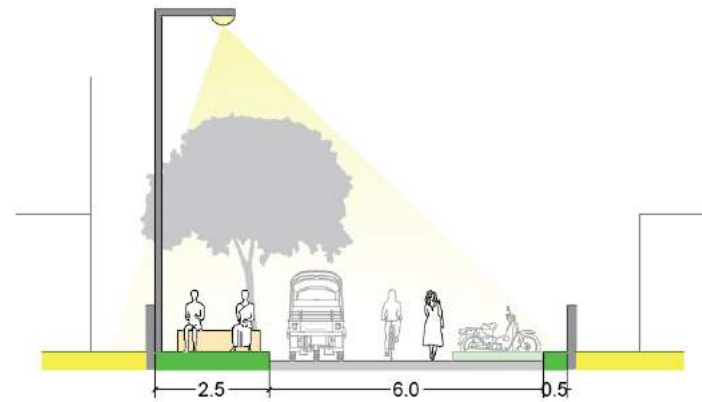
Street design templates

Street design templates are proposed for different streets and their function.

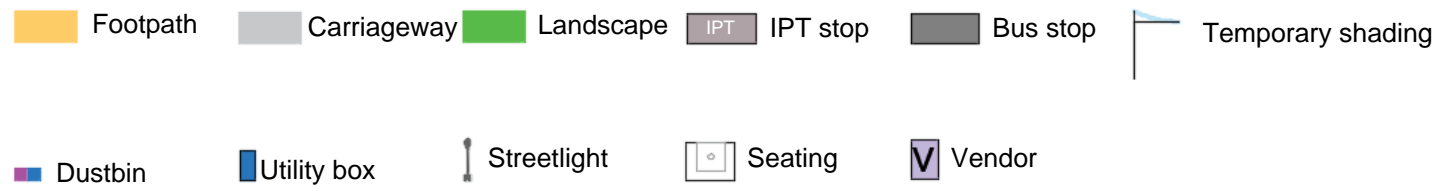
ROW 9 (one way)



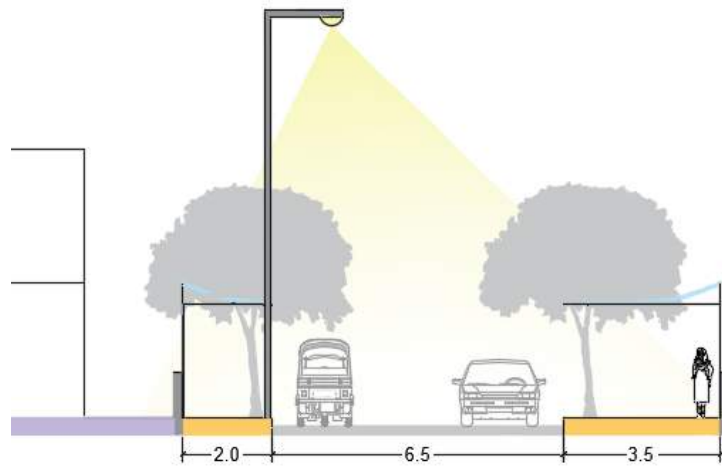
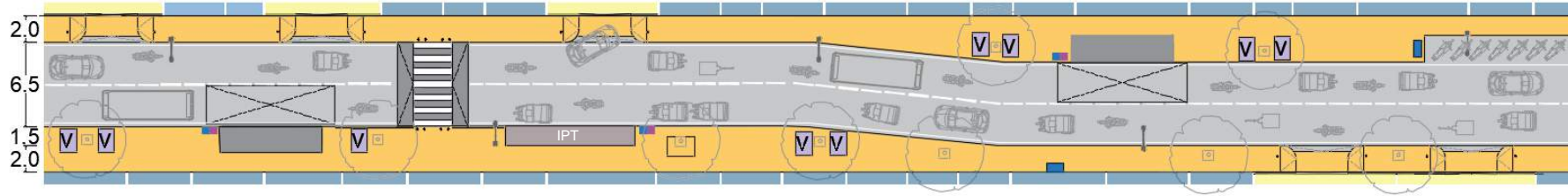
OPTION 1



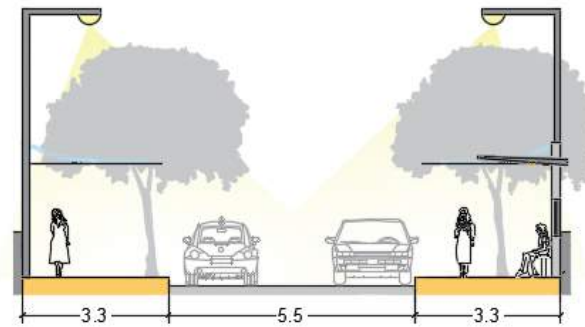
OPTION 2



ROW 12



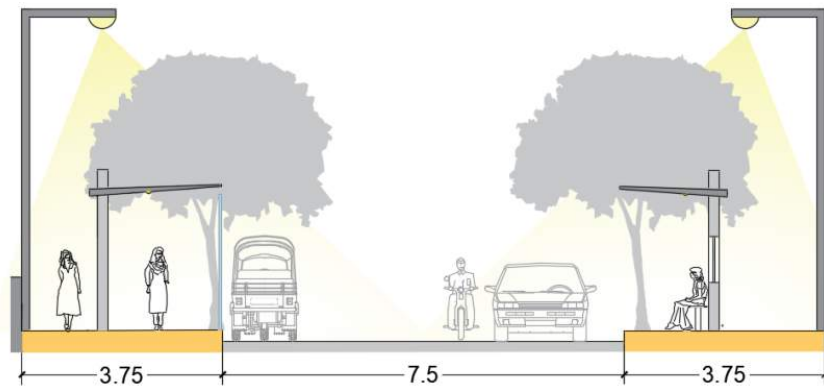
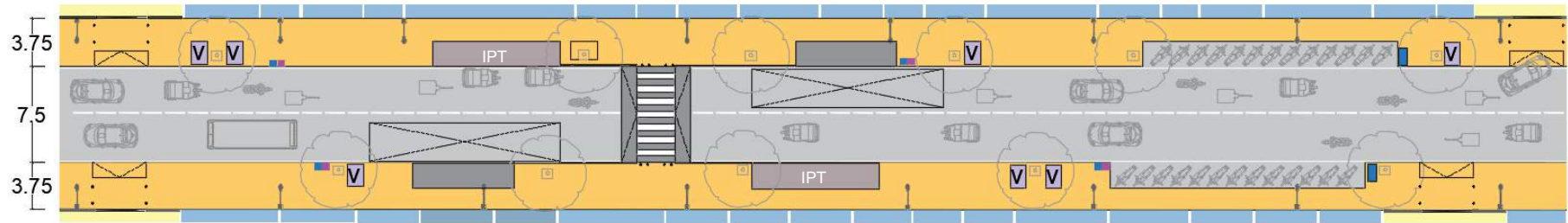
OPTION 1



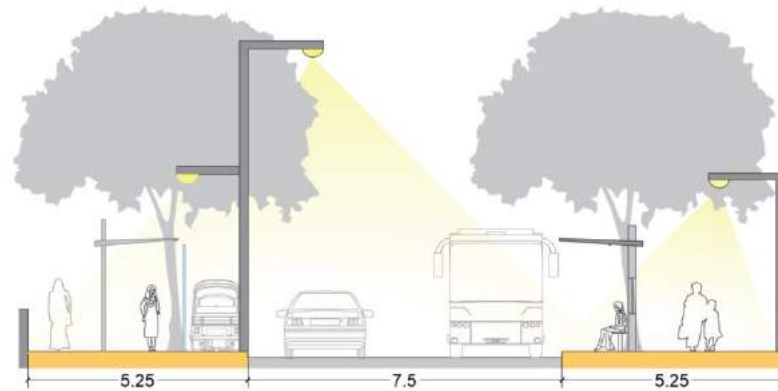
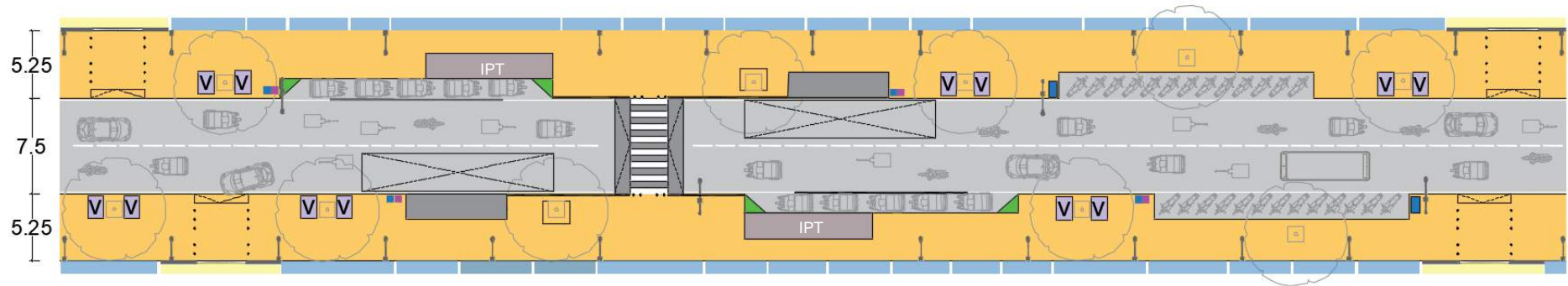
OPTION 2



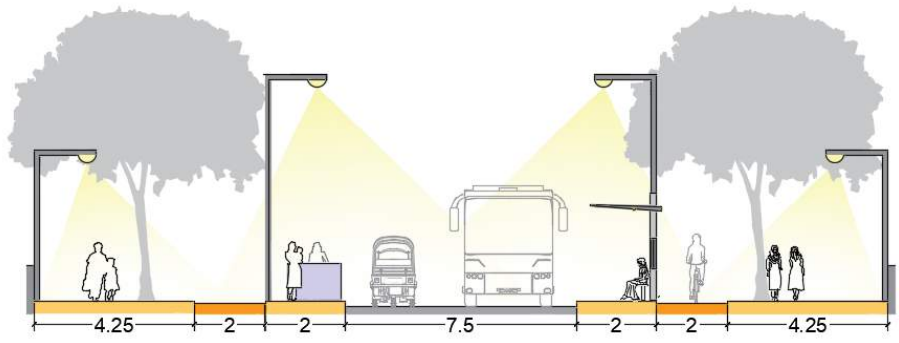
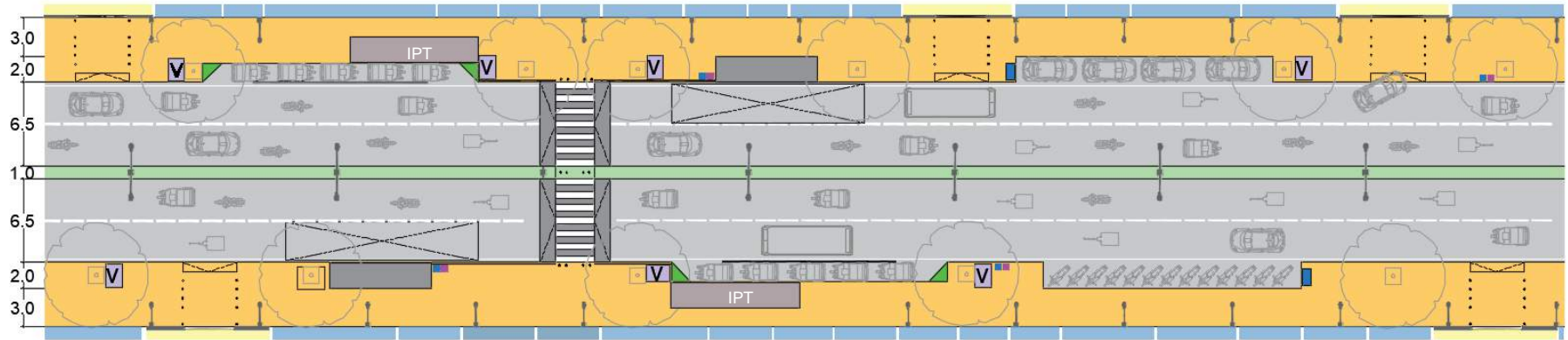
ROW 15



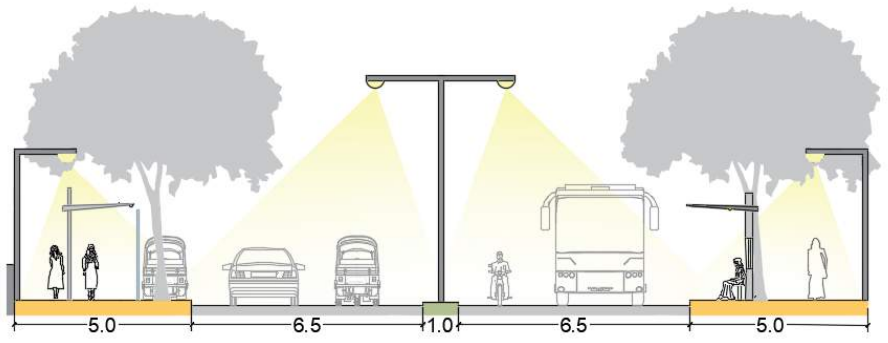
ROW 18



ROW 24



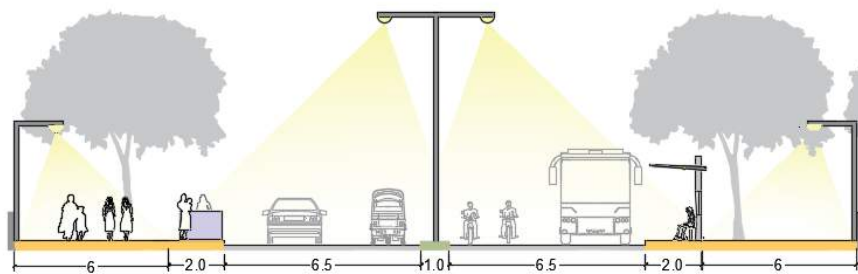
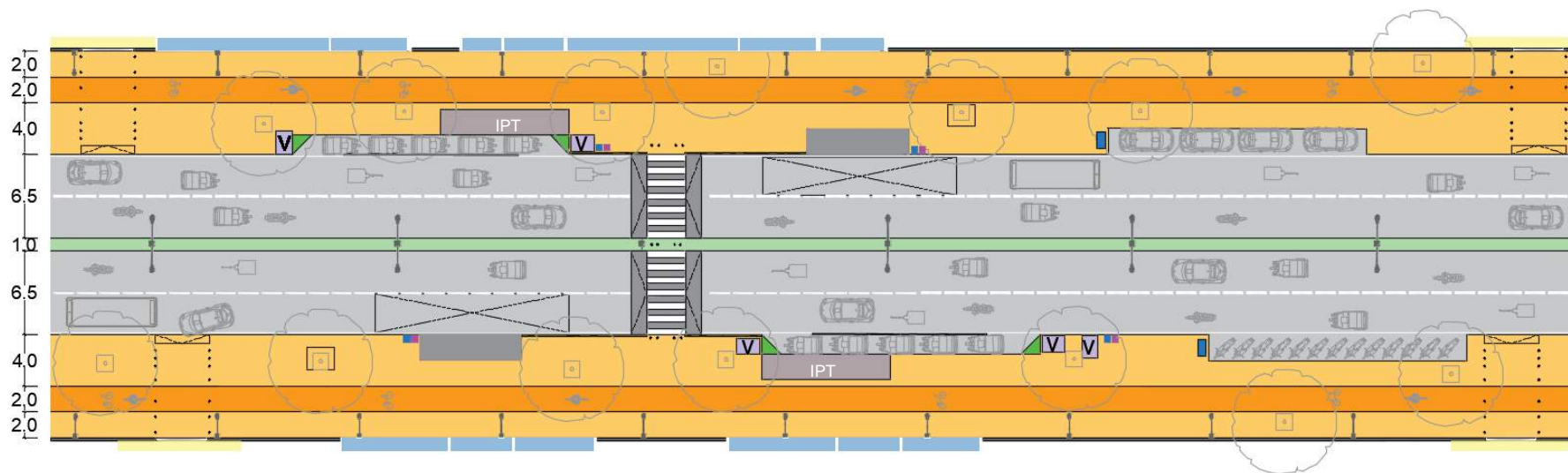
OPTION 1



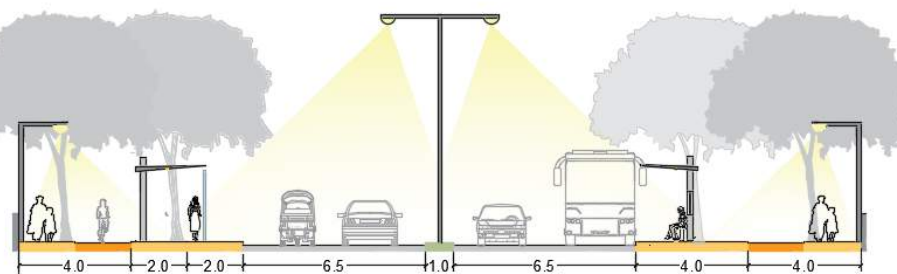
OPTION 2



ROW 30



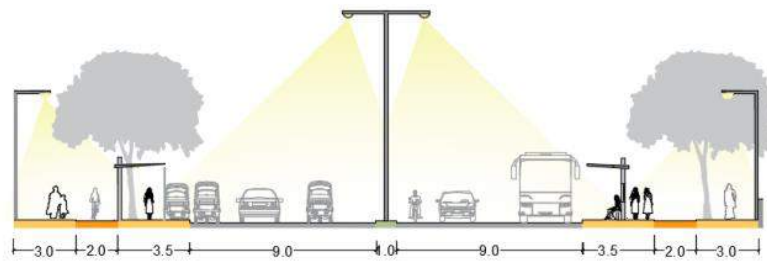
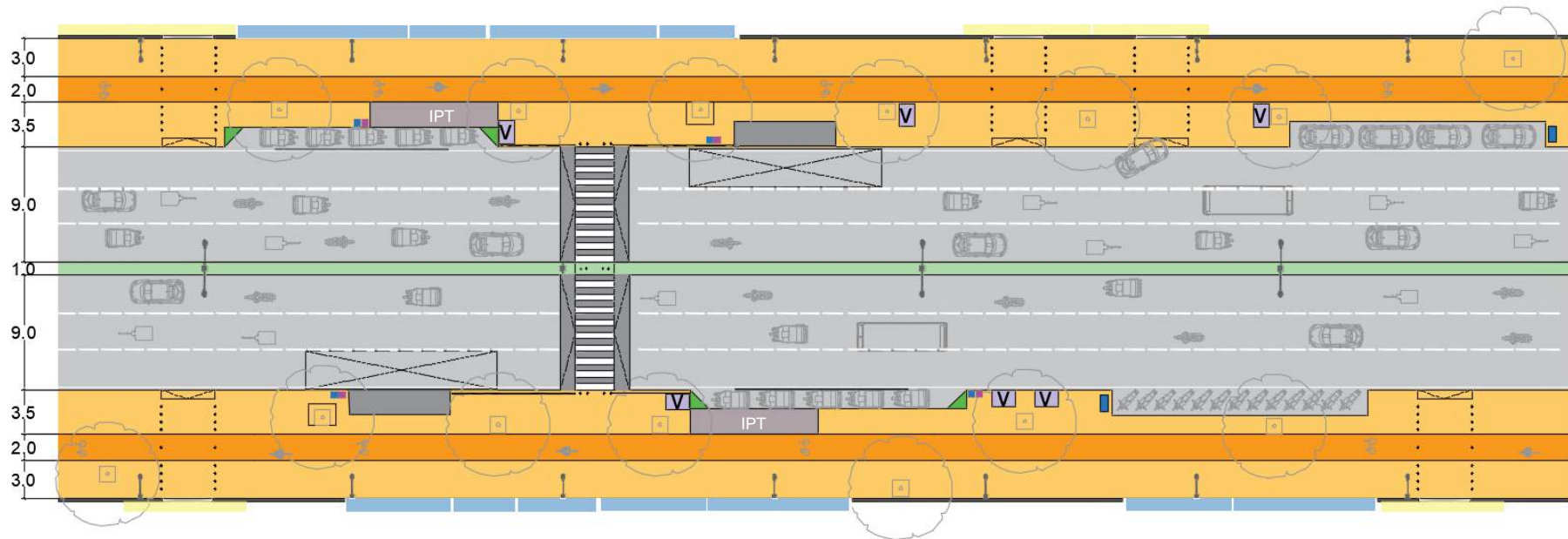
OPTION 1



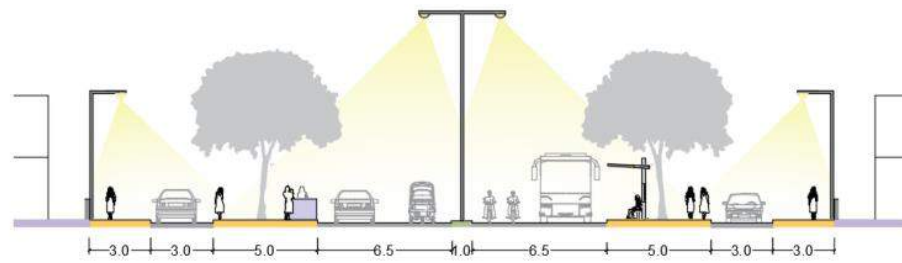
OPTION 2



ROW 36



OPTION 1



OPTION 2



Intersections

Intersections in Bihar are characterised by unregulated traffic movement, lack of footpaths and waiting areas for passengers. They also act as intermediate public transportation nodes. The redesign should include correcting the intersection geometry, organize the IPT stands, provide footpaths and sheltered waiting areas for passengers.

Correct road geometry

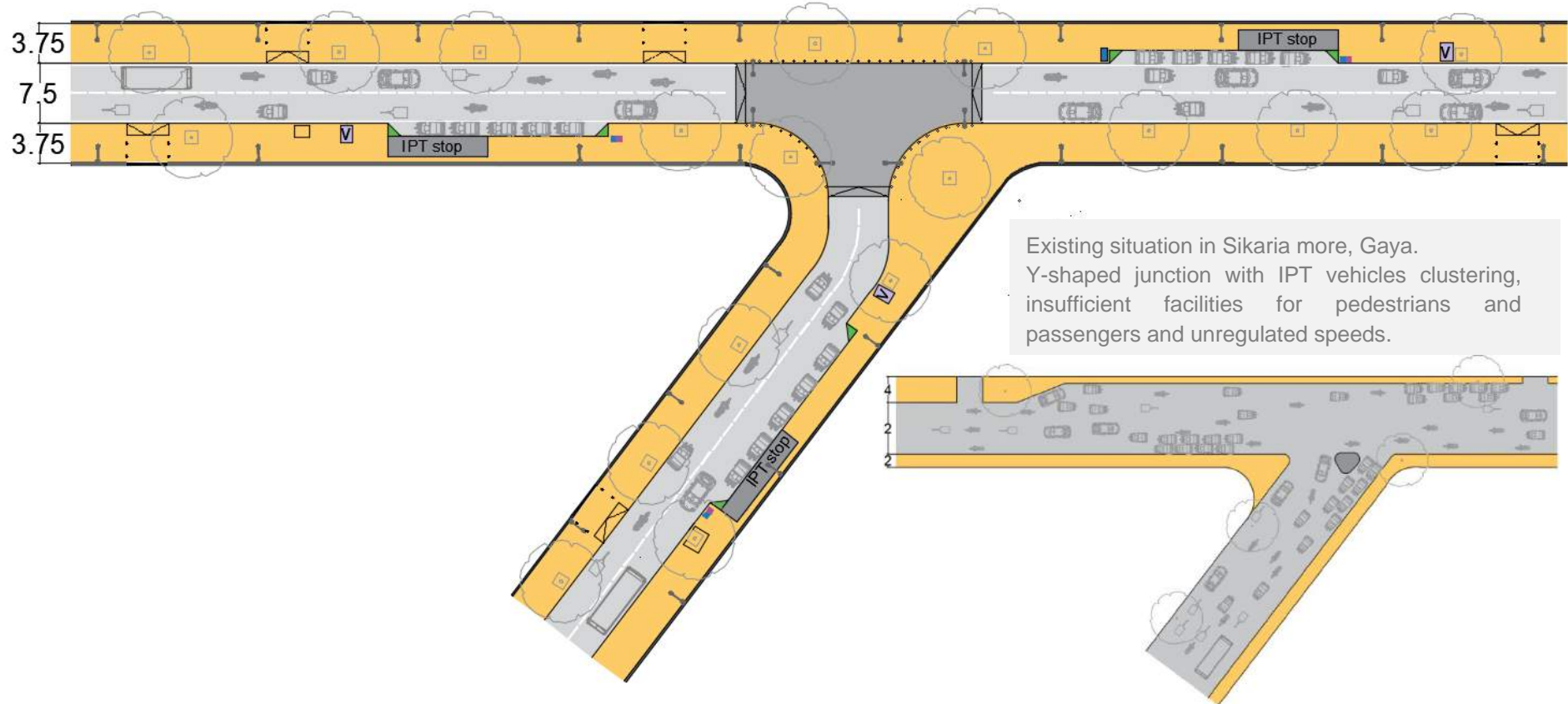
Realign road geometry for safe vehicular movement, provide space for pedestrians

Reduce turning radius

Reduce turning radius at intersections to slow down vehicles

Raised intersection

Raised intersections are recommended at unsignalized intersections



Signal phasing

Signals are effective for solving traffic conflicts and regulating traffic movement, increasing capacity of the intersection, and enabling safe crossing for pedestrians and non-motorized vehicles. While 4-phase signals are commonly used, Indian cities can consider a 2-phase system when through traffic is more than turning movements.

Safe pedestrian crossing

All major intersections and junctions to have signalised crossings.

Consider coordinated signal timings for closely spaced intersections, prioritize transit and low progression speeds in areas with high pedestrian footfalls.

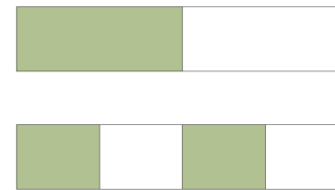
Pedestrian crossing intervals

Provide pedestrian lead intervals of 5-7 seconds.

Pedestrian noncompliance increases with delay greater than 40 seconds in a signal cycle.

Count down signals can increase pedestrian compliance behaviour.

Signal cycle length



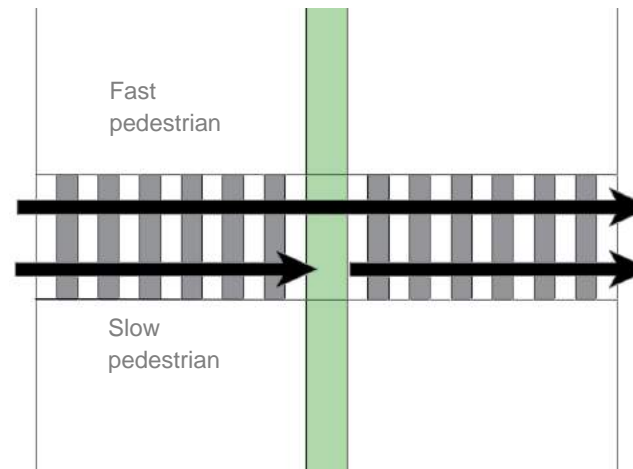
Shorter signal cycle length

Signal cycle length varies with intensity of traffic activity and pedestrian movement.

The signal cycle length must be less than 120 seconds. Shorter signal cycle lengths of 60-90 seconds are recommended.

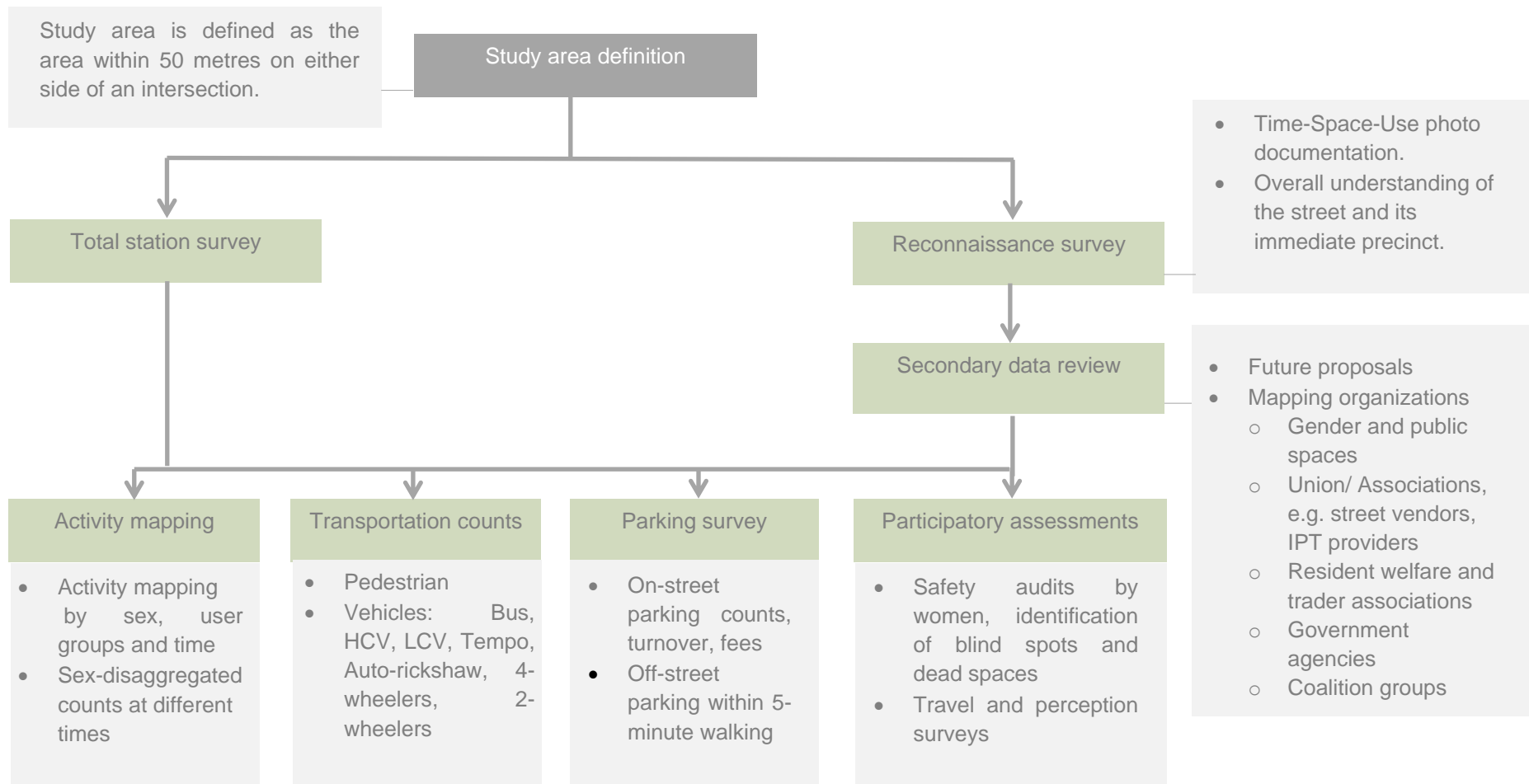
Signal cycle length must take into consideration pedestrian crossing speed, especially that of children, caregivers, elderly and persons with disabilities.

2 stage crossing for major roads. The signal allows the faster pedestrian to cross the street at one stretch but allows the slower pedestrian to cross in 2 stages.



Street design process

The street design process includes recommendations for gender inclusion in each stage of the process i.e. during data collection, analysis, conceptual proposals, reviews, and detail design.



Activity mapping

- Street vendor mapping, by sex, location, type, time

Transportation counts

- NMVs: Cycles, E-rickshaws, Cycle-rickshaws
- Passengers and waiting time at bus, IPT stops

Parking survey

- On-street parking counts: time of day, type of vehicle, turnover of vehicles, fees

Participatory assessments

- Focus group discussions with different groups of women (students, care givers, service providers)

Identification of issues

Identification of issues

Concept plan

Pilot testing

Final design

Detailed design and construction drawings

Implementation and monitoring

Feedback and consultation

- Gender, transport and urban design experts
- NGOs and CSOs
- Unions and associations

Review by experts

- Levels of service and road safety for pedestrians, cyclists, public transport and shared IPT users
- Blind spots, dead spaces, unsafe spaces for women and girls
- Amenities and infrastructure for users and service providers (street vendors, shared IPT providers, sanitation and workers in public spaces)
- On-street parking violations and issues



Example of a street design proposal pilot-tested in Coimbatore, SUTP-GIZ



Street design cell

A street design cell must be set up within the road owning agency to plan and design streets, communicate with the public and monitor implementation.



Team Lead:
Urban planner/designer
Experience: 10-12 years

Core team



Urban designer
Experience: 7-8 years



Traffic engineer
Experience: 5-7 years



Utilities engineer
Experience: 5-7 years



Transportation planner
Experience: 5-7 years



Communications associate
Experience: 2-3 years



Draftspersons (2)
Experience: 2-3 years

Experts



Gender and street design expert
Experience: 10-12 years



Universal access expert
Experience: 10-12 years



Landscape architect
Experience: 10-12 years



Reference publications

Abu Dhabi Urban Planning Council. 2009. "Abu Dhabi Urban Street Design Manual." www.upc.gov.ae.

Indian Road Congress. 2012."Guidelines for pedestrian facilities,IRC:103-2012". New Delhi

Indian Road Congress. 2015." Code of practice for road markings,IRC:35-2015". New Delhi

Indian Road Congress. 1997." Accomodation of utility services in roads,IRC:98-1997". New Delhi

Indian Road Congress. 2018." Guidelines for traffic calming measures in rural and urban areas,IRC:99-2018". New Delhi

Kost,C., Nohn,M., Bhatt,H., Deshpande,P., Dixit,P., & Jani,A. (EPC). 2011. "Better Streets , Better Cities."

Ministry of Urban Development. 2015. *URDPFI*.

Moreland City Council,. 2020. "WSUD Tree Pit."

Pune Municipal Corporation. 2016. "Urban Street Design Gudelines- Pune Municipal Corporation."

Raqshan, T. (2018, August 30). Recharge wells can help Chennai mitigate floods. Retrieved September 4, 2020, from DT Next: <https://www.dtnext.in/News/City/2018/08/30003025/1086393/Recharge-wells-can-help-Chennai-mitigate-floods.vpf>

Shah, S., Goswami,S., Rangwala, L., King,R., Das,H., & Suri,A. 2014. "Safe Access Manual." *EMBARQ*.

