



WRI INDIA

A photograph showing a man in a red and white striped shirt riding a bicycle on the left, and a man in a light-colored shirt and dark trousers walking on the right, both on a paved road. The background is slightly blurred, suggesting motion or a busy environment.

ENCOURAGING DESIGN PRACTICES FOR SUSTAINABLE MOBILITY IN INDIAN TOWNSHIPS: A GUIDEBOOK

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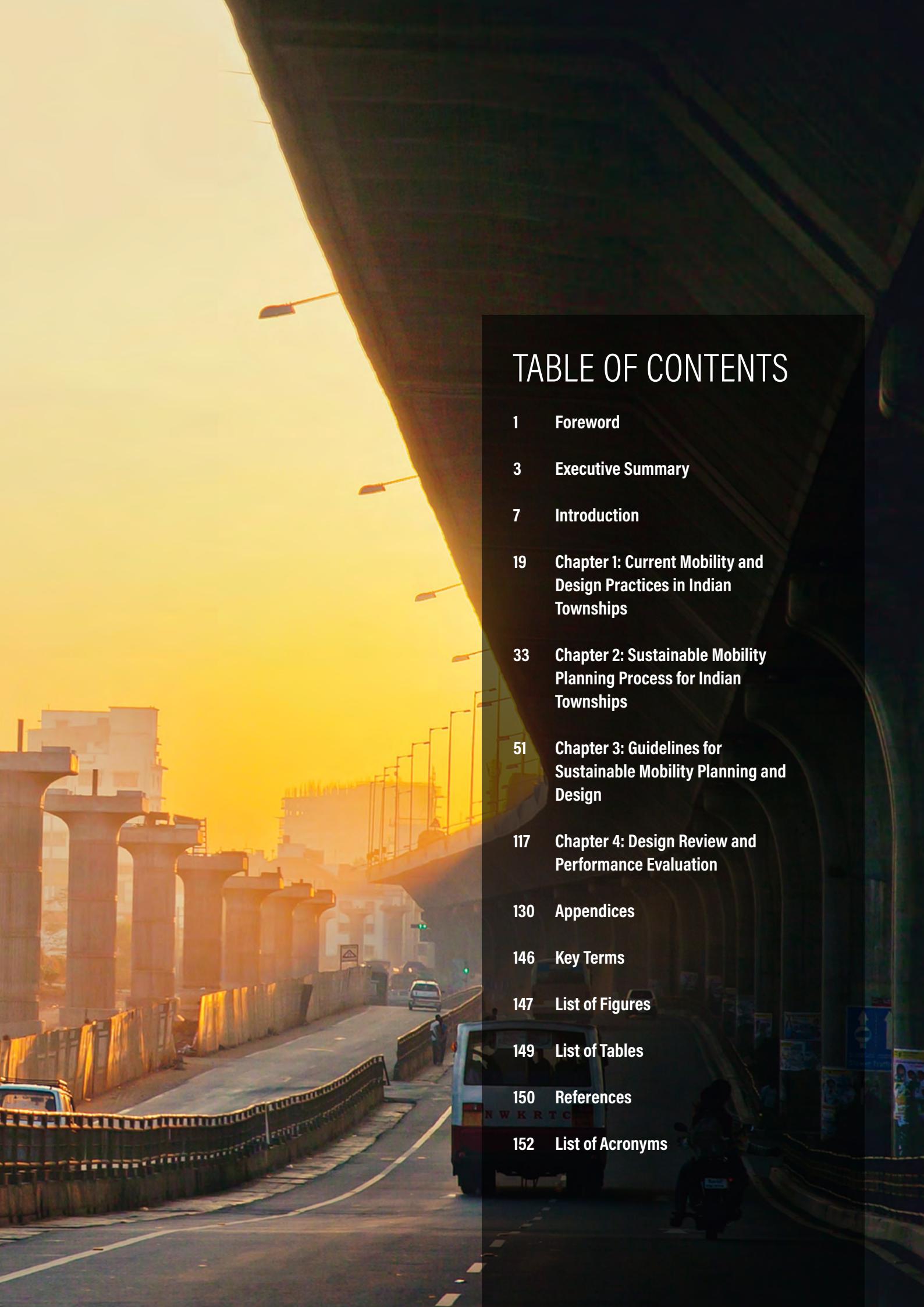


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FOREWORD

Rapid urbanization in major metropolitan cities in India, has in some cases, such as Bangalore, more than doubled its population in just the past decade. This increase in population has led to a demand for housing that has been filled, to a large extent, by private developers selling homes in independent, self-contained large-scale enclaves or developments, commonly referred to as ‘integrated townships’ or ‘gated communities’. In Bangalore alone, over 1500 such developments have been completed in the last 15 years, with at least 500 more under construction. These developments are characterised by secured and restricted access, multiple lifestyle homes and amenities catering to upper middle and high income population groups. With their size ranging from 100 residential to over 10,000 residential units, the potential impact of these developments on the environment is compelling. Due to land market and other space considerations, such developments are typically situated in the outer suburbs and peripheries of the city. Consequently, limited public transit connectivity to these areas leads to increase in private vehicle usage to meet daily travel needs. This threatens sustainability goals by requiring reliance on fossil fuels and production of additional greenhouse gases from the transportation sector. While challenging, the situation also presents a unique opportunity for intervention in urban design and development.

Sprawled growth patterns, automobile-oriented site planning and the absence of basic amenities spur increased vehicle use for short-distance trips, even within the development. Existing regulatory documents in India pertain to the shaping of built form in designing townships, while street design guidelines and toolkits on subjects such as road safety, evaluation of non-motorised transport (NMT) infrastructure and parking management exist separately for design of the public realm. These documents provide a supportive framework for sustainable mobility but tend to offer little guidance on the more micro-scale of site design required by real estate developers. There is, thus, a need to recognise an

integrated approach to site planning and design of large developments, across different scales, to ensure ease and efficiency for users wanting to move to sustainable mobility modes. Sustainable mobility modes provide an alternative to single occupancy vehicles and include active transportation modes such as walking and cycling, all forms of public and intermediate public transportation and shared occupancy vehicles such as rideshares and shuttle buses.

This guidebook highlights the role of urban design interventions applied across different stages in the township master planning process that promote the use of sustainable modes such as walking, cycling and public transit for trips under five kilometres; promote mixed land uses that provide easy access to daily necessities through clean, safe and secure environments; and set targets for reducing carbon emissions generated from motorised vehicle use. The proposed strategies are based on the premise that effective site design can enhance the attractiveness, convenience and safety of sustainable mobility modes, while maintaining the efficiency of travel by other modes. This guidebook was produced through a grant by the U.S. Department of Energy for a project titled ‘Building Sustainable, Energy Efficient and Connected Communities in India’. We hope it will serve as a useful reference for the real estate developer-builder community, as well as local authorities, to value, encourage and facilitate the incorporation of sustainable mobility design practices into such large urban developments.



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EXECUTIVE SUMMARY

As incomes increase in India's cities, the number of private vehicles grows, bringing the attendant congestion and pollution problems, as well as increased energy consumption and carbon emissions. These problems can be reduced by a sustainably designed mobility system and sensible neighbourhood layouts.

India's rapid urbanisation has created new challenges for reducing pollution and congestion as well as meeting national sustainable energy and emission reduction goals. Yet it also provides unique opportunities for new urban design concepts to meet these challenges.

Burgeoning demand for upper- and middle-class housing in Indian cities has been met by large, private, self-sustaining enclaves, referred to as 'townships', 'integrated townships' or 'gated communities'. These developments usually have restricted, secured access; a variety of types of homes; and amenities such as stores and recreation. They are usually located outside city boundaries where enough land is available.

Limited public transit from cities to these townships has caused an increase in private vehicle use leading to increased fuel use and road congestion. Likewise, within these developments automobile-oriented site planning discourages walking, cycling and shuttles, and necessitates vehicle use for short trips.

Growing concerns related to long-term environmental sustainability has led to the evolution of an alternate approach to transportation planning called 'sustainable mobility'. Sustainable mobility calls for designing sites to accommodate walking and cycling, all forms of public and intermediate public transportation and shared occupancy vehicles such as shuttle buses.

Currently, township site plans are regulated by urban master plans and city development regulations. Public guidelines on street design, toolkits on road safety, evaluations of non-motorised transport infrastructure, and guidelines for parking management provide a supportive framework for sustainable mobility, but offer little guidance at the scale of site design required by professionals engaged in township design. Thus, there was a need to showcase an integrated approach to the design of large developments, from the macro-scale of the overall site and its connection to the rest of the city to the micro-scale of individual buildings and intersections to ensure consistency in applying sustainable mobility principles.

This guidebook shows how certain design elements can promote sustainable mobility to save fuel, reduce emissions and save money for

the residents of new township communities. The strategies in the guidebook are based on the premise that effective site design can enhance the attractiveness, convenience and safety of sustainable mobility modes while maintaining the efficiency of travel by other modes for longer trips. These design practices:

- Promote the use of sustainable modes such as walking, cycling and public transit for trips under 5 kilometres;
- Promote mixed land uses that provide easy access to daily necessities through clean, safe and secure environments for all income groups; and
- Set targets for reducing carbon emissions generated from motorised vehicle use.

This guidebook is part of WRI India's project 'Building Sustainable, Energy Efficient and Connected Communities in India' funded by the U.S. Department of Energy. Over several years, the project formed partnerships with township developers around Bangalore to identify opportunities to improve site designs to incorporate sustainable transit modes.

For three planned townships, WRI reviewed the site designs and made recommendations on specific improvements to foster non-motorised transport. It also conducted opinion surveys in six townships on residents' transit preferences, willingness to use sustainable forms of transit and current barriers to non-motorised transit. The audit and survey findings show that suitably planned low-cost design interventions can not only reduce the negative impact of automobile-oriented planning on the built and natural environment, but can also save residents money spent on fuel. In fact, in just the six surveyed communities in Bangalore, residents would save an estimated 6,873 litres of fuel daily, or about 2.5 million litres annually. At 2014 fuel prices, the savings would be about \$3 million or Rs 19 crore annually (Rajagopalan, et al. 2015).

Information and examples from the WRI India project are thoroughly incorporated into this guide. Yet the guide goes further to organize material into practical guidelines that planners can use to different steps of the design process or to retrofit existing designs.

- The guide:
 - Describes residents' perceptions towards non-motorised mobility modes and how design can alleviate resident concerns about adopting sustainable transport;
 - Gives detailed critiques of how traditional site plans can be transformed into sustainable mobility plans;
 - Provides an overview of the key challenges to and benefits of providing sustainable mobility within townships;
 - Outlines seven steps to adopting designs that prioritise more compact and connected developments;
 - Describes essential guidelines for different scales and stages in the planning process; and
 - Provides evaluation criteria to assess design elements and looks at existing green rating systems in the country as a basis for evaluating the quality of site design.

All chapters are amply illustrated with sketches that clarify the design concepts.

By using this guide, urban planning, engineering and design professionals and real estate developers will be able to incorporate sustainable

Effective site design can enhance the attractiveness, convenience and safety of sustainable mobility modes while maintaining the efficiency of travel by other modes

mobility design practices into their projects. Further, WRI India hopes the guidebook will encourage a dialogue between private and public stakeholders on incorporating similar guidelines at neighbourhood and city levels. Ultimately, WRI India hopes it will bring about a market transformation where residents recognize the externalities of typical developments and demand more sustainable communities so private developers and public policies are pushed in this direction.



INTRODUCTION

Well-planned, compact developments with mixed uses that provide equitable streets and public spaces with high-quality walking and cycling infrastructure, increased connectivity and public transit access can improve energy efficiency and liveability, while reducing the cost of delivering basic services by 30 to 40 percent (The World Bank 2012).

India is experiencing rapid economic growth and urbanisation. In 2011, an estimated 340 million people lived in cities and surrounding areas and the number is projected to increase to 590 million by 2030 and 700 million by 2050 (Majumdar, et al. 2014). A 2009 McKinsey Report on building inclusive cities estimates that “India needs to build 700 to 900 million square metres of residential and commercial space each year – equivalent to adding more than two Mumbai’s or one Chicago annually – and that 70 percent of this building stock is yet to be built” (Shanke, et al. 2010). In addition, the report states that 20–25 new cities or towns will need to be built by 2030 to house the additional 250 million people.

Recent Trends In Residential Township Development In India

Since 2005, Indian cities have experienced a phenomenon known as ‘reverse brain drain’, as a large number of highly skilled Indian professionals residing abroad return to India. For example, an estimated 25,000 professionals returned between 2000 and 2004 (Chacko 2007). This returning population, with its global exposure, growing income levels, and smaller family sizes, has led to greater demand for housing across most major Indian cities (Figure 1). These returnees expect quality homes that promote a ‘global lifestyle’ including access to well-developed recreational, commercial and infrastructure amenities such as:

- High-quality built environments that are visually appealing, secure and efficient;
- Uninterrupted power and water supply and efficient waste disposal systems;
- Round-the-clock security and maintenance systems; and
- Access to retail, recreational and open spaces (Chacko and Varghese 2009).

The prospering middle class’s rising demand for better living standards is mostly being met by private integrated township developments. Because of the inadequacy of the public sector, private developers are providing suitable urban housing options with a minimum level of services.

Under the integrated township model, the developer is responsible for acquiring the land, planning and building housing and infrastructure and selling the units. The public sector sets standards for planning, building and infrastructure and ensures compliance (IDFC 2009).

In addition, the Indian Government’s proactive and liberal 2005 foreign direct investment policy for construction projects (Government of India 2014) has contributed to an upsurge of such developments through partnerships, agreements and construction deals between private developers, foreign counterparts and the public

Figure 1 | Projected Cumulative Real Estate Demand in India 2008 to 2012



Source: Anon, 2008. The metamorphosis, Changing Dynamics of Indian Realty Sector, Cushman & Wakefield

sector (Goel 2013). Furthermore, bank financing initiatives such as the SBI Green Home Loan, DHFL Home Loan, and similar loans from other banks offering lower interest rates for green and energy efficient homes, have contributed to the current trend toward ‘green’ integrated developments (bankbazaar.com n.d.; Business Today 2013; Hans 2011; Figure 2).

However, township development has led to serious consequences in the way Indian cities are growing. The large amount of land required for townships requires that they be located in the peripheral or peri-urban areas of cities, which have limited public infrastructure (Floater, et al. 2014). Figure 3

shows the locations of developments launched in 2014 in Bangalore, Chennai and Pune.

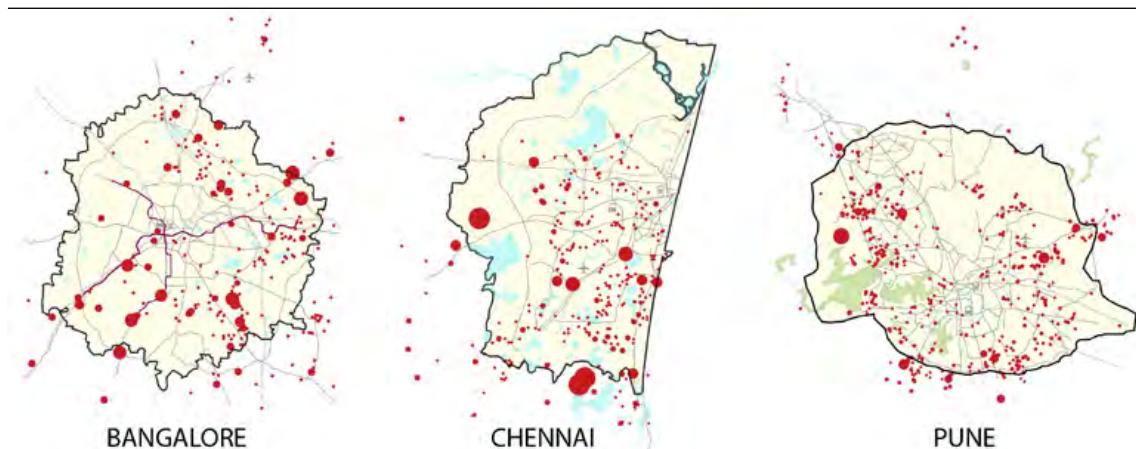
Most integrated and greenfield developments privately provide basic internal infrastructure such as road networks, access to water and power supply, waste management and social facilities such as open spaces and community centres. However, they often lack external infrastructure such as access to good road networks, public transport and pedestrian and cycling infrastructure. This lag in the pace of public infrastructure development has led to accessibility issues and increased dependency on private transport within and outside the developments.

Figure 2 | Advertisement of an Integrated Township in Bangalore Promoting ‘Walk to Work’ and ‘Green Living’



Source: The Hindu, February 26 and March 18, 2015

Figure 3 | Most Developments Launched in Bangalore, Chennai and Pune in 2014 Were on the Peripheries of City Centres



The difference in dot sizes represents the number of units in a development ranging from 100 units (smallest dot) to over 1,500 units (largest dots).
Source: WRI India, 2015. Data Source: www.commonfloor.com.

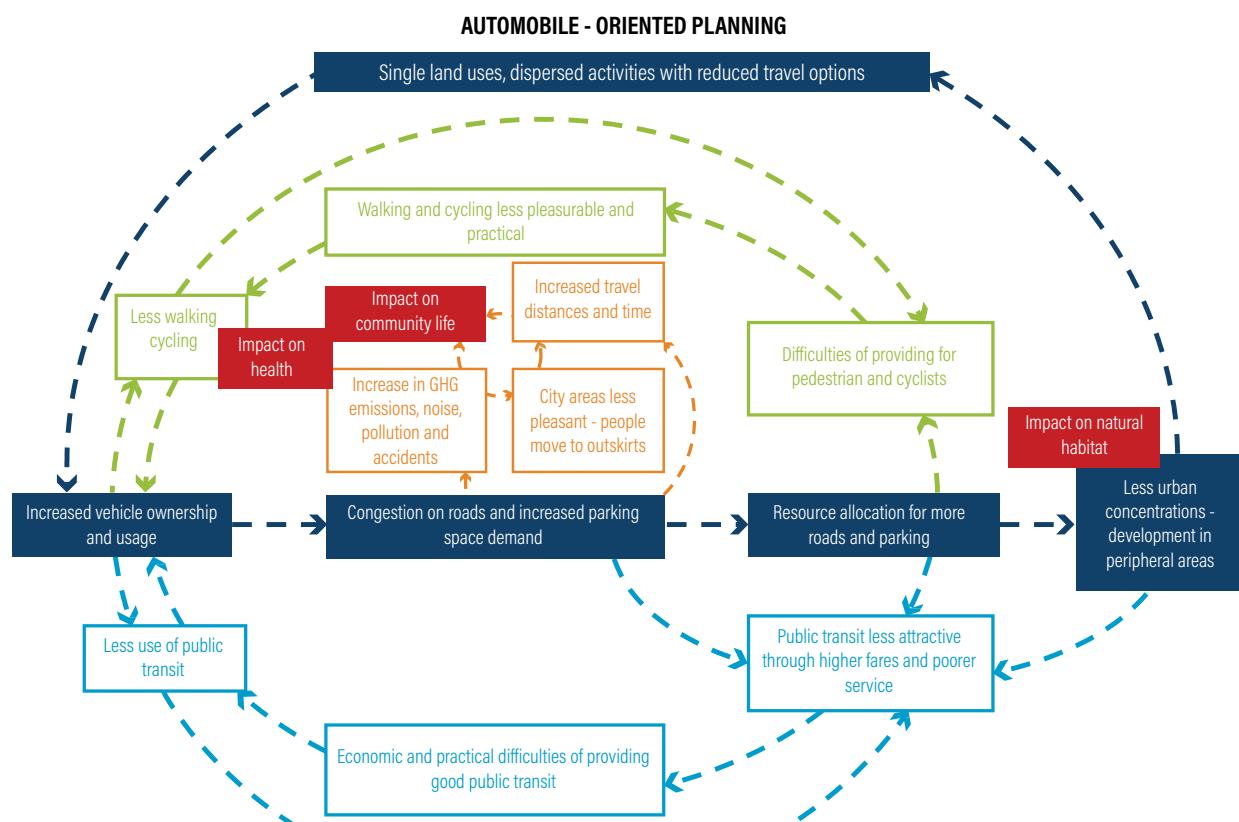
An automobile-oriented planning pattern that leads to dependence on private transportation not only leads to urban sprawl but also locks plans into a spiral of unsustainable transportation patterns that increase the number of vehicle miles travelled, congestion, pollution, and encourages other negative effects as shown in Figure 4 (Litman 2015). Evidence suggests that the interaction of transportation patterns and urban form is cyclical (Litman 2009) and that current development patterns increase residential communities' dependence on private vehicles. Moreover, household and mobility surveys show that dependence on private transportation for work and other everyday activities requires greater effort, cost, energy and time because average distances and travel times increase year on year. Apart from increased social, environmental and economic cost, spending a considerable part of their time

in travel has a negative effect on people's quality of life.

While the real estate developer does not control the factors contributing to urban sprawl, the pace of public infrastructure development, or ensuing transportation issues, the developer does control the mobility patterns within the development and the connectivity of the development to external public transit.

There is an urgent need to break out of this negative cycle through interventions and strategies that promote sustainable mobility by encouraging non-motorised transport modes and access to public transit. This is particularly important for integrated townships with a large number of households and some commercial and business activities.

Figure 4 | Vicious Circle of Automobile-Oriented Planning



Source: WRI India, 2015; Adapted from Victoria Transport Planning Institute.

Examining Township Plans And Resident Attitudes In Bangalore

In 2011, as part of its project ‘Building Sustainable, Energy Efficient and Connected Communities in India’, WRI India formed partnerships with several township developers around Bangalore to identify opportunities to sustainable transit modes.

WRI reviewed the site designs of three planned townships and recommended specific improvements to foster non-motorised transit. It also conducted opinion surveys in six townships on residents’ transit preferences, willingness to use sustainable forms of transit and current barriers to non-motorised transit.

The design audit and survey findings show that suitably planned low-cost design interventions can not only reduce the negative impact of automobile-oriented planning on the built and natural environment, but also save residents money spent on fuel (see Box 1).

Since there is a paucity of good sustainable mobility practices in townships, WRI India’s audits that provide insight into the application of design guidelines are heavily referenced in this guidebook. Additionally, the guidebook references WRI India’s projects on creating accessible, safe and inclusive development in greenfield scenarios and neighbourhood improvement planning.

Observations from these projects are used as case studies and are referenced throughout the design guidelines to support key recommendations. Table 1 provides a brief outline of the projects, their context and basic statistics as of June 2014.

Appendix A provides a detailed outline of the audit projects that WRI India has been involved in since 2011, with brief recommendations for each.

Findings from Household Surveys

(Mahendra, et al. 2014)

17%

of the average weekday travel includes additional trips i.e. trips not counted as work or school trips

56%

of all additional trips were local shopping trips

46%

of the trips were for distance less than 5 kilometres

37%

of the trips were done within 30 minutes one-way

BOX 1 | BUILDING SUSTAINABLE, ENERGY EFFICIENT AND CONNECTED COMMUNITIES IN BANGALORE

In 2009, Bangalore's \$83 billion economy boomed to claim fourth position, just behind Mumbai, Delhi, and Kolkata (Yahoo Finance 2012). Spurred by its burgeoning technology sector, Bangalore more than doubled its population in a decade, reaching 9.6 million in 2011 (Indian Census 2011). This increase led to a boom in housing demand that has been largely met by privately financed independent developments referred to as integrated townships or gated communities.

The sheer rise in the number of private developments in Bangalore city over the last 15 years is represented in Figure 5. More than 1,500 developments have been completed and almost 500 more are under construction. With the smallest development consisting of

about 100 residential units and most planned for over 10,000 units, the potential impact of these communities on the environment needs to be carefully considered (www.commonfloor.com, 2007).

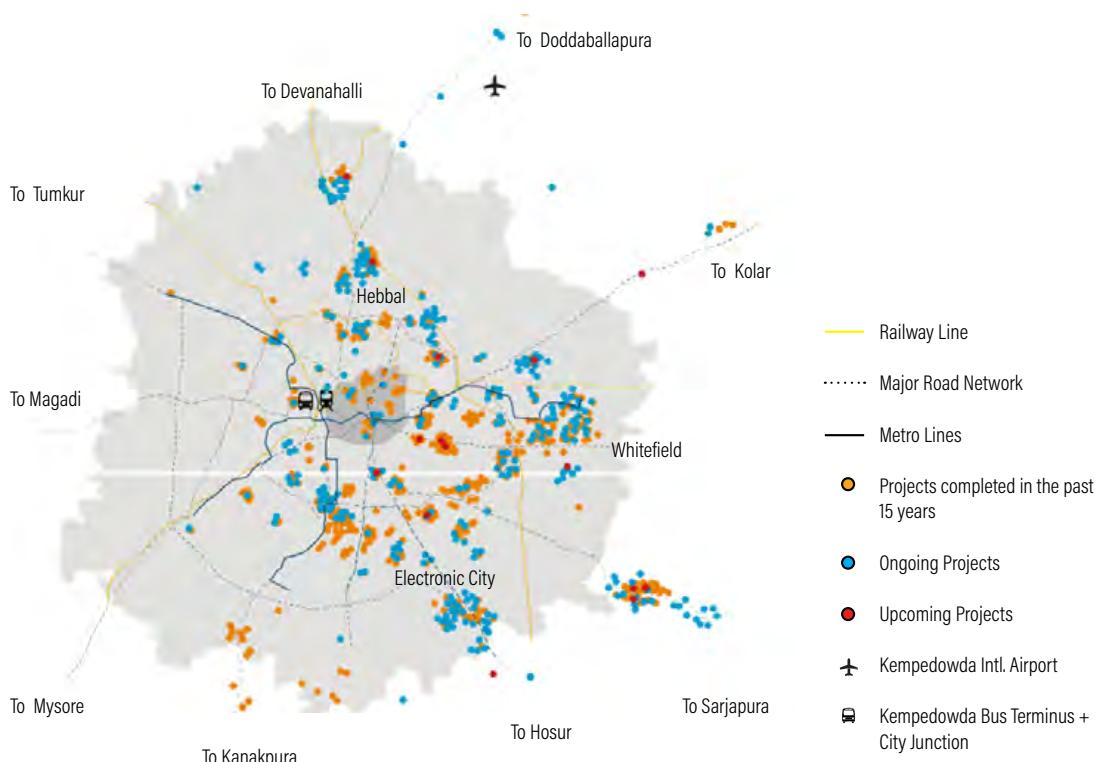
In 2013, as part of the project, 'Building Sustainable, Energy Efficient and Connected Communities in India', WRI India established partnerships with real estate developers that were planning and constructing private developments in the greater Bangalore metropolitan region. These partnerships aimed to identify opportunities to sensitise and influence developers to:

- Adopt sustainable mobility (non-motorized transport) models that

enable movement with minimal environmental impact, through strategies promoting energy-efficient travel by foot, bicycle, and public transit, as defined by the Universitat Autònoma de Barcelona;

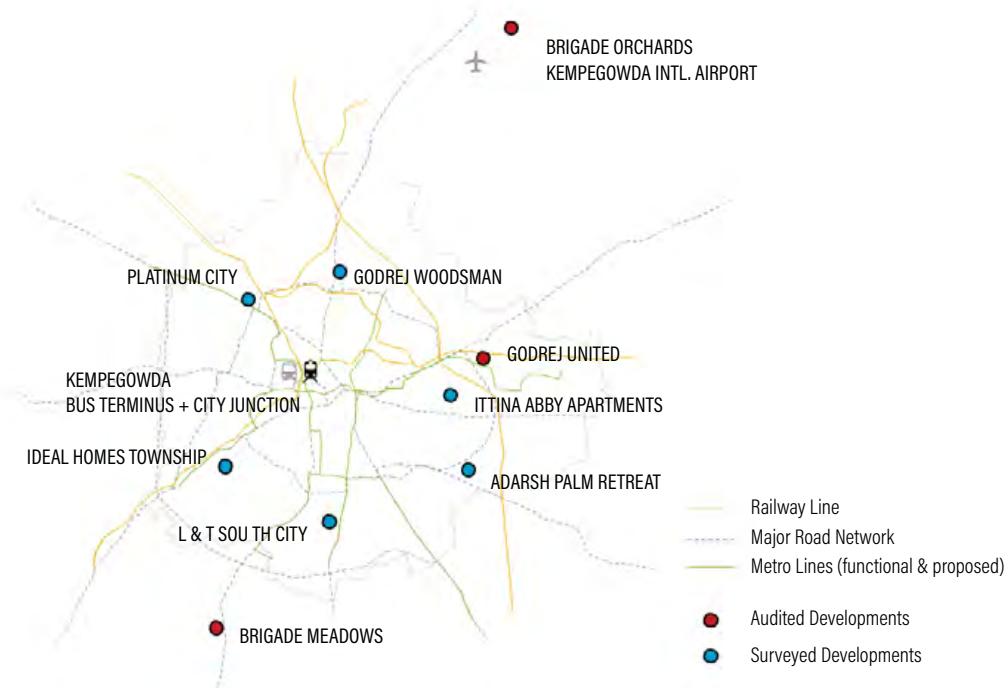
- Incorporate renewable energy and energy efficiency features to the extent possible;
- Improve the quality of life and health of residents through opportunities for physical activity; and
- Identify key mobility issues within large developments and propose design interventions that promote sustainable mobility.

Figure 5 | Locations of Completed, Ongoing and Upcoming Private Community Developments in Bangalore, 2014



Source: WRI India, 2014. Data Source for Gated Community Locations: www.commonfloor.com.

Figure 6 | Locations of Private Community Developments in Bangalore Audited (red) and Surveyed (blue) by WRI



Source: WRI India, 2014. Data Source for Gated Community Locations: www.commonfloor.com.

WRI India worked with developers to (1) conduct design and mobility audits for three Bangalore developments in the planning stages, (2) conduct household surveys and visual assessments for six gated communities, and (3) hold workshops on challenges faced by developers in incorporating sustainable mobility within townships.

The developments that WRI has audited (red) and surveyed (blue) are shown in Figure 6 .

To audit the three planned developments, WRI India first evaluated the architectural plans to assess indicators of sustainable mobility, accessibility, safety and liveability. Then, in partnership with project design staff, it worked on incorporating recommendations for proposed road networks and linkages, the use and nature of buildings, block sizes, open space networks, safety features and connectivity to external transport systems. An overview of the audited developments and recommendations for each project along with other relevant case studies

conducted by WRI India are shown in Appendix A.

WRI's household surveys focused on (1) detailed travel patterns and residents' perceptions of their environment, (2) attitudes about transport facilities and options, and (3) preferences

for different transport modes and commuting patterns. The responses of residents in each development were evaluated by how much they differed from the overall survey responses, allowing WRI India staff to determine relationships between the built environment and resident perceptions. The WRI team looked at multiple scales of design and development:

- Macro scale – Master plan: Improving street network connectivity
- Meso scale – Street scale: Design based on a green transportation hierarchy
- Micro scale – Designing pedestrian friendly environments

Based on these scales, the following key strategies were proposed for the three audited developments:

- Develop alternate networks of mobility.
- Relocate community amenities to enable easy non-motorized traffic movement.
- Redesign streets to accommodate non-motorised transport infrastructure.
- Ensure safe access for pedestrians, non-motorised transport and vehicles.
- Enhance open space connectivity.

The findings also made it clear that at different scales of development, various actors or stakeholders carry different responsibilities.

The survey instrument is shown in Appendix B while a summary of the key survey findings are given in Appendix C.

The household surveys were also analysed for the number of motorised trips that could be potentially shifted to non-motorised modes and public transit. It was estimated that if design audit recommendations such as providing continuous, safe footpaths and cycle lanes and internal shuttle services connecting the development to public transit, were applied to the six surveyed communities, their households would save an estimated

6,873 litres of fuel daily, or about 2.5 million litres annually. At 2014 fuel prices, the savings would be about \$3 million or Rs 19 crore annually—for just the six surveyed communities in Bangalore (Rajagopalan, et al. 2015). The audit and survey findings thus showcase that suitably planned low-cost design interventions can not only reduce the negative impact of automobile-oriented planning on the surrounding built and natural

environment, but also save money spent on fuel. This in turn can increase market demand for the development.

Recommendations from the WRI workshops on challenges to incorporating sustainable mobility patterns into townships are mentioned throughout this guide and summarized in Section 1.4 of Chapter 3 and listed in Appendix D.

Table 1 | Outline of WRI India Project References Used in the Guidebook

PROJECT NAME	LOCATION	SITE AREA (ACRES)	PROJECT TYPE	NUMBER OF HOUSEHOLDS	ESTIMATED RESIDENTIAL POPULATION	ESTIMATED NUMBER OF CARS
Adarsh Palm Retreat ^a	Bangalore	250	Mixed-use	2,790	13,300	4,200
Brigade Orchards ^b	Bangalore	130	Mixed-use	1,800	7,200	2,700
Brigade Meadows ^b	Bangalore	68	Mixed-use	3,022	12,000	3,300
Godrej United ^c	Bangalore	10.5	Residential	514	2,300	661
L & T South City ^d	Bangalore	34	Residential	2,000	8,500	3,000
Godrej Garden City ^c	Ahmedabad	250	Mixed-use	13,000	55,250	14,000
Sector 31 ^e	Naya Raipur	149	Residential	3,421	15,400	8,323

Sources:

^a Adarsh Developers

^b Brigade Enterprises Limited

^c Godrej Properties Limited

^d South City Group Housing Apartment Owners' Association

^e WRI India and Naya Raipur Development Authority (NRDA)

Purpose and Target Audience

Use of sustainable mobility practices will build communities that provide safe, comfortable and healthy living options leading to increased demand for and value of townships. Developers can shape townships that promote the use of non-motorised transport (NMT) modes and public transit by creating sustainable and liveable neighbourhoods that incorporate people-oriented master planning² practices that encourage sustainable, energy-efficient mobility patterns and provide safe, environmentally friendly communities.

The design strategies presented in this guidebook can be linked to current planning process followed in developing townships.

The guidebook aims to provide direction for urban planning, engineering and design professionals and real estate developers on how to incorporate sustainable mobility design practices in their projects. Further, it aims to encourage a dialogue between private and public stakeholders on incorporating similar guidelines at neighbourhood and city levels.

The guidebook ultimately seeks to bring about a market transformation where residents recognize the externalities of typical developments and demand more sustainable communities so that private developers and public policy and regulation are pushed in this direction. To this end, the guidebook targets a diverse audience, including private developers, architects, decision makers, policy and planning professionals, transit agencies, resident associations and civil society organisations.

2 The term 'master plan/planning' in this guidebook refers to the township site plan and should not be confused with the master plan of a city.

Scope and Limitations

This guidebook can be used in planning new townships and many design elements may be useful for redeveloping or retrofitting existing developments. The strategies and guidelines cater to townships located at the peripheries of cities, with limited access to basic amenities and public transport.

The guidebook's scope is limited to design strategies in areas directly under the control of a developer. This includes site access points that form the interface between the township and city and the 'last mile of connectivity' within the development. However, to work successfully, these strategies require that the quality and pace of city infrastructure growth complement the development's growth.

The guidelines aim to strike a balance between motorised transport, public transport and non-motorised transport while maintaining the efficiency of all modes. Proposed street design elements follow the principles of safety, comfort, and equity as these are critical factors in increasing the use of non-motorised modes.

The guidebook does not specify traffic operations strategies that promote safety and use of non-motorised transport such as signal timing and traffic management. Street pavement markings, way-finding or signage, furniture and fittings design are addressed only as to placement and location. Strategies that focus on energy efficiency in building design and form are not in the scope of the guidebook.

The design guidelines are prescribed within India's framework of existing development control regulations.

Guidebook Structure

This document focuses on site planning process and design practices for integrated townships or mixed-use developments that have a balanced mix of residential, commercial, retail, recreational and institutional uses. However, most of these guidelines can also be used in designing large, non-residential, single-use developments such as business or technology parks and institutional campuses.

Chapter 1: Current Mobility and Design Practices describes residents' perceptions towards non-vehicular mobility modes and how design can alleviate resident concerns about adopting sustainable transport. It also provides an overview of the key challenges in providing sustainable mobility within townships along with the benefits of adopting and enforcing sustainable mobility provisions.

Chapter 2: Sustainable Mobility Planning Process outlines seven steps to successfully adopt design that prioritises compact and connected developments. Going a step further, it summarises the necessity of guidelines that focuses on making urban areas more efficient and sustainable.

Chapter 3: Guidelines for Sustainable Mobility Design outlines essential design elements, translated into guidelines and detailed across different scales and stages in the planning process. The guidelines are structured to provide definition and intent, recommended practices, illustrative examples and related topics. This chapter also applies design elements to sample design projects.

Chapter 4: Design Review and Performance Evaluation provides evaluation criteria to assess the design elements in Chapter 3. It looks at green rating systems as a basis for evaluating the quality of site design and suggests maintenance checks that can assess the functioning of street elements within a project.

Appendix A outlines the design audit projects that WRI India has been involved in since 2011, with brief recommendations for each.

Appendix B is the complete survey questionnaire used for the Bangalore household mobility survey.

Appendix C reviews of key findings from household surveys conducted by WRI India between November 2013 and April 2014.

Appendix D summarises policy recommendations captured through engagements with participants at WRI workshops conducted in 2014.

Icons throughout the guidebook represent different mobility modes and development infrastructures. The key is shown in Figure 7.

Figure 7 | Key to Icons Used in the Guidebook

	PEDESTRIANS		CYCLISTS
	PUBLIC TRANSIT		INTERMEDIATE PUBLIC TRANSIT
	HANDICAPPED USERS		SERVICE VEHICLES
	RIDESHARE		MOTORISED TRANSPORT
	SHUTTLE / COMPANY OR SCHOOL BUS		TWO- WHEELERS
	OPEN SPACE		PARKING

Application Scales of Design Guidelines

The guidelines in this book are intended for implementation by a developer at the township and street levels. However, because the relationship of the township with its regional, urban and neighbourhood contexts is critical, they are also frequently mentioned. Four scales of intervention are identified for applying the design guidelines (Figure 8):

City and Urban Region

Developments in peripheral areas of cities are linked to the city's infrastructure and have a strong influence on the city's growth. At this scale, the design guidelines focus on linking the township physically, environmentally, socially and economically to the city.

Neighbourhood

Every township is part of a neighbourhood and must acknowledge its relationship with other developments in the neighbourhood. In some cases, townships can be so large that they function as a neighbourhood in themselves, comprising offices and retail, parks, and leisure amenities, in addition to housing. Creation of interconnected economic, social, environmental and mobility networks between and within developments produces a vibrant neighbourhood that functions in a complementary manner.

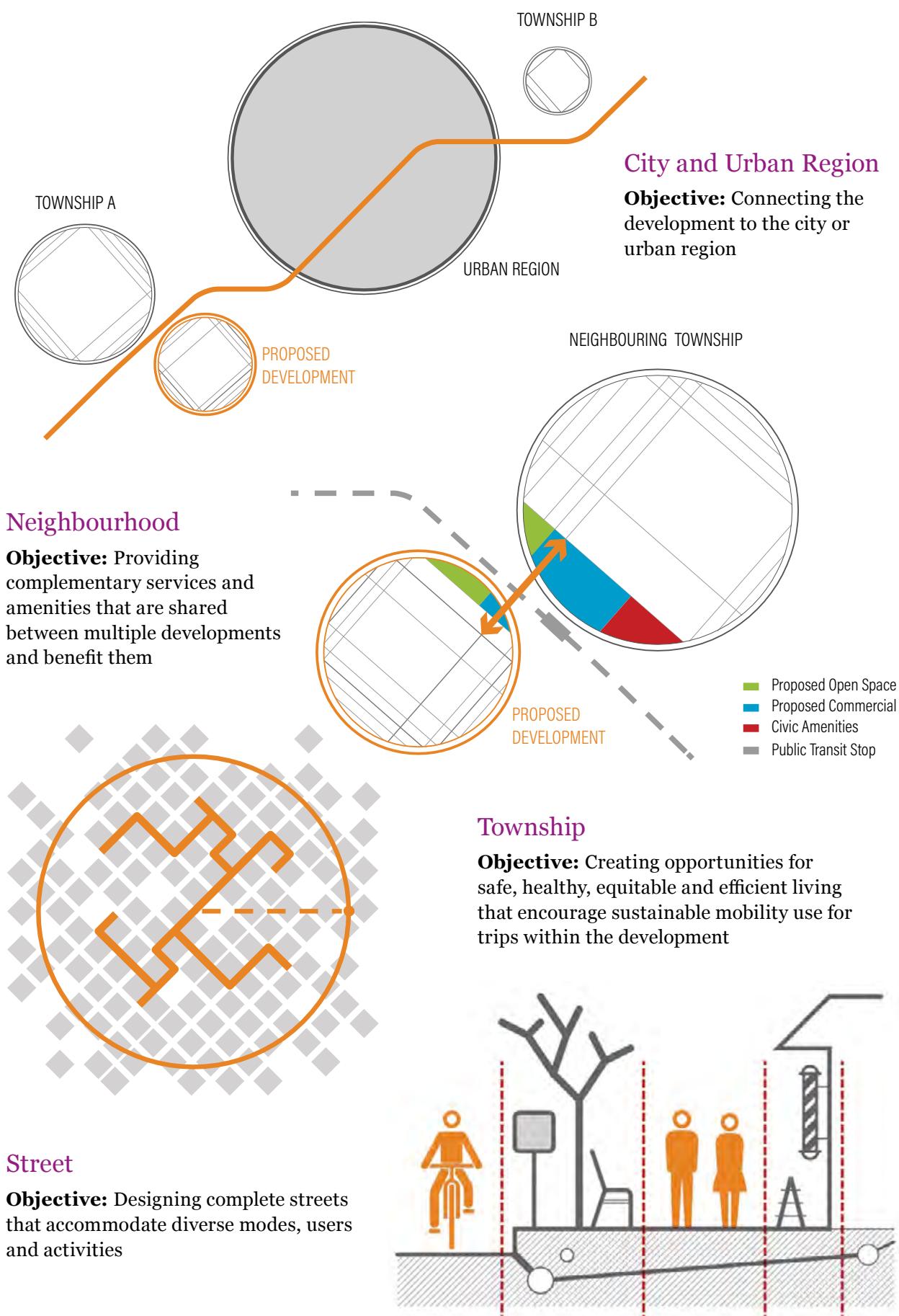
Township

Township plans that prioritise a sustainable, people-centric design approach form the basis of planning. Such developments are planned around the needs of people, not vehicles. Apart from benefitting the residents of such projects, a pedestrian-scale development also benefits neighbouring areas.

Street

Streets, the basic building blocks of every development, host multiple users and activities. 'Complete streets' that include non-motorized transport options such as walking, cycling and mass transit, provide many benefits including improved accessibility, energy conservation, emission reductions, improved community liveability, improved health and fitness, and user savings.

Figure 8 | Applying Design Guidelines at Four Scales





CHAPTER 1

CURRENT MOBILITY AND DESIGN PRACTICES IN INDIAN TOWNSHIPS

Apart from increased social, environmental and economic costs, dependence on private motorised transportation for work and everyday activities increases the time and effort spent on travel and reduces commuters' quality of life. Current township mobility designs do little to address these consequences.

Large-scale developments – of tens to hundreds of acres – include institutional or educational campuses, gated residential communities, special economic zones (SEZ), integrated townships and even satellite towns.

While the guidelines for planning and design of sustainable mobility described in this guidebook can be applied to all types of large-scale developments in Bangalore, the master planning process focuses exclusively on mixed-use developments, commonly called integrated townships. Integrated townships combine residential and commercial uses, open space areas and basic amenities required for the community. Unlike institutional and educational campuses, most townships are conceived and built by developers and then sold to buyers for occupation and maintenance.

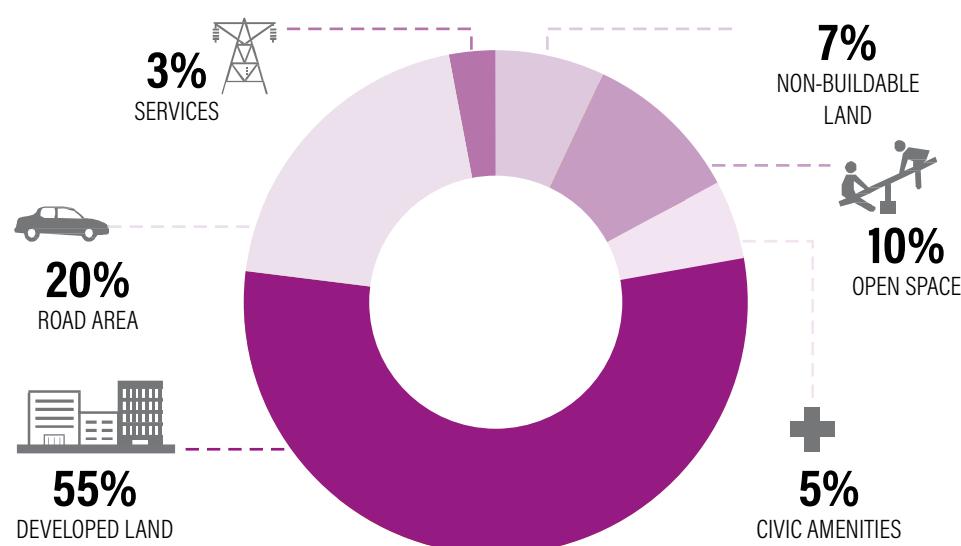
1.1 Integrated Townships

Integrated townships are defined as “large, self-sufficient and self-contained enclaves, ranging from 100 up to thousands of acres, with homes, schools, offices, work places, malls, multiplexes, private security and high-quality water, sewerage, and solid waste management systems” (IDFC 2009). These townships are promoted by private real estate developers as ‘model solutions’ to the need for increased housing and gaps in public infrastructure. They try to match the expectations of upper-middle and middle-income families.

In integrated townships, the residential component generally includes subdivided plots with or without a variety of housing types such as high- and low-rise, multi-dwelling apartment units, row houses and villas. They include schools, hospitals and convenience stores in addition to other lifestyle facilities such as malls, multiplexes, shopping and sports centres, and health and social clubs. Different states in India have different policies on integrated townships with most requiring that they be a minimum of 100 acres. However, some states such as West Bengal and Rajasthan have relaxed the minimum land requirement criteria (JLL, 2013). Some development control regulations, such as those in Bangalore, specify that developers provide civic amenities and open space on 5 and 10 percent of the site area, respectively. Figure 9 shows the percentage of land allocated to various components in an integrated project. This division is derived from research based on urban design guidelines, development control regulations and observations from audited developments.

Due to their large land requirements, integrated townships are mostly situated in outer suburbs and peripheral areas of cities. The developer is responsible for providing the internal infrastructure such as power, roads, water, drainage and sewage systems. Most developments struggle with external linkages to the city infrastructure.

Figure 9 | Percentage of Integrated Township Land Area Used by Key Components



Source: WRI India, 2015; Data adapted from Urban Development Plan formulation and Implementation Guidelines and Development Control Regulations for Bangalore

Peripheral areas develop slowly and public infrastructure support is provided only after the townships are occupied as is the case around the Bangalore International Airport.

This guidebook focuses mainly on strategies for the site itself which is directly under the purview of the developer, but also offers strategies to reduce the pressure on city roads due to vehicular commutes between the township and the city.

Current Mobility Patterns of Residents of Townships and Resulting Impact

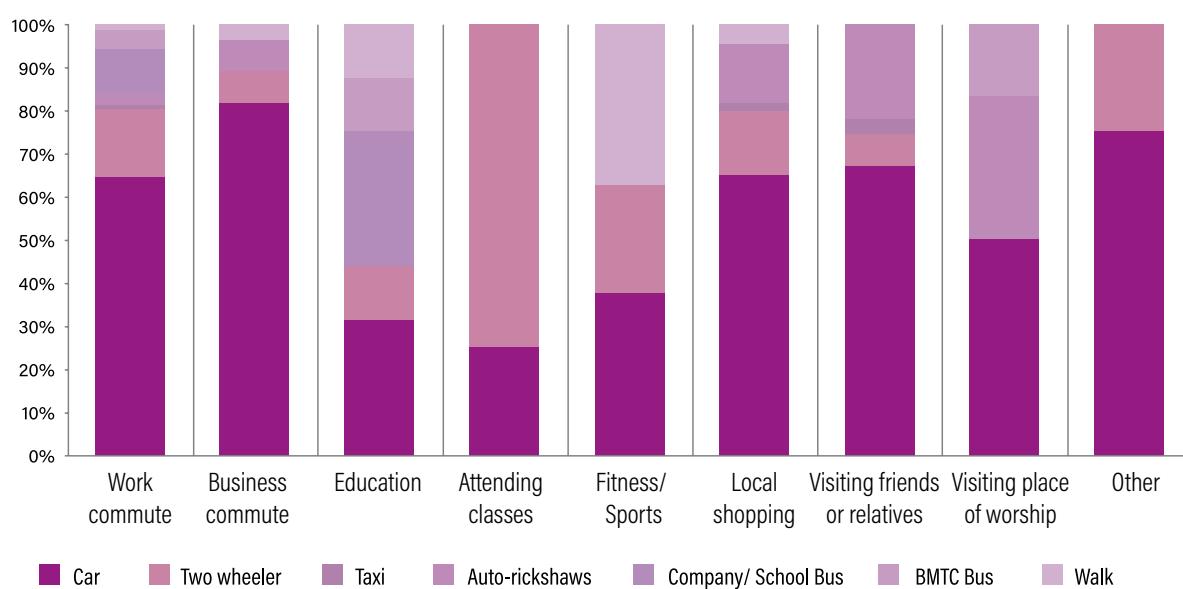
When identifying strategies to encourage the use of mobility modes other than personal vehicles, it is important to consider the factors that motivate residents to choose a mode of transport. Most travel decisions come down to individual assessments of relative time, cost and convenience of the competing modes, with comfort, safety and mode availability also factoring into the decision. Figure 10 highlights which modes residents in two household surveys selected for some key weekly activities in Bangalore (See Appendix C).

The WRI India household surveys captured the conditions under which people might switch or consider switching to walking, cycling or public transit (Figures 11, 12, and 13). It is clear that many individuals choose not to walk, cycle or

take transit due to personal preferences, not because they are captive to a vehicular mode. Safety was an important concern among the respondents. Other key reasons included lack of adequate facilities, such as footpaths or cycle lanes that would encourage use of non-motorised modes, lack of better public transit quality and connectivity (34 percent) and absence of shuttle or feeder services from their place of residence (35 percent) to transit stops.

Selection of site location and design are parameters directly under the purview of the developer and are important considerations that make the difference between a person choosing to walk, cycle or share a vehicle versus using their automobile.

Figure 10 | Share of Transit Modes Used for Weekly Trips by Township Residents Surveyed



Source: WRI India, 2014

Figure 11 | I Would Walk More If...

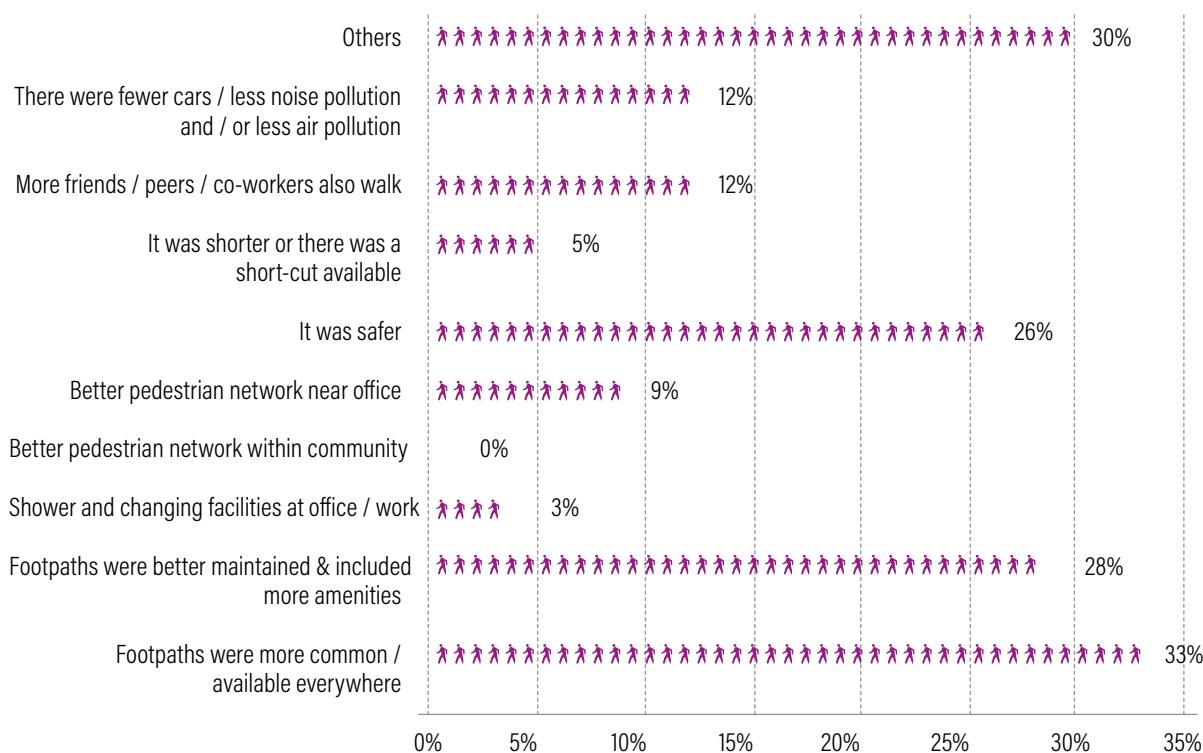


Figure 12 | I Would Cycle More If...

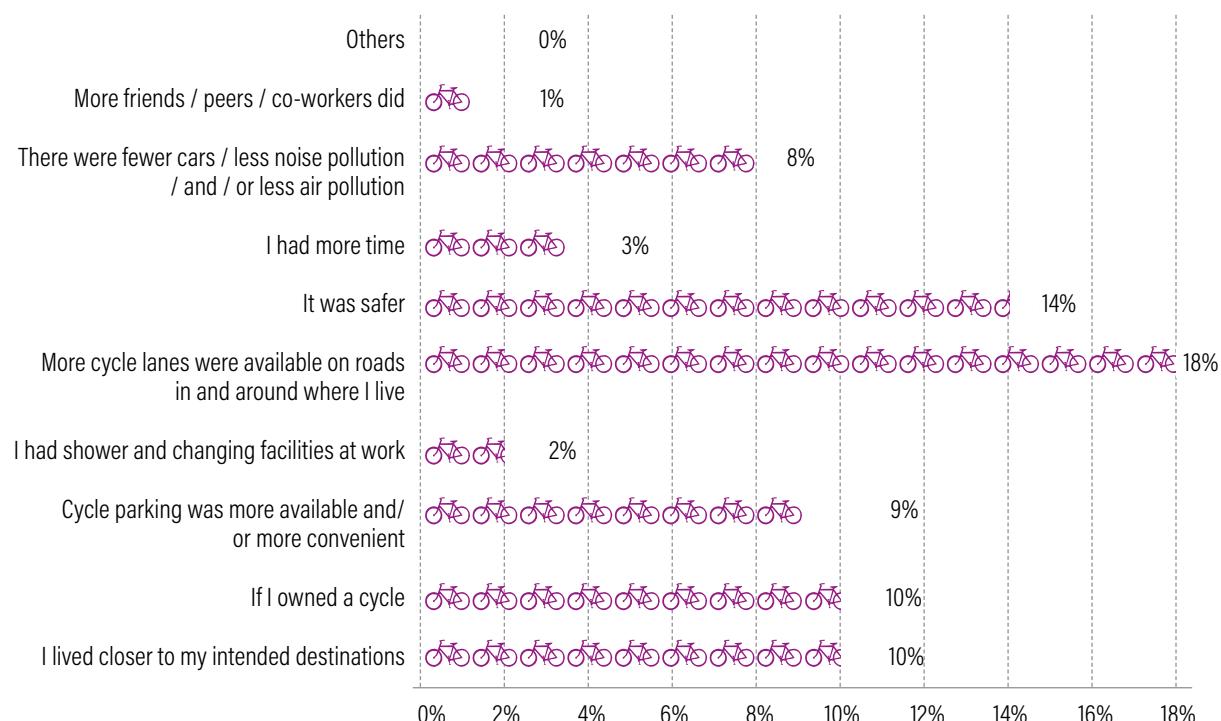
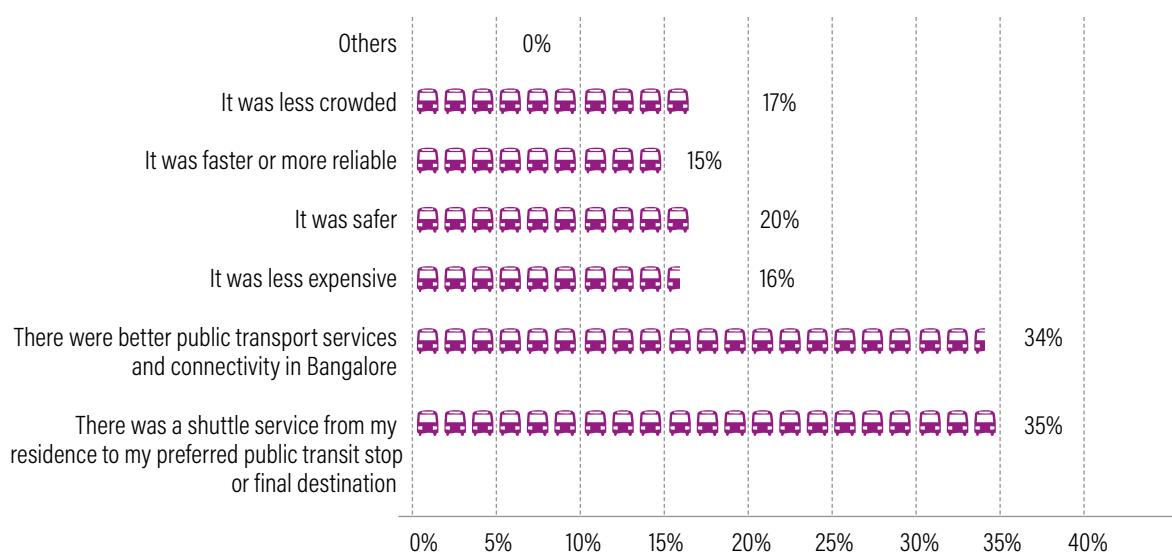


Figure 13 | I Would Use Public Transit More If...



Note: Respondents could give more than one response; therefore percentages add to more than 100%.

1.2 Need for good design

Good township design can address the most commonly cited concerns about walking, cycling and using public transit. Table 2 lists common concerns that hinder non-motorised transport and specific design interventions that address them with reference to the guidelines in Chapter 3. Most mobility-related strategies work best when considered at the onset of the planning

process. Although good site design cannot alleviate all concerns, improper site design can certainly discourage individuals from using sustainable travel modes as indicated in the Case Study 1: L&T South City, Bangalore. After construction, retrofits are more expensive and tougher to implement than amending any major deficiencies identified at the design stage.



Table 2 | Design Interventions to Alleviate Common Concerns about Using Non-Motorized Transport

COMMONLY CITED CONCERN	DESIGN INTERVENTIONS	GUIDEBOOK REFERENCE	REFERENCE SECTION (PAGE NUMBER)
Travel time and distance	Site selection	Site Selection and Program Development	Step 1 (p.37)
	Compact and mixed-use development	Zoning and Building Placement	3.2.3 (p. 68)
Weather	Building placement	Zoning and Building Placement	3.2.3 (p. 68)
	Weather protected walkways	Pedestrian and Cycling Network	3.3.3 (p. 82)
Convenience and comfort	Enclosed transit shelters and waiting areas	Street Elements	3.5 (p. 111)
	Continuous pedestrian and cycling network	Pedestrian and Cycling Network	3.3.3 (p. 82)
Safety and security	Visible pedestrian and cycling linkages	Pedestrian and Cycling Network	3.3.3 (p. 82)
	Universal accessible design for all	Internal Street Design	3.4.1 (p. 90)
Lack of amenities	Proper placement of land use functions	Zoning and Building Placement	3.2.3 (p. 68)
	Location of building entrance	Building Entrance and Plot Access	3.3.5 (p. 86)
Lack of amenities	Supportive street design	Internal Street Design	3.4.1 (p. 90)
	Proper lighting and landscape	Street Elements	3.5 (p. 111)
Lack of amenities	Continuous pedestrian and cycling lanes	Pedestrian and Cycling Network	3.3.3 (p. 82)
	Provision of supportive street furniture	Street Elements	3.5 (p. 111)
Lack of amenities	Amenities like secure cycle parking	Cycling Zone	3.4.3 (p. 98)
	Availability of shuttle and feeder services to transit stops and nearby office/retail	Provisions for Shared Vehicles and IPT	3.2.4 (p. 70)

Case Study 1: Site Design Can Impede Sustainable Mobility Practices

Project: L&T South City, Bangalore

Residents of the integrated township L & T South City near Bangalore faced major traffic clogging along the main public street adjacent to the township between 7 a.m. and 10 a.m. because so many cars stopped to drop off children at school bus stops.

Although the distance from the farthest residential building to the main gate of the township was only 535 metres, residents chose to use their cars to traverse this distance.

Detailed analysis coupled with resident surveys found that though walking to the gate was within comfortable limits, the added considerations of

safety, the need to carry school bags and the need to transport young children led parents to favour car trips (Figure 14). The design of buildings actually favoured using private vehicles because pedestrians had to share space with vehicles on the ramps into parking podiums, which many considered a safety hazard.

A parent choosing to drop off and pick up a child in a vehicle would make four trips a day to and from the bus building, whereas a child who walked or cycled to the building would make two trips by a sustainable travel mode.

Figure 14 | Factors Impeding Pedestrian Movement from Home to School Bus Pick-Up Point



The same pattern was also seen for residents accessing convenience shops and other amenities located outside the development. Improper site design inhibited people from walking and encouraged the use of private vehicles for short-distance trips.

The impact of short daily car trips on a family's monthly budget is illustrated in Figure 15. For six short weekly vehicle trips³ averaging 1 kilometre each, one household's fuel expenditure per month would be approximately Rs 1,000. This pattern repeated by the 1,000 households

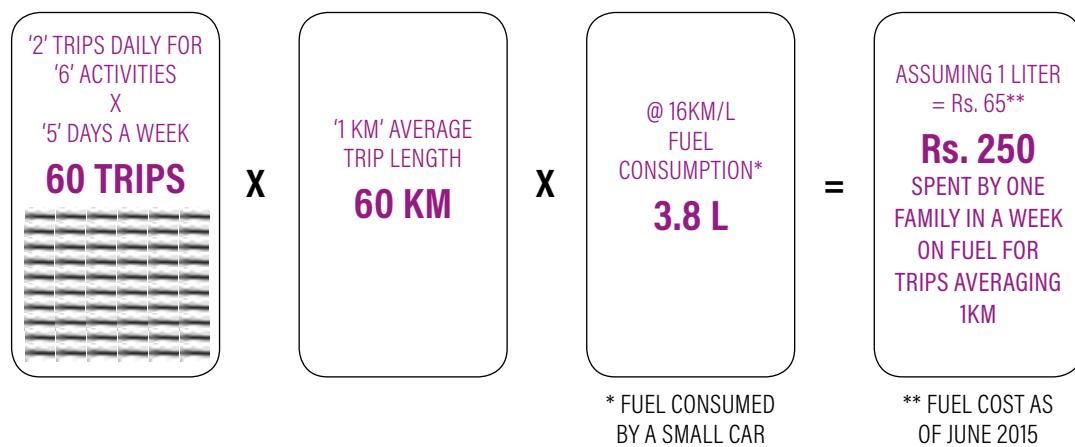
in the development would generate 60,000 trips a week amounting to approximately Rs 10 lakhs monthly or Rs 1.2 crores spent on fuel annually.

Short vehicle trips impact the traffic along the main public roads, inconvenience other road users, increase time spent in commuting, and finally discourage residents from getting exercise by walking to short-distance destinations.

³ Six short-distance trips identified from the Bangalore household surveys include (1) accessing public transit or transport for work, (2) attending classes or tuitions, (3) accessing daily fitness or sport activity, (4) accessing local convenience shops, (5) visiting religious place of worship and (6) accessing entertainment areas etc.

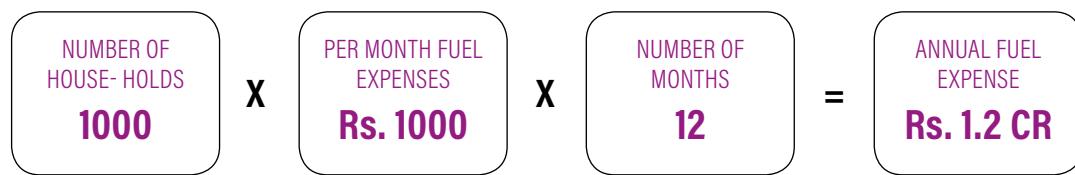
Figure 15 | Fuel Expenditure for Six Weekly Short-Distance Trips at L&T South City

IN A WEEK,
ONE FAMILY'S EXPENDITURE ON FUEL FOR SIX TRIPS AVERAGING 1 KILOMETRE



ESTIMATED MONTHLY EXPENDITURE ON FUEL = 250×4 WEEKS = INR 1,000

IN A YEAR,
EXPENDITURE OF 1,000 HOUSEHOLDS ON FUEL FOR SIX TRIPS PER WEEK AVERAGING 1 KILOMETRE



Source: WRI India 2015.

1.3 Benefits of Sustainable Mobility

Sustainable mobility can be defined as “the mobility model that enables movement with minimal environmental and territorial impact. A sustainable mobility model would be one in which means of transport consume the least energy and produce less pollution per kilometre travelled and passengers have greater recognition (travel on foot, by bicycle, collective transport and shared car)” (Universitat Autònoma de Barcelona, 2015).

Findings from the WRI India Bangalore household survey (See Appendix C) indicate that an individual's mode choice, especially for non-work trips, was affected by the following factors:

- Distance
- Lack of safe access from the community to public transit stops on the main road;
- Lack of transportation options available to the household;
- Lack of amenities located within the development; and
- Lack of pedestrian infrastructure outside the development (Mahendra, et al. 2014).

In addition, a majority of respondents in six townships felt that a mix of land uses within the community connected by a good-quality non-motorised transport infrastructure could influence their walking and cycling behaviour.

Integrating sustainable mobility practices within townships can pave the way for low-carbon development by reducing:

- The use of private motorised modes for non-work trips;
- Travel outside the township by providing amenities within the community; and
- Fuel usage and transportation costs.

These reductions in turn have a positive impact on the quality of life of residents living in these townships as illustrated in Figure 16.

1.4 Challenges to Integrating Sustainable Mobility

Key stakeholders including private and public developers, designers, investors and members of town planning bodies, resident associations and civil society organisations participated in WRI India workshops and conference sessions in Indian cities between 2012 and 2015.

The main objectives of the sessions were to:

- Introduce mobility as part of the sustainability discourse;
- Enable interaction among stakeholders; and
- Understand key challenges that hinder the adoption of sustainable mobility practices in real estate design.

These sessions identified four main challenges: information and awareness, finance, policy and regulation and design (Table 3). The absence of an integrated process-based planning approach and lack of detailed design knowledge were recognised as key barriers among designers. This guidebook outlines a planning framework and describes design strategies to integrate sustainable mobility practices in townships. A summary of policy recommendations captured through engagements with participants at the workshops is shown in Appendix D.

Designers need to push the boundaries of acceptable sustainable practices, looking at long-term paybacks rather than focusing only on the initial investment cost.

Figure 16 | Benefits of Adopting Sustainable Mobility Practices

FOCUS ON PEOPLE

- Increase in physical activity → reduced risk of obesity, heart disease, Type 2 diabetes
- Lower rates of traffic injuries and fatalities
- Improved mobility and accessibility options
- Increase in social interactions within community



OPTIMAL AND COST EFFECTIVE

- Increase in local economic activity
- Increase in real estate / property value
- Reduced transportation costs
- Decrease in healthcare costs



IMPROVED QUALITY OF LIFE

- Shift to cleaner transportation modes
- Fewer miles traveled → reduced congestion, reduced air and noise pollution, reduced fuel consumption, reduced greenhouse gas emissions
- Improved sense of community, neighbourhood safety and security



Source: WRI India, 2013

Table 3 | Key Challenges to Adopting Sustainable Mobility Practices in Townships

CHALLENGE AREA	FOR DEVELOPERS	FOR RESIDENTS	FOR PUBLIC AGENCIES
Information and awareness	Difficulty in obtaining authentic and accurate data for project feasibility studies Difficulty in sourcing information on planned public transport services	Unavailability of housing options with sustainable transport Expectations are for secure, monitored living spaces with amenities and willingness to pay for the same Lack of awareness about measurable benefits of sustainable mobility Preference is for sustainability aspects such as water and waste management and energy efficiency	Lack of awareness and coordination between different development agencies and departments Sustainability not a mandate in regulations
	Lack of market interest in sustainable mobility Preference is for sustainability aspects such as water and waste management and energy efficiency		Developers place more importance on floor space and parking norms
	Lack of any demonstration projects to prove benefits		
CHALLENGE AREA	FOR DEVELOPERS	FOR RESIDENTS	FOR PUBLIC AGENCIES
Finance	Providing a non-motorised transport infrastructure is seen as a 'non-revenue generator'	Lack of information on costs and benefits of using sustainable mobility modes in terms of health expenditures and overall quality of life	Absence of floor space index (FSI) bonus for sustainable mobility planning or dis-incentives for road construction and parking. Lack of incentives for open spaces, communal amenities, etc.
	Inadequate budget – due to high price of land and the cost of execution	Lack of incentives for resident welfare associations to encourage green transport provisions within the development	Absence of taxation for using unsustainable modes
	Absence of cost information on initial investments	Absence of tax and cost benefits to encourage use of sustainable mobility modes	
	Lack of tax benefits or incentives to provide sustainable mobility		

CHALLENGE AREA	FOR DEVELOPERS	FOR RESIDENTS	FOR PUBLIC AGENCIES
Regulation and policy	Lack of basic metrics and governance frameworks to promote and measure sustainable mobility	Lack of policies and penalties to discourage vehicle use	Regulations exist to provide parking spaces but not amenities for sustainable mobility modes
	Conflicting norms across different government bodies – current regulations do not allow for a mix of uses in all townships	Lack of good-quality public transport facilities as an alternative to motorised transport	Absence of detailed regulations for township developments
	Lack of a single authority/regulatory body empowered to approve, implement and monitor regulations		Sustainability certification process is not a part of the township development process
Design	No mandate for performance indicators and sustainability ratings as part of the planning process		
	Lack of flexibility in acceptance and approval of design innovations	Deceptive marketing: A development may be marketed as an accessible and connected community, whereas in fact it promotes a car-centric lifestyle and ignores last mile connectivity	Developers are unwilling to enable a market shift in the design of communities
	Lack of time and design knowledge to provide detailed non-motorised transport infrastructure		Non-motorised transport design is either completely ignored or executed in a haphazard or incomplete manner
	Scarcity of space in planning and design, after accounting for parking and other amenities		Absence of implementation checks for site design, especially road construction
	Incorporating sustainable mobility would add another element to the existing tedious approval processes		

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CHAPTER 2

SUSTAINABLE MOBILITY PLANNING PROCESS FOR INDIAN TOWNSHIPS

As the number of township developments in and around Indian cities grows, there is a need for a planning, design, implementation and evaluation process that ensures reduced use of motorised transport and encourages sustainable mobility practices.

Many opportunities to promote sustainable mobility are present during the six broad stages followed in the development of a township site: pre-design, concept development, site planning, building and landscape design, construction and operations.

However, audit evidence from townships in cities like Bangalore and Ahmedabad reveal that there is no clear process for incorporating sustainable design practices in site planning, data collection, documentation and detailed design of sustainable mobility. In addition, regulatory documents that govern the shaping of the built environment do not provide specific direction for incorporating design practices that are sustainable and that lead to efficient and liveable communities.

This chapter defines seven progressive steps to conceptualise, plan, implement and evaluate sustainable mobility design in township master plans.

The steps have five key objectives:

- Creating sustainable opportunities for short-distance trips;
- Providing accessibility to public transit nodes;
- Providing a clean, safe and secure environment for non-motorised transport within project limits;
- Enabling a parking management system for all vehicle types; and
- Reducing carbon emissions generated from vehicle use within the township.

Seven Steps for Sustainable Mobility Planning

The seven steps were formulated through WRI India's engagement with developers and designers to seamlessly integrate sustainable mobility into each stage of the master planning process to successfully develop sustainable communities. The stages described in this document involve not just the developer and designer but the implementation team, residents and public agencies as well as collaboration among all of them.

Table 4 | Steps to Incorporate Sustainable Mobility

STAGE OF MASTER PLANNING PROCESS	STEPS TO INCORPORATE SUSTAINABLE MOBILITY
PRE-DESIGN CONCEPT	<p>Step 1: Identify opportunities for sustainable mobility practices To influence the design of the master plan and also the mobility choice of future residents of the development</p>
CONCEPT DEVELOPMENT	<p>Step 2: Conduct context and regulatory framework analysis To evaluate site and neighbourhood opportunities and constraints to determine suitable mobility design strategies</p>
SITE PLANNING, BUILDING AND LANDSCAPE DESIGN	<p>Step 3: Determine traffic projections and impact To establish a base case that can help formulate sustainable objectives and set goals for the development</p>
CONSTRUCTION	<p>Step 4: Define objectives and set carbon footprint reduction targets To set the stage for all stakeholders in the successive stages of design to adopt sustainable mobility principles</p>
OCCUPATION	<p>Step 5: Incorporate design elements into the master plan To translate the sustainable mobility objectives and project requirements into a functional master plan</p>
	<p>Step 6: Conduct design review and performance evaluation To assess the township master plan against the project brief, objectives, budget, design quality and functionality</p>
	<p>Step 7: Define responsibilities for implementation and maintenance practices To ensure participation of all stakeholders to achieve the objectives set out for the project</p>

The seven steps are

1. Identify opportunities for sustainable mobility practices.
2. Conduct context and regulatory framework analysis.
3. Determine traffic projections and impact.
4. Define objectives and set carbon footprint reduction targets.
5. Incorporate design elements into the master plan.
6. Conduct design review and performance evaluation.
7. Define responsibilities for implementation and management.

Table 4 provides an overview of the seven steps highlighting their role in achieving sustainable mobility. The table includes a list of strategies for each step and key considerations and resources aiding the planning process. Each step is described in detail in this chapter.

Practices In Indian Townships

PRIMARY STRATEGIES UNDERTAKEN DURING PLANNING	KEY CONSIDERATIONS IN THE PLANNING PROCESS	RESOURCES AIDING THE PLANNING PROCESS
<ul style="list-style-type: none"> ■ Select the site such that the location encourages connectivity and access to city transit systems, employment centres and city destinations. ■ Develop a program that enables a mix of land and building uses, active street edges and provides opportunities for use of sustainable mobility modes. 	<ul style="list-style-type: none"> ■ Location of the site with relation to the city and neighbourhood ■ Demographics of the neighbourhood including socio-economic mix and population densities ■ Character and size especially the predominant land use type ■ Presence and accessibility to different public transit modes ■ Sustainable transport infrastructure including Non-Motorised Transport (NMT), shuttle buses and Intermediate Public Transport (IPT) modes ■ Existing traffic patterns around the development including parking provisions, road junctions and site access ■ Site features such as existing natural, cultural and historic and man-made features and topographic and landscape pattern of site 	Site and program feasibility studies and market trends
<ul style="list-style-type: none"> ■ Prepare an accurate base map of the project site along with the neighbourhood area. ■ Conduct a site visit with mapping, spatial and photo documentation of the site. ■ Conduct a review of the regulations governing development for the project area. ■ Undertake preliminary mobility and accessrelated data collection and analysis for the neighbourhood. 		<ul style="list-style-type: none"> ■ Official layout plans of the proposed development ■ Neighbourhood level plans including Local Area Plans (LAP) and city master plan ■ Area specific Development Control Regulations (DCR) ■ Zoning by-laws ■ Site-specific studies (traffic and environmental impact assessments, climate studies, topographical studies
<ul style="list-style-type: none"> ■ Calculate projected traffic and trip volume composition using evidence from either city level traffic data or similar developments in the area. ■ Undertake a traffic impact study that examines existing conditions around the project area and proposed infrastructure improvements. 		<ul style="list-style-type: none"> ■ Official layout plans of the proposed development ■ Transportation plans and proposals for the site area and vicinity ■ Development control regulations

PRIMARY STRATEGIES UNDERTAKEN DURING PLANNING	KEY CONSIDERATIONS IN THE PLANNING PROCESS	RESOURCES AIDING THE PLANNING PROCESS
<ul style="list-style-type: none"> ■ Define objectives that promote walking, cycling and use of other sustainable modes of transport and also the development of quality open spaces. ■ Set carbon footprint reduction targets that involves reducing the use of private motorised transport. 	<p>Objectives across different scales:</p> <ul style="list-style-type: none"> ■ Macro: mobility network planning ■ Meso or intermediate scale: apply 'green transportation hierarchy' with aim to reduce carbon footprint ■ Micro: designing for people and not cars 	<ul style="list-style-type: none"> ■ Development control regulations ■ National or city specific per capita carbon footprint data
<ul style="list-style-type: none"> ■ Prioritise connectivity to city transit and preserve ecological networks. ■ Provide linkages for shared amenities and services between neighbourhoods. ■ Increase opportunities for sustainable shortdistance commutes. ■ Create safe and equitable streets with provision of street infrastructure that complement the overall design. 	<p>Guidelines for designing:</p> <ul style="list-style-type: none"> ■ City connections ■ Neighbourhood links ■ Development layout ■ Complete streets 	<ul style="list-style-type: none"> ■ National Building Codes (NBC) ■ Development control regulations ■ Urban design guidelines ■ Fire and accessibility standards ■ Architectural standards ■ National and industry standards and guidelines
<ul style="list-style-type: none"> ■ Apply design checklists and sustainability ratings. ■ Conduct traffic impact assessments, design audits, road safety audits, regulatory approvals, and performance measures. 	<ul style="list-style-type: none"> ■ Design implementation ■ Traffic control and management of construction vehicles ■ Safe construction activities 	<ul style="list-style-type: none"> ■ Detailed design drawings ■ Architectural standards ■ National and industry standards and guidelines ■ Construction workers training manual
<ul style="list-style-type: none"> ■ Assign and ensure roles and responsibilities of key stakeholders such as developer's team, design and implementation teams, public agencies, residents and employee associations and other private partners are followed. 	<ul style="list-style-type: none"> ■ Facilities management – including of parks and open spaces ■ Site's traffic control and management ■ Parking policies 	<ul style="list-style-type: none"> ■ Transportation demand management guidelines ■ Occupational health and safety guidelines

Step 1: Identify Opportunities for Sustainable Mobility Practices

Site Selection and Development Planning

Creating a new township starts with selecting and acquiring land, followed by creating a vision for the development. The choice of an ideal site depends on land availability, market rates and demand as well as infrastructure availability. A new greenfield development can be based on the redevelopment or renewal of an existing urban site.

Choosing the site and developing the vision are beyond the purview of the designer. However, these decisions influence the master plan and the mobility choices of future residents. Thus the developer's team needs to consider multiple urban conditions such as site location, site accessibility and development potential at the early stages of project conception to aid the ensuing design process.



Step 2: Conduct Context and Regulatory Framework Analysis

The planning and design team commences work on the township design through a preliminary understanding of the site and its surroundings. This is essential to evaluate site opportunities and constraints, define objectives and determine suitable design strategies that include sustainable mobility practices.

Prepare an Accurate Base Map of the Project Site along with the Surrounding Neighbourhood

This activity involves acquiring a base map with the overall site boundary defined clearly from geographical surveys of the parcels that make up the site. The map should include information such as site location within the surrounding neighbourhood, topography and existing natural and human-made features. Satellite images are essential as base reference maps: they help developers understand the physical attributes of the site and can be used to prepare schematic diagrams.

Visit the Site to Aid with Mapping, Spatial and Photo Documentation

A site visit aids in:

- Understanding the existing conditions in and around the site; and
- Mapping actual locations of features at the site.

Review the Regulations Governing Development for the Project Area

Development control regulations provide the framework required to formulate a project brief with the percentages and types of land uses, number and type of household units, residential and floating populations, total built-up areas, floor area ratio consumed, density of the development, parking and mobility provisions for all vehicle types including service vehicles such as fire and emergency trucks. Other standards include the National Building Code (NBC), Energy Conservation Building Code (ECBC), environmental impact assessments (EIAs) and Ministry of Environment, Forest and Climate Change regulations, fire standards and others.

Collect and Analyse Preliminary Data on Mobility and Access to the Neighbourhood

Although having a thorough understanding of the surrounding neighbourhood is beneficial for planning, the time available for conceptual design might not permit detailed data collection. However, data can be gathered using these simplified techniques :

- Observational surveys of physical road network characteristics such as right-of-ways, carriageways, abutting land uses, intersections and traffic volumes, speeds and delays; and
- Diagrammatic mapping of neighbourhood household travel patterns including origin and key destinations and locations and distance of amenities and public transit stops from the development.

Climate Study: The site should also be analysed for its microclimate to plan for placement of buildings, design of walkways and open spaces, planting of trees, choice of local materials suitable to the climate and that would incur less cost to transport to the site.

Case Study 2: Diagrammatic Mapping of Amenities

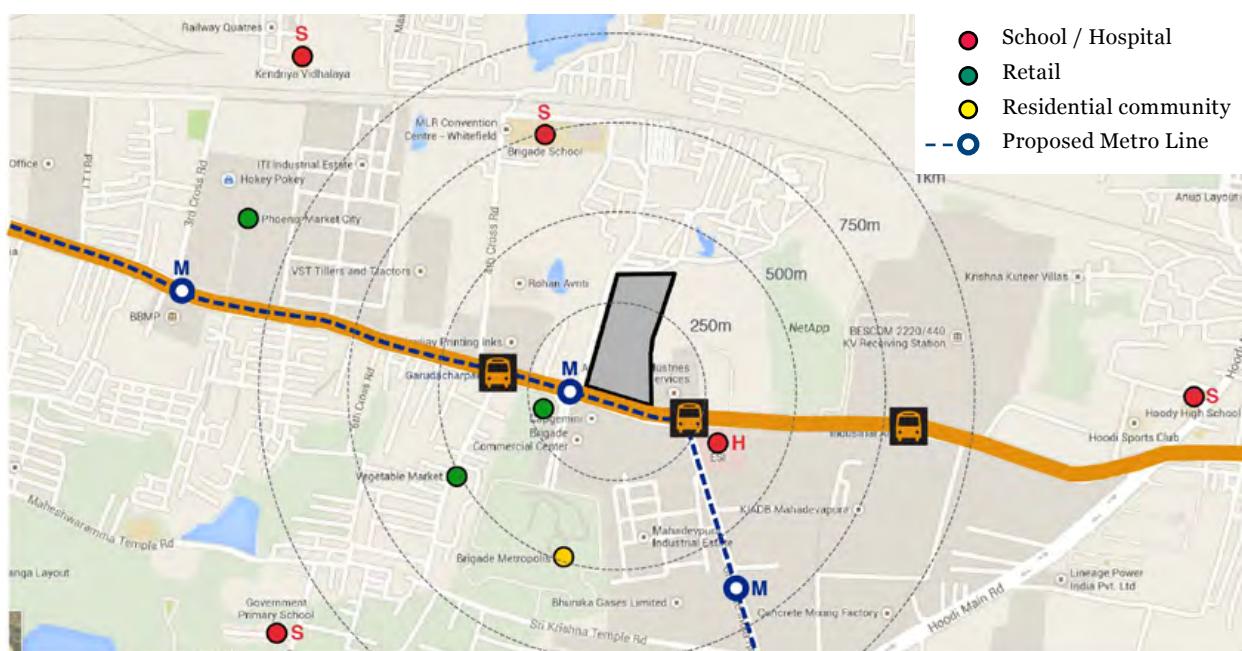
Project: Godrej United, Bangalore

The 10.5-acre Godrej United project is situated near similar residential townships such as Brigade Metropolis along the two-way main public Whitefield Road. BMTC (Bangalore Metropolitan Transport Corporation) bus stops are located on either side of the road less than 500 metres from the site.

A map of amenities within a one-kilometre radius of the Godrej United site shows the site is located near many schools, retail facilities and public transit stops including a proposed metro station to be located less than 250 metres from the site (Figure 17).

Through this exercise of mapping the local amenities, it can be concluded that it might be beneficial to provide access gates both along the north and south edges of the site for easy access to the available amenities.

Figure 17 | Amenity Mapping within a One-Kilometre Radius of the Godrej United Site



Source: WRI India, 2014; Base map: Google Maps

Table 5 gives a checklist of essential factors to consider in the analysis of the site and its context prior to design. These factors

have been arranged according to the city or urban region scale, the neighbourhood scale and the proposed township development scale.

Table 5 | Checklist of Factors to be Considered During Site Analysis Prior to Design

FACTORS AND RELEVANCE TO SUSTAINABLE MOBILITY	CHECKLIST
Location <p>The location of the proposed development can govern the number and type of amenities and mobility options that need to be provided in the development. Providing accessibility to such amenities can translate to increased interest in the development by potential buyers thus benefitting the developer.</p>	City and urban region scale <ul style="list-style-type: none"> ■ Distance to city and employment centres and business districts ■ Proximity to public and private transport hubs like bus stands, metro and railway stations and airport Neighbourhood scale <ul style="list-style-type: none"> ■ Percentage of destinations such as colleges, schools, retail areas in and around the site ■ Proximity and connectivity to major destinations around the site ■ Location of activities such as street vending to study provision of informal retail and also for space allocation considerations along footpaths
Demographics <p>Neighbourhoods with middle and lower-income groups might have higher public transit dependency than upper class neighbourhoods where people prefer using personal vehicles.</p> <p>Townships planned as homes for high and upper-middle-income groups tend to be rented by middle-income families and individuals*.</p> <p>Townships also serve as workplaces for a sizeable service staff population and designs have to accommodate their daily commute patterns as well.</p>	Neighbourhood scale <ul style="list-style-type: none"> ■ Population density ■ Socio-economic mix (broad range of ages and incomes such as low-income groups, middle class, high income, etc.) ■ Possible occupancy types – rental, owner-occupied or investment Proposed township development scale <ul style="list-style-type: none"> ■ Approximate proposed population – residential, working and floating including service and maintenance staff ■ Number and types of residential units
Character and size <p>In mixed-use developments, large employee populations will increase opportunities for transit and ride sharing, as there is a possibility that many residents live and work around similar locations.</p> <p>In developments with higher office and commercial percentages, the number and job type of employees determine both the amount of parking required (bicycle, carpool and vehicle) as well as site traffic volumes.</p>	City and urban region scale <ul style="list-style-type: none"> ■ City Master Plan land use allocation ■ Presence of high-activity zones that generate traffic such as business districts, educational or medical facilities, sports stadiums, etc. Neighbourhood scale <ul style="list-style-type: none"> ■ Neighbourhood description (transit-oriented, historic or cultural districts, institutional campuses) ■ Predominant land use (residential, commercial, industrial, agricultural, mixed-use, institutional) ■ Connectivity of the development to other developments' amenities Proposed township development scale <ul style="list-style-type: none"> ■ Type of proposed uses – mall and multiplex, hospitals, stadiums, markets, shopping complex, IT or other business units ■ The planned internal connectivity if the development is large enough to function as a neighbourhood

FACTORS AND RELEVANCE TO SUSTAINABLE MOBILITY	CHECKLIST
<p>Transit presence</p> <p>Availability and access to good public transit facilities enables connectivity to destinations and provides opportunities for introducing intermediate public transport and non-motorised transport.</p>	<p>City and urban region scale</p> <ul style="list-style-type: none"> ■ Proximity to nearby city bus, suburban railway and metro terminals and stops <p>Neighbourhood scale</p> <ul style="list-style-type: none"> ■ Presence and frequency of public transit modes operating within the vicinity of the site Presence of and access to transit stops with sheltered waiting areas and other facilities
<p>Sustainable transport infrastructure</p> <p>Certain infrastructure supporting sustainable mobility modes, such as bicycle networks and pedestrian facilities may not currently exist in a given area. However, projects should still be designed to facilitate access by sustainable mobility modes in the event supporting networks are developed in the future.</p>	<p>City and urban region scale</p> <ul style="list-style-type: none"> ■ Availability of taxis, auto-rickshaws or other intermediate public transit modes ■ Availability of shuttle services for public transit stops ■ Availability of any car pooling or ride sharing services <p>Neighbourhood scale</p> <ul style="list-style-type: none"> ■ Presence of shuttle bus and non-motorised transit routes and networks within the neighbourhood ■ Presence of intermediate public transport and non-motorised transit facilities such as sheltered walkways and bike paths and adequate parking facilities. <p>Proposed township development scale</p> <ul style="list-style-type: none"> ■ Footpaths of the same width on one or two sides of the road ■ Pedestrian crossing facilities at junctions ■ Reduce obstacles to pedestrian movement ■ Cycle lanes along roads with appropriate widths
<p>Traffic, road junctions and site access</p> <p>Primary traffic design considerations pertain to on-site traffic planning, including parking management and site connectivity to other areas in the city. Traffic volumes generated by the proposed land uses on site, type of traffic movement and the supporting infrastructure requirements have to also be considered.</p>	<p>Neighbourhood scale</p> <ul style="list-style-type: none"> ■ Presence of on-street parking and parking facilities for all vehicle types ■ Existing traffic volumes and type ■ Traffic counts at key locations between specified intervals ■ Peak volume counts and flow directions ■ Vehicle types with focus on office and school pick up and drop offs ■ Traffic generated from existing high-activity developments that are in the vicinity of the site, such as malls, multiplexes, etc. ■ Traffic patterns and volumes for goods and service vehicles <p>Proposed development scale</p> <ul style="list-style-type: none"> ■ Safety of access to the development ■ Estimated parking demand ■ Road junctions nearest to the site (signal controlled or not) ■ Junction turning movements and provisions

FACTORS AND RELEVANCE TO SUSTAINABLE MOBILITY	CHECKLIST
Parking facilities	<p>Neighbourhood scale</p> <ul style="list-style-type: none"> ■ Presence of on-street parking for different vehicle types with numbers, type, orientation and location ■ Off-street parking facilities in the vicinity ■ Presence of paid parking ■ Unauthorised parking instances ■ Provision for dedicated and short-term rickshaw and taxi points
Site features Sites for new developments should be carefully assessed in the context of the larger environment, particularly in relation to natural features on-site or on adjacent sites, as there could be a possibility to develop these as mobility corridors.	<p>Neighbourhood scale</p> <ul style="list-style-type: none"> ■ Existing natural features such as water bodies, trees, hills, etc. ■ Existing civic infrastructure around the site ■ Existing amenity provisions around the site <p>Proposed development scale</p> <ul style="list-style-type: none"> ■ Site topography ■ Utility and service lines ■ Existing human-made features such as buildings, compound walls, etc.
Redevelopment sites	<ul style="list-style-type: none"> ■ Entry/exit points for all types of users ■ Parking provisions for all vehicle types – number and location ■ Number and type of site occupants and users including non-residents ■ Peak traffic times for the development – if commercial, business or retail - arrival/departure timings

* In the Bangalore household survey,

* 57 percent of units were owner-occupied while 43 percent of units were either rented, leased or provided by the company where the respondent was employed.

Step 3: Determine Traffic Projections and Impact

Calculate Projected Traffic, Trip Volume and Composition

Based on the analysis of the neighbourhood and estimated project requirements, some assumptions can be made about the volume and composition of traffic the township will generate. A business-as-usual case for projected traffic volume of a new development can be calculated from either city traffic data or those of similar developments in the area. This projection helps formulate a set of achievable sustainable mobility goals and objectives which the township can be designed. Case study 3 illustrates a basic

calculation of trip composition and volume projection based on results of the Bangalore household surveys of similar townships located around the site neighbourhood.

Project the Impact of Estimated New Traffic on Existing Traffic Conditions

A traffic impact study assesses the effects that a new development's traffic will have on the surrounding transportation network. Ideally, the study is an iterative process that begins when the development's planning is initiated, and continues throughout the township development

process. The traffic impact study is prepared under the supervision of a qualified traffic engineer who has the training and experience to forecast and analyse traffic needs for the township and the surrounding road system. Although such a study is mandated only for projects aiming for Ministry of Environment, Forest and Climate Change⁴ clearance, it is essential that developers constructing townships, especially those with a mix of uses, should undertake one.

The contents and extent of a traffic impact study depend on the location and size of the proposed development and the conditions in the surrounding area. Larger developments in congested areas obviously require a more extensive traffic impact study while smaller sites may require only minimal analysis. An inappropriately large analysis area will unnecessarily increase costs and time to the developer.

At a minimum, any traffic impact study must address site access and adjacent intersections, plus the first major signalised intersection in each direction from the site. Beyond this minimum requirement, all known congested or potentially congested locations that may be impacted by the proposed development should be studied.

The data gathered from the traffic impact study help define the following areas in the master plan:

- Placement of access gates to the site with consideration for the internal and external traffic conditions around the site;
- Design of facilities for different vehicles such as school and company buses, intermediate transport modes like taxis and auto-rickshaws, shuttle services to access public transport, rideshares, motorists, pedestrians and cyclists, and service and emergency vehicles;
- Location and design of transfer stations that consider the operational timing and types of transport modes used; and
- Design of intersections and crossings that prioritises safety of pedestrians and cyclists.

⁴ (MoEF 2006) As per Environmental Impact Assessment (EIA) Notification, 14 September 2006, an EIA is mandatory for townships and area development projects covering an area greater than or equal to 50 hectares and/or built up area greater than or equal to 1,50,000 square metres

Case Study 3: Trip Composition and Volume Projection

Project: Godrej United, Bangalore

To understand the mobility requirements for Bangalore's Godrej United development, a basic trip projection study was carried out using the three main categories of daily travellers – people going to work, students going to an educational institution and service staff arriving to the development. It is assumed that on any non-holiday weekday, out of the estimated total population of 2,315 people:

- About 1,157 (50 percent) travel daily for work,
- About 694 (30 percent) are schoolchildren,
- About 257 daily travel to work at the 50% of the residential units that employ some form of help.

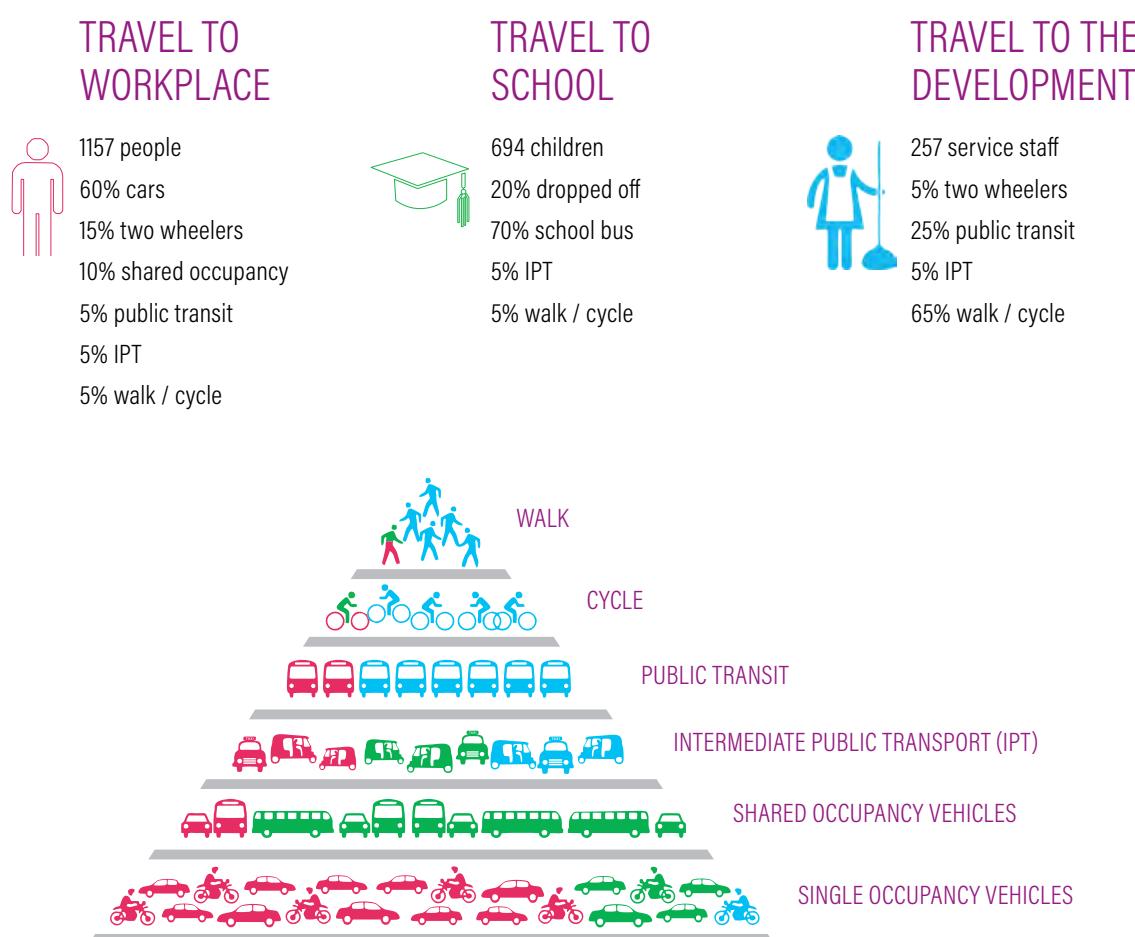
From the Bangalore household survey, the travel modes for each user type are shown in Figure 18 (Mahendra, et al. 2014). The data indicate higher volumes of single-occupancy vehicles and lower levels of pedestrian travel for all three travel groups.

Using this preliminary projection of traffic patterns, we can establish that although the development is located in close proximity to amenities and public transit stops, residents access these by using private vehicles.

To encourage sustainable mobility, the following strategies could be incorporated into the design so that residents need not rely on private vehicles for the majority of trips, thereby reducing fuel consumption and emissions:

- Provide adequate parking for different vehicle types such as school and company buses, two-wheelers, auto-rickshaws and bicycles;
- Provide shuttle services that connect the development to important amenities, destinations and public transit access within a 2-kilometre radius; and
- Provide safe, secure and comfortable walkways from the development to the closest transit stops (bus stops about 500 metres from the site entrance) even though this area is outside the project limits.

Figure 18 | Trip Projection and Vehicle Use Volumes for Godrej United by Vehicle Type



Source: WRI India, 2014

Step 4: Define Objectives and Set Carbon Footprint Reduction Targets

Before commencing the design process, the developer should define clear objectives and targets as part of the township's overall vision to set the stage for all stakeholders in the successive stages of design. The objectives should encourage sustainable developments with quality walking, cycling and open spaces and also promote the use of other sustainable modes of transport.

The objectives should be applicable across varying scales of design:

- Meso or intermediate scale: design prioritises the 'green transportation hierarchy' principles throughout the development to achieve reduced carbon footprint; and
- Micro scale: design ensures application of mobility strategies for people -not vehicles -first (see Figure 19).

- Macro scale: design aims at mobility networks that connect the development to city and neighbourhood services;

Figure 19 | Defining Objectives across Three Scales of Design



Source: WRI India, 2015

Sample Methodology to Set Carbon Footprint Reduction Targets

Adapted from (MNRE, Gol and ADaRSH 2012)

Because carbon emissions can be estimated at the onset of the design process, large developments can set targets for reduction of their carbon footprint prior to commencing design. Reducing carbon footprints through sustainable mobility objectives involves reducing the use of private motorised transport within the development and is achieved by the following means:

- Providing adequate and quality infrastructure for walking and cycling;
- Providing mass transport feeder options that run on clean fuels; and
- Promoting use of clean fuels in personal vehicles by providing adequate supporting infrastructure such as charging stations.

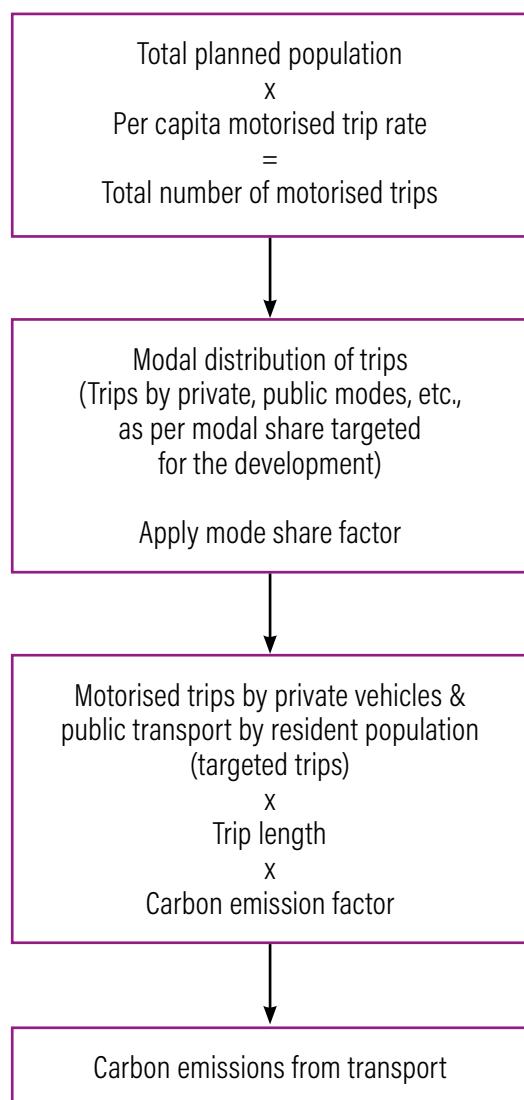
A carbon footprint reduction target should be set by one of the two methods outlined below:

- Estimate a baseline emissions scenario and set a business-as-usual (BAU) projection and fix a reduction target against the BAU, for example, a 30 percent reduction in per capita carbon emissions compared with the BAU projection (Figure 20); or
- Consider the national per capita carbon footprint or that of a city with a similar population size and fix a reduction target in reference to these values (e.g., the per capita carbon footprint will not exceed the national/city average, or it will be half of national/city average).

Once a carbon footprint reduction target has

been set, the developer, in discussion with all the consultants, should aspire to design the development to achieve the targeted carbon footprint. In the planning and design process it is recommended that the developer and consultants measure the reduction in carbon savings that will be achieved compared with a conventional approach (MNRE, GoI and ADaRSH 2012).

Figure 20 | Estimating Transport Emissions for a Planned Development Scenario



Source: Guidelines and benchmarks for Green Large Area Developments, GRIHA and MNRE, 2012

Step 5: Incorporate Design Elements Into the Master Plan

Once the necessary data and information have been gathered and analysed, the next step involves conceptualising and translating the

project requirements into a master plan. Chapter 3, Guidelines for Sustainable Mobility Design, provides detailed strategies and guidelines in four categories: city connections, neighbourhood links, development layout, and complete streets (Figure 21).

City Connections: Elements in this category help design the site to incorporate non-motorised transport and connectivity to public transit as key features. This is done by considering existing and future public and intermediate public transport stop locations and planning sites for motorised and non-motorised connections to access them. Identifying and preserving ecological areas that are part of a larger regional network and that can be sensitively harnessed into the design of public open spaces for the community is also considered at this stage (See Section 3.1 of Chapter 3).

Neighbourhood Links: This category provides guidelines that govern the township's relation to a larger neighbourhood or its own design as a neighbourhood through the appropriate placement of buildings and blocks that promote pedestrian mobility. Major decisions at this stage include design of site access to accommodate multiple mobility modes, the location and placement of buildings, and provisions for shared vehicles and facilities for intermediate public transport vehicles (those used between the residence and the transit station; See Section 3.2 of Chapter 3).

Township Development Layout: This category specifies guidelines for planning and designing mobility modes within the development to ensure seamless movement of individuals and goods. This is realised through a connected mobility network that allows users of different modes to safely and comfortably coexist. Decisions at this stage include location of non-motorised transport facilities and parking layouts (See Section 3.3 of Chapter 3).

Complete Streets: This category looks at physical features with the aim of providing streets that are appropriate for users of all mobility modes. Street infrastructure is typically designed in greater detail once the general layout of buildings, parking, access and internal roads have been established. Decisions made at this stage include requirements for different street users, material treatments and signage

provisions (See Section 3.4 of Chapter 3). Section 3.5 of Chapter 3 provides guidelines to incorporate essential street features such as street furniture and lighting, protected waiting areas, accessible bicycle parking, and showering and changing facilities. Provision of these features combined with attractive and functional landscaping can make the difference between whether a person chooses to walk, cycle or share a vehicle rather than using their automobile.

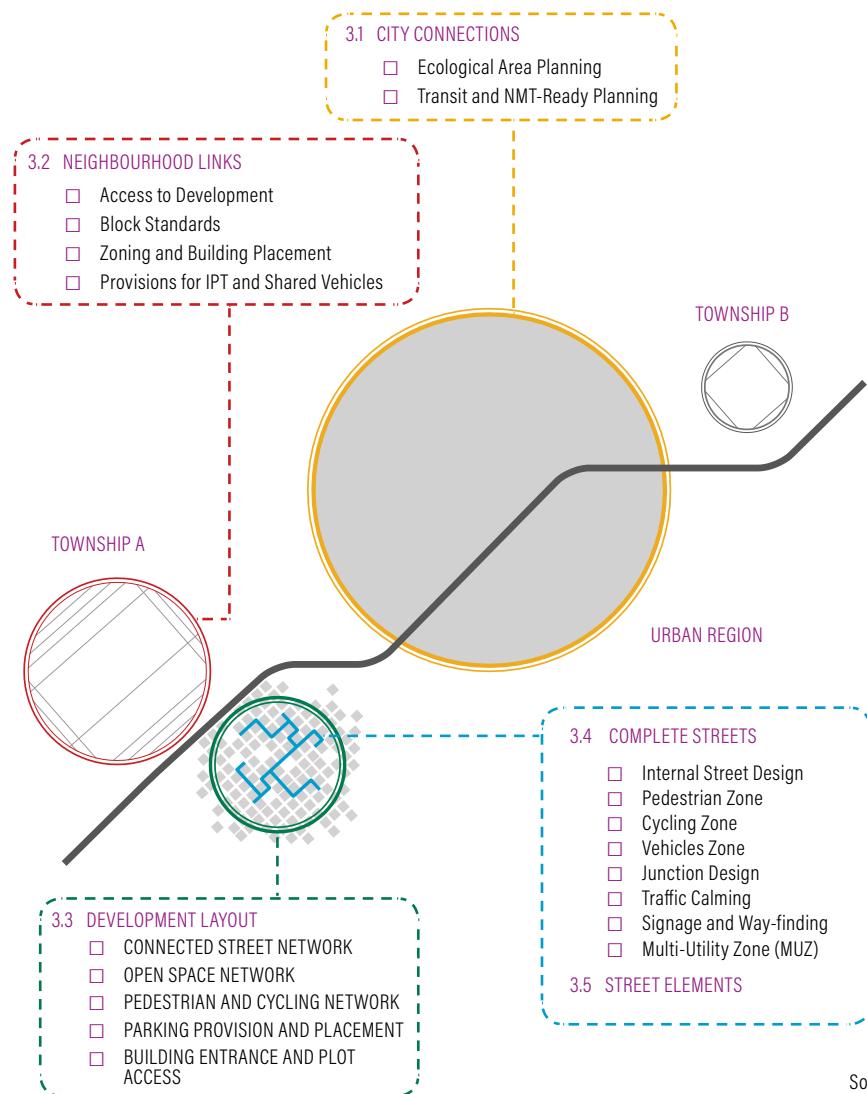
Step 6: Conduct Design Review and Performance Evaluation

Design review and performance evaluation assesses the township plan against the project's brief, design objectives, budget, design quality and functionality. This step also helps evaluate project impact on existing community

infrastructure – public streets in this case – and compatibility with the neighbourhood context. This process should include the developer, design team, traffic consultants and auditors, staff from municipal agencies, project stakeholders including neighbourhood civil society agencies and the residents' associations where they exist. Chapter 4, Design Review and Performance Evaluation, suggests examples of evaluation methods that can be adopted at different stages of planning. These include:

- Traffic impact assessments;
- checklists and audits;
- Road safety audits;
- Sustainability ratings; and
- Performance measures.

Figure 21 | Design Elements Described in Chapter 3



Source: WRI India, 2015

Step 7: Define Responsibilities for Implementation and Management

Stakeholder Responsibilities

Depending on the size and nature of the project, the process of master planning in townships can involve professional inputs from several areas of expertise, such as planning, architecture, mechanical, electrical and plumbing engineering services, landscape design, urban design, structural engineering, sustainability design, and transportation engineering. Successful implementation of sustainable mobility practices involves the involvement of multiple private and public agencies, professionals and institutions as indicated in Table 6.

However, residents – the end users of the townships – are usually not involved in the planning process. Thus the development professionals' objectives and strategies regarding sustainable practices may not be transferred to the building occupants. While the development team cannot be involved with a project beyond its initial operational years, it is essential that critical ideas and approaches adopted by the developer be communicated to early occupants. Responsibilities of key stakeholders discussed in Table 6 may be used as a starting point to developing core implementation strategies to bridge the gap between structuring a sustainable community and transferring the vision and awareness to residents.

Management and Maintenance

Management and regular maintenance of site infrastructure is important for proper functioning and use of sustainable mobility modes within the township. These activities are often undertaken by user associations.

Management of the property typically involves:

- Regular cleaning and removal of litter and dry leaves from streets and surface drains, especially before rains.
- Proper maintenance of traffic signs at correct heights and angle and updating them with latest and valid information.

- Proper placement of utilities to avoid impairing pedestrian and vehicular sight lines and obstruction of pathways. New utility provisions and maintenance are the responsibility of utility providers and it is essential to coordinate with such agencies before implementation.
- Regular trimming of trees and plantings and proper maintenance of the area around them. Foliage should not obstruct sight lines, signage or lighting.
- Regular maintenance of street furniture and walkway treatments.
- Regular maintenance of parks and open spaces.

Observations on common maintenance practices along internal mobility networks within townships are summarised in Section 4.5 of Chapter 4..

Successful implementation of sustainable mobility practices involves the presence and involvement of multiple private and public agencies, professionals and institutions.

Table 6 | Recommended Stakeholder Responsibilities to Promote Sustainable Mobility in Townships

STAKEHOLDERS	RESPONSIBILITIES TO PROMOTE AND ACHIEVE SUSTAINABLE MOBILITY
<p>Developer team: Departments involved in:</p> <ul style="list-style-type: none"> ■ Land acquisition ■ Design ■ Marketing ■ Sales ■ Finance ■ Legal 	<ul style="list-style-type: none"> ■ Conduct extensive market and site studies as indicated in Step 2 of this chapter to ascertain opportunities and constraints in developing the site in a cost-effective and timely manner. ■ Design program parameters that suit the land, the context and the users travelling to the development. ■ Attempt new and innovative strategies, such as introducing infrastructure for alternate fuel vehicles. ■ Market the development's sustainable features with impact projections highlighting cost savings and benefit to quality of life. ■ Orient buyers on project's sustainability features and translate goals, objectives and vision for the development during handover. ■ Manage site and facilities until project completion. ■ Aim to change industry image from 'profit-driven consumers of land and resources' to 'responsible providers of sustainable living environments'. ■ Note that while some of these recommendations may entail an initial cost to the developer, these costs are more than recovered in the project's market value.
<p>Design and implementation team:</p> <ul style="list-style-type: none"> ■ Land and site planners ■ Architects and landscape architects ■ Land survey and soil analysts ■ Environmental consultants ■ Civil and traffic engineers ■ Economists ■ Sustainability experts ■ Contractors ■ Vendors and material suppliers 	<ul style="list-style-type: none"> ■ Conduct thorough site research for adopting sustainable mobility practices before preparing the master plan for the project. ■ Showcase the economic and qualitative benefits of adopting sustainable initiatives to project teams. ■ Prepare an accurate base map as indicated in Step 2 showing site boundaries, topographical survey including site constraints and features. ■ Arbitrate between agencies on conflicting regulatory design requirements with the intent of providing sustainable mobility. ■ Identify environmental and traffic concerns caused by the project and prepare an environmental impact assessment and traffic impact assessment to allay the same. ■ Prepare detailed and legible construction drawings for street designs and obtain approvals from required agencies to implement the same. ■ Streamline design and implementation process with proper coordination between design team members.
<p>Public agencies:</p> <ul style="list-style-type: none"> ■ Central, state and local development and planning authorities ■ Public works departments ■ Fire, police and emergency service departments ■ Transport department ■ Utility companies 	<ul style="list-style-type: none"> ■ Facilitate the promotion of sustainable mobility design practices. ■ Assess future growth patterns and determine growth scenarios to ensure public infrastructure is in place before development commences, or both commence at the same time to avoid time lags in infrastructure access for residents later on. ■ Collaborate with developers to ensure last mile connectivity to developments. ■ Manage growth and land use policies to ensure proper land utilisation. ■ Provide all relevant data and information for the area. ■ Streamline and expedite the review and approval process. ■ Create a transparent process for timely delivery of project. ■ Ensure proper maintenance of utilities. ■ Develop policies that enable the integration of sustainable mobility into real estate development. ■ Facilitate public-private workshops to invite citizen participation.

STAKEHOLDERS	RESPONSIBILITIES TO PROMOTE AND ACHIEVE SUSTAINABLE MOBILITY
<p>Resident and employee associations</p> <ul style="list-style-type: none"> ■ Oversee management and maintenance of streets, amenities, non-residential areas, buildings and utilities including operational costs of the same. ■ Incentivise use of shared transport services such as car and bike sharing, shuttle buses, carpooling and transit use. ■ Enable a parking management system for all vehicle types within the development. 	
<p>Other private partners:</p> <ul style="list-style-type: none"> ■ Financial partners ■ Real estate agencies ■ Civil society agencies ■ Private transit providers 	<ul style="list-style-type: none"> ■ Commit to promote the developer's vision for the project. ■ Provide incentives to further project goals and objectives. ■ Market and promote realistic sustainability objectives of the township. ■ Evaluate and measure performance of mobility options in the development and provide feedback to developer.



ON RED



CHAPTER 3

GUIDELINES FOR SUSTAINABLE MOBILITY PLANNING AND DESIGN

A township sustainable mobility plan prioritises connectivity to city transit and public spaces, links shared amenities and services between neighbourhoods, increases opportunities for sustainable short-distance commutes and creates safe and equitable streets

This chapter provides guidelines for site design elements.

The guidelines are derived from survey analysis and urban design standards such as Indian Roads Standards Code (IRC). Their relevance to a particular stage in the planning process is noted. For example, elements that impact city and neighbourhood connections (such as transit access and land use placements) are required at earlier stages, while elements that are specific to the township (such as the internal street network

and street amenities) come into play as the project evolves.

The design elements and their relevant stages in the planning process are listed in Table 7. However, it is suggested that all the elements be assessed as part of initial site design to ensure a comprehensive development approach. Although, other considerations are needed for sustainable development, these guidelines are specific to sustainable mobility design.

Table 7 | Design Elements and their Relevance at Different Stages of the Township Master Planning Process

CATEGORIES WITH COLOUR CODE	GUIDEBOOK REFERENCE NUMBER	PAGE NUMBER	DESIGN ELEMENTS	STAGE OF PLANNING PROCESS
City Connections	3.1.1	58	Ecological Area Planning	Concept Development
	3.1.2	60	Transit and Non-Motorised Transit-Ready Planning	
Neighbourhood Links	3.2.1	64	Access to Development	Site and Building Planning
	3.2.2	66	Block Standards	
	3.2.3	68	Zoning and Building Placement	
	3.2.4	70	Provisions for Intermediate Public Transit and Shared Vehicles	
Development Layout	3.3.1	74	Connected Street Network	
	3.3.2	78	Open Space Network	
	3.3.3	82	Pedestrian and Cycling Network	
	3.3.4	84	Parking Provision and Placement	
Complete Streets	3.3.5	86	Building Entrance and Plot Access	Detailed Design
	3.4.1	90	Internal Street Design	
	3.4.2	94	Pedestrian Zone	
	3.4.3	98	Cycling Zone	

CATEGORIES WITH COLOUR CODE	GUIDEBOOK REFERENCE NUMBER	PAGE NUMBER	DESIGN ELEMENTS	STAGE OF PLANNING PROCESS
	3.4.4	102	Motor Vehicles Zone	
	3.4.5	104	Junction Design	
	3.4.6	106	Traffic Calming	
	3.4.7	108	Signage and Way-finding	
	3.4.8	110	Multi-Utility Zone	
	3.5	111	Street Elements: <ul style="list-style-type: none"> ■ Landscaping ■ Storm Water Drainage ■ Street Lighting ■ Street Furniture ■ Waiting Areas and Shelters ■ Street Utilities ■ Additional Amenities 	



How to Read the Guidelines

Figure 22 | Key to Design Element Guideline Layout

TITLE stating the design element

OBSERVATIONS on its current application in practice, based on WRI India case studies in Indian cities^a

DESCRIPTION of the element

RELEVANCE TO SPECIFIC MOBILITY MODES

Walking



high



moderate



moderate



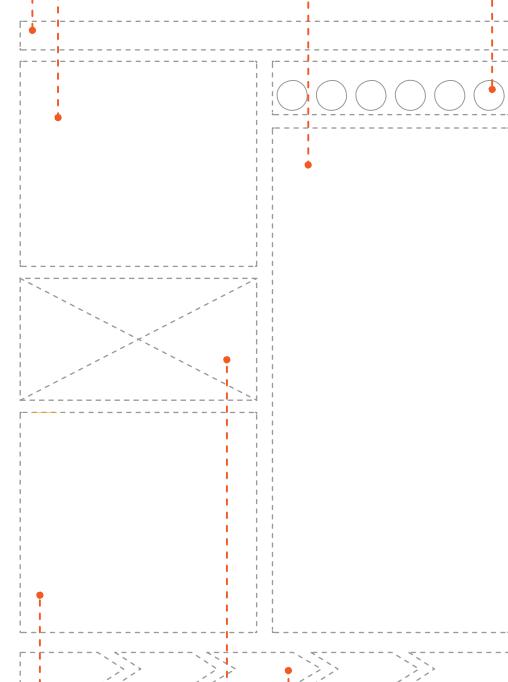
negligible



negligible



negligible



INTENT of the design element

RELATED TOPICS arranged in ORDER of their appearance in the guidebook with page numbers for reference

IMAGE/ SKETCH to support description of the design element

Recommended GUIDELINES for achieving the intent

COLOUR CODE AND TITLE of the category of the design element

a. Observations are excluded in Section 3.4 - Complete Streets



3.1

CITY

CONNECTIONS

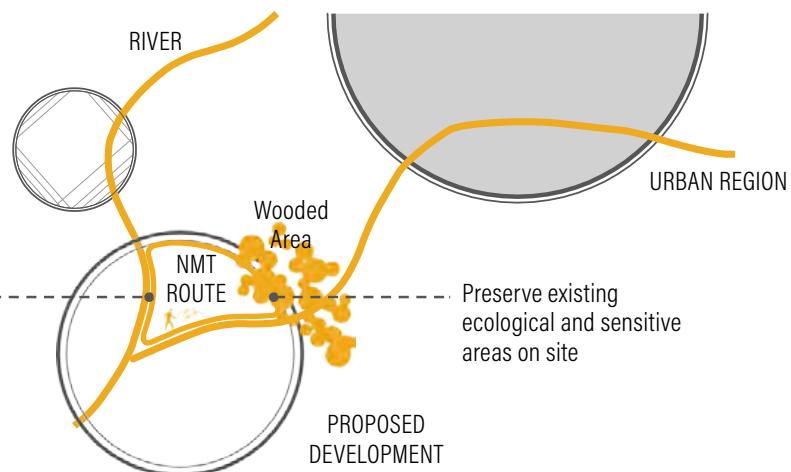
3.1 City Connections

Developments in peripheral areas of cities are linked to the city and its infrastructure and have a strong influence on the city's growth. At the urban scale, township master plans should link the development to the city physically, environ-

mentally, socially and economically. This guide-book addresses two key elements in promoting sustainable mobility within the township and in the wider area: planning ecological areas and planning motorised and non-motorised transit.

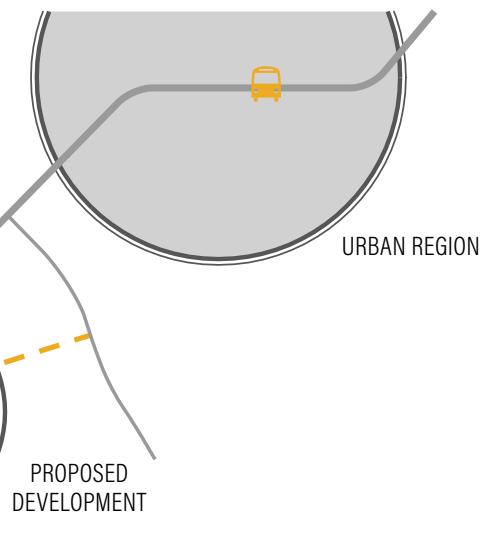
3.1.1 PLANNING ECOLOGICAL AREAS

Define the ecological site framework such that it enables recreational and sustainable mobility opportunities



3.1.2 PLANNING MOTORISED AND NON-MOTORISED TRANSPORT

Develop a site planning framework that facilitates existing and future transit system considerations



3.1.1 | PLANNING ECOLOGICAL AREAS

Description

Ecological areas are part of a site's natural infrastructure that may be sensitively harnessed into the design of public open spaces for the community. These areas are significant assets that improve the overall desirability and value of the development. Ecological mapping involves a series of spatial analyses based on land and water features to determine the nature of the site landscape. Identifying such areas or features can also provide opportunities for an alternative non-motorised movement network through the site (Calgary Regional Partnership 2015).



South Delhi Greenway

Image Source: Oasis Designs Incorporated

Intent

Define the physical framework and improve aesthetics of the development, develop mobility and recreation opportunities, and provide an asset that improves property value and the overall desirability of the township.

Related Topics

Site and Context Analysis (p.37)

Ecological Area Planning

3.2.3 Zoning and Building Placement (p.68)

3.3.2 Open Space Network (p.78)

3.3.3 Pedestrian and Cycling Network (p.82)

Relevance to Mobility Modes



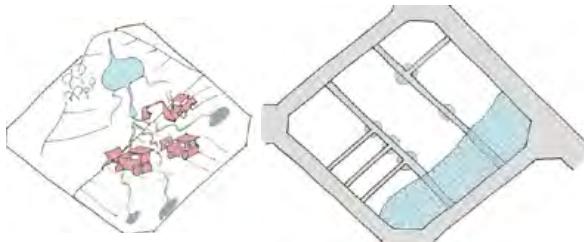
Case Study Observation

PROJECT: GREENFIELD DEVELOPMENT - SECTOR 31, NAYA RAIPUR

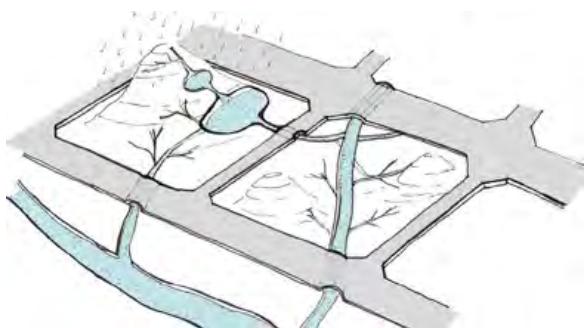
Most sector designs in Naya Raipur follow conventional construction practices, such as terrain levelling, that are cost and resource intensive and harmful to the ecology. Such practices lead to flooding along junctions as illustrated in Figure 23a. This could require complicated and difficult corrective measures post occupancy. Instead, Sector 31 is designed to maintain the site's existing topography and retain its water systems. This preserves the ecological functions of the landscape. The valleys and riparian zones that are mapped on site are designed as a hierarchy of green connections that enable walking trips to amenities (Figure 23b).

Figure 23 | Enhance Environmental Services of Water Features

a. Flattening of terrain leading to flooding



b. Design retaining the existing water systems;

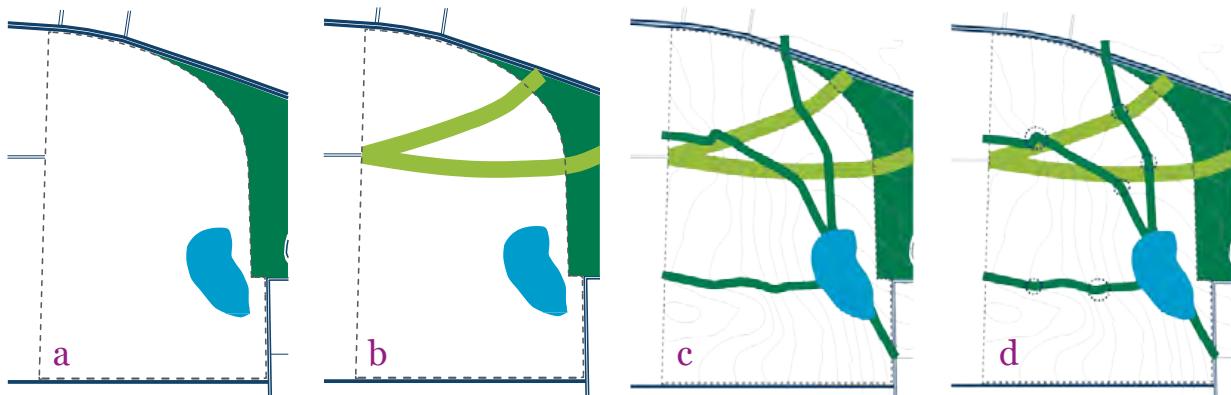


Source: WRI India, 2013

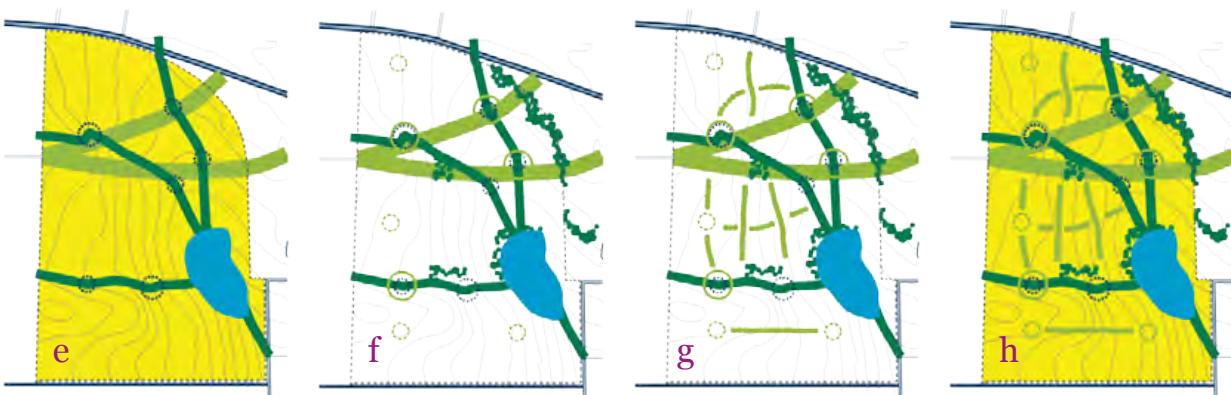
Guidelines for Planning Ecological Areas

The following steps aid in determining the structure of a greenway and open space network plan in a development (Figure 24).

Figure 24 | Process and Considerations for Designing a Greenway and Open Space Network



- a. Identify areas of ecological importance to be preserved.
- b. Map potential conservation areas such as wetlands, riparian areas with buffers, vegetation distribution, wildlife habitats, ridges, other landscape features and regional corridors. These can then be developed as NMT corridors.
- c. Take account of topography and existing watercourses.
- d. Position existing water features or ecological infrastructure as focal elements in the development.



- e. Finalise potential development area or the buildable area. Buildable area is the land area suitable for the development of various functions such as buildings, roads, and formal parks and playground spaces, taking into consideration the existing network of ecologically sensitive areas within the site.
- f. Identify other areas such as parks and areas for sports, pedestrian and cycling infrastructure.
- g. Outline a planting strategy for developed spaces to connect them with the larger greenway and open space network.
- h. Final result is a landscape framework that stitches together all elements listed in steps a-g.

Source: Adapted from The Greenfield Toolbox (Calgary Regional Partnership, 2015)

3.1.2 | PLANNING MOTORISED AND NON-MOTORISED TRANSIT

Description

Transit-ready planning is a long-term design strategy that considers opportunities to link into existing and future planned transportation networks. In particular, transit-ready planning assesses opportunities for public transit, intermediate public transit and non-motorised transport to inform land use planning from the onset of the planning process, even if these types of transport are not part of the initial development. Being transit and non-motorised transport ready does not imply construction of all infrastructure (i.e., bus lanes, stops and other supporting facilities) concurrently with development of the site. A transit-ready planning strategy provides the development with the necessary tools to evolve with the ever-changing needs of its residents.



Tennessee's Greensboro North Transit Ready Development

Image Source: Cumberland Region Tomorrow, 2012

Intent

Develop a framework for site planning which ensures that the design facilitates existing and future transit system placement, meets neighbourhood accessibility needs successfully and encourages use of public transit and alternate transit modes.

Related Topics

Site Selection and Program Development (p.34)

Site and Context Analysis (p.37)

Transit and NMT-Ready Planning

3.2.3 Zoning and Building Placement (p.68)

3.3.3 Pedestrian and Cycling Network (p.82)

Relevance to Mobility Modes

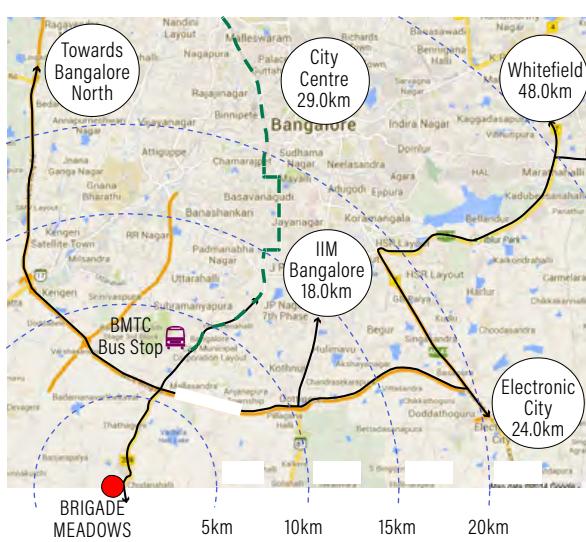


Case Study Observation

PROJECT: BRIGADE MEADOWS, BANGALORE

While planning the Brigade Meadows site in Bangalore, no consideration was given to the existing public bus routes or proposed metro development providing connectivity to the city. The distance from the development to the city is about 25 kilometres. Commuting by BMTC (Bangalore Metropolitan Transport Corporation) buses involves at least three to four transfers. The closest planned metro station (green line) will be accessible by BMTC buses and would involve no transfers. As the township is already in its construction phase, WRI India's audit could not address preparing the site for public transit considerations that would have helped with overall connectivity to the city. Recommendations to provide connectivity to the city included neighbourhood shuttle services and enhanced facilities for para-transit (flexible first- and last-mile transit) and non-motorised mobility.

Figure 25 | Distance from Brigade Meadows to Areas around the City

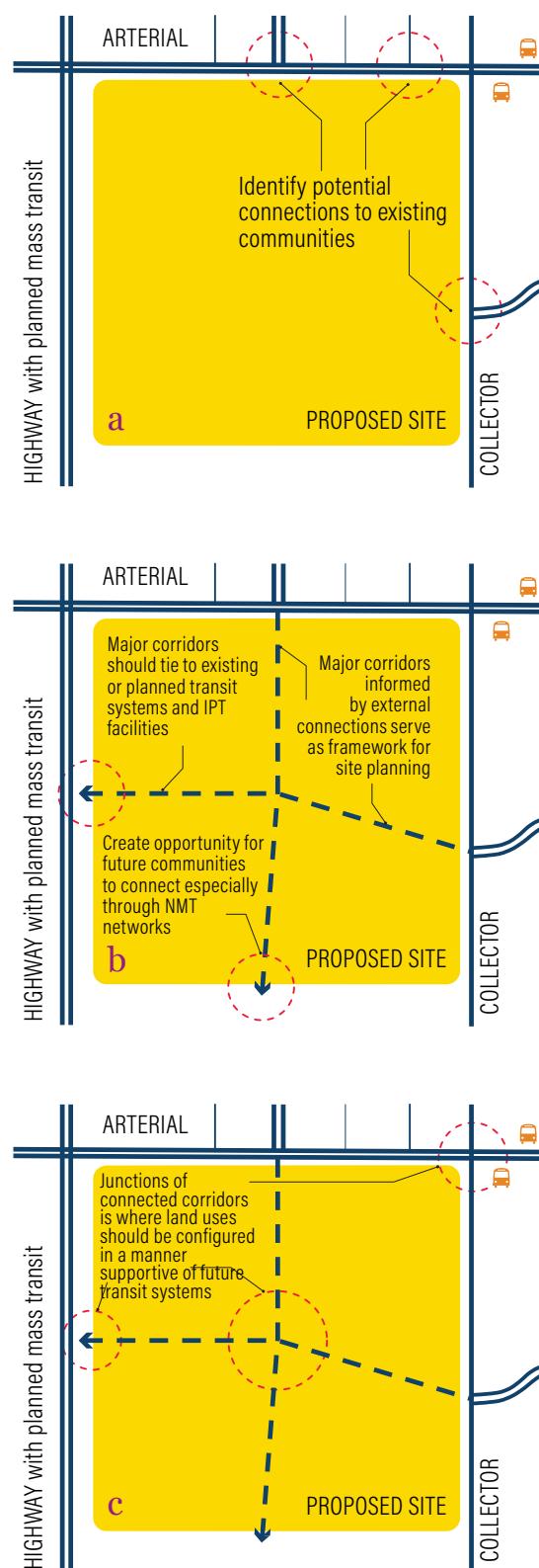


Source: WRI India, 2015

Guidelines for Planning Motorised and Non-Motorised Transit

Use the steps in Figure 26 to prepare a site for transit readiness.

Figure 26 | Process and Considerations for Preparing the Site for Transit and Non-Motorised Transport Readiness



- a. **Identify all existing and proposed road, transit and pedestrian connections around the development to maximise connectivity (Figure 26a).**

Ensure that the site is connected to all existing road transit, intermediate public transport infrastructure and pedestrian networks, unless existing conditions do not permit it. Instances of such situations include presence of limited access highway or boundary walls of adjacent developments or ecological considerations, such as a lake located near site boundaries.

- b. **Consider existing and future requirements of public transit routing around the site when placing major corridors within the development (Figure 26b).**

Major mobility corridors within the site should be the shortest, uninterrupted routes between site boundaries, and should connect to the network outside the site. Corridor locations could also:

- Be part of a future transit system including potential routes and stops; and
- Provide alternate routes to existing transit systems.

- c. **Consider locations that provide good connectivity to transit and other destinations, while configuring land uses on site (Figure 26c).**

Take into account the land use mix, locations and concentrations near transit and their impact on transit usage.

3.2

NEIGHBOURHOOD

LINKS GUIDELINES

3.2 Neighbourhood Links Guidelines

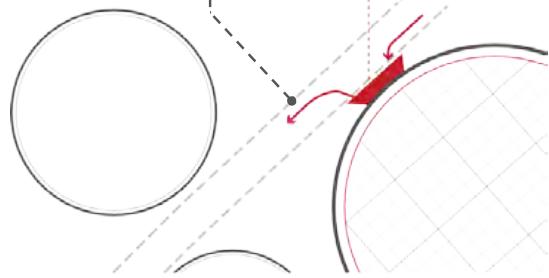
Every township is part of a larger neighbourhood and must acknowledge its relationship with other developments around it. Creation of interconnected economic, social, environmental and mobility links between and within developments produces a vibrant neighbourhood.

These guidelines address four key design elements that encourage the use of sustainable mobility: provide facilities for multiple transport modes at the access to the development, create walkable blocks, mix building uses and provide facilities for high-occupancy shared vehicles.

3.2.1 PROVIDE FACILITIES FOR MULTIPLE TRANSPORT MODES AT THE ACCESS TO THE DEVELOPMENT

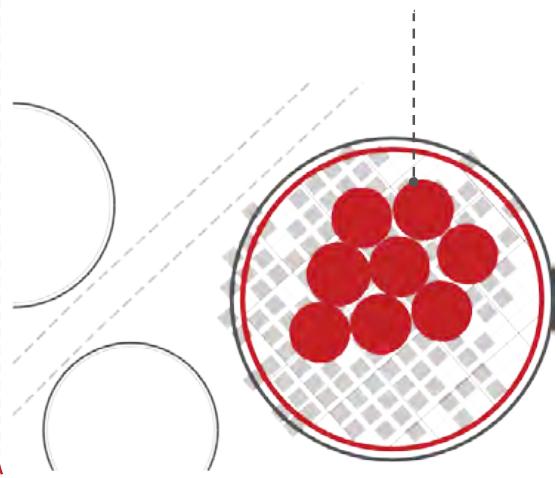
Provide facilities for users of all mobility modes at development entrance(s)

Minimise conflicts between internal and external mobility modes



3.2.2 CREATE WALKABLE BLOCKS

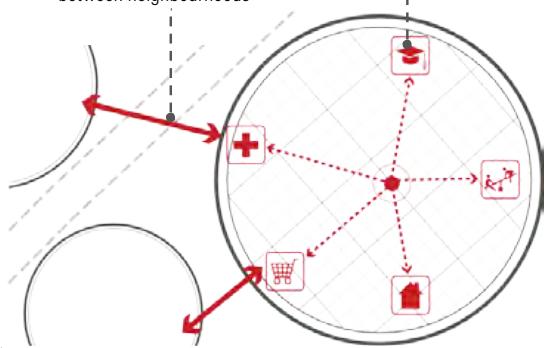
Create walkable block sizes that maximise development opportunity



3.2.3 MIX BUILDING USES

Enable sharing of commercial uses, open spaces and amenities between neighbourhoods

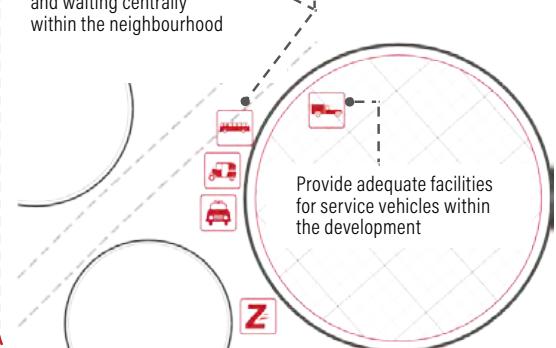
Provide mix of land and building uses to minimise the number of vehicular trips by residents



3.2.4 PROVIDE FACILITIES FOR HIGH-OCCUPANCY AND SHARED VEHICLES

Coordinate with relevant parties to locate facilities for intermediate public transport vehicle parking and waiting centrally within the neighbourhood

Provide facilities for high occupancy mobility modes to reduce private motorised vehicle use



3.2.1 | PROVIDE FACILITIES FOR MULTIPLE TRANSPORT MODES AT THE ACCESS TO THE DEVELOPMENT

Description

The main access gateway to a township is the interface between private and public realms where all internal and external mobility modes meet creating a high-volume junction. Main access gateways cater to a multitude of functions such as school and company vehicle pick up and drop off, interchange between different mobility modes, and security checks of vehicles and visitors.

Most townships have a single entry point, which usually serves as an advertisement for the development rather than as a transit interchange. Functional access points can enhance seamless and secure movement of goods, vehicles and people into the township and along the public corridor.



Tennessee's Greensboro North Transit Ready Development
Image Source: Cumberland Region Tomorrow, 2012

Intent

Streamline mobility at the approach to the development for different transit modes including service vehicles by minimising conflicts between motorised vehicles and non-motorised modes, particularly pedestrians and cyclists.

Related Topics

3.1.2 Transit and NMT-Ready Planning (p.60)

3.2.2 Block Standards (p.66)

Access to Development

3.3.3 Pedestrian and Cycling Network (p.82)

3.4.5 Junction Design (p.104)

Relevance to Mobility Modes

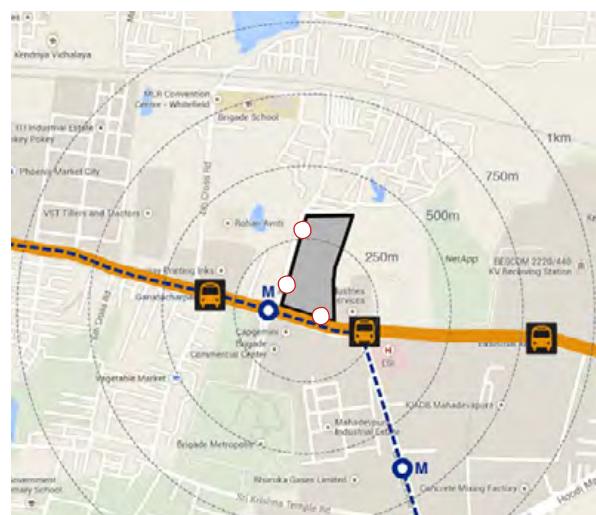


Case Study Observation

Project: Godrej United, Bangalore

Most township developments are located along major roads with heavy traffic. Sometimes, as in Godrej United township (Figure 27), a mass transit route is planned along the road. Locating the main entrance into the development along this road would pose problems for future residents and pedestrians accessing the site during and after metro construction. The main entrance was designed primarily for residents' vehicles with no provision for pedestrians or people arriving by public transit, auto-rickshaws or bicycles. The absence of proper waiting areas for auto-rickshaws, service vehicles, school buses, visitors and parking bays for cycles to facilitate mode change to public transit also hinders seamless movement to and from the development.

Figure 27 | Access Points to the Godrej United Development



Source: (WRI India, 2015)

Guidelines for Access to the Development

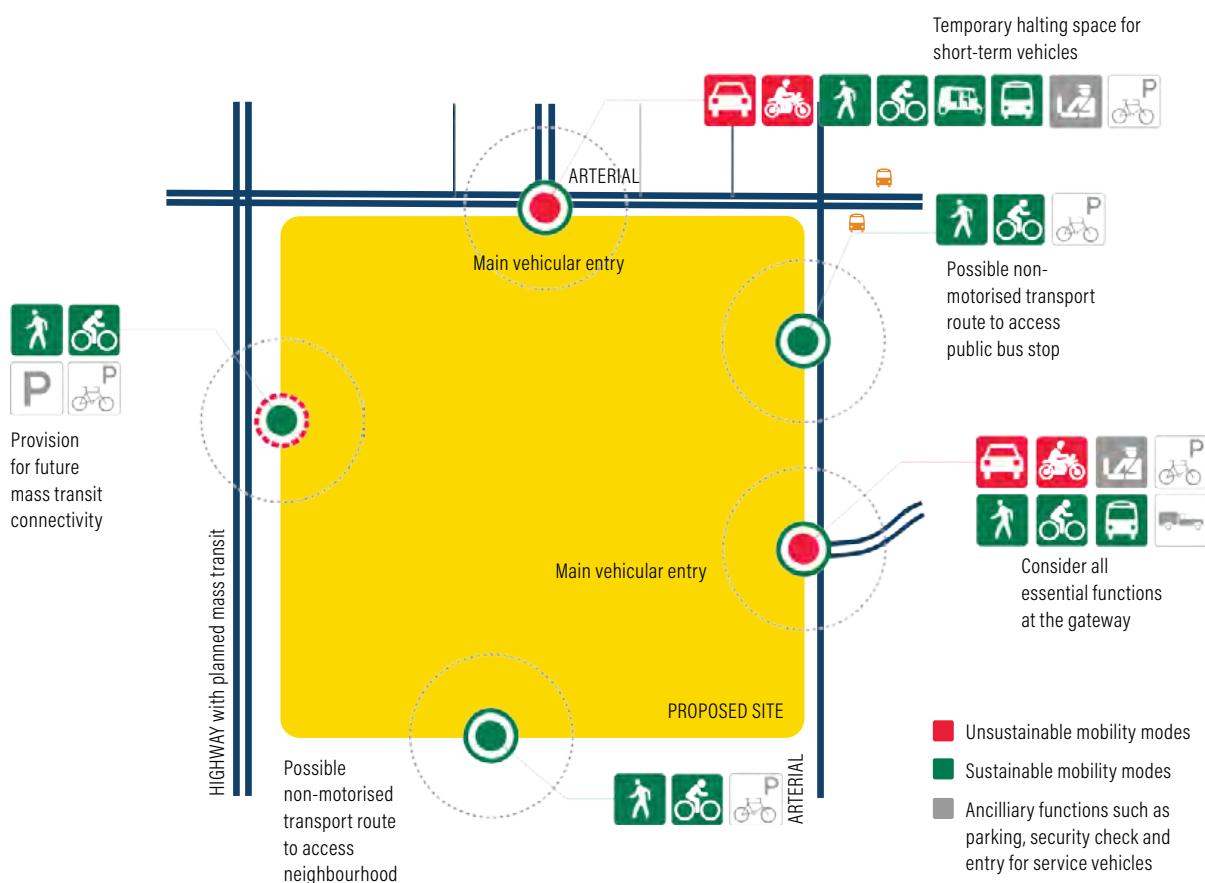
Number and Placement of Entry Points

- Assess whether the number of entries and exits are able to handle the peak hour loads from the development.
- If more than one edge of the site is bound by public roads, create multiple entry-exit points to ease traffic movement to and from the development.
- Although increasing the number of access points can increase the need for security personnel and other security mechanisms, some points can be kept operational for shorter time periods and for specific user groups depending on fluctuations in daily traffic volume.
- Design site entrance junctions to minimise the impact of traffic circulation within the township on city traffic.
- Align main streets in the development with streets from adjacent neighbourhoods, particularly when amenities are shared between neighbourhoods.

Facilities at Entrance

- Consider essential functions at the access gateway such as security checks, entry logs for service staff and visitors, and intercom facilities while designing the gateway. The design should be both functional and aesthetic as it plays an integral part of the township's image.
- Designate temporary waiting spaces for different types of vehicles such as school and company bus stops, intermediate public transit modes like auto-rickshaws and taxis.
- Create waiting spaces for visitors arriving by vehicles and other modes, taking into account the estimated time required to check into the development at the security point.
- Include loading/unloading bays for trucks delivering goods to the development.

Figure 28 | Application of Guidelines for Designing Access Gateways to the Development



3.2.2 | CREATE WALKABLE BLOCKS

Description

Blocks, which provide a framework for the placement of buildings, are the fundamental unit of the urban fabric. Blocks are ideally designed to allow pedestrians, cyclists and motorists to move safely and comfortably through the neighbourhood. Most cities contain a variety of block sizes and shapes which determine the 'fabric' of the city (Figure 29). For example, many pre-industrial urban areas have organic street patterns and small blocks, while urban areas planned for vehicle movement are typically based on grids.

Figure 29 | **Types of Blocks**

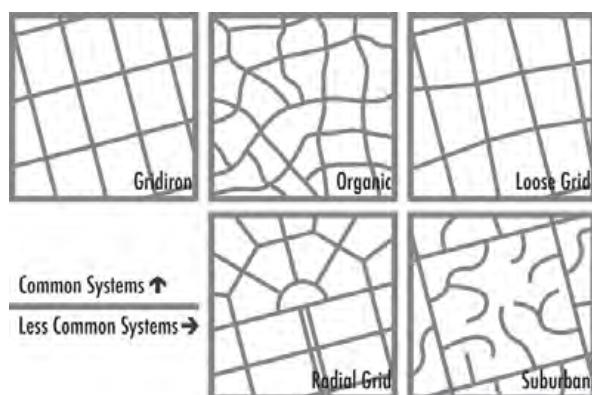


Image Source: Munson, 2013

Intent

Encourage design of smaller blocks that maximise development opportunity, create a connected street network with active building frontages and provide opportunities for non-motorised transport.

Related Topics

Site and Context Analysis (p.37)

3.1.2 Transit and NMT-Ready Planning (p.60)

3.2.1 Access to Development (p.64)

Block Standards

3.2.3 Zoning and Building Placement (p.68)

Relevance to Mobility Modes



Case Study Observation

Project: Godrej Garden City, Ahmedabad

Most townships in India follow the superblock model in which a site is divided into large blocks with peripheral road access, as seen in the Godrej Garden City master plan (Figure 30). The superblock (800 metres or more) is much larger than a traditional city block (200–250 metres) and its design is based on vehicular distance and speed scales. Hence wide, high-speed arterial roads, rather than pedestrian scale local streets, define block edges. In areas that are predominantly low-rise residential, these blocks are divided into plots that are served by cul-de-sacs or looped streets.

Figure 30 | **Superblocks Flanked by Wide, High-Speed Arterial Roads**



Source:
Godrej Properties Limited

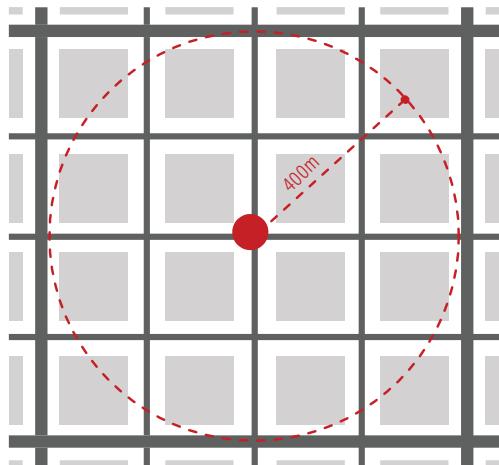
Walkable Neighbourhoods

The benchmark for walkable neighbourhood units is blocks of a 400-metre radius. Most people will walk a distance of approximately 400 metres (one-quarter mile or a five-minute walking distance), before opting to drive or ride a bike. Where larger blocks are needed to accommodate large-footprint buildings, pedestrian and bicycle connections should be created.

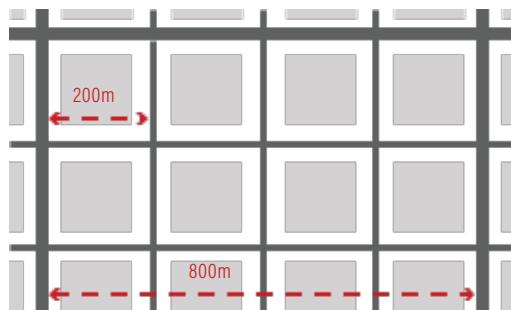
Guidelines for Creating Walkable Blocks

Figure 31 | Block Design Guidelines

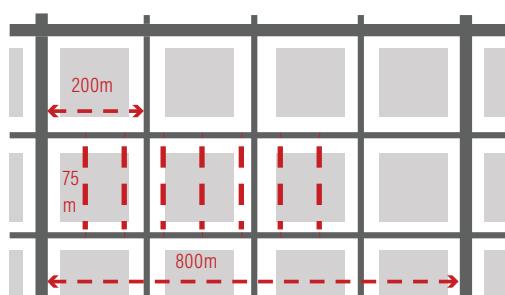
- a. Define blocks by using the 5-minute walking radius or 400-metre (quarter mile) grid as the standard for block configuration and size.



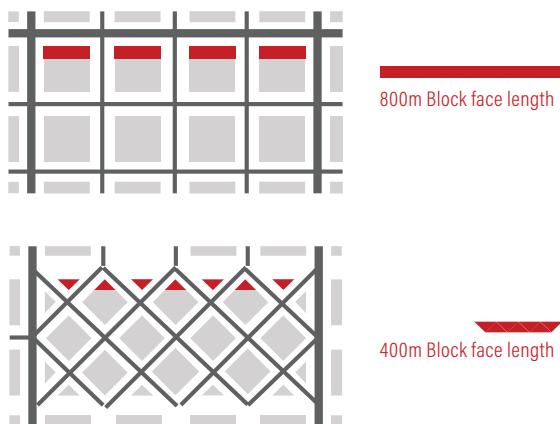
- b. In superblocks scaled for automobiles (800 metres or more), midblock crossings and pass-throughs are recommended every 200 metres as either signalised or raised crossings or with speed humps before crossings (See Section 3.4.6).



- c. For a high degree of walkability, block lengths of 75 to 150 metres are more desirable.

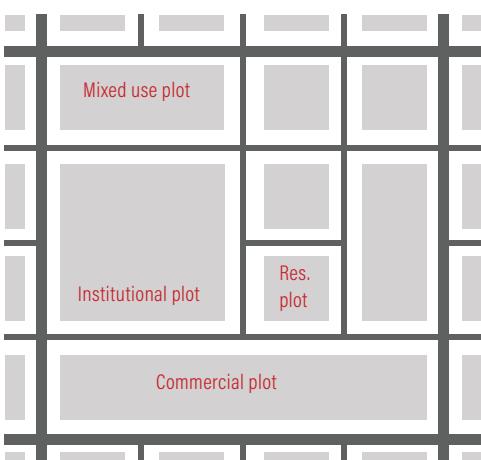


- d. Create block perimeters and block face lengths that maximise real estate value by forming more high-value perimeter-facing lots.



- e. Create block areas that can accommodate a range of building types for employment, commercial, mixed-use, live-work, and residential uses.

- f. Block sizes should enable subdivision in the future, for instance, to provide neighbourhood shopping that meets near- and long-term community needs and can respond to changing real estate market demands.



- g. Configure blocks taking into account pedestrian and bicycle comfort and mobility, access to services, such as rear lanes, access to parking, garages, and waste collection.

3.2.3 | MIX BUILDING USES

Description

A township can provide easy access to daily needs and recreational opportunities for its residents. Identifying land uses is “not a matter of varying land use on a block-by-block basis, but integrating complementary uses in a range of appropriate building types within a common area” (Calgary Regional Partnership 2015).

The orientation of buildings relative to the street affects how the development is structured and how streets adjoining buildings are used. For example, as shown in Figure 32, pedestrian activity declines where blank walls or basement parking face footpaths. Streets with active frontages are more user-friendly.

Figure 32 | **Pedestrian Activity Declines where Blank Walls Face Footpaths**



(www.deccanchronicle.com)

Intent

Place land uses and building functions that optimise pedestrian, cycling and transit linkages to, from and within the site and promote activity along street frontages.

Related Topics



Relevance to Mobility Modes

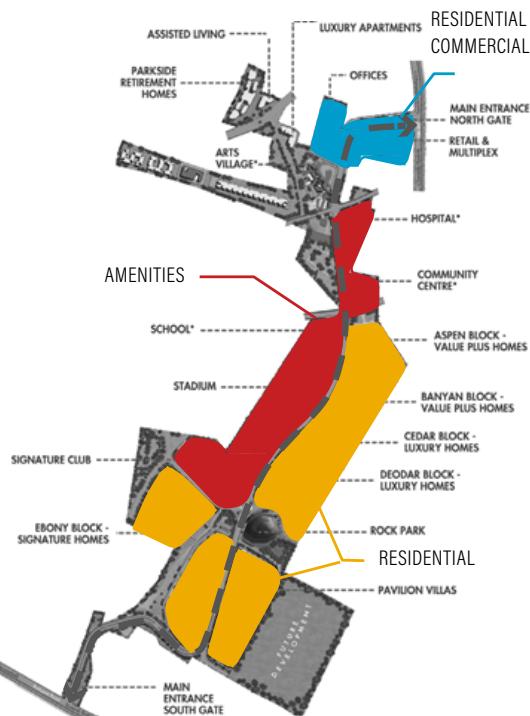


Case Study Observation

Project: Brigade Orchards, Bangalore

The Brigade Orchards development in Bangalore is designed along a central spine of about two kilometres (a 25–30 minute walk) between its two entrance gates. Commercial amenities are grouped at the north end of the site and housing segments catering to varying income groups are pooled into mini-neighbourhoods at the opposite end of the site (Figure 33). Each residential parcel is designed as a separate block with compound walls separating each block from its neighbour.

Figure 33 | **Segregated Land and Building Uses at Brigade Orchards**



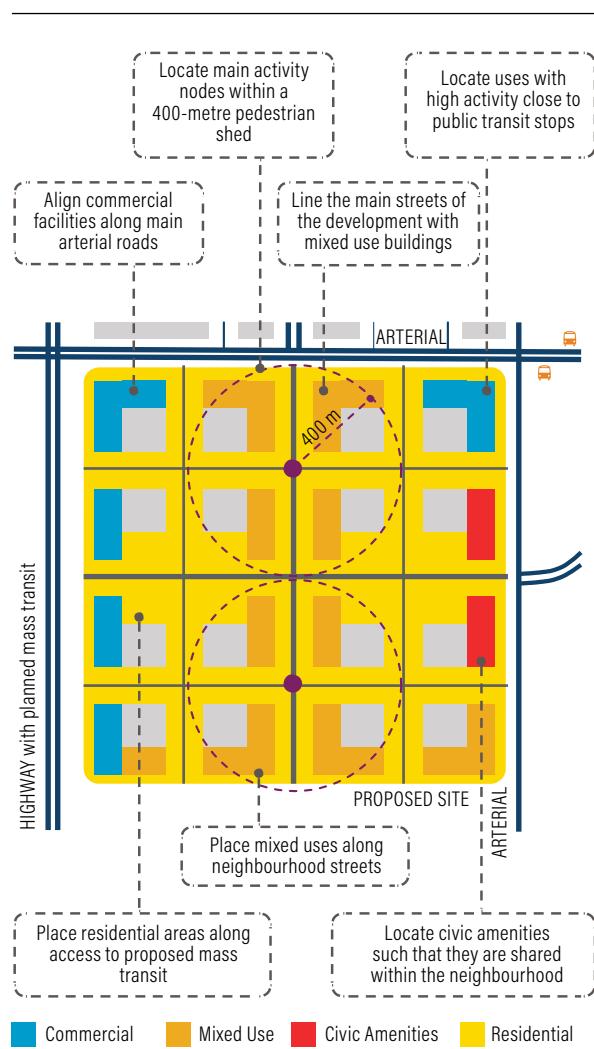
Source: Brigade Enterprises Limited

Guidelines for Mixing Building Uses

Mixed-Use Development

- Propose a mix of land and building uses to minimise the number of vehicular trips by residents. However, some vehicle use is necessary to stimulate pedestrian activity and to provide economic incentives for developing mixed uses (Figure 35).
- Place neighbourhood destinations such as retail stores, services and restaurants at grade level and parallel to the street to animate the street front, encourage pedestrian activity and improve personal security.
- Enable sharing of commercial uses and amenities to reduce over-provision within a neighbourhood.

Figure 34 | Zoning and Building Placement Guidelines



Building Arrangement

- Arrange buildings so that complementary uses are located close to one another to minimise walking distances (Figure 34). Plot these within a quarter mile or 400-metre radii walking area to delineate a cluster of pedestrian sheds (Figure 36).
- Arrange buildings to ensure compactness within the development and facilitate walking.
- Ensure that similar building types face one another across major streets; transitions between substantially different building types ideally occur across side streets.
- Locate uses that generate noise or odours away from pedestrian areas; limit heavy commercial vehicles on streets with high pedestrian or bicycle traffic.

Figure 35 | Walking Distances to Neighbourhood Destinations

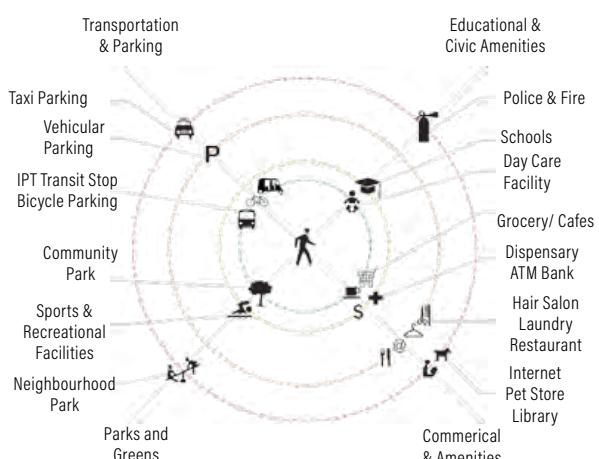
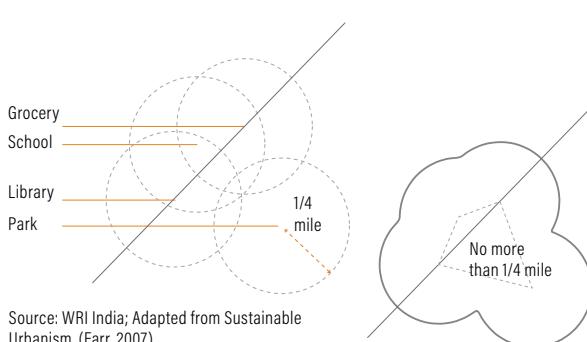


Figure 36 | 400-Metre Pedestrian Shed for a Cluster of Destinations



3.2.4 | PROVIDE FACILITIES FOR HIGH-OCCUPANCY AND SHARED VEHICLES

Description

Developers can connect people to areas outside the development by providing for shared vehicles and para-transit. These options are as convenient and comfortable as private motorised transport modes and complement existing public transit systems. Some examples of shared vehicles include:

- Shuttle buses and rideshare facilities between the township and nearest public transit points, employment centres and other destinations;
- Intermediate public transport (IPT) services such as auto-rickshaws and taxis for short-distance trips;
- Self-driven car rental services such as Zoom car; and
- Electric vehicles and golf carts that ferry people within the development.



Provision of Dedicated Auto-Rickshaw Parking and Waiting Space;
Image Source: Udupi Today.com, 2014

Intent

Balance circulation and promote shared mobility in the development and reduce private motorised vehicle use with alternative mobility modes that move more than one individual at a time.

Related Topics

3.2.3 Zoning and Building Placement (p.68)

Provisions for IPT and Shared Services

3.3.3 Pedestrian and Cycling Network (p.82)

3.3.4 Parking Provision and Placement (p.84)

3.4.8 Multi-Utility Zone (p.110)

Relevance to Mobility Modes

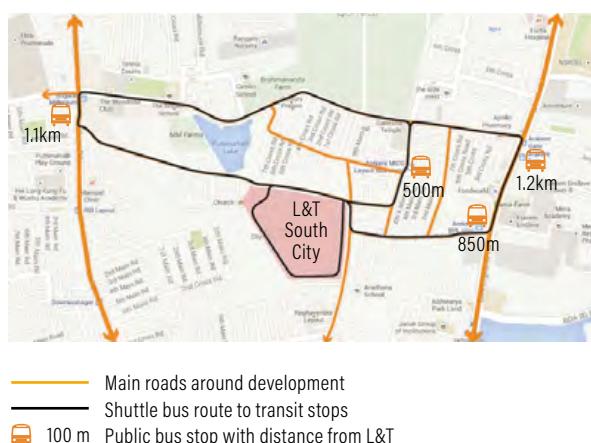


Case Study Observation

Project: L&T South City, Bangalore

When many L&T South City residents parked their vehicles along the road outside the development to drop off school children or commuters between 7am and 10am, users of the public street felt inconvenienced (See Case Study 1 in Chapter 1). Recommendations to ease this situation included providing a shuttle bus service within the development to drop off residents at school bus and public bus stops around the neighbourhood. The buses would operate during peak hours encouraging people to reduce vehicle use for short-distance trips at rush hour. Providing dedicated auto-rickshaw parking outside the main entrance would also help reduce congestion along the public road.

Figure 37 | Proposed Shuttle Bus Route through L&T South City, Bangalore



Source: WRI India, 2013

Guidelines for Providing Facilities for High-Occupancy and Shared Vehicles

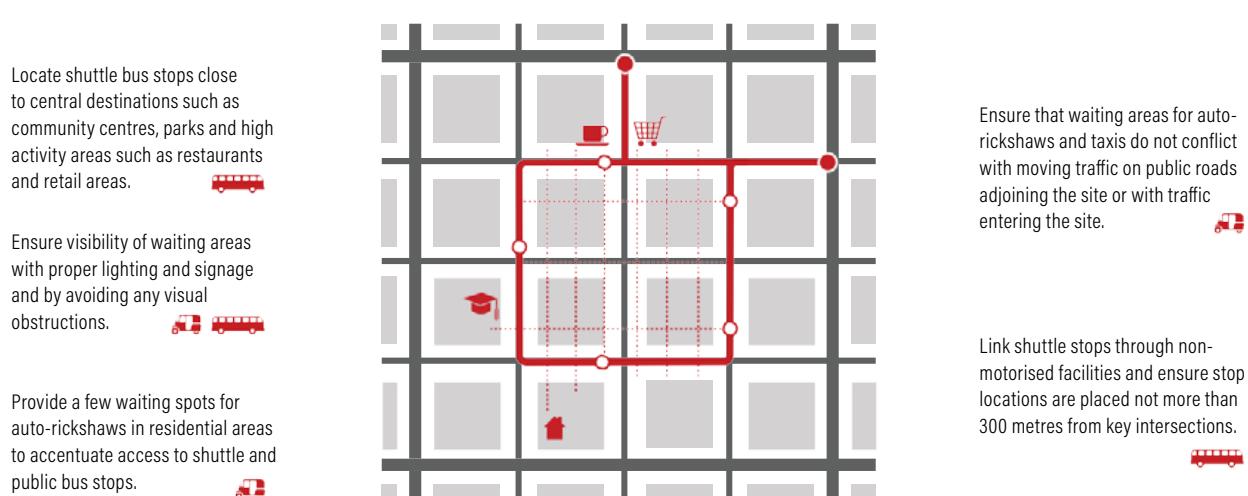
Shuttle Buses

Shuttle buses can be different sizes for different passenger loads and route frequency. In small- to mid-sized townships (20–75 acres), shuttle buses can link the township to key parts of the city and transit nodes. In large townships (greater than 75 acres), shuttle buses also connect important nodes within the immediate neighbourhood and the site itself.

Auto-Rickshaws and Taxis

Auto-rickshaws and taxi services play an integral part in moving people from the township for short-distance trips. Due to security concerns, these modes are mostly positioned outside the site boundaries. However, they are sometimes permitted within large townships with public streets passing through them,

Figure 38 | Guidelines for Shuttle Buses and Auto-Rickshaw Provisions



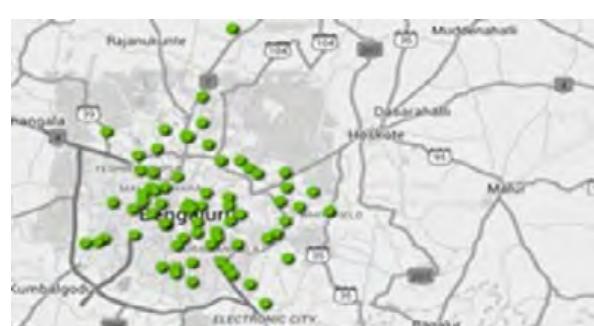
School and Company Pick Up / Drop Offs

- Locate school bus stops closer to residential areas and away from high-activity areas.
- Minimise automobile concentrations near bus stops and restrict on-street parking to increase safety for children who walk or cycle to the stops.
- Provide protected bicycle parking around the stops to encourage cycling.
- Design safe routes with sufficient illumination and signage to the bus stops.
- Consider non-motorised access from surrounding neighbourhoods.

Car Rentals

Self-driven car rental companies like Zoomcar, which are common in city neighbourhoods in India, are considered an affordable and convenient alternative to personalised vehicles (Figure 39). These systems work in locations with sufficient densities, a mix of uses and easy access to transit services allowing users to meet their daily needs without owning a car.

Figure 39 | Zoomcar Website Showing Car Pick Up Locations in Bangalore



Source: Zoomcar, 2015

3.3

DEVELOPMENT LAYOUT GUIDELINES

3.3 Development Layout Guidelines

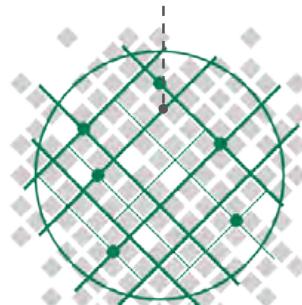
Sustainable, people-centric township layouts form the basis of a city's growth and development.

Townships should be planned around the needs of people rather than vehicles. A pedestrian-scale development benefits not just its own residents but also those in adjoining neighbourhoods.

Five design elements play an integral part in the use of sustainable mobility modes within townships – connect the street network, design an open space network, create a pedestrian and cycling network, manage parking, and segregate building entrances for vehicles and pedestrians.

3.3.1 CONNECT THE STREET NETWORK

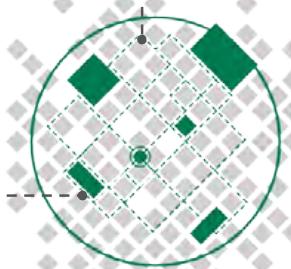
Create connected and complete circulation systems that minimise conflicts between different users



3.3.2 DESIGN A NETWORK OPEN SPACES

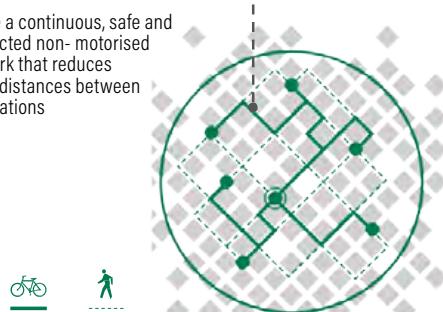
Provide opportunities for non-motorised transport movement and connections to existing transit networks

Improve recreation and social interaction by linking parks and other public spaces to non-motorised routes



3.3.3 CREATE A PEDESTRIAN AND CYCLING NETWORK

Create a continuous, safe and connected non-motorised network that reduces travel distances between destinations

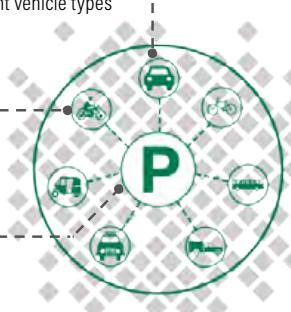


3.3.4 MANAGE PARKING

Manage parking demand for different vehicle types

Minimise need and supply of vehicular parking

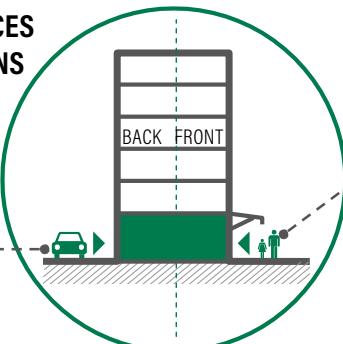
Provide parking such that any conflict with pedestrians is minimised



3.3.5. SEGREGATE BUILDING ENTRANCES FOR VEHICLES AND PEDESTRIANS

Segregate building and plot entrance for motorised and non-motorised users to minimise conflict

...Locate well-defined, visible and safe access that increases safety and security for pedestrians and cyclists

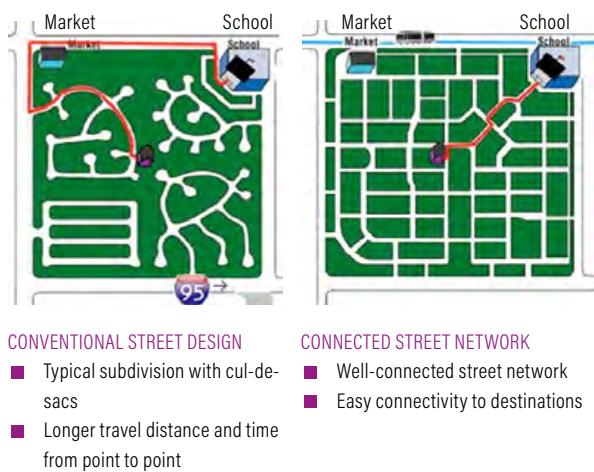


3.3.1 | CONNECT THE STREET NETWORK

Description

Streets bound the edges of blocks and define potential sites for development. They provide access to the block and facilitate connectivity within neighbourhoods. A street network is a connected web of streets, not necessarily in an orthogonal grid, that allows pedestrians, cyclists and motorists to move safely and comfortably through a neighbourhood while also incorporating public space and functional green infrastructure (Calgary Regional Partnership 2015).

Figure 40 | Conventional Street Design vs. Connected Street Network



Intent

Provide a circulation system that encourages safe and efficient access for pedestrians, cyclists and motorists, results in efficient traffic movement and minimises conflicts between different street users.

Relevance to Mobility Modes

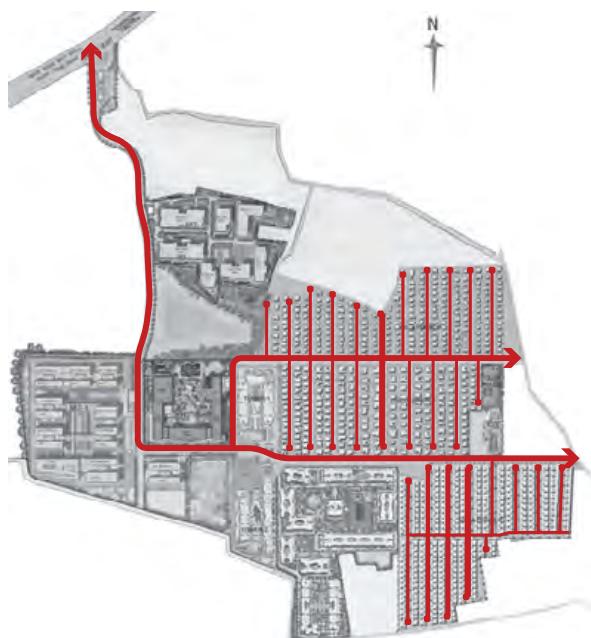


Case Study Observation

Project: Adarsh Palm Retreat, Bangalore

The street network for Adarsh Palm Retreat township has low connectivity (many streets dead end) which forces vehicles onto the main roads creating traffic jams at some intersections (Figure 41). Three defined entry points segregates users towards three residential enclaves. Because drivers cannot move easily through one enclave to another, they must travel farther and longer, causing congestion during peak hours. Average distances for internal trips range from one to two kilometres. Due to traffic congestion and automobile-oriented master planning strategies, such as lack of proper crossings for pedestrians and bicyclists, personal cars are the preferred mode of travel by residents.

Figure 41 | Master Plan Showing Disconnected Road Hierarchy



Base Map Source: Adarsh Developers

Related Topics

3.2.2 Block Standards
(p.66)

3.2.3 Zoning and Building Placement
(p.68)

Connected Street Network

3.3.3 Pedestrian and Cycling Network
(p.82)

3.4.1 Internal Street Design
(p.90)

Guidelines for Connecting the Street Network

To achieve a safe and attractive street environment, the design should account for:

- The function of each street and the grid or placement of blocks.
- Streets designed for appropriate vehicle speeds; and
- Different types of street users – pedestrians, cyclists, motor vehicle users, shared transport users and emergency and service vehicles. Detailed design considerations for each user type are covered in Section 3.4.

For neighbourhood streets, design should begin with an understanding of the street function - either to provide mobility or accessibility or both. Street carriageway width is determined by whether the street is designed for vehicular throughput or neighbourhood access and then by non-motorised mobility requirements, prioritising walking and cycling.

Depending on the land use context, streets in residential neighbourhoods must at least connect residents to public transit and provide access to homes. Neighbourhoods with intensive land uses such as retail and commercial activities may require greater provisions for collective transit, wider footpaths, greater network connectivity, and in some cases, more travel lanes.

Classification of Street Types

In conventional urban scenarios, street typologies are defined by the degree to which they emphasize through movement for vehicles. As per Indian Roads Congress safety standard IRC 86-1983, the classification of road types is as follows:

- **Arterials:** Streets primarily for through vehicular movement, usually on a continuous route.
- **Sub-arterials:** Streets serving similar functions as arterials but offering lower mobility levels.
- **Collectors:** Streets that collect and distribute traffic and also provide access to arterial streets.
- **Locals:** Streets that primarily provide access to buildings.

Within a township, the street classification can also include sub-local streets, exclusive

non-motorised transit lanes and alley lanes for services (Figure 43). Table 8 classifies street typologies as per their functions and lists their design standards.

Vehicle Design Speeds

The desired speed of vehicles on a street determines various street characteristics like right-of-way, carriageway widths and traffic calming measures and parameters like signals and operations. Research has shown that vehicular speeds of more than 40 kilometres per hour increases the chance of fatal accidents (Shah and Jain 2014). Road lengths and widths increase with higher vehicular speed demands because the required safe distance between vehicles increases (Figure 42).

The target speed for various streets ranges from 3 kilometres per hour for pedestrians to 40 kilometres per hour for motorists for the street types described in this guidebook. Design speeds for the different street classifications are illustrated in Figure 43.

Figure 42 | **Road Length Increases with an Increase in Planned Vehicular Speed**

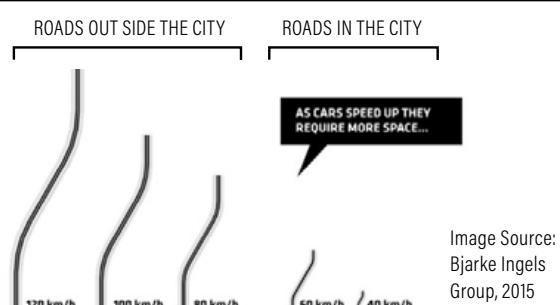


Image Source:
Bjarke Ingels
Group, 2015

Figure 43 | **Street Classifications by Maximum Design Speeds for Vehicles**

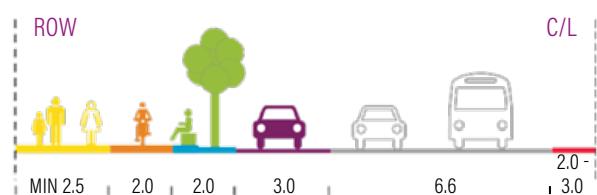


Table 8 | Functional Classification of Streets in a Neighbourhood

■ Footpath ■ Cycle Track ■ Landscape ■ Multi-Utility Zone ■ Parking ■ Carriageway ■ Median
ROW- right of way, C/L = Centre Line

1. SUB-ARTERIALS

Sub-arterials are streets that bring in traffic from main arterial roads. They may also support infrastructure such as parking for different vehicle types.



Design speed range: 30–40 km per hour

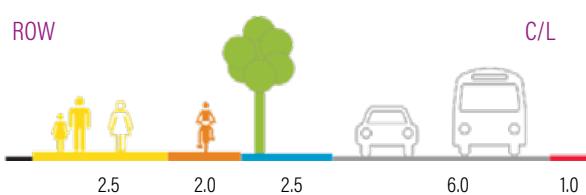
ROW width range: 30–40 metres (~100–130 feet)

Carriageway requirement

- Minimum two lanes in each direction
- Minimum width: 3.3 metres per lane

2. COLLECTORS

Collectors are streets outside or within the development that collect the traffic to disperse it to different blocks. They could be the main access within a development.



Design speed range: 20–30 km per hour

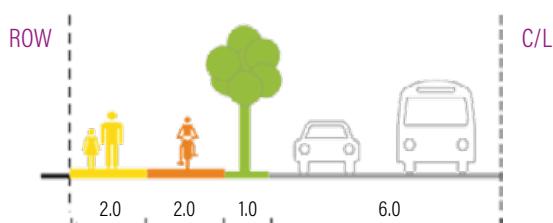
ROW width range: 18–26 metres (~60–85 feet)

Carriageway requirement

- Minimum one lane of vehicle traffic in each direction
- Minimum width: 3.0 metres per lane

3. LOCAL STREETS

Local streets collect traffic from sub-arterials and collectors and provide access to blocks.



Design speed range: 10–20 km per hour

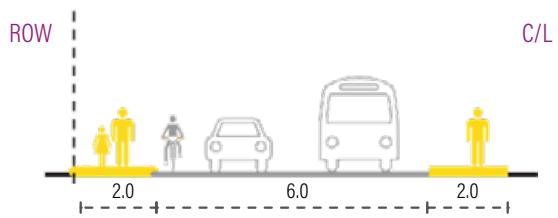
ROW width range: 12–24 metres (~40–78 feet)

Carriageway requirement

- Minimum one lane of vehicle traffic in each direction
- Minimum width: 3 metres per lane

4. SUB-LOCAL

Sub-local streets provide access to plots. These streets are also used as leisure or public open spaces especially by children for playing. In narrower streets, cyclists and vehicles share road space.



Design speed range: 10–15 km per hour

ROW width range: 6–12 metres (~20–40 feet)

Carriageway requirement

- Minimum one lane of vehicle traffic in each direction
- Minimum width: 3 metres per lane

5. NON-MOTORIZED TRANSPORT LANES

Non-motorised transport (NMT) lanes are exclusive pedestrian and cycling routes. They can connect public recreational spaces like parks or provide promenades along water bodies.



Design speed range: 4–10 km per hour

ROW width range: 3–6 metres (~10–20 feet)

Carriageway requirement - None

6. ALLEY LANES

Alleys are unobstructed places between buildings or plots that are used for services and emergencies. These areas have the potential to be transformed into secondary public streets.



Design speed range: 15 km per hour

ROW width range: Minimum 6 metres (~20 feet)

Carriageway requirement: Unobstructed 3 metre space

Source: Adapted from Street Design Guidelines (UTTIPEC 2010) and IRC 69-1977: Space Standards for Roads in Urban Areas

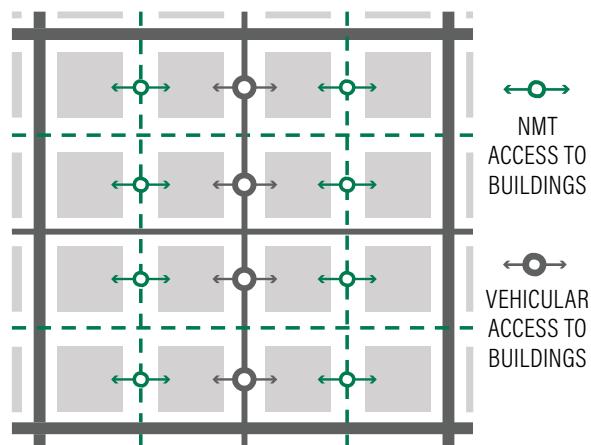
Guidelines for a Connected Street Network

Figure 44 | Design Considerations for Street Networks

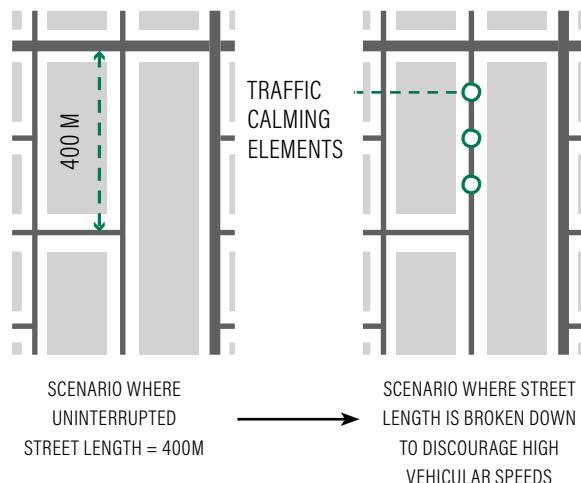
- Lay out streets in a grid pattern that complements the topography of the land. Design the grid segments 150 – 200 metres apart to facilitate pedestrian and cyclist Connectivity throughout the site and to neighbouring areas.
- Alternate the motorised road network with non- motorised routes to provide exclusive space for pedestrians, cyclists and motorists. This minimises the number of potential conflict points between modes.



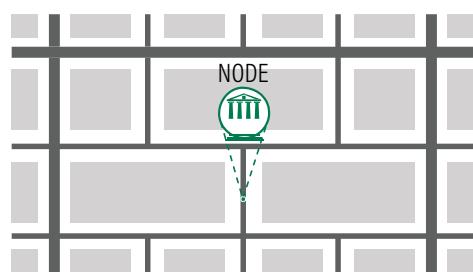
- Minimise the number of building and vehicular access points along main roads to reduce conflicts between pedestrians, cyclists and motor vehicles. Access points to blocks for non-motorised transport modes should be segregated from vehicular access points.



- As per the Indian Roads Congress public road safety standards, IRC 103-2012, ensure uninterrupted street lengths of no more than 120 metres and preferably 50 metres on internal streets adjacent to a building or plot access to discourage high vehicle speeds.



- Design intersections of streets to facilitate safe walking and cycling (See Section 3.4.5). At junctions where pedestrian and cyclist routes meet vehicular networks, use 90-degree junctions rather than non-orthogonal angles.
- Avoid one-way streets, where possible, for simplified circulation and to discourage greater vehicular speeds.
- Configure principal streets in the network to frame views and create nodes.



- Connect the internal motorized and non-motorized mobility network to any external non-motorised and public transit routes that pass through the neighbourhood to provide a seamless interface between external and internal routes.

SOURCE: CANADIAN INSTITUTE OF TRANSPORTATION ENGINEERS, 2004 AND IRC 103-2012

3.3.2 | DESIGN A NETWORK OF OPEN SPACES

Description

Open spaces, such as parks, recreation areas and playgrounds, benefit all types of developments. However, many city regulations follow blanket land allocation and lack zoning criteria that allow designers to build a network of open spaces. A planned open space network can reduce impervious ground cover to prevent flooding and absorb pollutants from storm water, lower construction costs including the need for grading, and prevent loss of natural areas. It can contribute to the physical, mental, and emotional well-being of residents. A network also provides opportunities to develop a non-motorised transport framework and increases mobility options and connections to public transit modes.



OPEN SPACES CONTRIBUTE TO THE WELL-BEING OF RESIDENTS;
IMAGE SOURCE: PWL PARTNERSHIP, N.D.

Intent

Create a network of open spaces that is integrated into the overall site plan. The network should comprise a complementary set of parks, recreation and community areas that fulfill multiple user interests and sustainability functions.

Related Topics

3.1.1 Ecological Area Planning (p.58)

3.2.3 Zoning and Building Placement (p.68)

Open Space Network

3.3.3 Pedestrian and Cycling Network (p.82)

3.5 Street Elements (p.111)

Relevance to Mobility Modes



Case Study Observation

Project: L&T South City, Bangalore

In Indian townships, open space is usually allocated in a single location mostly to allow for convenient upkeep and maintenance. As a result, residents do not have a sense of ownership and the open space ends up being neglected over time. Large expanses of land, such as Salt Lake Central Park and several city parks in Bangalore, are actually more susceptible to neglect than smaller intimate parks and gardens scattered around the development.

At L&T South City, the township park (10 percent of the total site area) is to the north of the site with a public road separating it from the development. Although the park was fenced by the municipality to keep out non-community members, residents feared using it because of safety and security concerns. As traffic on the public road increased, access to the park became more difficult, which resulted in its neglect. This led to the residents propose a new open space within the confines of the site (Figure 45).

Figure 45 | Master Plan Showing the Park Separated from the Development by a Public Road



Base Map Source: South City Residents Welfare Association

Guidelines for Designing a Network of Open Spaces

Building an Integrated Open Space Network

Open spaces and natural resource areas can help add value to developments as they:

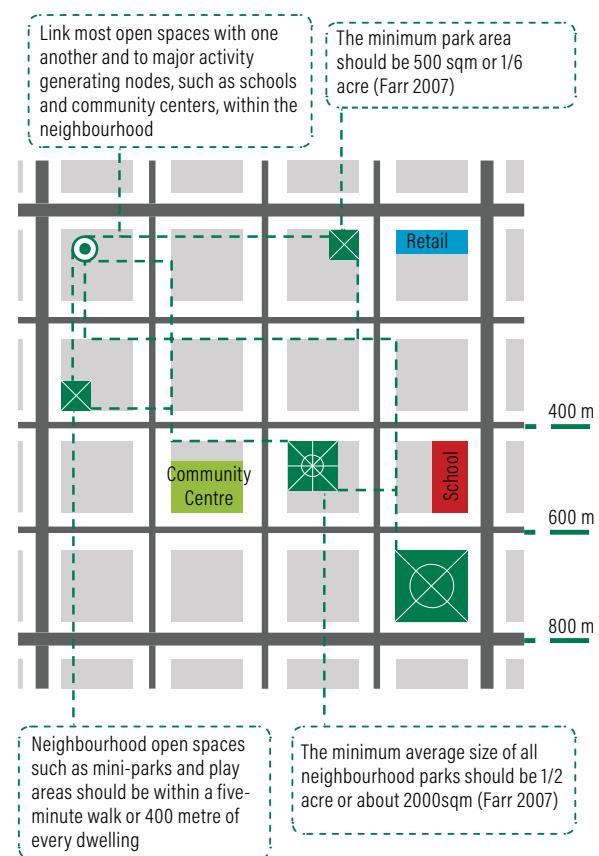
- Separate incompatible land uses;
- Provide visual or physical connections between townships (and neighbourhoods);
- Reinforce community identity; and
- Provide opportunities to develop a non-motorised network and increase mobility options and connections.

Open space network design is an integrated process that involves coordination among developers, master planners, landscape designers, engineering professionals, ecologists and other design professionals

This section is limited to basic land allocation guidelines and criteria for designating open space and recreation areas during planning (Figure 46). Some guidelines are:

- Provide adequate access to open spaces and supporting infrastructure such as bicycle parking; and
- Bound all parks on at least two sides by public rights-of-ways including bicycle routes and trails.
- Secured parks shared between neighbourhoods at night, if necessary.

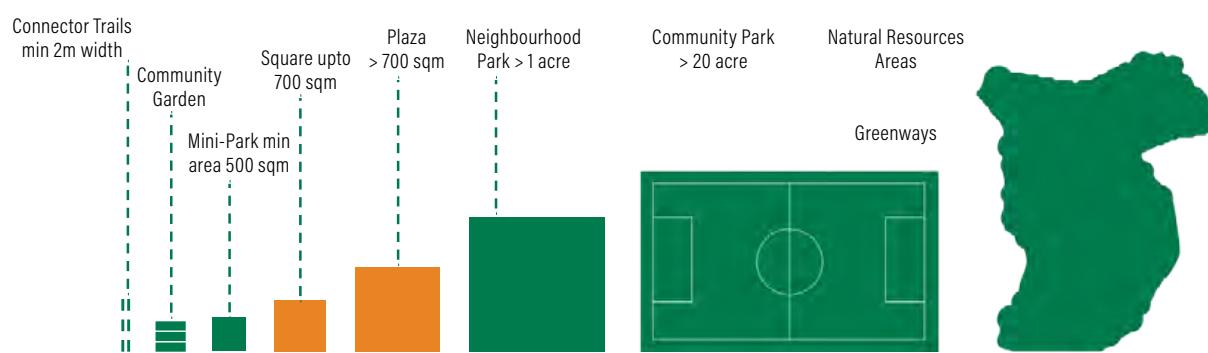
Figure 46 | Open Space Network Guidelines



Open Space Types

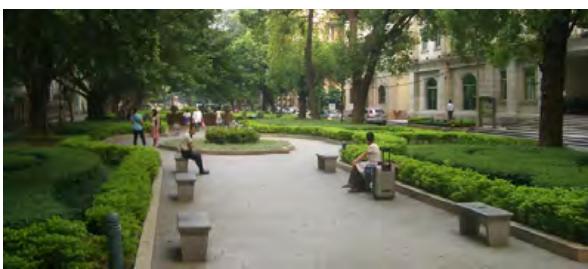
Open spaces can have many forms, shapes, purposes, and functions as illustrated in Figure 47. No single example typifies an ideal model. Each community will need to design a system of open spaces that incorporates different elements and criteria to meet a variety of community needs. Table 9 outlines a basic classification of neighbourhood open spaces and describes the important functions they provide for a community.

Figure 47 | Open Space Types



Adapted from Sustainable Urbanism (Farr 2007)

Table 9 | Types of Open Space in a Community

1. MINI-PARK	2. NEIGHBOURHOOD PARK
<p>A mini-park provides isolated or unique recreational needs such as a children's playground or dog park.</p> <p>Location Criteria: Less than a 400 metres distance in residential settings</p> <p>Size Criteria: 500 square metres to half an acre</p> 	<p>A neighbourhood park is the basic unit of open space systems and serves as a recreational and social focus of the neighbourhood for a diversity of users. These parks provide recreation and open space benefits within walking distance of the residences they serve.</p> <p>Location Criteria: 400 to 800 metres distance and uninterrupted by non-residential roads and other physical barriers</p> <p>Size Criteria: Greater than one acre is considered the minimum</p> 
<p>Image Source: Charter Township of Meridian, n.d.</p> 	<p>Image Source: Oregon Live LLC, 2015</p>
3. COMMUNITY PARK	4. SQUARE
<p>Community parks serve a wider purpose than neighbourhood parks as the focus is on meeting community-based recreation needs, as well as preserving unique landscapes. These parks often include specialised recreational facilities (such as athletic fields or swimming pools) that serve larger areas.</p> <p>Location Criteria: Usually serves two or more neighbourhoods and at 800 metres to 4.5 kilometres distance</p> <p>Size Criteria: As needed to accommodate desired uses. Usually between 30 and 50 acres</p> 	<p>Squares are public spaces at the intersection of important streets. The streetscape flanking squares consists of paved walks, lawns, trees, and civic buildings.</p> <p>Location Criteria: At the intersection of major streets and shaped by surrounding building frontages</p> <p>Size Criteria: Up to 700 square metres</p> 
<p>Image Source: Wikimedia Foundation, n.d.</p>	<p>Image Source: Land perspectives, n.d.</p>

5. PLAZA

Plazas are used for civic and commercial purposes (such as outdoor cafes) and are primarily hard-surfaced (stone, brick, pavement, etc.). They are larger than a square and spatially defined by surrounding frontages.

Location Criteria: At the intersection of important streets set aside for civic and commercial activities

Size Criteria: Larger than squares – usually greater than one acre



Image Source: Landezine/Landscape Architecture Works, 2015

6. NATURAL RESOURCES AREA

Land set aside for preservation of significant natural resources and landscapes. They are often centred on a unique feature or resource, such as a lake, mountainous area, or river corridor.

Location Criteria: Resource availability and opportunity

Size Criteria: Variable



Image Source: EPD LLC, n.d.

7. NEIGHBOURHOOD CONNECTOR TRAIL

Multi-purpose trails emphasize safe travel for pedestrians to and from parks and around the community. The focus is as much on transportation as it is on recreation. Trails can provide fitness and recreation opportunities and non-motorised access to natural areas, schools, or even commercial and employment centres.

Location Criteria: Separate/single-purpose, hard-surfaced trails for pedestrians or cyclists

Size Criteria: Minimum width of trails is 2 metres



Image Source: InTech, 2015

8. COMMUNITY GARDEN

A group of garden plots available for small-scale cultivation, generally for residents of a community without private gardens.

Location Criteria: Residential areas with resource availability

Size Criteria: Variable



Image Source: Real Estate Webmasters, 2015

9. GREENWAY

Greenways effectively tie the park system components together to form a continuous park environment..

Location Criteria: Resource availability and opportunity

Size Criteria: Variable



Image Source: The Atlantic Monthly Group, 2015

3.3.3 | DESIGN A PEDESTRIAN AND CYCLING NETWORK

Description

Walking and cycling networks offer residents a safe and comfortable experience while making destinations and amenities accessible. They also create opportunities for a healthy, economically viable and enriched community environment.

Non-motorised routes need not be along streets if an alternate direct route can be provided



IMAGE SOURCE: METRO JACKSONVILLE, N.D.



IMAGE SOURCE: DEPOSITPHOTOS, INC. USA, 2015

Intent

Create a continuous, safe and clearly defined non-motorised network that reduces travel distances between destinations and decreases conflicts with motorised vehicles.

Relevance to Mobility Modes



Case Study Observation

Project: Brigade Meadows, Bangalore

The road network of Brigade Meadows township has a central spine that connects two arterial public roads flanking the township. Access roads to the residential areas stem from this central road. Most of the wider roads in the development provide the minimum required width for footpaths (0.9 metres). However, roads within the low-rise residential sectors cater primarily to vehicles and have no provision for pedestrians or cyclists. Uninterrupted long stretches of road increase the possibility of higher vehicular speeds. Intersections that hamper smooth movement, one-way streets, and entries to parking lots can create unsafe and unfavourable streets for non-motorised transport users.

Figure 48 | Lack of Pedestrian Infrastructure and Facilities along the Road Network



BASE MAP: BRIGADE ENTERPRISES LTD.

Related Topics

3.2.3 Zoning and Building Placement (p.68)

3.3.2 Open Space Network (p.78)

Pedestrian and Cycling Network

3.4.1 Internal Street Design (p.90)

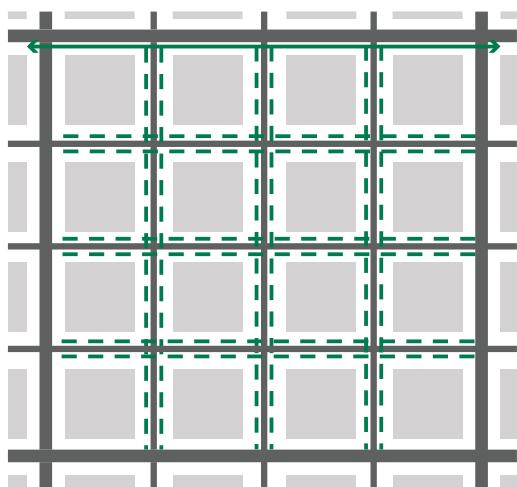
3.5 Street Elements (p.111)

Guidelines for a Pedestrian and Cycling Network

Figure 49 | **Pedestrian and Cycling Network Guidelines**

Locating Pedestrian and Cycling Routes

- Plan all internal motorised streets to accommodate pedestrians and cyclists.
- Connect the internal pedestrian and cycling network to external transit and pedestrian routes.



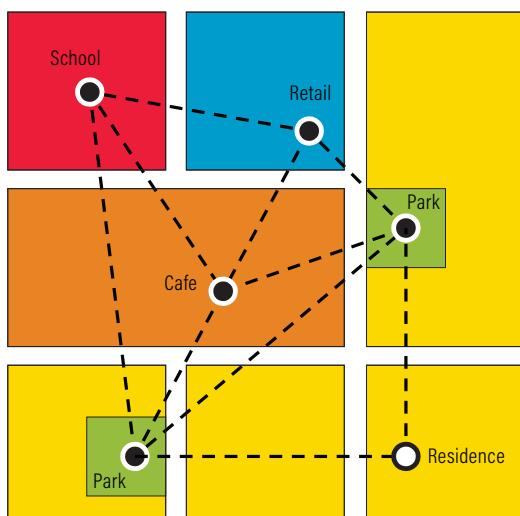
- Design walking routes that are separate from roads to ensure safety for pedestrians.
- Separate dedicated cycling routes along the right-of-way: mark them and use traffic calming measures in the roadway. Cycling routes can be at-grade or grade separated from roadways (See Section 3.4.3).
- Design a network of pedestrian and cycling routes that is separate from the motorised



Image Source: David Baker Architects, n.d.

network. These routes should provide direct paths to destinations via green open spaces.

- Create a matrix of proposed links that directly connect different uses, building entrances, parking areas and transit waiting areas. To prevent safety and security concerns, avoid locating the routes through rear alleys that face blank building facades or compound walls.



- Complete the routes and network with properly designed walkways, signage, lighting and landscape elements including facilities such as benches, dustbins and pause points for resting and socialising.

Street Crossings

- Design the pedestrian and cycling network with minimum street crossings to reduce potential conflicts between motorised and non-motorised transport modes. Because conflicts often happen at intersections of streets, the crossings should be and safe for all users.
- Mid-block crossings can break up large blocks such as in institutional areas but they should be located more than 200 metres from the nearest intersection.

3.3.4 | PARKING PROVISION AND PLACEMENT

Description

To promote sustainable mobility modes in a neighbourhood, it is important to address the design and placement of private automobile parking, as well as parking for other modes of transport.

Conventional calculation practices in India to determine the number of vehicle parking spaces needed involve using a building code formula that allows for more vehicles per unit than are actually owned. The formula is based on planning parameters such as additional built up area, floor area ratio and customer aspirations.



CURRENT UNREGULATED PARKING PRACTICES IN INDIA;
IMAGE SOURCE: THE HINDU, 2015

Intent

Manage parking demand for different types of vehicles and locate parking areas to promote safe and efficient pedestrian, bicycle and transit access thus minimising the impact of vehicular parking on pedestrian safety.

Relevance to Mobility Modes

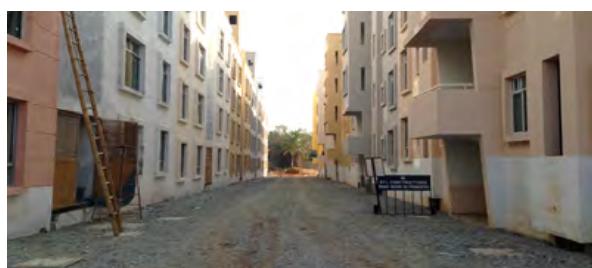


Case Study Observation

Project: Brigade Meadows, Bangalore

In Bangalore's Brigade Meadows development, the internal roads that provide access to the residential units are 6 metres wide. They also accommodate 90-degree car parking spots as seen in Figure 50. This type of parking, in which cars have to back out, is unsafe for pedestrian and cycling movement and inhibits smooth vehicular circulation. Internal pedestrian-scaled streets that could have doubled as play spaces for children have been reduced to vehicular corridors with increased conflict points between pedestrians and motorists.

Figure 50 | Internal Streets Designed to Accommodate Parking and Not Pedestrians



SOURCE: BRIGADE DEVELOPERS PVT. LTD.

Related Topics

3.2.3 Zoning and Building Placement (p.68)

3.3.3 Pedestrian and Cycling Network (p.82)

Parking Provision and Placement

3.4.1 Internal Street Design (p.90)

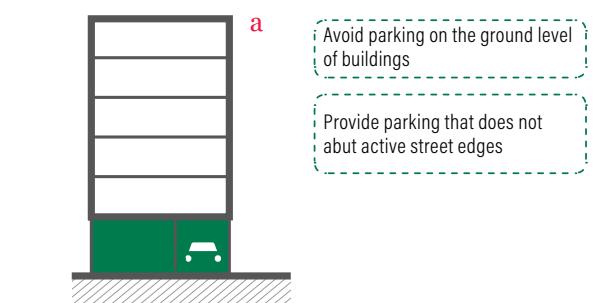
3.4.7 Signage and Way-finding (p.108)

Guidelines for Parking Provision

Figure 51 | **Parking Provision and Placement Guidelines**

Private Motorised Vehicle Parking

- Design vehicular parking underground, or above ground in enclosed podiums or in open stilt parking in the rear of buildings to avoid hindering activity along street edges.
- Avoid using the ground level area of buildings for private vehicle parking. Ensure that surface parking around commercial areas does not abut active street frontages and pedestrian routes.



- For resident parking, provide one four-wheeler parking space per household in the township to prevent oversupply of parking spaces.
- Providing more than the required number of parking spots promotes vehicle use and takes away valuable development area that can be used for other amenities beneficial to the community (such as convenience stores and recreational areas).
- In assessing the site, consider the possible percentages of different vehicle types that may be owned by residents and introduce the required number of two-wheeler parking spaces.

On-street Parking

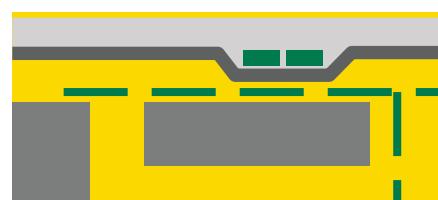
- Provide on-street parking to support high activity areas such as commercial, retail or recreational spaces with sufficient street widths to accommodate parking bays. Avoid on-street parking for private vehicles along residential streets.



- Design on-street parking adjacent to pedestrian and cycling routes as they can be used to buffer slower moving pedestrian and cycling traffic from fast moving vehicles.



- Provide one or two parking spots closer to building entrances for short-term pick up and drop off, emergency vehicles and parking for handicapped individuals.



- Parking spaces for ridesharing and car rental facilities that are to be shared between communities can be located conveniently within the neighbourhood with clear signage indicating the location of such spaces.

3.3.5 | BUILDING ENTRANCE AND PLOT ACCESS

Description

Defined building entrances and edges can form ideal environments for pedestrian activity by creating active frontages that increase interest and a sense of safety and security. Entrances serve multiple functions that include retail storefronts and restaurants (for pedestrians); pick up and drop off points for residents (for vehicles); and loading and unloading points for goods and services (for trucks).



WELL DEFINED BUILDING ENTRANCE AND PLOT ACCESS REDUCES VEHICLE CONFLICTS WITH OTHER STREET USERS;
IMAGE SOURCE: AS EASY AS RIDING A BIKE, N.D.

Intent

Locate well-defined, visible and safe building and plot access that minimises walking distances, increases safety and security for pedestrians, and reduces conflict between different street users.

Relevance to Mobility Modes



Case Study Observation

Project: L & T South City, Bangalore

Building access in the L & T South City development is through ramps that serve both pedestrians and vehicles. This limits pedestrian access to the ground level from the parking podiums and increases residents walking distances to amenities. The ground level of residential buildings is designed as stilt parking spaces creating unfavourable environments along street edges. They are sometimes dark and unsafe thus unattractive to pedestrians (Figure 52).

Figure 52 | Ramp Access to Buildings and Under-Used Building Edges



Source: WRI India

Related Topics

3.2.3 Zoning and Building Placement (p.68)

3.3.3 Pedestrian and Cycling Network (p.82)

Building Entrance and Plot Access

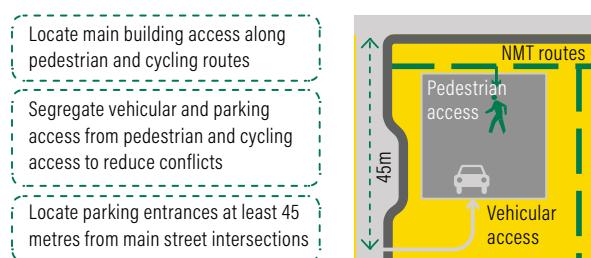
3.4.1 Internal Street Design (p.90)

3.4.5 Junction Design (p.104)

Guidelines for Building Access

Figure 53 | Building Entrance and Plot Access Guidelines

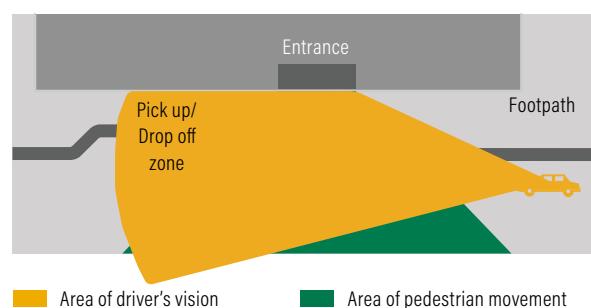
Entrance Design for Pedestrians



- Locate entrances close to passenger pick up and drop off areas and transit stops to minimise the distance travelled by pedestrians to access these facilities.
- In mixed-use areas, have separate entrances at the ground level for residents and retail areas. If a single entrance is shared by multiple users, provide proper signage to guide users to the right area.
- Design building frontage along main mixed-use streets with attractive features such as transparent glass facades and shaded walkways to encourage pedestrian activity.

Entrance Design for Passenger Pick Up and Drop Off

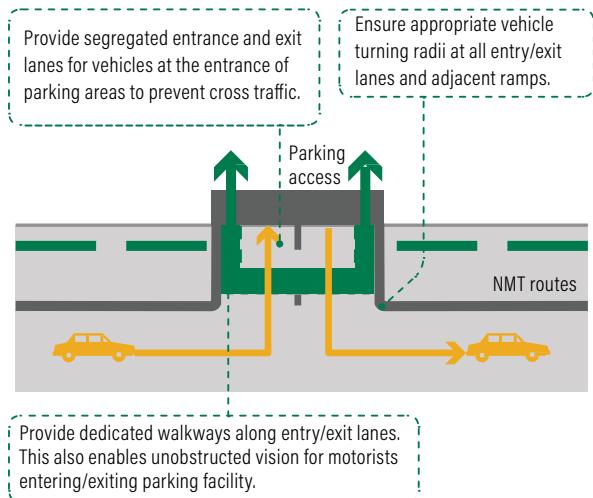
Along main streets, locate pick up/drop off points away from the building entrance along the line of traffic movement. This provides drivers with an unobstructed view of the pick up/drop off area. Recess these areas into the footpath to improve visibility for oncoming traffic and to prevent waiting cars from interrupting the flow of traffic.



- Locate pick up/ drop off areas at the side or rear entrances of buildings at a maximum walking distance of 30 metres from main entrance.

Entrance Design for Vehicle Parking Areas

- Locate vehicular entrances into parking areas away from main streets, preferably at the rear of buildings. If parking access is from a main street, provide more than one access to enable streamlined entry and exit flow.



- Provide clear, unobstructed vehicle landings at the entrance of parking basement ramps.
- Provide well-designed lighting and signage to reduce confusion and improve safety for all users.

Entrance Design for Service Vehicles

- Locate access for service vehicles away from the main streets and from routes that serve parking areas, and pedestrian, cycling and transit users. If service entrances must be located along main streets, provide defined times, outside of peak hours, for service vehicle parking.
- Avoid potential traffic backups along streets by providing service vehicle entry locations that do not require the vehicle to back out onto main streets. Ensure that vehicle staging and manoeuvring does not interfere with pedestrian or cycling routes.
- Design service entries to be screened from public view and minimise permeation of exhaust fumes and noise.

3.4

COMPLETE

STREETS

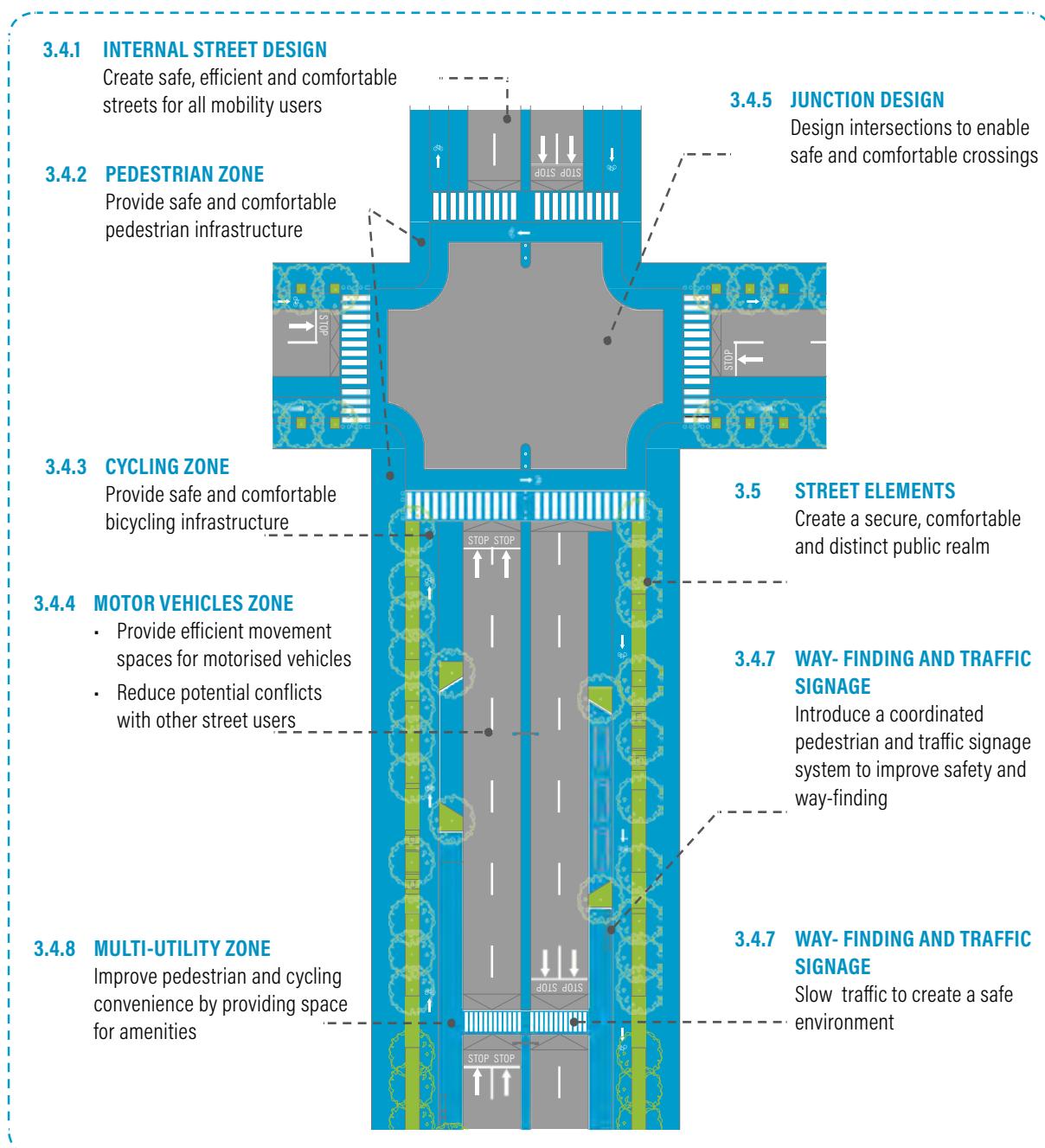
3.4 Complete Streets

'Complete streets' is a policy approach that recommends creating community streets that are safe for all users. This approach provides many benefits, including improved accessibility for non-motorised transport users, energy conservation and emission reductions, improved community liveability, improved health and fuel savings.

This section provides strategies and guidelines for designing complete streets with four zones—pedestrian, cycling, motor vehicles and multi-

utility – along with junction design, traffic calming features, traffic signage and way-finding signs.

This section also provides details on elements that form an integral part of street design, such as landscaping, storm water drainage, waiting areas and shelters, street lighting, street furniture and utilities. Complete street design is considered a necessary practice in every project thus case study observations are excluded in this section.



3.4.1 | INTERNAL STREET DESIGN

Description

Township streets are public circulation spaces that carry non-motorised and motorised traffic and provide access to abutting property. Streets are composed of elements such as pedestrian walkways, vehicle carriageways, bicycle lanes, building frontages, waiting and shelter areas and landscape features. A balance of all these elements is achieved through proper design of street right-of-ways with an emphasis on pedestrian accessibility, safety and comfort.



ILLUSTRATION SHOWING BALANCED STREET DESIGN;
IMAGE SOURCE: COMPLETE STREETS: PRINCE AVENUE, N.D.

Intent

Create safe, convenient and efficient circulation systems that facilitate safe mobility for pedestrians, cyclists, motorists and high-occupancy and shared vehicle users.

Relevance to Mobility Modes



Guidelines

Design Considerations

The guidelines for designing internal streets follow three fundamental criteria:

Safety and Efficiency

Ensure the safety of all street users without compromising the efficiency and functionality of street components. Address the needs of pedestrians and cyclists by incorporating safety features around residential areas, schools, intersections and other high-activity zones.

Universal Design

Accommodating the needs of all users, in particular vulnerable people with mobility and visual impairments, children, pregnant women and elderly people, are considered throughout these guidelines.

User Requirements

Balance the requirements of all users by understanding the space requirements for each mobility mode. The design priority for different user categories follows the Green Transport Hierarchy (See Step 4 in Chapter 2,), that is, pedestrians first, followed by cyclists and users of high occupancy vehicles such as shuttle buses and intermediate public transit such as auto-rickshaws, and finally motorists including delivery vehicles.

Related Topics



Cross Section Design

Street cross section design should consider:

1. Function of the street, which determines the required right-of-way;
2. Required vehicular throughput, which translates into the volume of traffic, the speed limit, and vehicular carriageway widths (See Section 3.3.1); and
3. Requirements of non-motorised users.

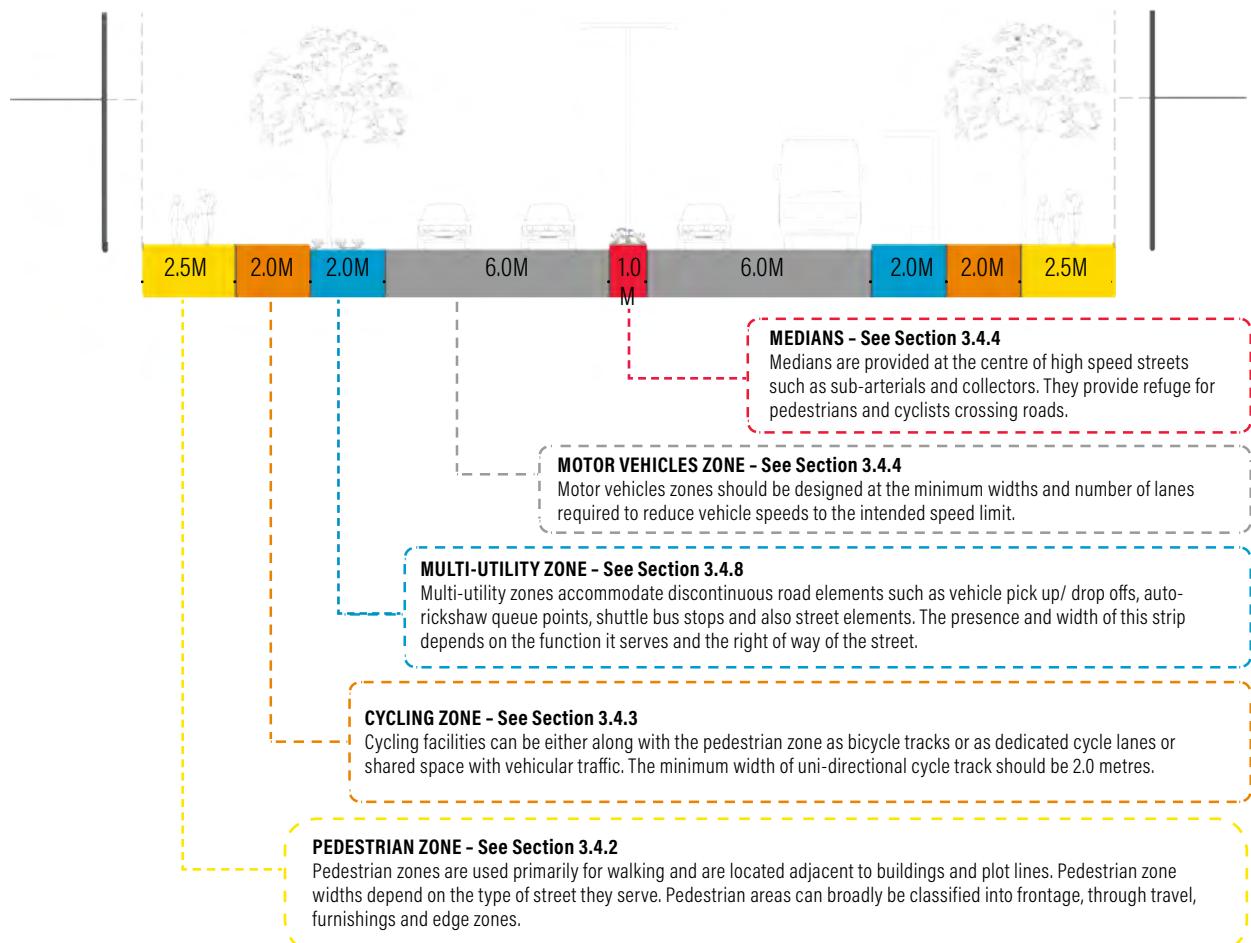
The following general guidelines should be considered while designing street sections:

- Separate pedestrians and vehicles, both physically and visually.
- Design neighbourhood streets for lower speeds than high-speed roads such as highways.

- Provide the minimum required number of vehicular lanes for each street type.
- Minimise the width of vehicle lanes on main streets, such as sub-arterials, to 3.3 metres (UTTIPEC, DDA 2009). Conventional road design manuals recommend a lane width of 3.5 metres, which is required for high vehicular speeds. However, collectors and local streets can be designed for lower speeds.
- Provide pedestrian footpaths along all streets in the development except service lanes.

A street section can be divided into zones with different functions and users. Figure 54 illustrates a 26-metre-wide right-of-way with zones for motor vehicles, utilities, cyclists and pedestrians .

Figure 54 | Division of a 26-metre-wide Collector Street Illustrating Different Zones



Preference Matrix for Street Design

Table 10 indicates the methodology of preparing a preference matrix for different street contexts (See Section 3.3.1) that includes various design

elements and their standard provisions. This matrix is suggestive and should be adapted to meet the requirements of each project.

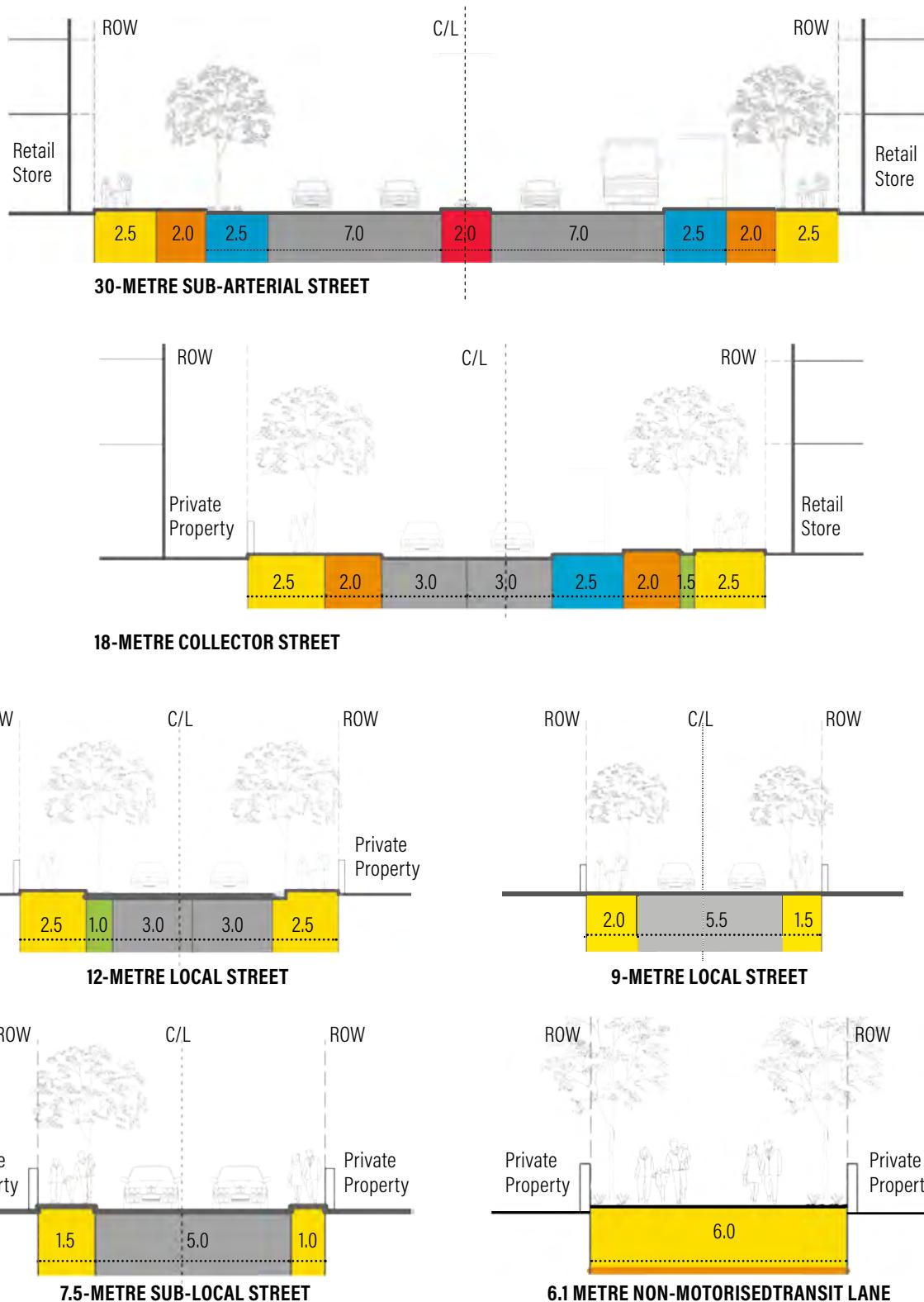
Table 10 | Suggestive Preference Matrix for Street Cross Section Design

	✓ Provided	✗ Not Provided	○ Shared Space	NA - Not Applicable					
STREET TYPE	SUB-ARTERIAL	COLLECTOR	LOCAL STREET	SUB-LOCAL STREET	NON-MOTORISED TRANSIT	ALLEY			
Right of Way Width (metres)	30.0	26.0	18.0	12.0	9.0	7.5	6.0	3.0	6.0
Primary Function	Mobility		Mobility + Access	Access		NMT Mobility + Access		Service Access	
Number of Dedicated Vehicle Lanes	2+2	2+2	1+1	1+1	○	○	✗	✗	○
Minimum Carriageway Width (metres)	3.3	3.3	3.0	3.0	5.5	4.5	✗	✗	3.0 clear
Median	✓	✓	✗	✗	✗	✗	✗	✗	✗
Active Street Frontage	✓	✓	✓	✓	✗	✗	✗	✗	✗
On-Street Parking	✓	✓	✓	✗	✓	✗	✗	✗	✓
Dedicated Footpath	✓	✓	✓	✓	✓	✓	✓	✓	✗
Minimum Footpath Width (metres)	2.5	2.5	2.0	2.0	1.8	1.8	3.0	3.0	NA
Dedicated Bicycle Route	✓	✓	✓	○	○	○	○	○	✗
On-Street Bicycle Parking	✓	✓	✓	✗	✗	✗	✗	✗	✗
Multi-Utility Zone	✓	✓	✓	✗	✗	✗	✗	✗	✗
Landscaping	✓	✓	✓	✓	✓	✓	✓	✓	✗
Waiting Area	✓	✓	✓	✗	✗	✗	✗	✗	✗
Pick Up / Drop Offs	✓	✓	✓	○	○	✗	✗	✗	✗

NMT = non-motorised transport.

Figure 55 | Suggested Sections for Streets of Different Widths

■ Footpath ■ Cycle Track ■ Landscape ■ Multi-Utility Zone ■ Carriageway ■ Median ■ ROW = right of way, C/L = Centre Line



3.4.2 | PEDESTRIAN ZONE

Description

Well-designed pedestrian facilities promote safe and comfortable pedestrian mobility, support activity along street edges and encourage opportunities for socialising. Because most trips start as pedestrian trips, it is crucial to design streets to be safe and comfortable for pedestrians. All pedestrian areas should meet the following general criteria.

- Be continuous and connected across the mobility network;
- Be present on both sides of the street;
- Have wide and unobstructed walking paths;
- Have clearly defined zones for walking, street furniture and building frontage;
- Have moderate grades and cross slopes;
- Have minimal changes in level;
- Have firm, stable, and slip-resistant surfaces; and
- Have good lighting.



IMAGE SOURCE: : CITY AND COUNTY OF SAN FRANCISCO, 2015

Intent

Create safe, comfortable and attractive walking environments for all pedestrians including people with mobility and visual impairments.

Related Topics



Relevance to Mobility Modes



Guidelines

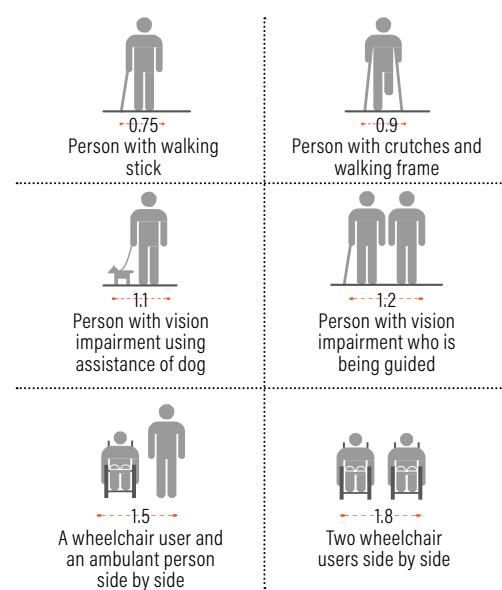
User Requirement

Pedestrians move more slowly than other forms of transport with speed profiles ranging from children walking at slower rates to adults walking briskly.

- Design safe and sheltered environments for different weather conditions.
- Locate proper, legible signage to guide pedestrians along travel routes.
- Avoid long pedestrian street crossings by providing curb extensions and median islands.
- Provide traffic-calming measures to reduce vehicle speeds and to create safer streets for pedestrians.
- Provide unobstructed travel routes and appropriate surface materials that are skid proof for walkways.

Design Speed Range: 1 to 3 kilometres per hour

Figure 56 | Design Dimensions for Pedestrians (in metres)



Source: IRC 103-2012

The design guidelines in this section were adapted from IRC 103-2012: Guidelines for Pedestrian Facilities Standards.

Pedestrian Sub-Zones

The pedestrian realm along streets should be divided into the following sub-zones:

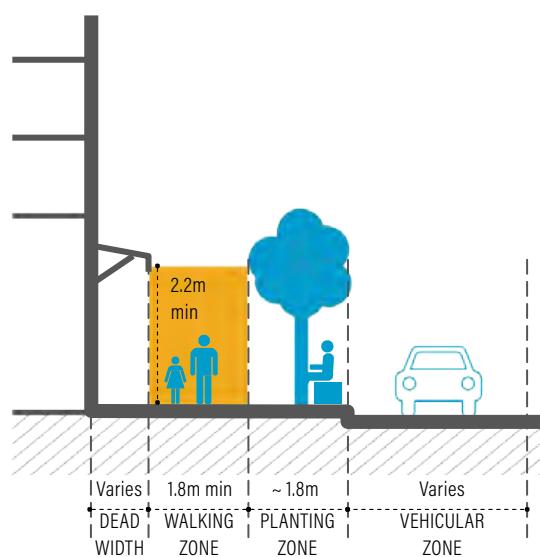
- **Frontage zone or ‘dead width’** - the space abutting building edges or property lines and used to access the street, place planters or displays in retail areas. A minimum width of 0.5 metre is recommended, but in commercial or high-activity areas, this width is increased to 1 metre. Any difference in levels between buildings and the street is to be addressed by steps or ramps within the building.
- **Clear walking zone:** A space unobstructed vertically and horizontally makes up the clear walking zone. Pedestrian paths should be at least 1.8 metres wide to accommodate people with mobility or visual impairments. A clear height of 2.2 metres is maintained for the entire width of the walking zone (Figure 57). The width of the walking zone is a function of the land use adjacent to it. Table 11 indicates the recommended widths for different types of street uses.
- **Furnishing zone:** Furnishing zones are buffer areas between fast-moving vehicles and slow-moving pedestrians and cyclists. This zone can incorporate elements of the multi-utility zone described in Section 3.4.8. They include elements like street furniture, bus stops, utility boxes, fire hydrants and landscape features. IRC 103-2012 recommends a minimum of 1.8 metres.

Table 11 | Recommended Width of Footpath as per Adjacent Land Use

LAND USE	WIDTH (METRES)
Residential / Mixed-Use Areas	1.8
Commercial / Mixed-Use Areas	2.5
Retail Frontages	3.5 - 4.5
Bus Stops	3.0
High Intensity Commercial Areas	4.0

Source: IRC 103-2012

Figure 57 | Sub-Zones Within the Pedestrian Realm



CLEAR WALKING ZONE

Obstruction-Free Minimum Walking Zone shall be 1.8 X 2.2 metres - both horizontally and vertically.

No utility ducts, utility poles, electric, water or telecom boxes, trees, signage or any kind of obstruction should be placed within the walking zone.

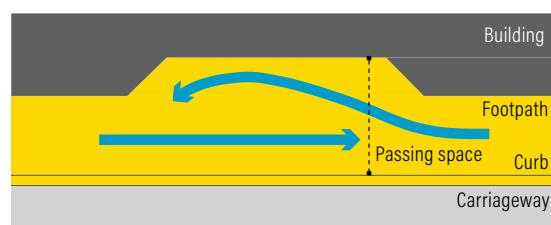
Adapted from IRC 103-2012

Figure 58 | Pedestrian Zone Guidelines

Narrow Footpath Considerations

Footpaths located along narrow residential streets can be less than 1.8 metres.

- Avoid locating any obstacles including street elements such as trash receptacles, landscape and utility objects along such narrow footpaths.
- Provide passing spaces at a minimum of 60-metre intervals to facilitate crossing for bi-directional pedestrian traffic.

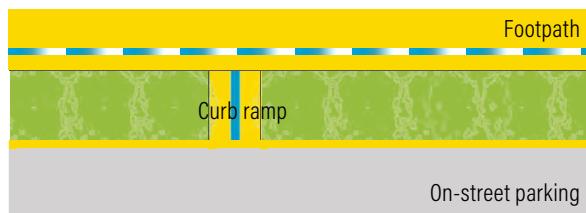


Adapted from IRC 103-2012

Curbs

Curbs are borders of footpaths immediately adjacent to the carriageway. Curbs discourage motorists from encroaching onto the pedestrian realm and also prevent excess water from collecting along the footpath.

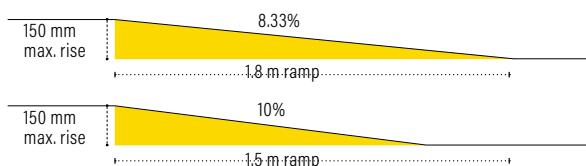
- They should be a maximum height of 150 millimetres to enable pedestrians to step onto the carriageway or on-street parking areas.
- If on-street parking is provided, periodic curb ramps along the planting strip in the multi-utility zone can facilitate pedestrian access onto the footpath.



Curb Ramps

Curb ramps facilitate pedestrian accessibility at elevated walkway edges such as street junctions and mid-block crossings.

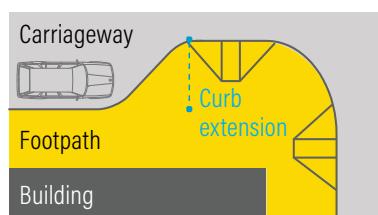
- Curb ramps should be provided at slopes of 1:12 where possible, and should not exceed slopes of 1:10 in areas with space constraints.
- The low end of the curb ramp should be designed so it meets the street grade with a smooth transition.



Curb Extensions

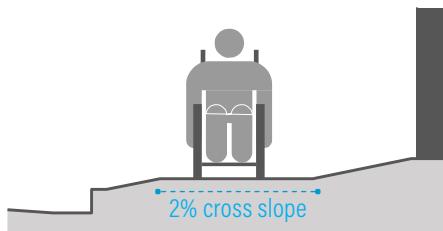
Curb extensions are bulb-outs that improve pedestrian visibility and provide additional space for level landings at curb ramps.

- Curb ramps should be aligned at all junction areas in each direction of crossing.



Grades and Cross Slopes

- Provide a maximum longitudinal grade of 1:20 along footpaths. Steeper areas require ramps with levelled rest areas at frequent intervals especially for pedestrians with mobility impairments. Ramp slopes must not exceed 1:12 grade.
- Cross slopes should be provided only when absolutely necessary for drainage purposes and should not exceed 1:50 slope in any direction to allow smooth and safe circulation for wheelchair users. Where building entrances are at a higher level than the street realm, rest areas should be provided to allow seamless movement between elevations.



Access to Properties

- Building and property access should be designed to ensure that pedestrians have the right of way over vehicles. Vehicle ramps should be provided in the multi-utility strip or inside property lines, and not in the area of through pedestrian movement.
- Textured surfaces should be provided to warn visually impaired people about an upcoming crossing.

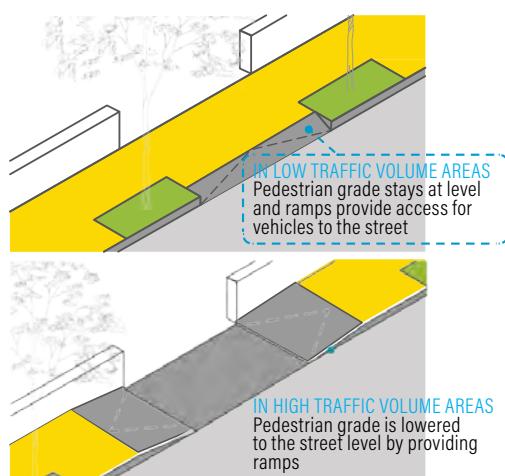


Image Source: : ITDP, 2011

Pedestrian Crossings

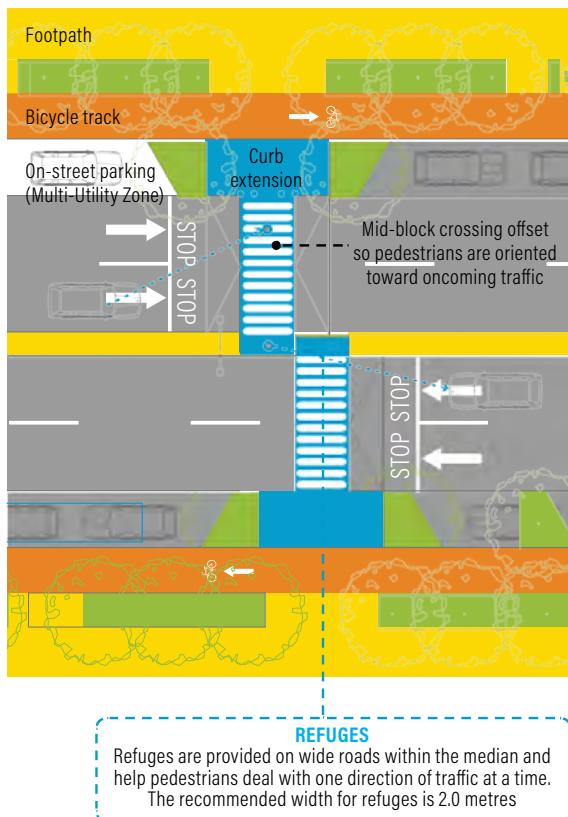
Pedestrian crossings should be introduced at junctions and mid-blocks to ensure safety.

- Crossings should be designed at-grade with the footpath, particularly in pedestrian priority areas. The crossing should have a minimum width of 3 metres and include universal accessibility features and directional signage.

Mid-block crossings

Locate mid-block crossings based on pedestrian movement, building entrances and bus stop locations.

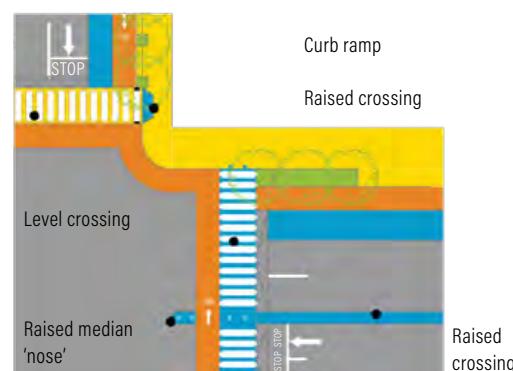
- Mid-block crossings should be located every 80–250 metres in residential areas and every 80–150 metres in commercial and mixed-use areas.
- On streets with multi-utility zones and on-street parking, provide curb extensions to allow better visibility for motorists and pedestrians.
- Offsetting midblock crossings forces pedestrians to turn towards oncoming traffic at the median, thus making eye contact with traffic and potentially reducing accidents.



Crossings at intersections

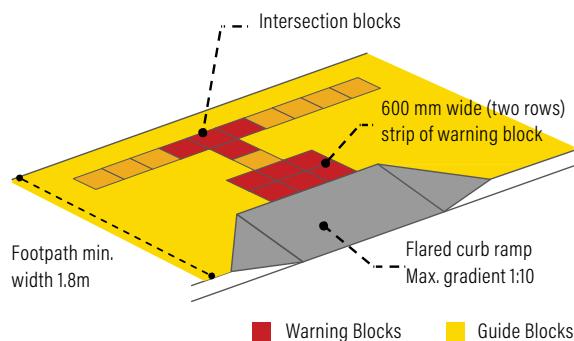
Place crossings in line with the adjoining walkway or curb ramp.

- Raised street crossings should be at the same level as the pedestrian walkway.
- Ramps for motor vehicles should be at minimum slopes of 1:4. These can be used in busy areas with high traffic volumes.
- Vehicle stop lines should be marked 3 metres ahead of the crossings.
- The tips of the medians should be extended past crossings to be in line with the adjacent footpath at junctions.



Surface Material Treatment

- Use all-weather pavement surfaces that are firm, stable and slip-resistant to allow seamless movement across level changes. Paver blocks should be laid evenly so that gaps between blocks are not greater than 5 millimetres.
- Tactile pavers that guide visually impaired people in pedestrian areas should have a colour and texture that contrasts with the surrounding surface. They should be placed 600 millimetres from the pavement edge, boundary wall or any obstruction to enable the visually impaired to navigate.



Images Source: : IRC 103-2012

3.4.3 | CYCLING ZONE

Description

Cycling is a sustainable means of transport that can be adopted by anybody if proper infrastructure and facilities are available. Designing for cyclists includes providing cycling paths that are continuous, connected, unobstructed and not encroached by vehicles, pedestrians or utilities. These paths can be physically separated from main vehicular paths to ensure safety and comfort to cyclists.

All cycling areas should meet the following general criteria:

- Be on both sides of the street;
- Be wide and unobstructed;
- Have rest areas at intermediate intervals;
- Provide moderate grades and cross slopes;
- Have minimal changes in level;
- Have firm, stable, and smooth surfaces; and
- Have good lighting.



IMAGE SOURCE: BRT_DELHI/FLICKR

Intent

Create safe, comfortable and attractive cycling environments for cyclists that include essential facilities and infrastructure provisions.

Related Topics



Relevance to Mobility Modes



Guidelines

User Requirement

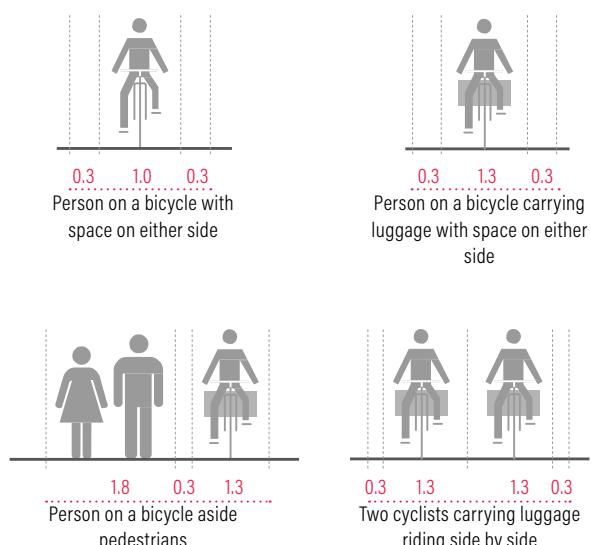
Provide either:

- Dedicated cycle tracks at the same grade as pedestrian zones in high activity areas;
- Dedicated cycle lanes in high-volume streets with less space where cyclists are at grade with motorists; or
- Shared space with motorists on the carriage-way in low-speed streets at the same grade as motorists.

Provide cycling amenities such as secure parking areas, waiting shelters and unobstructed travel paths. Providing higher quality facilities will encourage additional ridership.

Design Speed Range: 5 to 20 kilometres per hour

Figure 59 | Design Dimensions for Cyclists (in metres)



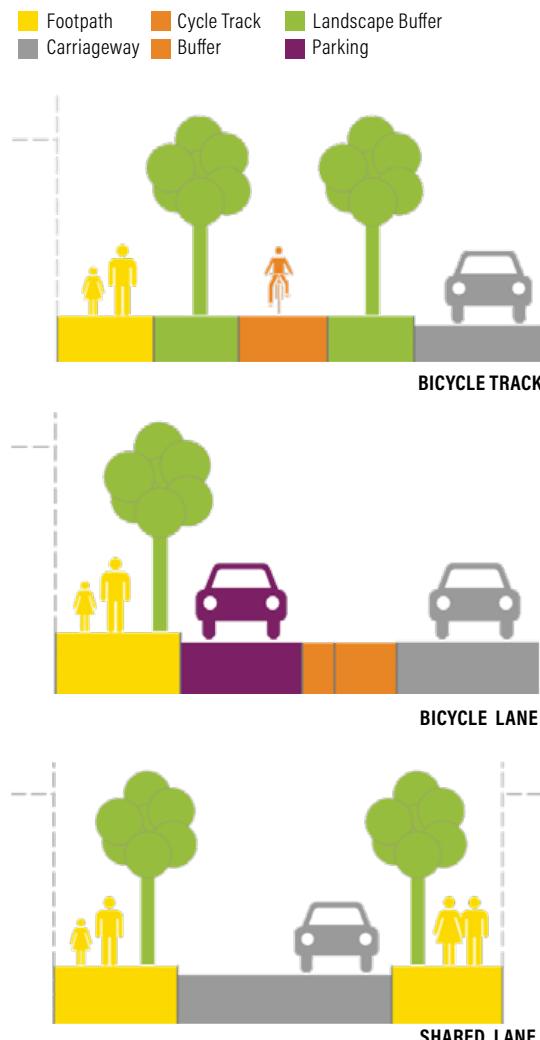
Source: Abu Dhabi Urban Planning Council (UPC), 2010

Bicycle Facility Types

The type of cycle facility needed on a particular street depends on the street type, the vehicular speed, the traffic volume and the available width along the street. Three types of facilities can be provided for cyclists:

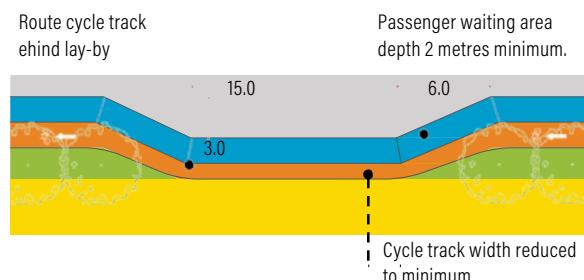
- **Bicycle Track:** A facility that is reserved for cyclists and separated from motor vehicle traffic by a buffered space. It is usually grade-separated from vehicle carriageways and can be at-grade with the pedestrian zone. It is a continuous path along the pedestrian network and should be routed behind the bus stop area and pick up/drop off and lay-by spaces (Figure 61).
- **Bicycle Lane:** A lane reserved for cyclists at the same grade as the carriageway. This lane includes buffer spaces from on-street parking and travel lanes to discourage drivers from entering onto the bicycle lane. When locating the bicycle lane adjacent to on-street parking, reduce the parking lane to the minimum required width to encourage motorists to park close to the curb.
- **Shared Lane:** In low-vehicle-volume and speed areas, bicycles can share space with motorists. The widths of such shared space must be a minimum of 3.6 metres. Cyclists can also share space with pedestrians in low-density areas.

Figure 60 | Different Types of Bicycle Facilities



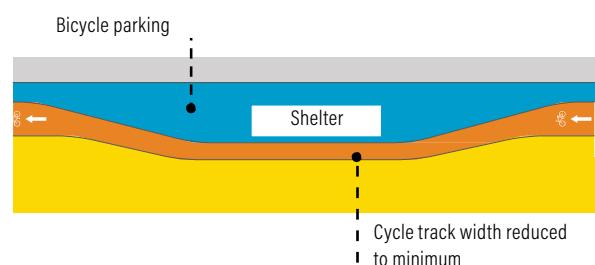
Source: Abu Dhabi Urban Planning Council , 2010

Figure 61 | Continuous Cycling Facilities around Pick Up / Drop Offs and Bus Shelters



TAXI AND PRIVATE VEHICLE PICK UP / DROP OFF LAY-BY

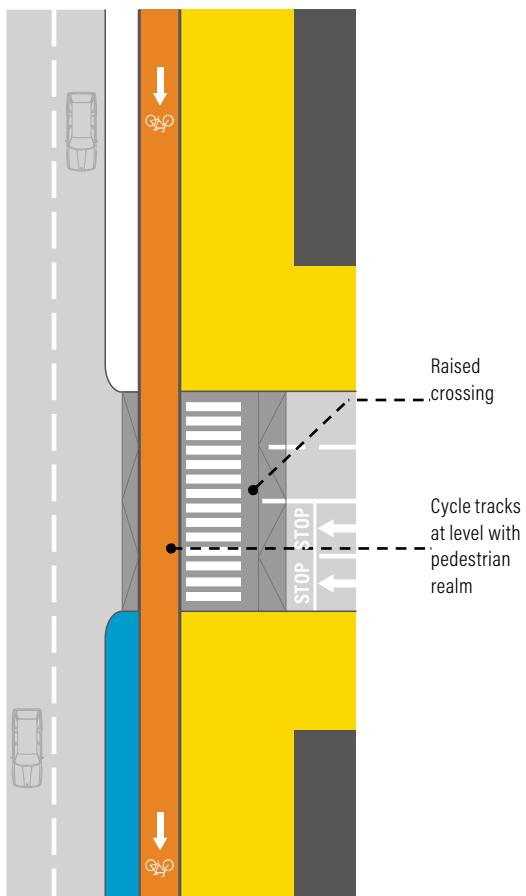
Source: Abu Dhabi Urban Planning Council , 2010



TYPICAL BUS STOP ALONG MAIN STREETS

Bicycle Facility Design

- Design one-way bicycle paths to be at least 2 metres wide one-way. If a bi-directional bicycle path is provided on only one side of the street, the minimum width should be 3.5 metres.
- Provide a smooth surface made of asphalt or concrete for the track and avoid using paver blocks.
- Highlight bicycle facilities with a separate colour especially at junctions and other conflict zones.
- Avoid routing cycle paths over covers for manholes and inspection chambers. If unavoidable, make sure the covers are at the same level as the path.
- Provide shading for cycle paths through well-designed tree cover.
- If the cycle path and carriageway are at the same grade, provide a minimum buffer of 0.5 metre between the two areas.
- Maintain the same level as pedestrian paths at access to properties and buildings.



CONTINUOUS CYCLE TRACKS AT MINOR JUNCTIONS

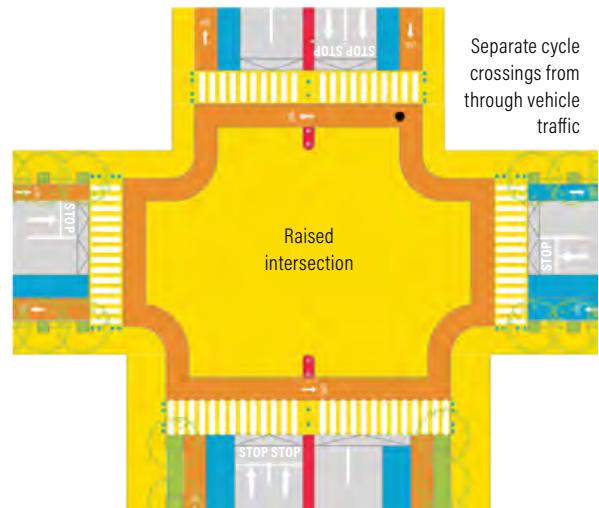
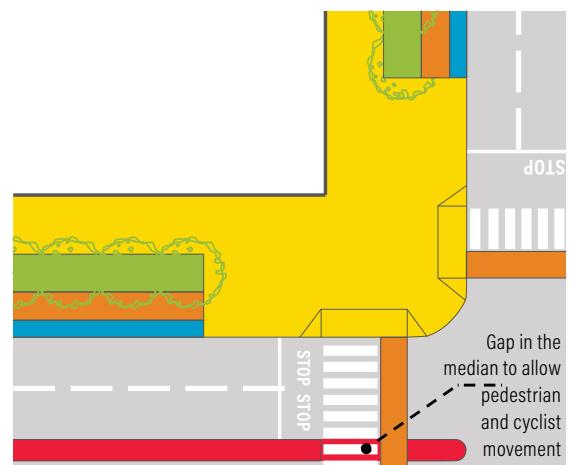
Junction Design

At major and minor junctions, make the following provisions for bicyclists:

- Provide continuous cycle tracks through access ways and minor junctions.
- Switch from a lane format to a track where possible, to accommodate the changing conditions of the street.
- Separate cycle crossings from through-vehicle traffic at main junctions.
- Design crossings with a minimum width of 2 metres to accommodate cyclists.

Figure 62 | **Cycling Zone Guidelines**

Legend:
Yellow square: Footpath
Orange square: Cycle Track
Blue square: Multi-Utility Zone
Green square: Landscape Buffer
Grey square: Carriageway
Red square: Median



CONTINUOUS CYCLE TRACKS AT MAIN INTERSECTIONS

Source: Abu Dhabi Urban Planning Council (UPC), 2010

Bicycle Parking

Designing parking for bicycles is not mandated in building regulations and no standards are provided to calculate the number of bicycle parking bays required. Table 12 provides minimum standards for bicycle parking for different building uses. Also consider that large townships have a fair number of service staff accessing the site by bicycle.

Table 12 | **Typical Minimum Bicycle Parking Supply Standards**

TYPE OF ESTABLISHMENT	MINIMUM NUMBER OF BICYCLE PARKING SPACES
Primary or secondary school	10 percent of the number of students, plus 3 percent of the number of employees
College or university classrooms	6 percent of the number of students, plus 3 percent of the number of employees
Commercial – retail or office	One space per 250-300 square metres of commercial space
Sport and recreation centre	10-20 percent of the design quality of number of visitors and employees (depending on the type of sport)
Movie theatre or restaurant	5-10 percent of the number of seats plus employees
Industrial	5-10 percent of the number of employees
Multi-unit housing	1 space per 1-2 apartments
Public transit stations	Varies, depending on usage

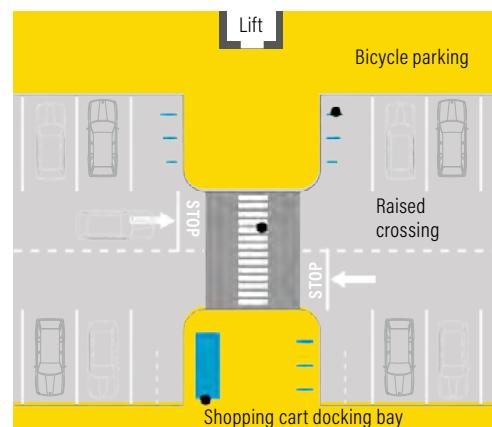
Source: T. Litman, Online TDM Encyclopedia

Additional Amenities and Racks

- Provide storage and lockers for equipment such as clothing, helmet, gloves and shoes.
- Ensure that bicycle racks are durable and securely anchored to the ground. They should be designed so that at least one wheel and the frame can be locked.

Long-Term Bicycle Parking (for Residents and Employees)

- Long-term parking spaces are indoors or in sheltered areas that are easily accessible by cyclists.
- If located within motorised vehicle parking spaces, the bicycle parking area should be situated closer to service cores.



PARKING IN BASEMENT SERVICE CORE

- Design bicycle parking and access with different surface materials and adequate lighting, locking systems and surveillance by building security personnel.
- Secure cycle racks to the ground or to the wall to prevent theft or vandalism.

Short-Term Bicycle Parking (around Shopping, Recreation and for Deliveries or Couriers)

- Locate short-term bicycle parking spots near buildings 15–20 metres from the entrance.



- Ensure that the parking spots are weather-protected. They can be located under canopies, building overhangs or close to the building edges.
- Design the parking area with sufficient illumination and signage.
- Secure parking racks to the ground and incorporate vandal-resistant features to prevent theft or damage to the bicycles.

3.4.4 | MOTOR VEHICLE ZONE

Description

Carriageway, the space motor vehicles occupy on streets, is used for all types of vehicles including public transport, intermediate transport modes and private two and four-wheeled vehicles.



MAIN STREETS; IMAGE SOURCE: FBT ARCHITECTS, N.D.



ALLEY LANES; IMAGE SOURCE: SOCIAL MEDIA TODAY LLC, 2013

Intent

Create efficient movement spaces for motorised vehicles reducing potential conflicts with other street users

Relevance to Mobility Modes



Guidelines

User Requirements

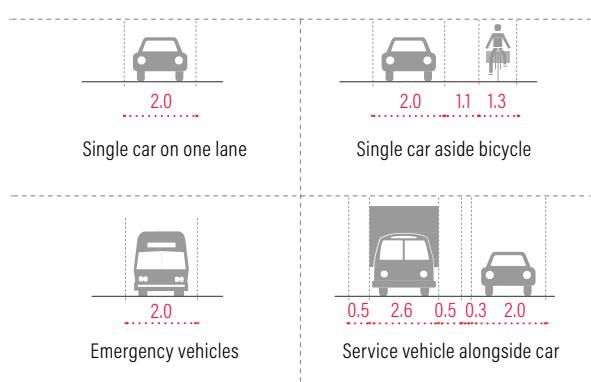
Private Motorists: Design for lower vehicle speeds in residential areas to enable safe walkable environments.

Emergency Vehicles: Emergency vehicles, which are required to serve developments occasionally, are not accounted for in the main vehicle standards used for street design. A network that provides emergency access to all buildings and unhindered approaches along narrow streets should be considered during the design phase.

Service Vehicles: Mixed-use developments and commercial areas require delivery of goods and services at certain times of the day. Street design should accommodate sufficient area for loading/unloading of goods, vehicle turning radius and temporary parking.

Design Speed Range: 15 to 40 kilometres per hour

Figure 63 | Design Dimensions for Motorists (in metres)



SOURCE: ADAPTED FROM ABU DHABI URBAN PLANNING COUNCIL , 2010

Related Topics



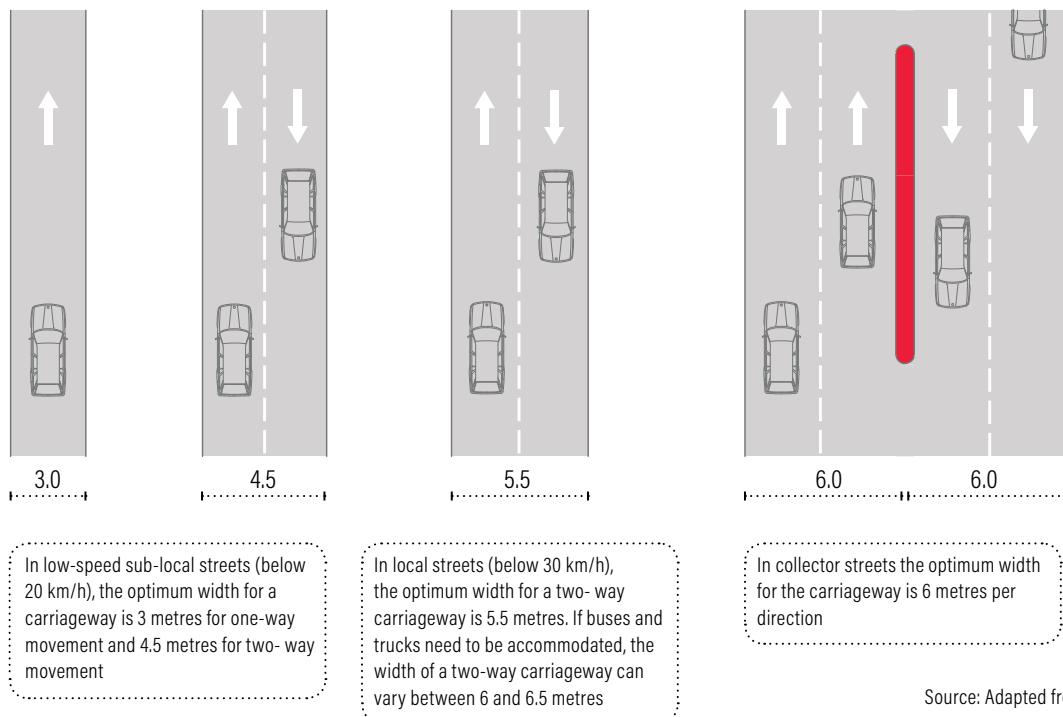
Carriageway Design

- Design carriageway lane width based on the street function and the adjacent land uses, not the available right-of-way (see Section 3.3.1).
- Maintain a constant carriageway width along

the entire length of the street and adjust lane widths in the pedestrian realm if necessary .

- Limit frequency of access points to properties to reduce conflict points for non-motorised transport users.

Figure 64 | Carriageway Widths for Different Streets in a Neighbourhood (in metres)

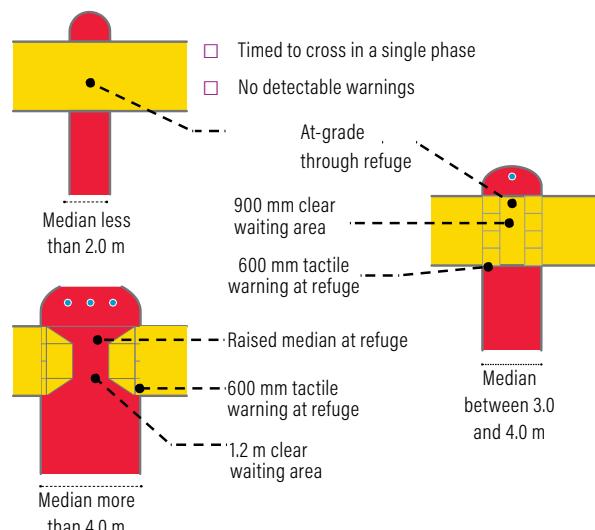


Medians

Medians divide the carriageway and are used typically to separate different directional traffic flows. They also provide refuge to pedestrians and cyclists crossing the street and must be of minimal width.

- In high non-motorised transport priority areas, medians should have a minimum width of 2 metres to accommodate cyclists waiting at the refuge areas.
- Provide sufficient breaks in medians to allow for pedestrian street crossings along important pedestrian routes.
- Avoid placing vertical elements such as trees, lighting poles and banners on medians at intersections to allow clear sight lines for motorists.
- Avoid guardrails and high curbs on medians along neighbourhood streets.

Figure 65 | Median Design for Various Street Widths



Source: Adapted from Street Design Guidelines UTTIPEC, DDA 2009

3.4.5 | JUNCTION DESIGN

Description

Junctions are street intersections where all mobility modes share space. They should be compact, designed for low speeds, and safe for all users.



RAISED INTERSECTION;
IMAGE SOURCE: LANDSCAPE ONLINE, 2015



IMAGE SOURCE: NACTO, 2015

Intent

Create compact, comfortable and efficient junctions that prioritise safety and throughput of vehicles, public transit users and non-motorised transport users.

Related Topics

3.3.1 Connected Street Network (p.74)

3.3.3 Pedestrian and Cycling Network (p.82)

3.4.1 Internal Street Design (p.90)

Junction Design

3.4.6 Traffic Calming (p.106)

Relevance to Mobility Modes

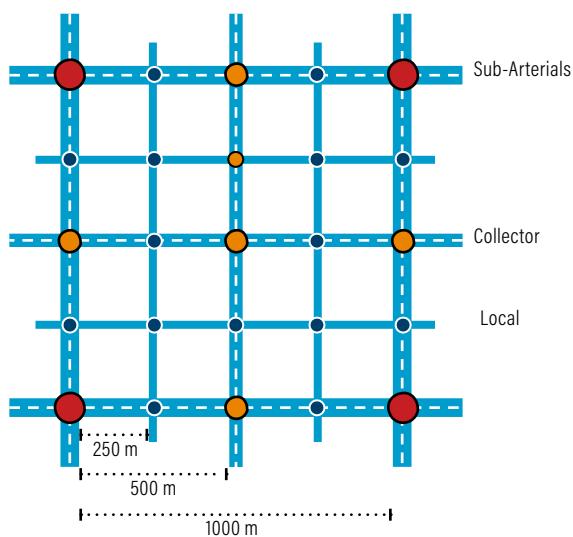


Guidelines

Junction Spacing

Street junctions should be spaced to allow street networks to work efficiently. Spacing junctions too close to one another may cause traffic to queue up, particularly if sufficient queuing space is not provided. If junctions are located too far apart from one another, there may be insufficient connectivity within the network thus reducing the efficiency of the overall network.

Figure 66 | Spacing of Junctions along Different Types of Streets



● Major junctions ● Semi-major junctions ● Minor junctions

The recommended dimensions for different street spacing is as follows:

- Major junctions - between sub-arterials: 1,000 metres
- Semi-major junctions - between sub-arterial and collectors: 500 metres
- Minor junctions - between sub-arterial and locals: 250 metres
- Minor junctions - between collector and locals: 250 metres

Source: Adapted from Abu Dhabi Urban Planning Council (UPC), 2010

Design of Junctions

- Avoid extreme angles and complex junction profiles. Figure 67 shows some common and suitable junction types.
- Adopt design practices that accommodate vulnerable users such as pedestrians first and least vulnerable users such as vehicles last.
- Encourage compact junction designs to reduce excess movement space for vehicles.
- Design junctions to reduce conflicts between different modes that share the same space at the same time.
- Provide proper visibility along junctions, especially between pedestrians and motorists.
- Reduce crossing distance and duration to minimise pedestrian exposure from moving vehicles.
- Provide direct paths for pedestrians with minimal deviation and adequate shading at waiting areas.

Figure 67 | Common Junction Types

TYPE	NOTES
	Rectilinear junction 75 - 90° angle
	T - Junction 75 - 90° angle
	Offset junction bend minor streets to create junction max. 150° angle, otherwise separate into two junctions (possibly with one signal control)
	Y - junction bend minor street max 150° angle
	Angle junction treat as two Y - junctions
	Rectilinear junction with extra legs separate extra legs into right-in, right-out junctions
	Roundabout multi-arm, yield to circulating traffic

Source: Adapted from Abu Dhabi Urban Planning Council (UPC), 2010

Sight Lines

- Provide curb extensions and restrict parking near crossings to improve visibility between pedestrians and motorists.
- Avoid any visual obstacles to motorists, cyclists and pedestrians at junctions.

Corner and Turning Radii

Corner radius is the actual dimension of the curb and turning radius is the effective dimension of the motor vehicle while turning (IRC 103-2012).

- A 4-metre radius is appropriate for streets that cater to light motor vehicles.
- Design speed for vehicles at turnings must not be more than 15 kilometres per hour.
- Additional space requirements should be required in streets accommodating larger vehicles, for example buses, to accommodate their turning radii.

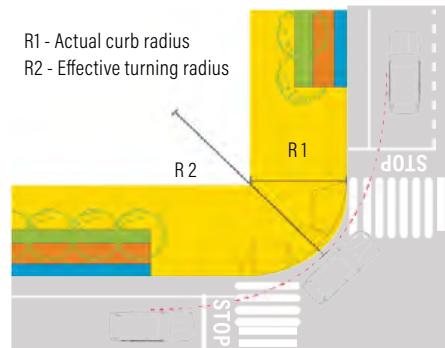


Image Source: Abu Dhabi Urban Planning Council (UPC), 2010

Left Turn Lanes

Left turns, if not properly designed, can deter pedestrian safety. Conventional turns allow faster moving vehicles and are unsafe for pedestrians.

- Left turns should be provided with no dedicated lanes and tight curb radii.
- If dedicated left turn pockets are provided, designed turns should incorporate a 30° angle of approach to reduce vehicle speeds.

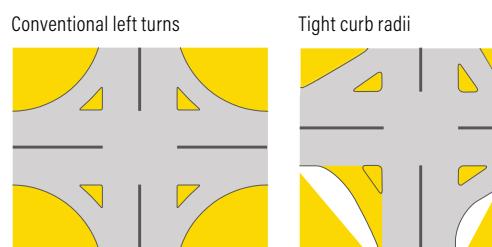


Image Source: ITDP 2011

3.4.6 | TRAFFIC CALMING

Description

Traffic calming is a combination of street design and management measures to slow motor vehicle traffic through vertical or horizontal displacements, real or perceived narrowing of the carriageway or changes in surface material or colour. Such self-enforcing elements compel drivers to slow down to desired speed limits for their own safety and to improve street conditions for pedestrians and cyclists.

Adopt traffic calming measures after consultation with transportation experts who are familiar with traffic calming strategies and should be involved in the planning and implementation phase of the project.

Relevance to Mobility Modes



Guidelines

- Consider adopting a variety of traffic calming measures rather than relying on a single type, such as speed tables (Table 13).
- Apart from controlling traffic speed, traffic calming measures should enhance street aesthetics and improve walking and cycling conditions.

Figure 68 | Different Types of Traffic Calming Measures

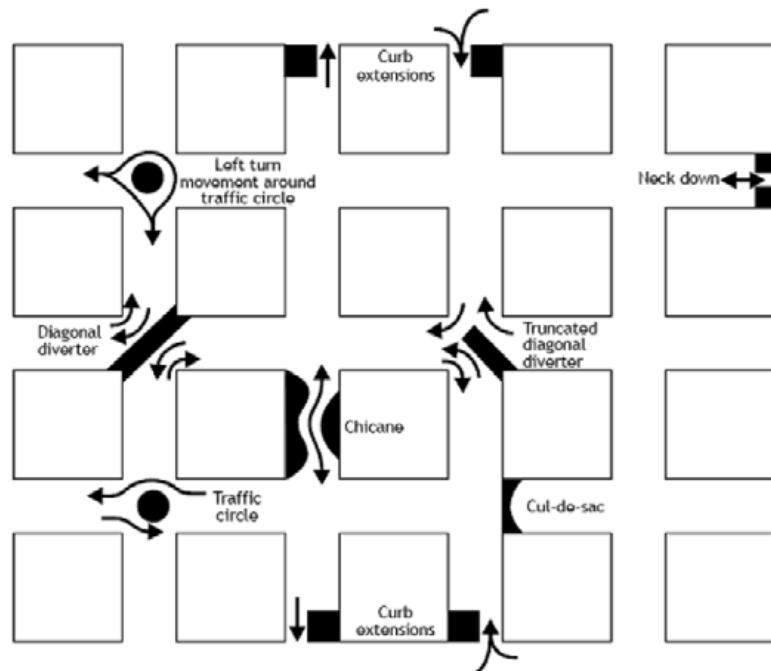


IMAGE SOURCE: U.S. DEPARTMENT OF TRANSPORTATION, N.D.

Intent

Ensure safety of non-motorised and motorised transport users by reducing vehicle speeds.

Related Topics

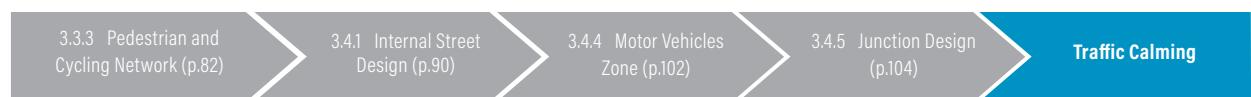


Table 13 | **Traffic Calming Measures**

Vertical Displacement Measures

SPEED HUMPS

Speed humps are rounded raised areas placed across the roadway.



Image Source: Cheap Safety, 2011

SPEED TABLES

Speed tables are ramped, flat-topped speed humps, 75-100mm high, long enough for the entire wheelbase of a vehicle to rest on the flat surface.



Image Source: Miller Micro Computer Services, 2014

RAISED CROSSINGS

Raised crossings are marked pedestrian crossings located at mid-blocks or at intersections, built to curb height.



Image Source: streetsblog sf, n.d.

RAISED INTERSECTIONS

Raised intersections are speed tables constructed across the entire junction that calm two streets at once.



Image Source: Smith Planning Group. n.d.

Horizontal Displacement Measures

CURB EXTENSIONS

Curb extensions are horizontal bulb-outs into the carriageway, primarily used to narrow traffic lanes and reduce pedestrian crossing distances.



Image Source: Hoboken City Hall, 2015

CHICANES

Chicanes are a series of curb extensions on alternating sides of the carriageway, used to reduce road width.



Image Source: Bicycle Outreach and Planning, 2015

CORNER RADII REDUCTIONS

Corner radii reductions reduce turning speeds for vehicles and crossing distance for pedestrians.



Image Source: Fansided, 2011

TRAFFIC CIRCLES

Traffic circles are raised islands at the centre of intersections that require traffic to move around in a clockwise direction.



Image Source: EG Neighborhood Council, 2015

3.4.7 | SIGNAGE AND WAY-FINDING

Description

Signage and way-finding elements assist users in navigating through the township safely and efficiently. A hierarchy of consistent signage can guide users along different points in the development.

Relevance to Mobility Modes



Guidelines

Sign Types

Establish a clear hierarchy for signage placement along different points in the development. Based on their functions, signs can be broadly categorised into five types as shown in Table 14.

Table 14 | **Types of Signage Based on Functions**

TYPE OF SIGNAGE	CHARACTERISTIC	USERS	PLACEMENT
Identification signs	Highlight special areas and orient people to locations	Pedestrians, vehicles, bicyclists, complementary mobility users such as rideshare and shuttle service users	Within the pedestrian zone edge
Direction signs	Direct people towards destinations	Vehicles	Within the median or pedestrian zone edge but can span over carriageway
		Pedestrians / cyclists zone edge	Multi-utility zone or pedestrian
Information signs	Provide detailed information on parking, location, landmark characteristics, hours of operation, etc.	Pedestrian / cyclists zone edge	Multi-utility zone or pedestrian
Regulation signs	Provide information primarily on traffic and pedestrian regulations	All street use	Multi-utility zone or pedestrian zone edge
Cautionary signs	Provide speedlimits, do's and don'ts along streets and against impending conflict	Vehicles, pedestrians, cyclists	Multi-utility zone or pedestrian zone edge

Source: Abu Dhabi Urban Planning Council (UPC), 2010

Intent

Provide coordinated and legible guiding signs that efficiently aid pedestrians and vehicles into and within the development.

- Signage should be provided in multiple languages as needed..
- Ensure a simple and unified visual language for all non-traffic signage paying attention to material type, colour and location.

Related Topics



Signage Placement

- Ensure that the placement of signage and way-finding elements do not cause physical or visual obstruction to pedestrian and cycling routes and at intersections.
- Provide signage at key intersections, waiting areas, and access points to highlight and define pedestrian and cycling routes (Figure 69).

Figure 69 | Signage and Way-finding

Site Access / Entrance

- Provide clear, visible and easy-to-understand maps at site entrances and along approach roads. This allows motorists and non-motorised users to orient themselves before entering the development.
- Provide separate signage and way-finding maps indicating the specific routes for each mode along the site. Size and scale of the signage should vary depending on the user – pedestrian and cyclist signage should be closer to users than vehicle signage.



Waiting Areas

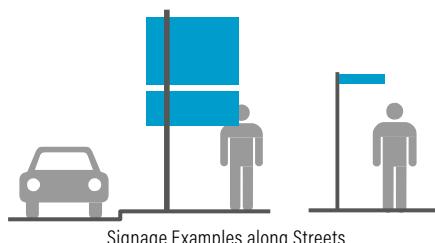
- Provide directional signs to guide users towards the nearest waiting area or shelter. Informational signage can be combined with other street elements such as seating areas and light poles to reduce space requirements.



Waiting Area Signage Examples

Signage along street

- Provide simple and clear directional signs that does not confuse the user. The signs should be placed at an appropriate height for both pedestrians and vehicle users.



Signage Examples along Streets

Parking Area Signage

- Provide way-finding signs to guide cyclists and motorists towards appropriate parking areas.
- Provide distinct signage for separate parking facilities such as parking for visitors, short-term, physically impaired people or carpools.
- Provide signs that direct motorists to parking areas at frequent intervals so motorist do not have to cruise around looking for parking, wasting fuel and time and possibly driving while distracted.

Traffic Signage

- Provide clear and legible regulatory signs at correct heights and angles for driver visibility. They should be maintained, updated and replaced at regular intervals.
- Provide traffic signs that conform to the visual language maintained by the municipality and traffic departments.

3.4.8 | MULTI-UTILITY ZONE

Description

Street design includes elements such as street furniture and landscaping, which can cause safety concerns if placed in pedestrian or vehicular space.

The Multi-utility zone (MUZ) is a continuous strip usually provided along major streets to accommodate all discontinuous street elements. This zone can be used for varying purposes along the length of the street but its continuous presence ensures that there is adequate space to accommodate all street elements without infringing on the space of other street users.



Image Source: Streets.mn, n.d.

Intent

Provide adequate space that accommodates various discontinuous street elements to improve the convenience and comfort of the street user.

Relevance to Mobility Modes



Guidelines

According to IRC 103-2012, MUZs should be a minimum of 1.8 metres wide to accommodate any or all of the following elements:

- Landscape including tree planting for shade and storm water management,
- Signage and way-finding elements,
- Street furniture and street lighting,
- Parking for auto-rickshaws, motor vehicles, bicycles, and
- Bus shelters and waiting areas for pick ups and drop offs.

Guidelines for these elements are discussed in detail in Section 3.5.

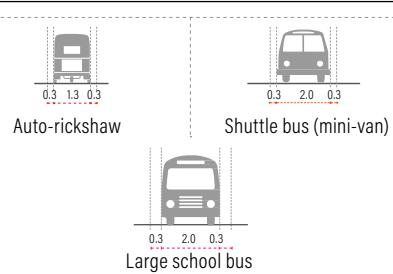
User Requirements

Intermediate transit includes private high-occupancy vehicles such as shuttle buses or public transport such as auto-rickshaws and taxis.

- Provide pedestrian-friendly transit stops to encourage use of the system.
- Design appropriate waiting areas that are sheltered, secure and safe to access these stops.

Design Speed Range: 15 to 40 kilometres per hour

Figure 70 | **Design Dimensions for Auto-rickshaw, School Bus and Small Shuttle Bus (in metres)**



Source: Adapted from Rickshaw Challenge, 2014 and Toyatech, n.d.

Related Topics



3.5 | COMPLETE STREET ELEMENTS

Complete streets require the provision and placement of essential elements for an attractive, efficient and safe street realm for all mobility users. The elements described in this section are shown in Figure 71. These guidelines are adapted from Street Design Guidelines by UTTIPEC, 2010, Better Streets, Better Cities by ITDP, 2011 and Safe Access Manual by EMBARQ, 2015

Relevance to Mobility Modes



Figure 71 | Street Elements Described in the Guidebook



Image Source: Philadelphia Streets, 2013

Related Topics

3.3.2 Open Space Network (p.78)

3.3.3 Pedestrian and Cycling Network (p.82)

3.4.1 Internal Street Design (p.90)

3.4.8 Multi-Utility Zone (p.110)

Street Elements

A. Landscaping

This section provides guidelines on incorporating landscape elements in street design.

Plant Selection

- Select plants according to the climate of the region. Native plants consume moderate water, influence the microclimate of the site and do not require extensive care and maintenance.
- Avoid choosing plants that are invasive, gaseous, thorny or toxic, or drop messy fruits that dirty the streetscape.
- Choose shade trees that have an upright growth pattern. The tree branches should be above 3 metres to allow visibility.
- One-metre-high plants should be used in areas where open sight lines are preferred, for example, at intersections.

Plant Placement and Location

- Place plants so they do not interfere with pedestrians or bicycling traffic.
- Group plants with similar water requirements.
- Ensure that the root structure of the plant does not interfere with the placement of underground utility lines. Where shallow utility lines are present, plants can be placed in movable planter boxes.
- Space trees appropriately to ensure continuous shade. The spacing depends on the tree's canopy size and shape and the sun path direction throughout the year.

Tree Pits

Tree pits provide the essential area for roots to spread and can be provided as individual or

connected elements.

- The recommended dimension for a tree pit is 1.8 metre by 1.8 metre. Along narrow pavements, the width can be reduced to 1 metre, provided the length of the pit allows root spread.
- Provide the pit at the same level as the adjoining paving along with grating that allows water to flow through. The width of the holes on the grating should be minimal such that stroller or wheelchair wheels do not get stuck.

Water Management

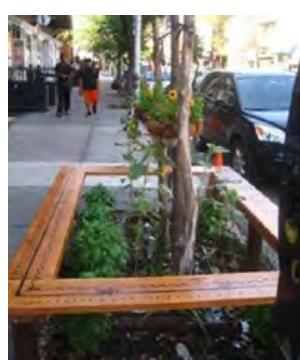
Water for street landscaping should be considered as part of the larger water management plan for the development.

- Prevent use of potable water for landscape irrigation. Plan for alternative water sources such as treated grey water or harvested water for certain areas of the landscape.
- Avoid standing water features like pools that might waste available resources or provide breeding grounds for mosquitoes.
- Provide efficient drip irrigation systems.

Materials

- Hardscape materials such as natural stone, tiles or pervious pavers without reflective colours or finishes may be used for surface treatment in landscaped areas.
- Loosely grouped rocks, soil, stones, shells, etc. can also be used for areas that require water permeability. However, these should not be provided in areas with through non-motorised transport movement.

Images Source: Commonwealth of Massachusetts, 2015



B. Stormwater Drainage

- Design different levels in street cross sections from the building edge to the street center; that is, pedestrian walkways, cycle paths, and transit stops, should be at higher levels than the carriageway.
- Provide surface drains at grade with the adjacent street surface unless the drainage is provided within landscaped areas.
- Locate drainage catch pits to hold and settle the runoff at the lowest point of the street cross section and at regular intervals depending on their size and catchment area.
- Provide low-impact approaches, such as bio- retention features like swales, permeable pavements and proper tree planting, to improve groundwater recharge and reduce storm water runoff.
- Provide the minimum number of storm water lines across the street cross section to keep construction and maintenance costs low.

C. Street Lighting

- Typically, two levels of lighting are provided along a streetscape – pedestrian lighting and carriageway lighting . Use energy-efficient fixtures including those powered by solar energy.

Pedestrian Oriented Lighting

- Provide sufficient lighting along pedestrian and cycling routes and in areas of high pedestrian activity to promote safety.
- Provide additional lighting in locations such as junctions and mid-block crossings, ramps

and stairs, building entrances, waiting areas, public spaces, parking areas and shaded areas such as colonnades.

- Avoid conflict with trees or other elements that create shadows, when placing light poles.
- Ensure that the height of pedestrian lighting does not exceed 4 metres from ground level to enable uniform illumination of the pedestrian walkway.

Vehicle Oriented Street Lighting

- Mount light fixtures at heights less than or equal to 12 metres above ground level, depending on the street type and required illumination levels.
- Maintain appropriate spacing between light poles depending on the light fixture and throw (the area the light fixture illuminates). The spacing between light poles should be approximately three times the height of the pole.
- Select fixtures that minimise glare and reduce light pollution.
- Locate streetlights at the edge of the pavement or along the median.

Image Source: Virginia Department of Environmental Quality, 2014



Image Source: NACTO, 2015



D. Street Furniture

- Provide street furniture at high activity areas such as retail spaces, near waiting shelters, parks and residential nodes.
- Locate street furniture primarily in multiple utility zones based on space availability.
- Avoid placing street furniture in the line of through pedestrian or bicycle movement. To maintain clear sight lines for vehicles and pedestrians, avoid placing bulky objects at intersections.
- Select street furnishing design in coordination with the local municipality specification, especially for public amenities on site.
- Develop a consistent and ergonomic palette for the entire neighbourhood that enhances the community identity and character.

Seating Elements

- Place seating in shaded areas.
- Don't use materials that reflect heat.
- Combine seating types with back and arm support and benches.

Trash Bins

- Locate trash bins along collection routes to ensure regular trash collection.
- Coordinate with municipality programs or neighbourhood recycling initiatives.
- Incorporate disposal spaces for cigarette butts and closed spittoons away from publicly visible areas to maintain visual quality and cleanliness.

Bollards

Bollards are used to prevent vehicles from entering the pedestrian space.

- Place bollards far enough apart to allow people with mobility impairments to pass through.
- Provide a minimum gap of 1.2 metres at intersections and entry to cycle tracks. Bollards can also be fitted with lights to allow visibility.

Drinking Water Fountains

- Provide drinking water fountains in essential areas such as schools, parks and recreational spaces.
- Ensure provision of clean drinking water.
- Provide fountains at accessible heights for all.
- Provide good drainage around fountains to avoid wet surfaces.

Advertising Elements

- Don't allow banners to obstruct paths .
- Maintain horizontal and vertical clearances.
- Locate banners visibly along line of movement.

Public Art Features

- Incorporate public art to create place markers within the community and to activate otherwise dead facades and spaces.
- Ensure that public art features and objects do not obstruct movement paths.

Image Source: ESI.info, n.d.



Image Source: Hartecast 2015



Image Source: Abadi Accessibility 2015



E. Waiting Areas And Shelters

- Provide clear, paved pedestrian access, shade, seating, trash bins, proper lighting and route information at all bus shelters.
- Use a common and legible visual theme to identify waiting areas.
- Ensure that waiting area design does not block through movement on the pavement.
- Waiting areas should meet the needs of all users including people with mobility and visual impairments, parents with strollers, pregnant women, children and the elderly.
- Integrate bicycle storage and parking near waiting areas to enable multi-modal transport.
- Ensure clear visibility between drivers and waiting passengers as well as other pedestrians and cyclists on the street. Provide safe pedestrian crossings near shelters and waiting areas for users accessing these facilities.

F. Street Utilities

- Locate underground utilities under the least disruptive position in the street cross section. This could be either below parking or service lanes, if present, or at the outer edge of the right-of-way.
- Avoid locating underground utilities directly below street tree lines.
- Avoid placing above ground utility boxes in the through movement path of pedestrians and cyclists.
- Use utility boxes as public art to avoid being vandalised with printed advertisements. They can also be treated as neighbourhood markers.

Image Source: Rouse, 2015



Image Source: Tess, 2013



Image Source: Bushboard, 2015



G. Additional Amenities

Shower, Change Rooms and Lockers

- Provide shower and change facilities around employment centres such as office buildings, large retail stores, malls, recreation facilities and educational institutions.
- Provide adequate space for changing, and storage facilities for wet or dirty clothes and equipment.
- Locate showers and lockers in washrooms in centrally accessible locations.

Shopping Carts

- Community retail establishments often provide shopping carts to customers to ferry their provisions back to their residences or the nearest parking lots. These are collected and retrieved back to the stores at frequent intervals in the day. Docking areas within the neighbourhood can facilitate this process.

Electric Cars

- To promote energy efficient travel by residents, developers should provide charging facilities for electric cars.

Other modes

- Provide modes such as electric golf carts and e-rickshaws that can be scattered around central areas of large, spread out sites.



CHAPTER 4

DESIGN REVIEW AND PERFORMANCE EVALUATION

Evaluating planning, design and operational practices, from concept to construction and occupation is essential to achieving the vision and objectives set out for the township.

The primary purpose of design review and evaluation is to assess the township master plan against the design brief, objectives, quality and functionality as well as the project budget.

The process is also used to evaluate the project's compatibility with the neighbourhood context and its impact on existing community infrastructure.

The process includes participation of the developer, design team, traffic consultants, safety and design auditors, staff from municipal agencies, project stakeholders and end users such as neighbourhood civil society agencies and resident associations, wherever one exists. While the design team usually undertakes evaluations during planning, it is recommended that a trusted and unbiased third party undertake post-occupancy evaluation of the design. Evaluation by external agencies that can apply sustainability rating systems and acquire project approvals can also count as design review.

This guidebook suggests some design review and evaluation tools for assessing mobility design impacts in a township. These include design checklists, traffic impact assessments, sustainability rating systems and performance measures. Applied throughout the master planning process, these tools can enhance the design. They are described in detail in this chapter.

4.1 Design Checklists

Design auditing is an iterative process that should be applied at all stages of planning to achieve good quality living environments. A qualitative checklist with a list of audit parameters can help designers determine whether the design meets the project's larger goals. Table 15 provides a sample checklist of site design considerations that can be used by designers to evaluate the master plan for sustainable mobility practices.

Table 15 | Checklist of Site Design Considerations to Evaluate the Mobility Design of a Township Master Plan

SITE DESIGN CONSIDERATIONS	CHECKLIST	GUIDEBOOK REFERENCE (PAGE NUMBER)
Site context and connectivity	<ul style="list-style-type: none"> ■ Development is compact and orients major uses to transit-based streets. ■ Proposed land-use and density is compatible with adjacent uses and long-term land use plans for the area. ■ Adjacent street network provides for connectivity of transit, cycling and pedestrian routes. 	3.1.2 (p.60), 3.2.1 (p.64) 3.2.2 (p.66), 3.2.3 (p.68), 3.3.1 (p.74)
Land use and site planning	<ul style="list-style-type: none"> ■ High-density land uses are located closest to activity nodes such as transit stops and community spaces. ■ Proposed land use adds to mix of land uses in surrounding areas. ■ Proposed land use encourages interaction of a diverse mix of people. ■ Open space design respects and preserves the existing land topography and conditions. ■ Open space design follows a hierarchy enabling different types of uses and allows opportunities for people to gather and socialise. 	3.1.1 (p.58), 3.2.3 (p.68), 3.3.2 (p.78)
Building placement	<ul style="list-style-type: none"> ■ Buildings are located close to the street and allow pedestrian activities along the street frontage. ■ Mix of uses that generate pedestrian activity animates the street in mixed-use areas. ■ Building design provides continuity at street level avoiding long blank facades. ■ Building scale is comfortable for pedestrians with adequate setback provisions. ■ Building entrances are located close to the street, with direct pedestrian access. 	3.2.3 (p.68), 3.3.5 (p.86)

SITE DESIGN CONSIDERATIONS	CHECKLIST	GUIDEBOOK REFERENCE (PAGE NUMBER)
Internal street network	<ul style="list-style-type: none"> ■ Streets match up with surrounding mobility networks and ensure direct connections throughout for pedestrians and cyclists. ■ Block lengths are pedestrian-scaled and mid-block crossings are provided where appropriate. ■ Transit networks for pedestrians, cyclists and motorists are connected ■ Intersection geometries control vehicle speeds and allow safe passage for cyclists and pedestrians. Sight lines are respected. ■ Facilities for sustainable transit modes are provided across the site. 	3.3.1 (p.74), 3.3.3 (p.82) 3.4.1 (p.90)
Design for pedestrians	<ul style="list-style-type: none"> ■ Pedestrian pathways are provided along all streets and also connect desirable destinations within the sites. ■ Pedestrian street crossings have clear signs for motorists. ■ Physical treatment and design features allow safe movement of people with disabilities. ■ Pedestrian paths are clearly defined, delineated and unobstructed. Amenities such as lighting, seating and weather protection are provided and safety is addressed. ■ Pedestrians have protected walkways through parking spaces. 	3.4.2 (p.94)
Design for cyclists	<ul style="list-style-type: none"> ■ Safe, continuous and clearly defined routes are provided. ■ Weather protection and amenities such as bicycle parking are provided around transit waiting areas. ■ Safe and sheltered bicycle parking is provided at building entrances for visitors. ■ Weather-protected bicycle parking for employees is provided in a secure area. Storage for cycling gear is also provided. ■ Where appropriate, facilities such as showers, changing rooms and lockers are provided. 	3.4.3 (p.98)
Design for vehicles	<ul style="list-style-type: none"> ■ Traffic speeds and lanes are designed according to street types. ■ Traffic calming principles are applied where appropriate. ■ Vehicle parking supply does not exceed the minimum standard. ■ Off-street parking is located away from the street, preferably behind buildings or underground. ■ Vehicle access is separate from pedestrian access. Egress and access are designed so vehicles do not block pedestrian walkways and traffic on streets. ■ Traffic calming is provided in underground and podium parking spaces. ■ Loading areas are located off the street and are screened. ■ Loading areas are designed so that pedestrian, cyclist and transit routes are not severed. 	3.3.4 (p.84), 3.3.5 (p.86), 3.4.4 (p.102), 3.4.6 (p.106)
Design for other mobility modes	<ul style="list-style-type: none"> ■ Walking distances to shuttle stops and intermediate public transport parking areas are safe and direct. ■ On-site or adjacent transit stops are located close to the main entrances of building that generate considerable activity. ■ Sufficient waiting areas are provided at auto and taxi waiting areas. ■ Parking for complementary mobility modes is provided in the most convenient locations within the development. ■ Passenger pick up and drop off areas are located away from the building entrance. ■ Stops and waiting areas are properly illuminated, visible and have essential amenities such as shelters and benches. 	3.2.4 (p.70), 3.3.4 (p.84), 3.3.5 (p.86), 3.4.8 (p.110), 3.5 (p.111)

SITE DESIGN CONSIDERATIONS	CHECKLIST	GUIDEBOOK REFERENCE (PAGE NUMBER)
Design of street elements	<ul style="list-style-type: none"> ■ Appropriate signage and way-finding features allow users of all mobility networks levels to determine their location, identify their destination and progress towards it. ■ Amenities are provided to create a comfortable and appealing environment and respond to weather and user needs. ■ Shelters and rest areas are provided at transit stops and locations used by a high number of users, the elderly or the disabled. ■ Landscaping along streets does not compromise user visibility and security. ■ Landscape elements are appropriate for local environment and conditions. ■ Lighting is provided along streets at sufficient intervals to allow clear visibility for motorists and pedestrians. ■ Terrain along pathways is kept reasonably level and ramps are provided wherever necessary. ■ Slopes along pathways are designed to allow proper drainage and to prevent water back up 	3.4.7 (p.108), 3.4.8 (p.110), 3.5 (p.111)
Safety and security considerations	<ul style="list-style-type: none"> ■ Overall site design attempts to minimise conflict between vehicles, pedestrians and cyclists. ■ Consideration has been given to sight lines and distances such that any visual obstructions in overall site design are prevented. ■ Consideration has been given to personal security for pedestrians, cyclists, shuttle and public transit users and rideshare patrons. ■ Overall design is safe for vulnerable users such as the elderly, pregnant women, children and people with mobility and visual impairments. 	3.3.3 (p.82), 3.4.5 (p.104), 3.4.6 (p.106)

4.2 Traffic Impact Assessment

Traffic impact assessments help the developer and the design team to understand the traffic generated by the proposed development and the capacity of the designed traffic infrastructure. Traffic impact assessments should be conducted by certified consultants and engineers with expertise and training in transportation and traffic analysis.

Table 16 shows the sections of a traffic impact assessment report. A Traffic impact assessment, at minimum, evaluates

- The traffic impact of the proposed development during the construction phase;
- The traffic impact of the proposed development during the operational phase; and
- Parking requirements of the proposed development and the design for accommodating them.

Evaluation of pedestrian, transit, and bicycle facilities should also be conducted to ensure that the street design addresses the needs of the

projected demands determined by the land use and other previously collected information.

All recommendations and data analyses should be studied and considered before the design is finalised. If required, the overall development plan should be revised and the revised plan should also consider alternative strategies that reduce traffic and promote non-motorised transport.

4.3 Sustainability Rating Systems

Rating systems encourage the incorporation of sustainable practices in large developments. Rating systems typically include a multi-criteria assessment process that uses credits (or points) to evaluate the potential environmental benefits and impacts of each project. Projects are required to integrate certain mandatory criteria to attain the corresponding credit. The total of the credits obtained determines the rating category and the project's eligibility to be certified as a green-rated development.

While development regulations do not mandate green ratings, the rating criteria can provide a methodology for third party evaluation of townships. Designers can use the rating criteria as a guideline when reviewing plans, incorporating regulations, and suggesting revisions. Rating systems can also be used at the onset of the design stage to achieve a predetermined level of certification. Rating systems allow designers to determine the degree to which a proposed development embodies key principles of sustainability and mobility.

Different countries adopt assessment systems that measure impact on the building's surroundings. BREEAM Communities, LEED-ND, CASBEE UD and Green Star are some international rating systems. In India, the Indian

Green Building Council (IGBC) and the Green Rating

for Integrated Habitat Assessment (GRIHA) council have formulated rating systems for large developments, namely the IGBC Green Township Rating System and the GRIHA-LD.

Indian Green Building Council Green Township Rating System

The IGBC Green Township System was developed by the Indian Green Building Council (IGBC) for townships and large developments. It is designed to address large developments including the residential development as part of the township. Developments are credits for certain prerequisites as well as credits for

Table 16 | **Sections in a Traffic Impact Assessment Report**

SECTIONS	SECTION CONTENT
Project introduction	<ul style="list-style-type: none"> ■ Overall plan showing existing land uses and zoning extending to the nearest major arterial road around the proposed project and the existing road system with road classification by hierarchy. ■ Proposed site plan showing the planned land uses and road network. ■ Plan indicating the project phasing strategy. ■ Location plan of the site showing the municipality (or local government equivalent) boundaries and existing and proposed public transit projects and road improvement schemes.
Existing conditions analysis	<ul style="list-style-type: none"> ■ Plan showing existing roads indicating right-of-ways, carriageway widths, pavement conditions, available parking infrastructure and existing utilities located within the ROW. ■ Recent traffic counts on existing roads including daily and peak-hour traffic volumes and turning movement data at existing intersections. ■ Existing road conditions in terms of horizontal and vertical alignments, sight-distance problems, drainage facilities, signage, utilities, and any other impediments, that is, buildings too close to the ROW, compound walls and fences, telephone or electricity pole locations, etc. ■ Capacity analysis and level of service determination of existing critical points and roads surrounding the proposed project.
Conditions analysis of the area in the future	<ul style="list-style-type: none"> ■ Analyse the existing road network taking into account future traffic projections. This includes not only any proposed road projects during the construction phase and in other proposed townships but also all possible developments that might be built around the site that would generate additional traffic. This would help in planning the construction phase of the development.
Trip generation data	<ul style="list-style-type: none"> ■ Predict the number of vehicle trips by all modes based upon the land use using industry standard data. This is used to determine the weekday, morning and evening peak-hour vehicle trips.
Trip distribution	<ul style="list-style-type: none"> ■ Demonstrate the trip distribution of traffic to and from the site and also multi-step trips once the project is fully built. This includes showing the number of vehicle trips by all modes and their directional movement at intersections and on roads leading to the development. This analysis highlights the roads that will receive the bulk of the trips and might require further design interventions. Non-motorised trip patterns should also be included while analysing the trip distribution of the site.

SECTIONS	SECTION CONTENT
Turning movements	<ul style="list-style-type: none"> Analyse the proposed road network, entry and exit points, surrounding intersections and junctions. The number of morning and evening peak-hour trips produced by the development should be used to assign vehicle movements. This information is illustrated on a plan and shows vehicle movements at project entrances and surrounding intersections labelled with peak-hour vehicle volumes.
Conditions analysis of the area including the proposed development	<ul style="list-style-type: none"> Analyse data from parking requirements and future traffic volumes that will be generated from the proposed project at full occupancy. This data should be combined with data from the earlier steps and the existing road and intersection analysis to determine the adequacy of the proposed road system in combination with the existing city systems.
Summary and recommendations	<ul style="list-style-type: none"> Include summary of peak-hour traffic volumes, capacity and level of service analysis of existing roads and intersections, a list of proposed improvements to the design network and intersections to ensure that a minimum level of service is maintained post occupancy. Include recommendations to reduce peak-hour trips and traffic volumes such as mixed land uses, carpooling, and mass transit options, parking demand management and increased pedestrian connectivity plans.

Source: Adapted from Traffic Impact Assessment Report by Arup Consulting Engineers

innovation in design and technology. The rating system addresses five categories - (1) site selection and planning, (2) land use planning, (3) transportation planning, (4) infrastructure resource management, and (5) innovation in design and technology. Table 17 correlates the credits and points awarded under IGBC Green Township to the guidelines described in Chapter

3. This rating system does not include design criteria for block definition, parking provisions, treatment of conflict zones such as intersections and junctions, inclusion of intermediate public transport in the design and detailed design guidelines, although attention to these aspects is considered good practice.

Table 17 | Indian Green Building Council Credits and Points and Corresponding References in the Guidebook

RATING SYSTEM CREDITS	GUIDEBOOK	RATING SYSTEM CREDITS	GUIDEBOOK
Site selection and planning		Transportation planning	3.1.2(p.60)
Local regulations	Step 2 (p.37)	Long-term transportation plan Design for differently abled	3.3 (p.73) - 3.4 (p.89)
Avoid development of inappropriate sites	3.1.1 (p.58)	Public transportation facilities	3.2.4 (p.70),
Preserve existing trees and water bodies	3.3.2 (p.78)	Eco-friendly transportation service	3.5e (p.115)
	3.1.1 (p.58),	Road and street network	3.2.4 (p.70)
Retain natural topography	3.3.2 (p.78),	Bicycle lane network	3.3.1 (p.74),
	3.5 (p.111)	Pedestrian network	3.4.1 (p.90)
Public landscape areas Urban heat island effect	3.1.1 (p.58), 3.3.2 (p.78) 3.4.2 (p.94)	Energy efficiency in infrastructural equipment	3.3.3 (p.82), 3.4.3 (p.98) 3.3.3 (p.82), 3.4.2 (p.94) 3.5c (p.113)
Land use planning			
Land use optimisation	3.2.3 (p.68)		
Basic amenities within the community	3.2.3 (p.68)		
Mixed-use development	3.2.3 (p.68)		
Social and cultural initiatives	3.2.3 (p.68)		

Green Rating for Integrated Habitat Assessment-Large Development Rating

The Green Rating for Integrated Habitat Assessment-Large Development (GRIHA-LD) is a rating system developed by the Ministry of New & Renewable Energy (MNRE) and Association for Development and Research of Sustainable Habitats (ADaRSH) for large developments. The guidelines for green large developments under GRIHA-LD have been categorised under seven headings :

- (1) sustainable site selection and planning,
 - (2) socio- economics,
 - (3) mobility systems,
 - (4) energy efficient and renewable energy,
 - (5) water and wastewater management,
 - (6) solid waste management, and
 - (7) risk mitigation/ adaptation and climate change.
- Table 18 correlates the GRIHA-LD criteria to the guidelines described in Chapter 3.

Table 18 | Green Rating for Integrated Habitat Assessment-Large Development Guidelines and Corresponding References in the Guidebook

RATING SYSTEM CREDITS	GUIDEBOOK REFERENCE
Sustainable site selection and planning	
Select a suitable site to preserve existing natural resources	Step 1 (p.37)
Development should preserve and protect geological and geomorphological features of the site	3.1.1 (p.58), 3.3.2 (p.78)
Surface water preservation	3.1.1 (p.58)
Conserve existing vegetation	3.1.1 (p.58)
Socio economics	
Measures to be undertaken on site and within site design to bring in equity and social well being	3.2.2 (p.66), 3.4 (p.89-110)
Mobility systems	
Develop a hierarchical road network within the development	3.3.1 (p.74),
Street networks within large developments should be developed in a manner so as to promote safety, efficiency, community living, environmental and aesthetic quality and cycling and walking.	3.3.1 (p.74), 3.4.1 (p.90), 3.3.3 (p.82)
Encourage walking and cycling within the development	3.3.3 (p.82), 3.4.2 (p.94),
Promote use of mass transportation	3.4.3 (p.98-101)
Promote use of clean fuels, sustainable road construction practice and use of Information and Communication Technologies (ICT)	3.1.2 (p.60) 3.2.4 (p.70)
Energy and energy systems	
Energy efficient street lighting	3.5c (p.113)
Water & waste water management systems	
Sustainable storm water management	3.5b (p.113)

4.4 Performance Measures

Performance measures test the accessibility, connectivity, performance quality and usability of a street or street network. They employ user-perception surveys and quantitative tools to determine the level of service of various transport mode facilities. Other evaluation tools include audits to establish usability of transport modes, road safety audits and indices to assess the connectivity and accessibility of street networks.

Performance measure tools can be applied at different stages of the design process. During

site planning and design process, tools can be used to assess whether planning concepts that provide people with sustainable mobility choices within the community have been applied. Post construction, measurement indicators can assess whether design concepts meet established community goals and connectivity standards. These measures can be informal or formal evaluation tools to approve plans for a new development. Table 19 lists some common performance measure tools used to assess non-motorised mobility design. These are elaborated further in this section.

Table 19 | Tools to Evaluate Pedestrian and Cycling Infrastructures

DESIGN ELEMENT	PERFORMANCE MEASURE TOOL	REFERENCE
Pedestrian	Pedestrian Level of Service	IRC 103-2012: Guidelines for Pedestrian Facilities
	User perception survey	WRI India Household Survey, 2014
Cycling	User perception survey	WRI India Household Survey, 2014
	Bicycle Level of Service	Parisar, Cycle Track Assessment Report
Safety	Road safety audit	Road Safety Audit of Mumbai Metro Rail Corridor, WRI India, 2013
Street network Policy Institute	Connectivity Index	Transportation Demand Management Encyclopedia, Victoria Transport
	Route Directness Index	Congress for New Urbanism
	Ped-Shed analysis / Walkability catchment	Congress for New Urbanism

Pedestrian Level of Service

The concept of pedestrian level of service has been adapted from IRC 103-2012: Guidelines for Pedestrian Facilities. Nine parameters are evaluated for the quality of service of a pavement facility of which six concern the physical characteristics such as footpath width, footpath surface, obstruction, encroachment, potential of vehicular conflict and continuity.

The other three parameters are user centric

such as pedestrian volume, security comfort and walking environment. Within the pedestrian LOS definition, six levels of service can be expressed as shown in Table 19.

Table 20 | Pedestrian Levels of Service

LEVEL OF SERVICE	DESCRIPTION	GRAPHIC REPRESENTATION
LOS A	Ideal pedestrian conditions exist and the factors that negatively affect pedestrian levels of service (LOS) are minimal	A  Pedestrian Space > 4.9 sqm / ped
LOS B	Reasonable pedestrian conditions exist but a small number of factors impact pedestrian safety and comfort	B  Pedestrian Space > 3.3 - 4.9 sqm / ped
LOS C	Basic pedestrian conditions exist but a significant number of factors impact pedestrian safety and comfort	C  Pedestrian Space > 1.9 - 3.3 sqm / ped
LOS D	Poor pedestrian conditions exist and the factors that negatively affect pedestrian LOS are wide-ranging or individually severe. Pedestrian comfort is minimal and safety concerns within the pedestrian environment are evident	D  Pedestrian Space > 1.3 - 1.9 sqm / ped
LOS E	Pedestrian environment is unsuitable. All or most factors affecting pedestrian LOS are below acceptable standards	E  Pedestrian Space > 0.6 - 1.3 sqm / ped
LOS F	Walking speeds are restricted, frequent unavoidable contact with other pedestrians have to be made, cross and reverse-flow movements are virtually impossible, space is characteristic of queued pedestrian than of moving pedestrian	F  Pedestrian Space < 0.6 sqm / ped

Source: IRC 103-2012

User Perception Survey

Surveys can be used to quantitatively analyse the travel behaviour of individuals or households from data collected about their daily trips. Surveys can also provide data on qualitative aspects such as user perceptions about their mode choice and their satisfaction levels about commute patterns, transport modes, travel expenses, safety within and outside the community and conditions along their travel modes. Survey results can identify potential alternatives or solutions to promote sustainable mobility within developments. Appendix B includes the full questionnaire from the Bangalore household surveys.

Bicycle Level of Service

Bicycle level of service analysis evaluates an area's cycling environment and identifies potential concerns related to access, comfort, facilities, destinations and safety. Parisar, a non-governmental organization working on sustainable transport issues in Pune, developed a Cycle Track Assessment Toolkit to assess and quantify the state of cycle tracks in Pune. Their analysis considered three key parameters: continuity, safety and comfort. The survey methodology involved analysis of approximately 500-metre segments of cycle tracks at different locations within the city and also aimed to understand the obstructions, geometries and intersections along the cycling infrastructure. Based on the survey, a scoring scale was prepared and applied to the bicycle path segments surveyed (Parisar, 2011)

Road Safety Audit

Road safety audits evaluate the safety aspects

of existing or proposed road projects to identify potential safety hazards. A road safety audit recognises pedestrians and bicyclists as the most vulnerable street users and assesses how a road will function with respect to them. The audits also address other modes of transport and evaluate

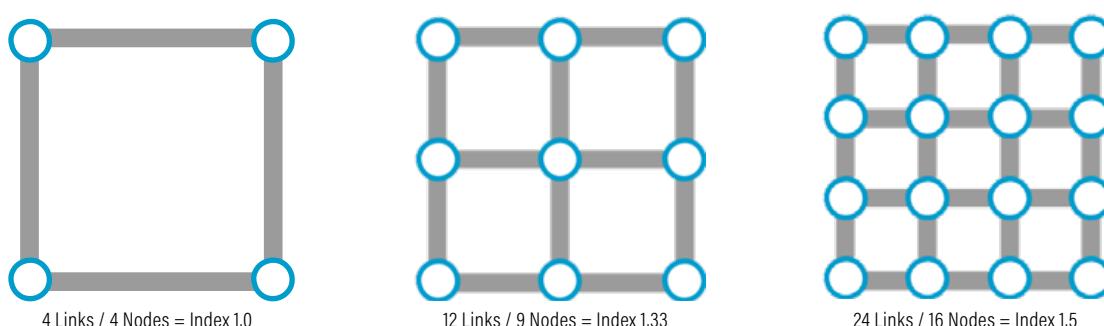
1. the facilities provided for various users,
2. the reduction in conflicts between transport modes, and
3. the usability of streets in particular for vulnerable users due to the implementation and maintenance of road safety elements.

Safety audits can be conducted at various stages in the design process but they are most effective post occupancy. Key elements evaluated include pedestrian crossings, parking provisions, turning radii of vehicles, visibility and conflicts at intersections, footpath conditions and property access from the road (WRI, 2013).

Connectivity Index

As per the Victoria Transport Policy Institute, a connectivity index quantifies the measure of connectivity of pedestrian and vehicular networks in a development. Indices can be measured separately for motorised and non-motorised travel taking into account shortcuts and barriers along travel routes. There are many methods for calculating the connectivity index. One commonly used measure uses the ratio of roadway links to the roadway nodes (Ewing, 1996). Links are the segments between intersections and nodes are the intersections themselves. A higher index value means that commuters have increased route choices (Figure 72).

Figure 72 | Using the Ratio of Links to Nodes to Determine Connectivity Index



A simple box scores an index value of 1.0. A four-square grid scores 1.33 while a nine-square scores a 1.5. A higher value means commuters have increased route choices.

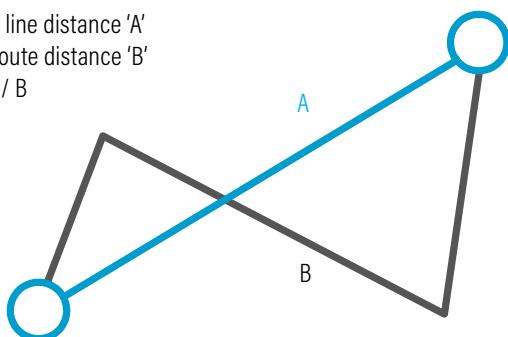
Source: Victoria Transportation Policy Institute

Direct Route or Route Directness Index

As per the Congress for New Urbanism (CNU), the Direct Route or Route Directness Index is used to measure the ease of access from one point to another within a development. It is calculated as the ratio between the length of the actual path to the length of a direct path. The method to calculate the level of directness from point A to point B includes dividing the length of the actual driving/walking route between the two points by the length of the direct route (Figure 73). This model can be applied to any site, no matter the street configuration. It may also be used for both vehicle and non-motorised transport routes. The best possible result is an index value of 1.

Figure 73 | **Method of Calculating Route Directness Index**

Straight line distance 'A'
Actual route distance 'B'
 $RDI = A / B$



Source: Congress for New Urbanism

Ped-Shed Analysis

A pedestrian shed or ped-shed analysis is a mapping tool used to identify an area within a five to ten-minute walk, also known as a walkability catchment, from a pedestrian destination. Identifying the walkable catchment provides a visual indicator of the ease of movement within and around a neighbourhood. The mapping process involves four steps (Figure 74):

- Identify and map the network that provides pedestrian mobility. The network includes streets, pavements, trails, bridges and other pedestrian infrastructure.
- Draw a circle around the destination with a 400-metre radius. The circle represents the maximum walking distance.
- Measure the walkable distance (i.e., 400 metres) from the destination along the pedestrian routes identified in Step 1.
- Identify the blocks, buildings, parks and other destinations that can be reached within that distance. The area around these features represents the ped-shed for that destination.

Some destinations might attract pedestrians from a farther distance than others. In such cases, different walkability radii can be applied to these destinations or land uses. Any areas not coloured in Figure 74 can be identified and reviewed to decide if they should be included in the nearest destination.

Figure 74 | **Method to Determine Ped-Sheds around Destinations**



Source: Adapted from Congress for New Urbanism

4.5 Maintenance Assessment

Township mobility networks can only function efficiently if they are maintained properly. To ensure that the street networks are maintained, it is essential to conduct suitable maintenance assessments regularly. Frequent condition checks and upkeep can help prevent escalation of minor

issues into major ones. Figure 75 showcases some common concern areas in townships. These concerns were identified during the design audits and household surveys that were conducted in Bangalore.

Figure 75 | Common Maintenance Concerns in Townships

STREET SIGNAGE



Traffic signs need to be maintained at the correct height and angle to the street



Signs should be visible, legible and relevant with correct and updated information



Maintain the quality of surface water drains



Regular street maintenance to clear drains

STREET SIGNAGE



Maintain and trim foliage to keep signage visible

STREET FURNITURE



Provide appropriate location and regular maintenance for street furniture

SURFACE TREATMENTS



Maintain surface treatments to avoid hazardous conditions

UTILITY PROVIDER RESPONSIBILITIES



Provide facilities and maintain at-and above-grade utility facilities

Appendices

Appendix A – WRI India Case Studies

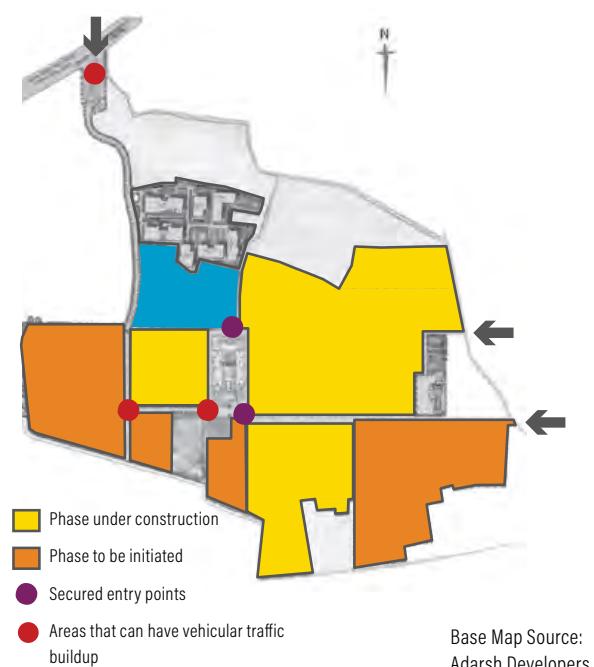
PROJECT	: ADARSH PALM RETREAT
CITY	: BANGALORE
PROJECT TYPE	: MIXED-USE
AREA	: 250 ACRES
AUDIT YEAR	: 2012
CURRENT STATUS	: UNDER CONSTRUCTION

Context

Adarsh Palm Retreat is located about 18 kilometres from Bangalore city centre. The development is planned to include three special economic zones (areas in which business and trade laws are more liberal than domestic economic laws), a five-star hotel, a municipal lake, around 750 high-end villas and 2,040 luxury apartments.

These zones would be located in enclaves, each of which would have exclusive recreational amenities with a common market and clubhouse (Figure a). Once completed, Adarsh Palm Retreat is expected to accommodate 13,000 upper-middle and upper class residents in 3– 4 bedroom units.

Figure A | **Segregated Enclaves and Access Points at Adarsh Palm Retreat**



Observations

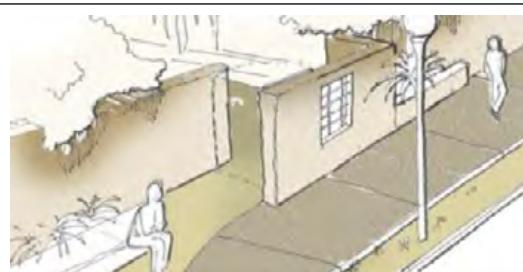
- The development has three restricted entry points
- The road system follows a hierarchical pattern with low connectivity creating larger concentrations of vehicles along the main roads.
- Each phase of the development had to be physically segregated from the others and required separate access points.
- The average distances of residents from entrances within the development range from 1 to 2 kilometres.
- The master plan does not account for internal accessibility for pedestrians or bicyclists, creating a primarily car-friendly, non-motorised-transport-hostile environment.

Audit Approach

The audit focused on improving the non-motorised transport network, and reducing trip lengths and number of trips within the development. Its recommendations were to:

- Puncture existing physical barriers such as compound walls to improve connectivity (Figure b).
- Enhance linkages within the project by providing continuous pavement at break points like driveways, especially in areas with high traffic volumes.
- Introduce informal shopping spaces, waiting areas and other related activities at transit stops along pedestrian networks.
- Enrich public and semi-public spaces such as markets and building edges by programming appropriate functions and creating accessible and inclusive designs.

Figure B | **Puncturing Existing Barriers to Facilitate Non-Motorised Movement**



PROJECT	: BRIGADE ORCHARDS
CITY	: BANGALORE
PROJECT TYPE	: MIXED-USE
AREA	: 130 ACRES
AUDIT YEAR	: 2014
CURRENT STATUS	: UNDER CONSTRUCTION

Context

Brigade Orchards is a 130-acre mixed-use development located on the outskirts of Bangalore city near Kempegowda International Airport, about 35 kilometres from the city centre. On completion, the development is proposed to accommodate 1,800 dwelling units with a residential population of about 7,200 people, occupying high-end villas and apartment towers, studio apartments and an assisted living space for the elderly. Amenities are grouped on one end of the site and include a commercial complex, office space, shopping mall, hospital, school, a stadium and fire and police stations. As of June 2015, the project was in its implementation phase (Figure c).

Figure C | **Master Plan of Brigade Orchards showing Proposed Land and Building Uses**



Source: Brigade Developers

Observations

The site is accessed from two gates – one at the north of the development and one at the south. A 26-metre-wide road – part of the comprehensive development plan – runs from north to south with multiple cross roads cutting through the site laterally.

Owing to the considerable distance of the project from the city centre and from other key destinations in the city, a high dependency on motorised transport is expected. The closest public transit stop providing access to the city is about 10 kilometres away along a main highway with no bus shelters. The development does not follow a clear hierarchical road network and the main amenities are located about 2 kilometres from the residential areas. The disconnected residential communities within the master plan will operate as individual gated communities.

There is no comprehensive parking management system for the stadium, which is expected to generate high-activity. The lack of an internal non-motorised network and the lack of facilities for pedestrians can be detrimental to non-motorised transport within the project. Certain intersections near the proposed school, hospital and stadium might experience traffic congestion.

Audit Approach

The primary objective of the audit was to identify strategies to connect the site to the city and public transit nodes. Strategies include:

- Provide an all-day shuttle bus system, operated by the developer until the development is completely occupied, after which the operations are taken over by residents.
- Add pick up and drop off points for school, company buses and auto-rickshaws to the design of the main entrance gates.
- Provide a well-connected internal network for pedestrians and cyclists to access entry-exit points, as well as essential amenities.
- Provide facilities such as secure bike parking spaces, bus shelters and shaded walkways to accentuate the non-motorised transport network.

PROJECT	: BRIGADE MEADOWS
CITY	: BANGALORE
PROJECT TYPE	: RESIDENTIAL
AREA	: 68 ACRES
AUDIT YEAR	: 2014
CURRENT STATUS	: UNDER CONSTRUCTION

Context

Brigade Meadows is a mixed-income, residential development that extends over 68 acres. It is located on Kanakapura Road in South Bangalore, approximately 29 kilometres from the city centre. It will house about 12,000 people in 3,022 dwelling units and will add about 3,300 vehicles when completed. The project has two clusters separated by a 18 metre comprehensive development plan road. Middle-income housing with dense low-rise blocks is situated to the south of the road and higher-income apartments are planned to the north of the road. As of June 2015, the project was in the construction phase.

Observations

Although located a distance from the city centre, the site had easy access to the southern part of the city. Public transit is frequent and a bus stop is just outside the main access gate. However, residents are expected to travel beyond the site to access their daily requirements, as adequate amenities are not planned within the site . This will generate additional vehicular traffic for people trying to access schools, colleges, entertainment areas and markets. For people travelling towards the city for work, the daily estimated travel is about 25 kilometre per day.

As with most large township designs, the internal vehicular network at Brigade Meadows doubles as the pedestrian network. However, the lack of proper facilities along this corridor does not facilitate walking within the development. The main gate is located near the main public bus stop about 1 kilometre from the furthest residential unit. The lack of non-motorised connectivity from the township to the bus stop doubles the time taken to reach this point.

The road hierarchy for the middle-income housing enclave follows an orthogonal grid pattern that is mostly used for vehicles to access stilt and street level parking. This, and the lack

of basic non-motorised transport facilities like footpaths renders the pedestrian spaces between buildings unsafe for playing and walking. The two project enclaves are divided by boundary walls and are designed to operate as individual communities upon completion.

Audit Approach

The objectives of the design audit at Brigade Meadows were to reduce the need for residents to use motorised transport for discretionary trips and to create an environment that is suitable for pedestrian movement. Some of the proposed strategies and recommendations are:

- Develop alternate networks of mobility within the township by providing facilities like parking bays for intermediate public transport and shuttle buses and bike paths along the main road (Figure d).
- Redesign streets to accommodate basic non-motorised transport infrastructure such as pavements, shaded paths, seating and lighting.
- Relocate community amenities centrally to enable easy access by all residents, such that daily needs such as proposed automatic teller machines (ATMs) and grocery stores are closer to the residential enclaves.
- Create safe access to parks and play areas especially for children by regulating traffic flow and reconfiguring stilt parking access roads.

Figure D | **Proposed Road Network with Pedestrian, Cycling, Intermediate Public Transport and Shuttle Facilities at Brigade Meadows**



Base Map Source: Brigade Developers

PROJECT	: GODREJ UNITED
CITY	: BANGALORE
PROJECT TYPE	: RESIDENTIAL
AREA	: 10.5 ACRES
AUDIT YEAR	: 2014
CURRENT STATUS	: UNDER CONSTRUCTION

Context

Godrej Properties is developing a residential property on 10.5 acres along Whitefield Road, Bangalore, comprising 2-4 bedroom units to house about 2,300 people. The master plan has two Y-shaped towers with 18 floors with 514 units and a clubhouse with state-of-the-art facilities such as swimming pool, badminton and squash courts and an indoor games centre. The two blocks are connected at the landscaped podium and basement levels. The basement contains services and resident parking. The project is currently in the design-construction phase. A small component along the main road is earmarked for future development (Figure e).

The estimated residential population for the development is about 2,315 people with a daily floating population of about 1,150 including service and maintenance staff and visitors. The total number of parking spots provided in the development is 661, that is about 1.3 parking spots per household.

Figure E | **Master Plan of Godrej United showing Placement of Land Uses and Buildings**



Base Map Source: Google Maps

Observations:

Godrej United's development is situated along a main public road close to other large developments like Brigade Metropolis and Prestige Shantiniketan. Public transit stops are within walking distance of the development and provide connectivity to main bus interchanges across the city. A number of amenities such as schools, hospitals and retail malls, like Phoenix Market City, are also within a kilometre radius of the development. Vehicle movement from these developments already creates traffic on Whitefield Main Road.

Lack of proper pedestrian infrastructure on the main thoroughfare necessitates the use of motorised transport to access amenities such as retail malls. Phase 3 of the Bangalore Metro is proposed to run adjacent to the site along this main road. The construction phase of the metro would add to the existing traffic woes of the residents and increase travel times substantially. However, once completed, the metro would aid in neighbourhood accessibility to the city.

Audit Approach

The primary audit objective was to improve accessibility to public transit nodes and to identify opportunities for non-motorised short trips. In addition, strategies to improve non-motorised transport facilities within the project and to enable a parking management system for all vehicle types were considered. The broad design recommendations for the project included:

- Initiate a shuttle service between the most frequented destinations around the neighbourhood to help address the concern of last-mile connectivity.
- Design the site entrance to cater to different user groups, for example, segregated right-of-ways for pedestrians and bicyclists, and pick up and drop off points for auto-rickshaws and school/company buses.
- Ensure safety measures throughout the development and pedestrian prioritisation at four main site intersections.
- Provide traffic management with clear indicators of traffic flow direction and pedestrian safety measures in basement parking areas.

PROJECT	: L & T SOUTH CITY
CITY	: BANGALORE
PROJECT TYPE	: RESIDENTIAL
AREA	: 34 ACRES
AUDIT YEAR	: 2013
CURRENT STATUS	: MOSTLY OCCUPIED

Context

Located in Arekere Mico Layout on Bannerghatta Road, Bangalore, L&T South City is a 34-acre residential township composed of 18 high-rise towers, with 2,000 apartments. The complex is mostly occupied with two towers still under construction. L&T South City accommodates a residential population of approximately 8,500 people in 2–3 bedroom units in the middle-to-upper-middle-class income groups. The apartments are provided with amenities such as tennis courts, a clubhouse, swimming pool, gymnasium, multipurpose halls, children's play area and badminton courts. Buildings are raised on a podium with two levels of basement parking to accommodate almost 3,000 cars.

A public park north of the site, divided from the development by the main access road, is also part of the project. Convenience stores are absent within the development and residents meet their grocery requirements from neighbourhood retail stores about a kilometre from the development.

Figure F | **Proposed Redesign of an Underused Space within the Development**



Source: WRI India

Observations:

Pedestrians have no separate entry and must use the same access as vehicles. This causes confusion and congestion along the main public road, especially during morning hours, due to school and office pick-ups. Vehicular traffic is not segregated within the community even from playing areas for children. The parking access ramp acts as the common movement path for both vehicles and pedestrians. Accessibility to street level from parking podiums is suitable for vehicles but increases walking distances for residents to amenities. Despite the fact that the farthest residential block is only a 10 -15 minute walk from the nearest gate, most school drop-offs are by private vehicles in the mornings. This clogs up movement along the main access gate and along the public road outside the development. The public park is not frequented by residents because heavy traffic on the main road separating the park from the apartment blocks.

Audit Approach

WRI India's recommendations focused on improving non-motorised mobility within the project and promoting walking as a viable option for discretionary trips. To facilitate this objective, accessible facilities and amenities and streets reconfigured to be safer and livelier were recommended. The strategies suggested for an improved environment at L&T South City are:

- Introduce a shuttle bus system that picks and drops off residents at school drop-off points and key employment and public transit stops within the neighbourhood.
- Use underutilised spaces to introduce retail and convenience shops within the complex (Figure f).
- Prioritise pedestrian movement within the development by providing dedicated pathways along the road network, podium and basement ramps and introducing linkages between built spaces.
- Introduce activities along the pedestrian links that enhance social interaction and provide necessary facilities like seating, dustbins, water fountains, proper signage and adequate lighting.

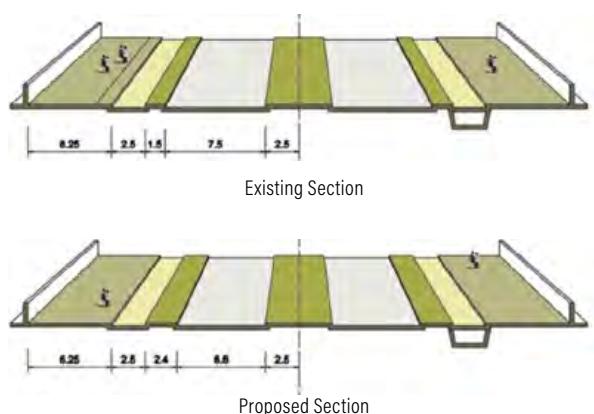
PROJECT	: GODREJ GARDEN CITY
CITY	: AHMEDABAD
PROJECT TYPE	: MIXED-USE
AREA	: 250 ACRES
AUDIT YEAR	: 2012
CURRENT STATUS	: UNDER CONSTRUCTION

Context

Godrej Garden City by Godrej Properties is spread across 250 acres in the northwest region of Ahmedabad within the administrative limits of Ahmedabad Municipal Corporation. The proposed master plan is for over 13,000 apartments and villas catering to different income groups surrounded by schools, colleges, playgrounds, malls, entertainment centres, hospitals and office spaces.

A proposed 30-metre-wide, tree-lined central boulevard with dedicated lanes will connect the township from end to end and wide arterial roads (12–18 metres wide), will connect various parts of the development. The estimated residential car usage for the development is estimated at about 14,000 cars. Although beneficial in reducing additional trips outside the complex, trip generators such as schools and markets will create more internal vehicular and pedestrian traffic on the single access road, which lacks non-motorised transport facilities.

Figure G | **Reconfiguration of Lane Widths along the Main Boulevard to Reduce Vehicular Speeds**



Source: WRI India

Observations:

The vehicular network that divides the site into segregated enclaves doubles as the main pedestrian network. This creates large block sizes that increase walking distances. The project is also situated at about 5 kilometres from the bust rapid transit system hence increasing the use of private vehicles to access mass transit. The entire development is designed for high vehicular speeds and the estimated average distance for car travel per day is calculated to be about 22 kilometres.

Audit Approach

The master plan audit aimed to (1) evaluate the connectivity of the township for internal and external trips; (2) evaluate pedestrian infrastructure and environment to gauge current mobility; and (3) work out a pedestrian and bicycle mobility plan for the township. To achieve these objectives, the following set of core strategies was developed:

- Improve non-motorised transport within the development by prioritising pedestrian access to existing links, reducing vehicular speeds, reconfiguring junctions around special activity areas like the school and market place and creating new pedestrian networks.
- Create public spaces across multiple levels - local, neighbourhood and township - and introduce the concept of open streets where weekly events can be organised to enhance the community bonding and the quality of public spaces.
- Integrate the public transit system with BRT by introducing bus stops into the road network (Figure g).
- Create a mix of uses along the main boulevard and design interconnections between neighbourhoods as public resting spaces (Figure h).

Figure H | **Interconnection between Neighbourhoods Designed as Public Spaces**



Source: WRI India

Appendix B – Bangalore Household Survey Form

Interviewer				Date	Time			
Location	Type (Apartment / Villa / Other)	Block	Floor	Door No.	Survey No.			
A.	HOUSEHOLD SECTION / DEMOGRAPHICS							
1. Is this a	1 BHK	2 BHK	2.5 BHK	3 BHK	4 BHK	Larger than 4 BHK / Penthouse etc		
2. What is the area of your house? Please include the total carpet area.								
Less than 600 SFT	601 – 800 SFT	801 – 1200 SFT	1201 – 1500 SFT	1501 – 2000 SFT	2001 – 2400 SFT	2401 – 4000 SFT	4000 Plus	Don't know / Don't remember
3. For how many years has your family lived in this house?								
Less than 1 year	1 year	2 years	3 years	4 years	5 years or more			
4. Is this house								
Own	Rented	Leased	Company provided	Other				
5. What is your annual household income?								
Upto 5 lakhs	5 to 10 lakhs	10-15 lakhs	15-20 lakhs	20-25 lakhs	25-30 lakhs	30 lakhs plus	Don't know / Refused	
6. Starting from the eldest person, please tell me their names, age and occupation of all your family members (Please list only those living in this house presently) CIRCLE TO INDICATE SURVEY RESPONDENT								
< 3 years	3 to 10 years	11 to 15 years	16 to 21 years	22 to 30 years	31 to 40 years	41 to 50 years	50 Plus	
Working full-time	Working part-time	Business	Trader/Shop owner	Housewife	Student	Retired	Other	
7. a. Do you employ any domestic help? Like maids / drivers / cooks etc? Yes No								
b. How many _____ do you employ?								
c. Is the _____ staying with you in this house or away? In this house Not in this house								
d. Where does the _____ live? I mean which locality?								
e. How does he/she travel to your house and back?								
Walk	Bicycle	Bus	Two wheeler	Car	Auto	Other		
8. a. How many vehicles do you have at home? b. How many are								
Total (All vehicles)	Car / Four wheeler	Two wheeler	Bicycle	Other				
9. How much do you usually spend on fuel per week? Please include all the vehicles in your house.								
10. How much do you usually spend on transport per week, other than your personal vehicles?								
11. How much do you usually spend on parking per week outside parking within the township?								
12. Who does most of the driving in this household?								
Head of the Family (HoF)	Driver	Self (if not HoF)	Other					

- 13. What is your average monthly electricity bill?**
- 14. Please indicate to what extent you agree or disagree with each. Our decision to live in the township is based on:**
- The distance from the township to schools
 - The open spaces and safe environment within the township
 - The distance from the township to employment opportunities / offices
 - The distance from the township to retail shops and other amenities
 - The number of retail and amenity shops located within the township
 - The distance from the township to transport points like railway station, airport, bus stop, metro station, etc.
 - Our family/friends live here
 - The "green"/(sustainable practices) features followed in the township, if any
 - Any other important reason not mentioned above

Strongly agree	Agree to some extent	Neither agree nor disagree	Disagree to some extent	Strongly disagree
----------------	----------------------	----------------------------	-------------------------	-------------------

- 15. Please indicate to what extent you agree or disagree with these statements:**
- I am satisfied with the transportation options available to our household
 - I am concerned about the high cost of our household's travel expenses
 - I am satisfied with the road and pedestrian network outside our apartments
 - I am concerned about the safety of household members during travel to/from our apartments
 - I face heavy congestion during my commute to work
 - I am content with my commute to work
 - I am content with the childrens' commute to school
 - I am content with travel options available to me to access retail/shops/amenities outside my apartments
 - I am satisfied with the quality and safety of open spaces available to walk or cycle in my township
 - I am satisfied with the quality and safety of open spaces available for children to play in the township
 - I am satisfied with the parking spaces available in the township
 - I am satisfied with the access to public transport stops that the township has
 - When possible and services are available, I prefer to stay within the township for shopping/retail trips
 - The environment within the township community impacts our household transportation decisions
 - I am satisfied with the number of retail and amenity shops located within the township

B.	PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOURSELF						
16. Gender	Male			Female			

17. a. What is your relationship with the Head of the Family?
Self (Head of Family) Spouse Son / Daughter Brother / Sister Parent Son/ Daughter -in-law Grandchild Other

17. b. What is your education level?
Illiterate Too Young for school School College but not graduate Graduate Post Graduate

C.	COMMUTE / TRAVEL MODE / CHOICE SECTION						
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ASK Q18 TO Q20 ONLY FOR PERSONS WORKING, BUSINESS, TRADER, STUDENT									
18. a. Where is your office/school located?									
b. How do you usually commute?									
Car	Two wheeler	Company / School Bus	Public Bus	Auto	Taxi	Metro	Walk	Bicycle	Other
18. c. If not personal vehicle, how much does this one way trip typically cost you?									
d. Usually how many persons travel with you during this trip?									
Alone	1 person	2 person	3 person	4 or more persons					

18. e. How long does it usually take you to reach office/school, one way?

Less than 15 mins	15 to 30 mins	30 to 45 mins	45 mins to 1 Hour	1 to 1.5 hour	More than 1.5 hours
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18. f. What is the approximate distance travelled by you on one-way - to reach office/school, on a normal day?

D.	OTHER TRIPS SECTION
----	----------------------------

19. On a typical day, do you go out anywhere / else? Yes No Can't Say

a. For what purposes do you go out? MULTIPLE RESPONSES POSSIBLE

Attending Class or Tuitions	Playing - badminton or tennis etc	Fitness - Gym or Yoga etc	Visiting friends or relatives	Local shopping like vegetables or fruits	Other
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19. b. What is your destination, when you go out for above activities?

c. How do you travel on these trips?

Car	Two wheeler	Company / School Bus	Public Bus	Auto	Taxi	Metro	Walk	Bicycle	Other
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19. d. What is the time needed for the trip, one-way?

Less than 15 mins	15 to 30 mins	30 to 45 mins	45 mins to 1 Hour	1 to 1.5 hour	More than 1.5 hours
-------------------	---------------	---------------	-------------------	---------------	---------------------

19. e. How much does this trip cost you, one-way?

f. What is the approximate distance travelled by you one way to make this trip?

IF PUBLIC TRANSPORT USED FOR ANY OF THE ABOVE TRIPS,

19. g. Where is the stop/station located?

h. How do you usually reach the stop/station and return home from the stop/station?

Car	Two wheeler	Auto	Taxi	Walk	Bicycle	Other
-----	-------------	------	------	------	---------	-------

19. i. How long does it take you to access the bus-stop/station from the house, one-way?

Upto 10 minutes	10 - 15 minutes	15 - 30 minutes	30 minutes - 1 Hour	More than 1 Hour
-----------------	-----------------	-----------------	---------------------	------------------

19. j. What is the usual waiting time for the bus/train?

Upto 10 minutes	10 - 15 minutes	15 - 30 minutes	30 minutes - 1 Hour	More than 1 Hour
-----------------	-----------------	-----------------	---------------------	------------------

E. PHYSICAL ACTIVITY

20. a. How long do you spend engaged in physical activity inside the township (walking, cycling, running, swimming, indoor gym)?

Upto 30 minutes	30 minutes to 1 hour	1-1.5 hour	1.5-2 hours	2-2.5 hours	2.5-3 hours	More than 3 hours
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20. b. What all physical activity do you typically do - on a daily or weekly basis inside the township?

Walking	Cycling	Running	Swimming	Indoor gym	Other
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F.

PERCEPTION SECTION

21. I would walk more if.....(PLEASE CHOOSE ONE TOP REASON THAT APPLIES TO YOU).

- a. Footpaths were more common / available everywhere
- b. Footpaths were better maintained & included more amenities such as benches
- c. I had shower and changing facilities at office / work
- d. The pedestrian network (footpath, benches, trees providing shade etc) inside the township was better
- e. The pedestrian network (footpath, benches, trees providing shade etc) near my office was better
- f. It was safer
- g. It was shorter or there was a short-cut available
- h. More friends, peers or co-workers also walk
- i. There were fewer cars, less noise pollution, and/or less air pollution
- j. Other
- k. None

22. I would use a cycle more if.....(PLEASE CHOOSE ONE TOP REASON THAT APPLIES TO YOU).

- a. I lived closer to my intended destinations
- b. If I owned a cycle
- c. Cycle parking was more available and/or more convenient
- d. I had shower and changing facilities at work
- e. More cycle lanes were available on roads in and around where I live
- f. It was safer
- g. I had more time
- h. There were fewer cars, less noise pollution, and/or less air pollution
- i. More friends, peers, or coworkers did
- j. Other
- k. None

**23. I would use more public transport (like Bus, Metro, shuttle or chartered bus, etc) if.....
(PLEASE CHOOSE ONE TOP REASON THAT APPLIES TO YOU).**

- a. There was a shuttle service from my residence to my preferred public transit stop, interchange, or final destination
- b. There were better public transport services and connectivity in the city
- c. It was less expensive
- d. It was safer
- e. It was faster or more reliable
- f. It was less crowded
- g. Other

24. I prefer to take my car (motorbike/scooter) because.....(PLEASE CHOOSE ONE TOP REASON THAT APPLIES TO YOU).

- a. It is fastest
- b. It is safest
- c. It can fit other members of the household
- d. It is the most comfortable
- e. Public transport options are not easily accessed at origin or destination point
- f. It is the least costly option
- g. Parking is easily available
- h. Other
- i. I do not prefer to take a private vehicle / my car / motorcycle

Appendix C – Key Findings from Bangalore Household Surveys - 2014

WRI India conducted visual assessments of six gated townships and household surveys of 445 respondents who lived in those communities in Bangalore, which were planned for 30,000 residents. The visual assessments were conducted to establish the linkage between travel patterns and the built environment. While township communities originated as high-income housing, in India, the middle class is increasingly choosing to live in these communities due to affordability and the desire to own a home (Figures i & j).

This section showcases key findings and benchmarks from the survey. The complete report can be accessed at www.embarqindiahub.org/reports/relationship-between-built-form-travel-behavior-and-energy-use-gated-communities-bangalore.

Figure I | Employment Status of Residents of Six Townships

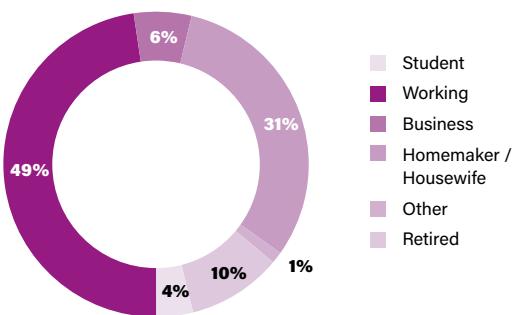
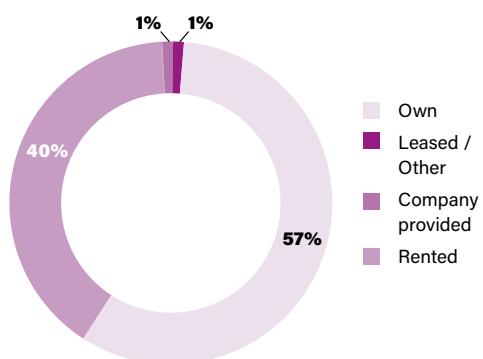


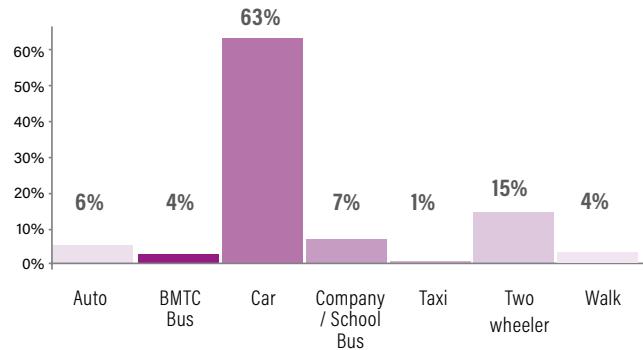
Figure J | Home Ownership Status of Residents



Commuting Modes for Household Trips

Survey respondents indicated that 78% commute using personal vehicles, that is, car and two-wheelers.

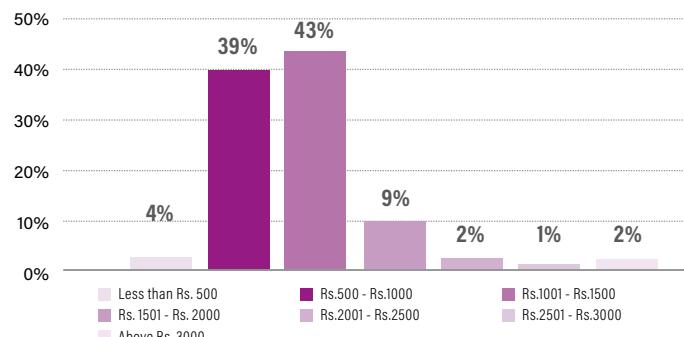
The location of these developments at the urban periphery and the lack of reliable public transit connections were given as the key reasons for choosing personal transport over



Energy Use

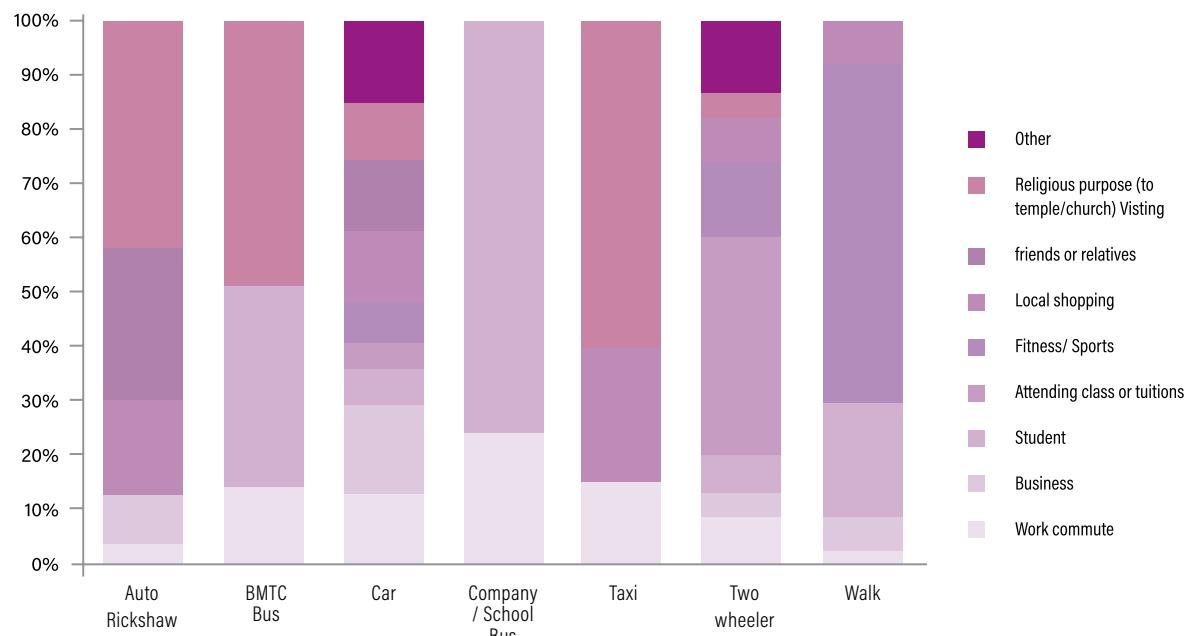
Almost 86%, that is, 380 of the 446 households responding, had an electricity bill of between Rs. 500 and Rs. 1,500 per month

or less. These high bills were probably due to larger home sizes in these gated communities compared with the average dwelling in the city.



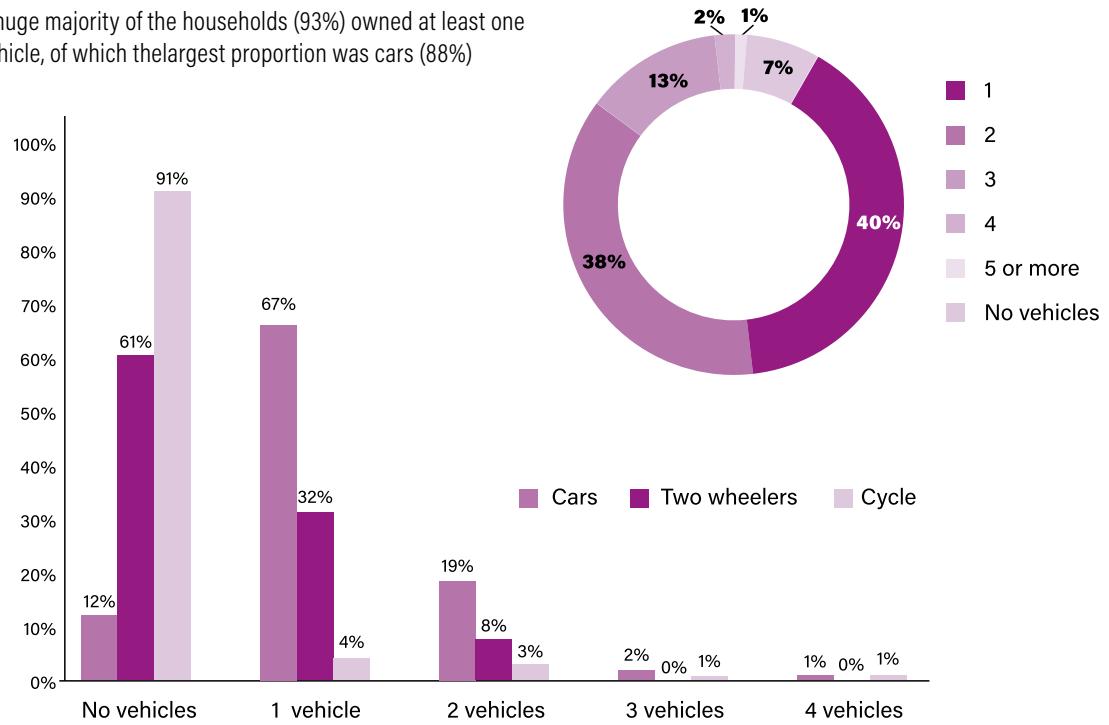
Travel mode

There is a greater dependency on cars that only other modes of transit for work trips and trips to grocery store, classes and others. Personal vehicles – cars (63%) and two-wheelers (15%) – were the primary mode for most weekday trips.



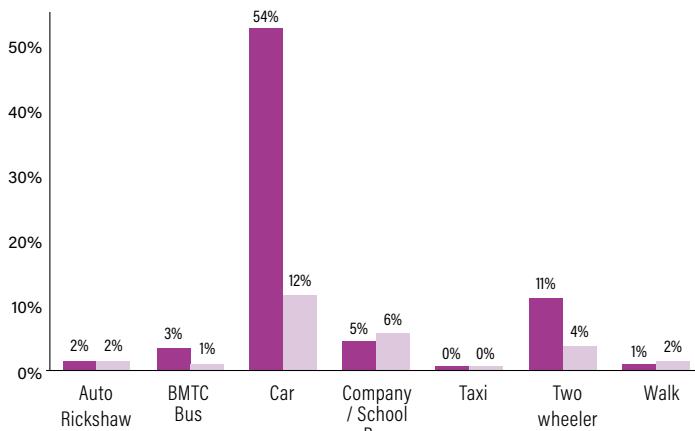
Vehicle ownership rates

A huge majority of the households (93%) owned at least one vehicle, of which the largest proportion was cars (88%)



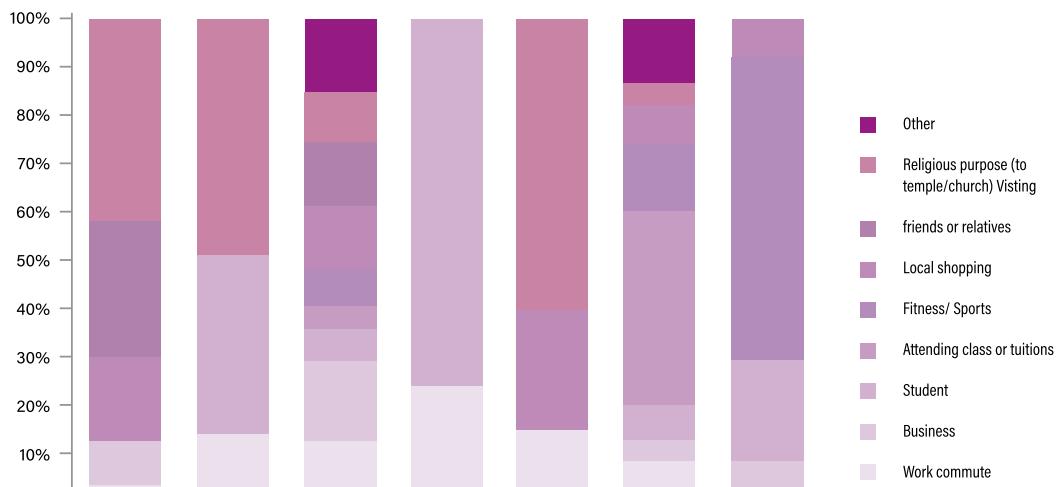
Mode Share of Work Trips by Gender

Men were more likely to commute for work and preferred travelling by car and/ or two-wheeler while travel patterns for women indicated that females were most likely to undertake walk trips and/or informal transit such as by autos/ taxis. Women also had a higher share of additional trips such as local shopping trips, attending classes or tuitions and visits to friends and relatives.



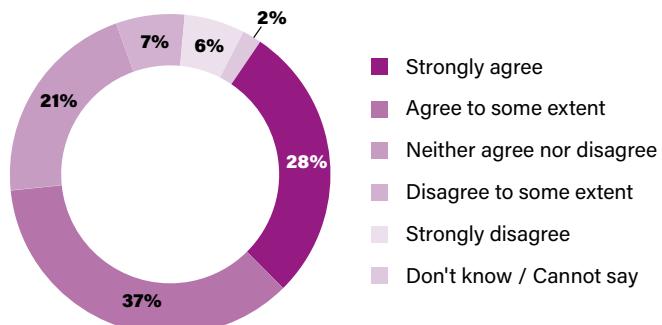
Travel distance and time for additional trips

Around 46% of the trips were less than 5 kilometres and 64% of the trips were done within 30 minutes one-way.



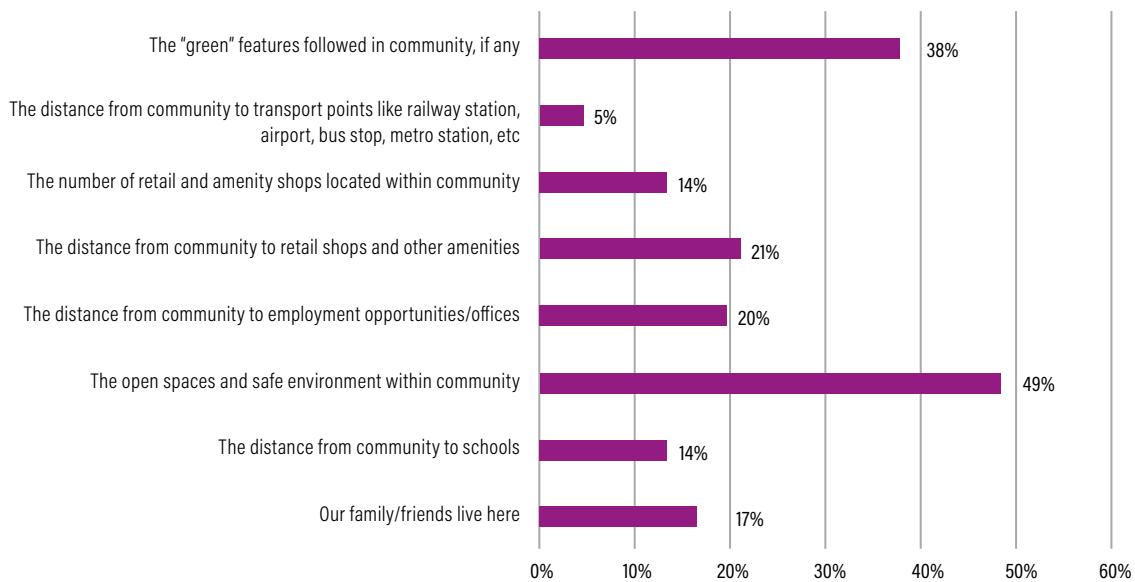
Shopping preferences

Around 65% of the respondents wanted to see a variety of accessible retail and amenity shops within the community. This indicates a demand for mixed-use.



Reasons for Choosing Current Community

Presence of safe, open spaces (49%) was one of the key reasons stated by residents for moving into their community. Distance to retail and shopping (21%) and distance to employment (20%) were next in importance.



Respondents could give more than one response, therefore percentages add to more than 100%.

Impact Evaluations Based on Changes in Travel Behaviour

As highlighted in Chapter 2, around 46% of the trips were less than 5 kilometres and 64% of the trips were carried out within 30 minutes one-way. In addition, 61% of the surveyed residents felt that the absence of a continuous and safe pedestrian network within the community hindered their motivation to walk, even for short trips less than 1.5 kilometres. Similarly, 23% of residents responded that they would cycle more if safe cycle lanes were present in the development. 35% of the residents reported that a to-and-fro shuttle between the community and the nearest public transit stop will increase their chances of utilising public transit.

These numbers were then applied to the total trips within the surveyed communities to estimate the mode shift. Using average fuel consumption data, fleet composition, for diesels and petrol cars, shares of petrol and LPG auto-rickshaws, as well as motorcycles and scooters, the potential fuel savings for a one-way trip was also calculated, as shown in Table a.

Mode Shift to Walking

The average distance of walking trips was less than or equal to 1.5 kilometres. 61% of the total trips i.e. 946 trips out of 1,551 trips would be switched to walking with an estimated savings of 43 litres of fuel per day.

Mode Shift to Cycling Trips

To calculate the mode shift to cycleable trips, all trips less than or equal to 1.5 kilometres or greater than 5 kilometres were excluded from the analysis. Walking trips and public transit trips were also not accounted for. The average cycle trip was estimated at 3.75 kilometres, with 1,178 trips moving from personal vehicles. These trips would result in an estimated fuel savings of 381 litres of fuel per day.

Mode Shift to Public Transit

All trips greater than 5 kilometres, not already on public transit, were included to calculate mode shift to public transit. The average distance of these trips was 14.9 kilometres. When applied to the total dataset, 4,884 trips would be switched to public transit. This would result in an estimated daily savings of 6,450 litres of fuel.

Table a | Fuel Changes based on Changes in Travel Behaviour

	WALKABLE TRIPS (≥ 1.5 KM)	CYCLEABLE TRIPS (1 KM $< X \leq 5$ KM)	PUBLIC TRANSIT TRIPS (> 5 KM)
Trips within Distance (Survey)	1,551	5,124	13,955
Potentially Mode-Shifted Trips	946	1,178	4,884
Average Distance (km)	0.5	3.75	15.0
Daily Fuel Savings (litres)	43	381	6,450
Daily CO₂ Emissions Prevented (kg)	64	6089,653 Annual Fuel Savings	
for 30,000 Households (six gated communities)			
Total= 2.5 million litres	15,695	1,39,065	23,54,250
Annual Emissions Prevented (CO₂) for 30,000 Households (six gated communities)			
Total= 3.8 million kg	23,360	2,21,920	35,23,345

Taken together, safe footpaths within the developments, internal bike lanes, and an internal shuttle that connects people to public transit stops to continue their journey outside the development, would save an estimated 6,873 litres of fuel every day, or about 2.5 million litres every year.

At 2014 fuel prices, the savings would be about Rs 19 crore every year—just for the residents of the six surveyed gated communities.

The Risk of Doing Nothing

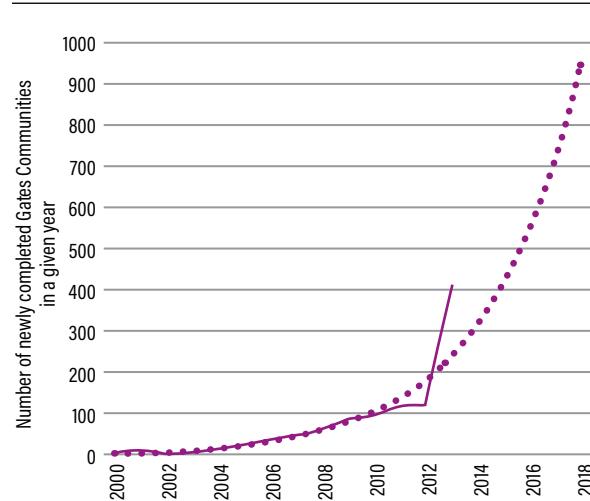
As of July 2014, there were approximately 1,500 completed gated communities in Bangalore (Bangalore Property n.d.), and around 500 projects currently under construction. As mentioned earlier, the majority of these townships are located on the periphery (60% are outside of the ring road), and the fact that 78% of the commuting is done by personal vehicles means that these communities are creating enormous challenges for already over-crowded and unsafe road networks.

Even conservative projections estimate that by 2018 there will be at least 1,000 such new communities finished every year (i.e. approximately 5000 units in total; Figure k). The number of units can vary from 200 to

3,000 per community housing 2.3 million to 6.9 million people.

Even conservative estimates reveal that the impact in terms of reduced fuel consumption and CO₂ emissions from our recommendations will be substantial. We estimated an annual fuel savings of 2.5 million litres and an annual prevention of 3.8 million kilograms of CO₂ emissions in just the 30,000 households from the six surveyed gated communities compared with the Business-As- Usual scenario.

Figure K | Number of Gated Communities Completed each Year through 2013 and Projected to 2018



Appendix D – Policy Recommendations to Integrate Sustainable Mobility in Residential Townships

This appendix summarises policy recommendations captured through engagements with participants at workshops conducted in 2014 as part of the WRI India project.

AREAS	RECOMMENDATIONS
Administrative and Governance	<ul style="list-style-type: none"> ■ Public agencies should include sustainable mobility elements as part of project evaluation criteria. This initiative should be taken up in collaboration with the Ministry of Environment, Forest and Climate Change (MoEF) and urban local bodies (ULBs) as these agencies have direct impact on the design of various developments from the stage of inception. ■ Present Development Control Regulations (DCR) of various cities, MoEF's construction manual, MoEF's Environmental Impact Assessment (EIA) Notification 2006 etc. should be reviewed and discrepancies should be highlighted. Efforts should be made to streamline and address the highlighted discrepancies. ■ Land use planning for new residential developments should consider corridor development patterns, that is, the scale of the development should be linked to the scale of mobility. Locations with existing public transport network should be targeted. This would help improve existing public transport use and avoid dependency on private vehicles. ■ DCRs should encourage traditional town planning practices of combining income groups. This enables eliminating dependency on a single mode of transport and fosters better social cohesion in the community. Mixed income group populations encourages mixed transport modes.
Approval Process	<ul style="list-style-type: none"> ■ Time taken for approval processes should be reviewed with the authorities. The entire process should be transparent so that all concerned stakeholders have complete knowledge and information before undertaking any development projects and citizens as well as investors have better access to information.
Incentives	<ul style="list-style-type: none"> ■ Development incentives in the form of financial or process-based incentives should be provided to encourage developers to work towards achieving community goals and sustainable developments. Alternately, disincentives could be used to prevent unsustainable practices. ■ Financial incentives include reduction or waiver of the approval fee, public money for street infrastructure, property tax abatements, and loans with low or discounted interest rates offered to developers building green or more sustainable developments. A disincentive could be traffic impact fees paid by developments that foster heavy reliance on private motorised modes. ■ Process-based incentives reduce the time taken for approvals, fast tracking of sustainable projects/GRIHA/IGBC. ■ Incentives for communities (and providers) that promote public transport use or shared transport use, such as a density floor space index bonus for the developer.

KEY TERMS DEFINED

Accessibility refers to ease of access to a place, person or thing, be it through mobility or proximity, or through social aspects, such as equality, affordability and gender.

Car sharing refers to private self-organised strategies to share private vehicles or public or private programs that offer semi-private vehicles to reduce the dependence on private use of vehicles.

Complete streets refers to streets for use by everyone. Streets are designed and operated to allow safe access to all its users. Pedestrians, cyclists, drivers and public transit users of all ages and abilities can move on and through a complete street. It is easy to cross the street, walk to stores and ride a bike to work.

Intermediate public transport (IPT) refers to transport networks that support public transit systems by providing commuters with last mile connectivity. This transport can be by foot, bicycle, auto-rickshaw (or e-rickshaw), taxi, mini-bus or van.

Last mile connectivity refers to trips (1) from origin to the transit stop, and (2) from the end station to the ultimate destination. These end trips to/from station areas are often made on foot, by bicycle, auto-rickshaw, taxi, shuttle bus or car/ vanpool.

Mass public transit refers to public transit systems managed by the local government, which transport a high number of users from one point of the city to another.

Mixed uses refers to the variety and combination of uses and activities that may be found within a neighbourhood, building, or architectural complex. They are an important factor in neighbourhood success because they energise public spaces and allow residents and visitors a variety of activities in a concentrated area.

Modal shift refers to the change between transport modes, usually from energy consuming modes such as single- occupancy vehicles to energy efficient and sustainable transport modes such as public transportation, biking etc.

Non-motorised transport (NMT) refers to modes of transport where no motorised system is used and only human powered movement occurs. Thus modes such as walking, cycling, wheelchairs, push carts and so on are considered non-motorised transport.

Ridesharing refers to carpools and vanpools, in which a vehicle carries additional passengers when making a trip, with minimal additional mileage. This does not include chauffeured trips in which a driver makes a special trip to carry a passenger.

Sustainable mobility refers to the mobility model that enables movement with minimal environmental and territorial impact. A sustainable mobility model favours means of transport that consume the least energy and produce less pollution per kilometre travelled. It prefers transport modes such as travel on foot, by bicycle, collective transport and ridesharing.

Traffic calming refers to the combination of street design strategies and traffic rules that deliberately reduces vehicle speeds by designing and building interventions (e.g. speed humps, raised crossings, chicanes) to improve safety for all road users, especially pedestrians and cyclists.

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ADaRSH	Association for Development and Research of Sustainable Habitats
AMC	Ahmedabad Municipal Corporation
BAU	Business As Usual
BMTC	Bangalore Metropolitan Transport Corporation
BREEAM	Building Research Establishment Environmental Assessment Methodology
BUA	Built Up Area
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CDP	City Development Plan
CNU	Congress for New Urbanism
DCR	Development Control Regulations
DHFL	Dewan Housing Finance Corporation Limited
ECBC	Energy Conservation Building Code
EIA	Environment Impact Assessment
FAR	Floor Area Ratio
FDI	Foreign Direct Investment
FSI	Floor Space Index
GHG	Green House Gas
GRIHA-LD	Green Rating for Integrated Habitat Assessment
ICT	Information and Communication Technologies
IDFC	Infrastructure development finance company
IGBC	Government of India Census
INR	Indian Green Building Council
IPT	ISO Code for Indian Rupee
IRC	Intermediate Public Transport
LAP	Indian Road Congress
LOS	Local Area Plan
LPG	Level Of Service
MNRE	Liquified Petroleum Gas
MoEF	Ministry of New and Renewable Energy
	Ministry of Environment, Forest and Climate Change
MUZ	Multi-Utility Zone
NBC	National Building Code
NIP	Neighbourhood Improvement Plan
NMT	Non-Motorised Transport
NRDA	Naya Raipur Development Authority
RWA	Resident's Welfare Association
ROW	Right-Of-Way
SBI	State Bank of India
SEZ	Special Economic Zone
TIA	Traffic Impact Assessment
TIS	Traffic Impact Study
TRP	Transit-Ready Planning
ULB	Urban Local Body
VMT	Vehicle Miles Travelled
WRI	World Resources Institute

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