

LOW-SPEED ZONE GUIDE

Empowering communities and decision-makers to plan, design, and implement effective low-speed zones



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EXECUTIVE SUMMARY

Every year approximately 1.35 million people lose their lives due to road traffic crashes. In many road crashes, speed plays a key role. As a result, managing speed has taken on great importance in cities around the world.

A popular method for reducing speed and improving road safety, especially in high-risk areas has been to establish low-speed zones.

This Low-Speed Zone Guide presents strategies for planning, designing, building, and evaluating low-speed zones. The guide intends to equip communities and decision-makers with the tools to implement low-speed zones that will suit their specific context.

HIGHLIGHTS

- Traffic crashes are a leading cause of death and serious injury worldwide; most notably, they are the leading cause of death and serious injury among young people aged 5–29. Higher motor vehicle speeds increase the likelihood and severity of crashes.
- Low-speed zones have emerged as one of the most promising strategies for speed management. They can be appropriate in many different contexts and at various scales, as exemplified by case studies of successful projects around the world.
- Low-speed zones in cities need to be well-planned, well-designed, and well-built, to maximize safety and other benefits.
- Physical traffic-calming measures and target speeds of 30 kilometers/hour (km/h) or lower have the greatest proven safety benefits.
- Key considerations for implementation include stakeholder engagement, site selection (including risk: pedestrian/vulnerable road user presence), enforcement, evaluation, and the adaptation of basic principles for low-speed zone design to the local context.

CONTEXT

Globally, road transportation is unsafe.

Roads can be dangerous places for people regardless of the mode of transport, whether they are in a car, on a motorcycle or bicycle, or on foot. However, in much of the world, roads are most dangerous for the most exposed, people walking or biking who are also the most economically and environmentally sustainable road users (Figure ES1.1). This is especially true in low- and middle-income countries (LMICs) where walking trips are often longer, and infrastructure poorer. As economies, populations, and car ownership rates are growing, so, too, are the numbers of deaths and serious injuries on the road.

There is a strong link between motor vehicle speeds, the likelihood of crashes, and the occurrence of traffic fatalities and serious injuries.

Higher speeds generate greater force, and increase the need for reaction and braking distance, resulting in more severe crashes and increased risk of serious injury or death (Nilsson 2004). Speed also affects the likelihood a crash will occur by narrowing drivers' field of vision and making it more difficult for drivers to stop or maneuver around obstacles (Stoker et al. 2015).

Low-speed zones with physical design measures have emerged as one of the most promising strategies for speed management. Pioneered in the Netherlands in the 1980s, low-speed zones have spread globally and established a track record for

improving the safety performance of streets. For example, a 2009 study of 119 48 km/h (30 miles/hour [mi/h]) streets in London found that converting them to 32.2 km/h (20 mi/h) zones with physical traffic-calming resulted in a 46 percent drop in killed and seriously injured (KSI) crashes for all ages and a 50 percent drop in KSI crashes for children aged 0–15 (Grundy 2009). In addition, research suggests that low-speed zones can have a range of economic, public health, and quality of life benefits (Tolley 2011; Steer Davies Gleave 2014; Webster and Mackie 1996; Sorrentino et al. 2015).

Not all low-speed zone implementations are equally effective. This guide considers the evidence and examples available to determine how low-speed zones can be most effectively planned, designed, and implemented in relation to the context, to make streets safe and comfortable for the people using them.

ABOUT THIS GUIDE

The intent of this Low-Speed Zone Guide (LSZ Guide) is to empower communities and decision-makers to implement effective low-speed zones. Understanding there are already many detailed technical design guidelines available that cover key design elements of a low-speed zone, strategic guidance is provided here on how to plan, design, and build streets where motorists are encouraged to operate at safer speeds through environmental design measures (Box 2.1). The target audience is decision-makers, urban planning and design

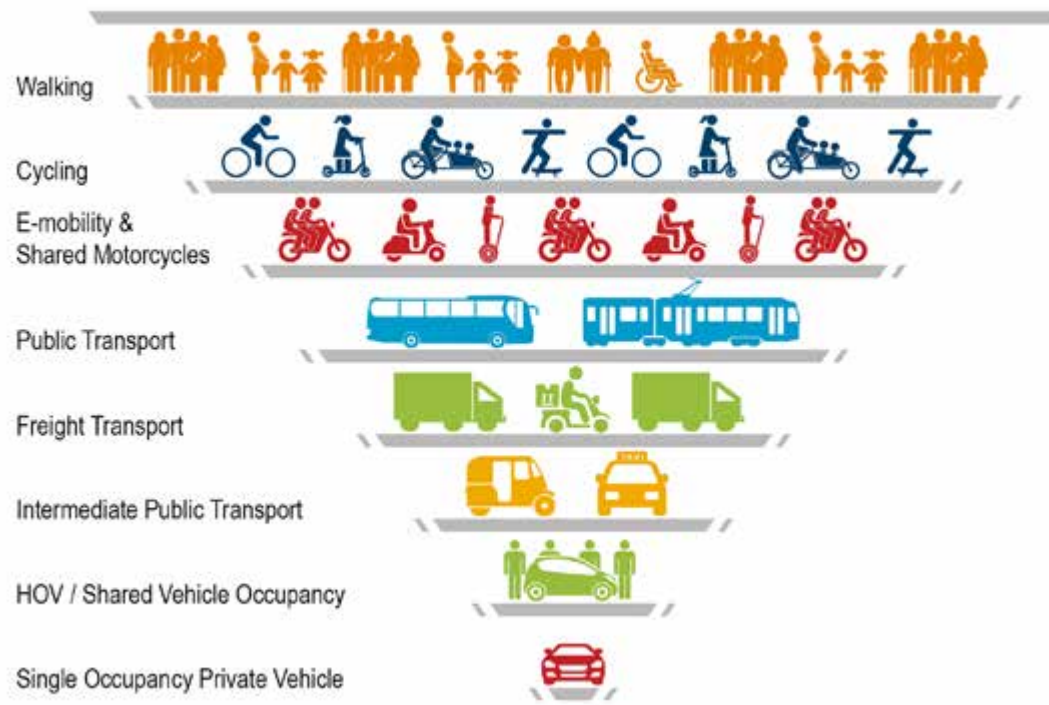
professionals responsible for designing and implementing road design projects, as well as nongovernmental organizations (NGOs) and private and community organizations with an interest in urban mobility and safe street design.

KEY PHASES FOR A LOW-SPEED ZONE IMPLEMENTATION

The **LSZ Guide** covers all phases of low-speed zone project development, including planning, design, construction, and postconstruction. It identifies key principles related to each phase and provides practical guidance for addressing them. The elements discussed include selecting sites, engaging stakeholders, identifying and securing funding sources, creating an evaluation plan, determining the zone's size and boundaries, setting target speeds, enforcing speeds, managing traffic diversion, and other related issues.

The **design section** discusses key design principles and provides guidance on how to approach each component of low-speed zone design, including transitions, gateways, streets, and intersections. Through clear, concise text and illustrative graphics, the **LSZ Guide** explains how to coordinate components to lower speeds; improve pedestrian, bicycle, and public transport access; and achieve other project goals in a variety of contexts.

Figure ES1.1 | Vulnerable Users—Pedestrians, Cyclists, and Motorcyclists



Note: Pedestrians, cyclists, and motorcyclists are considered vulnerable because they lack external protection.

Source: Adapted from the Green Transportation Hierarchy proposed by Chris Bradshaw in 1994.

Finally, the **LSZ Guide** discusses strategies for the construction and postconstruction phases of low-speed zone implementation. The strategies discussed include constructing low-speed zones on an interim or pilot basis if these need to be implemented quickly, if funding is insufficient, or to test out or demonstrate the impacts. Stakeholder and public education and ongoing monitoring and evaluation are also discussed.

CONCLUSIONS

Stakeholder engagement may be especially important in the case of low-speed zones. Despite the benefits, low-speed zones can be controversial due to concerns about traffic diversion to adjacent streets, traffic delays, noise, economic impacts, questions about fuel consumption and emissions, and other issues. If there is concern about a low-speed zone project, consider implementing it on a temporary or pilot basis before constructing it permanently.



The engagement of funding agencies, either public or private or both, is critical to both the implementation and maintenance of a low-speed zone. Involving stakeholders and key actors will also help identify and resolve any objections or conflicts that may emerge and address any misinformation or misperceptions. This guide also provides resources and information that will help to show the value of low-speed zones, for use in advocacy and for promotion of the concept.

The process of selecting low-speed zone candidate sites generally involves the consideration of three components—need, suitability, and feasibility.

Need involves an assessment of safety risks. Suitability evaluates a given location for implementation. Feasibility looks at a financial cost, a community's needs, demand, support, and legality of a low-speed zone.

Low-speed zones can vary in size from a single block on one street to an entire neighborhood, urban district, or city.

It is generally recommended that low-speed zone boundaries align with significant features of the urban landscape. Significant features may include major streets, train tracks, large parks, and existing neighborhood, commercial, or village boundaries or any visually prominent element. Low-speed zones can be scaled to eventually form a low-speed zone city and still be successful.

It is recommended that communities select target speeds of 30 km/h or lower due to the safety benefits, particularly for pedestrians (Rosen and Sander 2009).

Target speeds lower than 30 km/h may be appropriate in several circumstances, such as in the case of a shared street space or a school zone. The target speed should not exceed the speed limit but may be lower than the limit.

Ideally, low-speed zones are self-enforcing by design. Self-enforcing implies a physical design of the zone that leads people

to drive no faster than the target speed. In some instances, it may be necessary to conduct enforcement activities in the low-speed zone to obtain target speed compliance.

Low-speed zones that do not feature physical design changes are not effective.

A UK study of 250 32.2 km/h (20 mi/h) zones with physical traffic-calming measures found that average speeds fell by 15 km/h (9.3 mi/h) after implementation (Webster et al. 1996), in contrast to a study that found that the same speed limit change without physical traffic-calming resulted in an average drop of only 1.6 km/h (1 mi/h) (Mackie 1998).

Monitoring and evaluation are critical for understanding how successful a low-speed zone is in achieving the goals and objectives established, and whether any adjustments are needed to improve performance. The development of an evaluation plan is highly recommended. Ideally, evaluation should include consideration of impacts on commerce (if relevant) as well as safety and other public goods.

Early wins support political will for low-speed zones. Judicious selection of the first locations to be treated and evaluation of these are vital for sustaining political will. The first locations should be those with strong baseline data of crashes, victims, and other features that allow for a demonstration of success.



CIRCULATION INTERDITE
À TOUS LES VÉHICULES

SAUF



ET VÉHICULES
AUTORISÉS

TRAFFIC
LIMITÉ





INTRODUCTION

Speed is a key factor in road traffic injuries, influencing both the risk of a road crash as well as the severity of the injuries that result from crashes. Low-speed zones have emerged as one of the most promising strategies for speed management. This guide provides guidance on how to plan, design, and build streets where motorists are encouraged to operate at safer speeds through environmental design measures. It includes background on their history and benefits, and case studies illustrating low-speed zone implementation across the globe.

Motor vehicle speed is a factor in almost every crash. The link between motor vehicle speed and traffic fatalities or serious injuries is well-established. In high-income countries, speed is identified as the leading factor in about 30 to 40 percent of traffic fatalities. In low- and middle-income countries, the impact is much greater, with motor vehicle speeds estimated

as the leading factor in almost half of all traffic fatalities (WHO 2015). These figures are almost certainly significant underestimates. The real extent of the contribution of speed is significantly underestimated in most police statistics because in many crashes where speed was a factor this is not apparent or provable by police after the crash has occurred (Job and Sakashita 2016).

Cities around the world are working to manage motor vehicle speeds toward reducing fatalities and enhancing livability. Low-speed zones have emerged as one of the most promising strategies for speed management.

Box 2.1 | About This and Other Guides by World Resources Institute and World Bank Global Road Safety Facility

The Low-Speed Zone Guide (LSZ Guide) provides guidance on how to plan, design, and build streets where motorists are encouraged to operate at safer speeds through environmental design measures. It includes background on the history and benefits of low-speed zones, and case studies illustrating low-speed zone implementation across the globe.

The LSZ Guide is intended for decision-makers and urban planning, traffic engineering, and design professionals responsible for designing and implementing road design projects, as well as for private and community organizations with an interest in urban mobility and safe road design.

The LSZ Guide builds upon *Cities Safer by Design*, which was published by World Resources Institute (WRI) in 2015; *Sustainable and Safe: A Vision and Guidance for Zero Road Deaths*, published by WRI and Global Road Safety Facility (GRSF) in 2018; *The High Toll of Traffic Injuries: Unacceptable and Preventable*, published by GRSF in 2018; and *The Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Country Profiles*, published by GRSF in 2020.

Cities Safer by Design provides real-world examples and evidence-based techniques to improve safety through neighborhood and street designs that emphasize pedestrians, bicycling, and mass transport, and reduce speeds and unnecessary use of private vehicles.

Sustainable and Safe describes the components of the “Safe System” approach to road safety, which serves as the underlying principle for Vision Zero and related efforts. The Vision Zero strategy aims to eliminate all traffic fatalities and severe injuries while increasing safe, healthy, and equitable mobility for all. *Sustainable and Safe* provides guidance for policymakers on how to develop a context-specific Safe System–based road safety strategy and discusses general principles for street design and engineering.

The High Toll of Traffic Injuries: Unacceptable and Preventable proposes a comprehensive methodology to quantify both the income growth and social welfare benefits that safer roads could bring to developing countries. The study shows that

reducing the number of traffic deaths and serious injuries in developing countries not only increases income growth but also generates substantial welfare benefits to societies.

The Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Country Profiles gives a precise assessment of the magnitude and complexity of road safety challenges faced by low- and middle-income countries (LMICs) and helps policymakers understand the road safety framework in the context of their country systems and performance. The guide also helps countries to build and appreciate the business case for vital road safety investment.

This guide fills a vital gap by comprehensively considering low-speed zones. These are not addressed significantly in the above documents, or other documents published by the sector, such as *Speed Management: A Road Safety Manual for Decision-Makers and Practitioners* or *Pedestrian Safety: A Road Safety Manual for Decision-Makers and Practitioners* (GRSP 2008; WHO 2013).

WHAT IS A LOW-SPEED ZONE?

The primary goal of low-speed zones is to reduce motor vehicle speeds in a defined area to improve the safety of people walking, bicycling, using electric scooters or other human-scale mobility modes, accessing public transport, or driving a motorbike or car. Reducing vehicle speeds is key to improving road safety because it reduces the chances of crashes and their severity if they do occur. The “defined area” can vary in size from a single block (e.g., a school zone) to an entire residential neighborhood, commercial district, or city, depending on the

classification of the streets and the capacity of the wider traffic network. Within the low-speed zone, traffic-calming measures help keep motor vehicle speeds below a certain target speed.

A variety of strategies can be implemented to encourage speeds below the target speed. The most important strategy is design features that encourage slower speeds, but other strategies include enforcement, education, and changes in speed limits. Typically, the most effective approach is a combination of strategies. This can generate a variety of benefits (Boxes 2.2, 2.3).

Box 2.3 | Safety Benefits of Low-Speed Zones in London

An analysis of 20 miles/hour (mi/h) (32.2 kilometers/hour [32.2 km/h]) zones in London found a 46 percent reduction in killed and seriously injured (KSI) crashes overall and a 50 percent reduction in KSI crashes for children 0–15 inside the zones. The benefits extended to adjacent areas as well, where KSI crashes declined by 8 percent (Grundy 2009).

Box 2.2 | Benefits of Low-Speed Zones

Low-speed zones have many benefits, including the following:

- **Fewer traffic fatalities and serious injuries** (Grundy 2009).
- **Increased physical activity and play** due to improved comfort for people using active modes (Turley 2013).
- **Improved quality of life** through reduced cut-through traffic and traffic noise (Webster and Mackie 1996; Sorrentino et al. 2015; Job 1988).
- **Economic development** via environments that feel safer and are more inviting to people on foot, which encourages them to linger, socialize, and shop (Tolley 2011).
- **Improved public health** through reduced emissions and increased physical activity related to walking and biking (Steer Davies Gleave 2014).





THE IMPORTANCE OF LOW-SPEEDS FOR SAFETY

The LSZ Guide focuses on low-speed zones in urban areas with developed land uses that are designed for speeds of 30 kilometers/hour (km/h) and lower and include physical design measures to control speed. The 30 km/h (20 miles/hour [mi/h]) target is significant because research suggests that below 30 km/h (20 mi/h), the risk of a pedestrian fatality in a crash with a motor vehicle is relatively low (approximately 5–10 percent, depending on the study). The risk of serious injury for pedestrians reaches 10 percent at speeds of 20 km/h (Jurewicz et al. 2016). The risks of both death and serious injury increase exponentially as speed rises above 30 km/h (20 mi/h).

A meta-analysis of data from 15 studies on the relationship between pedestrian fatalities and vehicle speeds found that for each 1 km

increase in impact speed, there is an 11 percent increase in the likelihood of a pedestrian fatality and a 7 percent increase in the likelihood of a serious injury. The authors found that “these results provide support for prescribing speed limits of 30 and 40 km/h for high pedestrian active roads...[because] the risk of pedestrian fatalities increases more rapidly for any small increase in the impact speed between 30–70 km/h compared to the other speed regimes (Hussain et al. 2019, 246) (Box 2.4).

The study “found that an impact speed of 30 km/h has on average a risk of a fatality of around 5 percent. The risk increases to 13 percent for an impact speed of 40 km/h and 29 percent at 50 km/h” (Hussain et al. 2019).

In addition to the risk of death, consideration of the risk of serious injury is vital, because serious injuries are much more common (with 15 or more serious injuries for each fatality [Wambulwa and Job 2019]); serious

injuries can generate lifetime disabilities; they generate more of the economic cost of crashes than do deaths. A safe system is one in which crash forces are limited to those in which the human body can survive without serious injury or death. For pedestrians, lower speeds can still cause a serious injury. The analysis of Jurewicz et al. (2016), employing a rigorous definition of serious injury (a score of 3 or higher on the Maximum Abbreviated Injury Scale [MAIS], MAIS3+), showed that approximately 10 percent of pedestrians will be seriously injured if hit at 20 km/h.

Studies have identified four factors that strongly indicate that to protect pedestrians from serious injury or death, speeds of 20 or 30 km/h are required. First, the Hussain et al. (2019) study also noted that it could not take into account contextual and personal variables such as victim age and physical characteristics, vehicle type, and quality and speed of emergency response, all of which may lower the chance



of survival. Second, as noted above, the risk of serious injury escalates rapidly above 10 percent with speeds over 20 km/h. Third, earlier studies indicate that the risk of death is higher than the (Hussain et al. 2019) study indicates, with 10 percent of pedestrians being killed at 30 km/h (e.g., Wrangborg 2005). Consistent with this, the Hussain et al. study also found that the risk of death was higher in earlier studies, with reductions in risk of death for given speeds appearing in the most recent studies. A likely and relevant interpretation of this discrepancy is that in high-income countries (HICs), the most modern vehicles with good pedestrian protection scores are reducing the risk of fatality. However, this is deeply concerning for LMICs with generally weak pedestrian protection standards in the vehicle fleet, meaning that the risk of death for a pedestrian is likely to be higher in LMICs than in HICs for the same speed. Fourth, this higher risk in LMICs may also be exaggerated with a less rapid and effective postcrash response.

These factors all provide further rationales for keeping the speed limit at 30 km/h or below in locations with vulnerable users.

Lower speeds improve safety for all other road users. The decrease in risk of death for bicycle and motorcycle riders with speed reductions from 50 km/h to 30 km/h are similar to the reductions achieved for pedestrians. Vehicle occupant safety is also significantly improved. For example, the risk of death in a head-on crash is substantially reduced (Wrangborg 2005; Tefft 2011), and the risk of serious injury in a rear-end collision is more than halved (Jurewicz et al. 2016).

THE VALUE OF ROAD DESIGN FOR MANAGING SPEED

The LSZ Guide emphasizes the role of street design in producing safe motor vehicle speeds. This is often referred to as self-enforcing

design. Although motor vehicle speeds are influenced by many factors, research suggests that street design plays the most significant role. For example, a UK study of 250 32.2 km/h (20 mi/h) zones with physical traffic-calming measures found that average speeds fell by 15 km/h (9.3 mi/h) after implementation (Webster and Mackie 1996). A subsequent study by the same research agency found that changing the speed limit to 32.2 km/h (20 mi/h) without physical traffic-calming resulted in an average drop of only 1.6 km/h (1 mi/h) (Mackie 1998) or only 10 percent of the impact achieved through physical measures. The contrast between levels of impact demonstrates the importance of including design features in a low-speed zone. Furthermore, physical design features can bring other benefits to the zone at the same time, such as improving the visibility of pedestrians to car drivers and reducing their exposure time while crossing the road. Evidence from Mexico City shows that as the maximum



pedestrian crossing distance at an intersection increases by 1 meter (m), the frequency of pedestrian crashes increases by up to 3 percent (Duduta et al. 2015). Each additional lane (another measure of street width) also increases crashes at all severity levels (Duduta et al. 2015).

WHAT ARE THE STEPS TO DEVELOP A LOW-SPEED ZONE?

The process of establishing a low-speed zone typically includes a planning phase, a design phase, a construction phase, a postconstruction phase, and political, decision-maker, and stakeholder engagement throughout (see Figure 2.3. This may be a linear process, but the greater likelihood is that there will be some level of iteration required.

Also, in some instances, advocacy to develop the political will and approval of decision-makers in cities and at the state or national level may need to take place before the planning stage can begin and need to continue throughout the process.

- **The planning phase** involves defining goals and objectives; identifying key laws, policies, and guidelines; selecting sites; creating an evaluation plan; collecting and analyzing baseline data; determining key parameters such as the size and target speed for the zone; and developing recommendations for design and implementation.
- **The design phase** involves developing and advancing specific design and (if appropriate) regulatory measures that will be used in tandem to reliably reduce motor vehicle

Box 2.4 | Low-Level Speeding

In speed management, there is a tendency to focus on instances of extreme speeding (often defined as exceeding the limit by 30 km/h or more). Based on the known changes in the risk of a fatal crash, this seems justified. For example, applying Nilsson's curve (Nilsson 2004) in a 60 km/h zone shows that exceeding the limit by 5 km/h will increase fatality risk by 33 percent on average. Exceeding the limit by 10 km/h generates a 66 percent increase in fatality risk, which is substantial but not as high as the increased risk at 30 km/h above the limit, which produces more than a 200 percent increase in fatality risk.

However, this misses a vital point: many more people speed by 5 or 10 km/h above the limit compared with 30 km/h or more above the limit. If in each hour, 20 people are exceeding the speed limit by around 5 km/h while 2 drivers are exceeding it by 30 km/h, then the "low-level speeding" will produce more fatalities (20 times a 33 percent increase = 660, versus 2 times a 200 percent increase = 400). The actual risk of each level of speeding can be assessed if the frequency profile of speeding is known. Such a study exists in Australia, which shows that in a 60 km/h zone, because this level of speeding is much more common, drivers speeding by 1 to 10 km/h above the

limit generate 30 percent of fatalities of those exceeding the speed limit; while drivers exceeding the limit by 30 to 45 km/h above the limit contribute 6 percent of such fatalities; and those exceeding the limit by 45 km/h or more above the limit contribute 1 percent of these fatalities. Thus, managing the extreme speeders produces only small reductions in deaths, while managing all speeding results in large reductions in deaths. The same pattern applies to serious injuries. A simple tool exists by which the contribution of each level of speeding to deaths and injuries can be estimated.

Source and tool: Gavin et al. 2011.

Figure 2.3 | Process to Establish a Low-Speed Zone



Source: Authors.

speeds to the target speed or below throughout the zone. The design phase also involves producing the necessary documentation to enable the project to move into construction. The design phase should consist of a preliminary design where design measures to achieve the objectives of the zone are identified, followed by the development of a detailed technical design. A road safety audit of the designs can be vital in identifying issues to be addressed in revisions of designs before construction begins.

- **The construction phase** involves the on-site implementation of the low-speed zone. The construction phase may also include a

temporary on-site simulation of the proposed design to evaluate its potential impact and build support for more permanent implementation.

- **The postconstruction phase** includes operational activities such as speed enforcement, community education and outreach, any necessary maintenance, and monitoring and evaluation to determine the zone's effectiveness. It may also include refinements to the zone, which may be identified during monitoring and evaluation.
- **Stakeholder engagement** involves soliciting input and support from elected officials, government decision-makers and

technical experts, residents, businesses, potential funding agencies, and others, using a range of techniques. The engagement of funding agencies, either public, private, or both, is critical to both the implementation and maintenance of a low-speed zone. Involving stakeholders and key actors will also help identify and resolve any objections or conflicts that may emerge, and address any misinformation or misperceptions. Stakeholder engagement is necessary for all phases of low-speed zone development. The evidence presented in this guide on safety improvements as well as many other gains can provide a basis for demonstrating the value of low-speed zones to stakeholders.



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THE BACKGROUND TO LOW-SPEED ZONES

After the introduction of the automobile, many streets were redesigned to accommodate higher motor vehicle speeds and volumes. As a result, the use of private cars and rates of traffic fatalities increased. This chapter discusses how governments began recognizing the need for speed management in urban areas with complex traffic patterns and large numbers of vulnerable road users.

Streets can be more than thoroughfares for getting from one location to another—they can be places where children play, neighbors socialize, and street vendors peddle their wares, as shown in Figure 3.1. However, after the introduction of the automobile, many streets were redesigned to accommodate higher motor vehicle speeds and volumes. The redesign established a system of traffic controls and other measures that tended to emphasize motor vehicle priority and deemphasize the street’s role as a place for social, economic, and cultural exchange. Traffic laws and regulations also changed to prioritize fast motor vehicle speeds over the safety of people using other modes of transport. Over time, societies and their economies became more reliant on motor vehicles and more tolerant of the detrimental effects of higher motor vehicle speeds. As a result, the use of private cars and rates of traffic fatalities increased.

Around the world, driving as a means of transport continues to become more prevalent each year. The number of vehicles increased

by 27 percent globally from 2005 to 2015, with predominantly LMIC regions increasing much more than the average (60 percent increase in Latin America, and a 141 percent increase in Asia [Wambulwa and Job 2019]). According to WHO’s (2018) *Global Status Report on Road Safety 2018*, “With an average rate of 27.5 deaths per 100,000 population, the risk of a road traffic death is more than three times higher in low-income countries than in high-income countries, where the average rate is 8.3 deaths per 100,000 population. Furthermore, as shown in Figure 3.2, the burden of road traffic deaths is disproportionately high among low- and middle-income countries in relation to the size of their populations and the number of motor vehicles in circulation.”

At the same time, vulnerable road users—users with less physical protection and thus higher risk in traffic, such as pedestrians, bicyclists, and motorcycle drivers—account for almost half of all deaths on the world’s roads. In the Africa Region, for example, 44 percent of all traffic fatalities are pedestrians

Figure 3.1 | Malleswaram, Bangalore, India

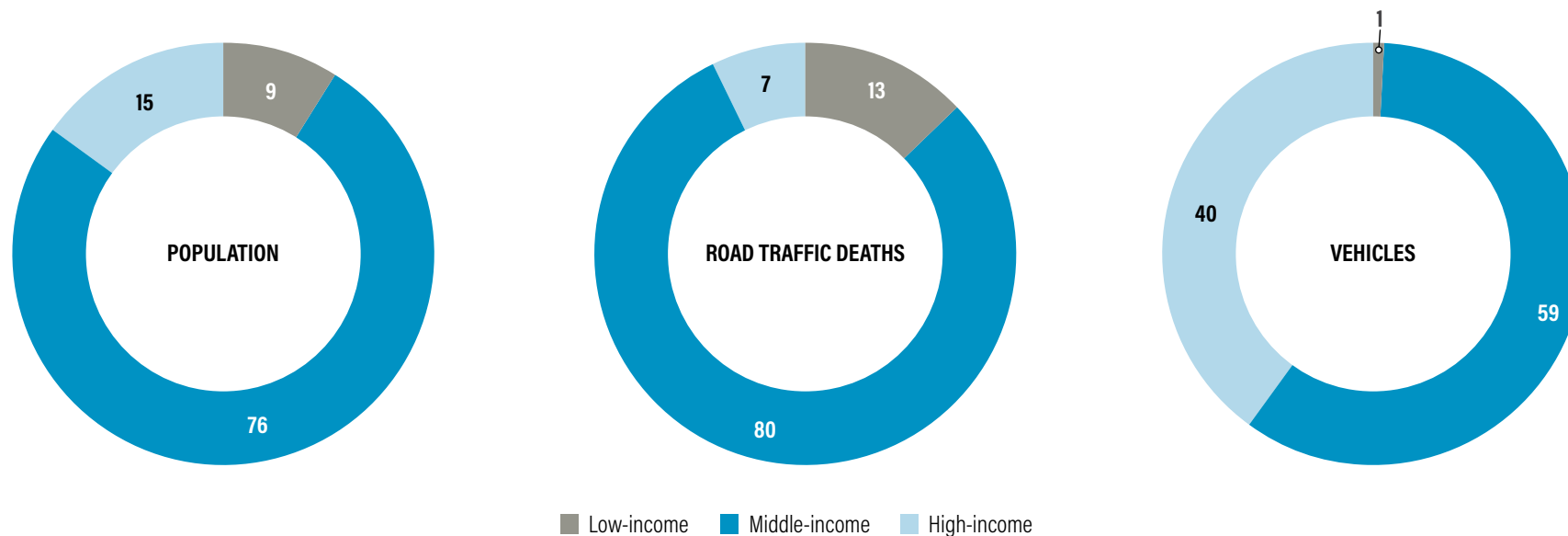


Photo: Wendy North/flickr.

and bicyclists (WHO 2018). In addition, the proportion of fatally injured people who are vulnerable road users is almost certainly underestimated due to underreporting because a vulnerable road user crash is less likely to be reported to the police than other crashes (see Wambulwa and Job 2019, 21–22). Children and the elderly are also at-risk and deserve particular consideration as pedestrians.



Figure 3.2 | Percent Population, Road Traffic Deaths, and Registered Vehicles by Country Income Status, 2015



Note: Income levels are based on 2017 World Bank classifications.
Source: WHO 2018.

THE EMERGENCE OF THE SAFE SYSTEM AND SPEED MANAGEMENT

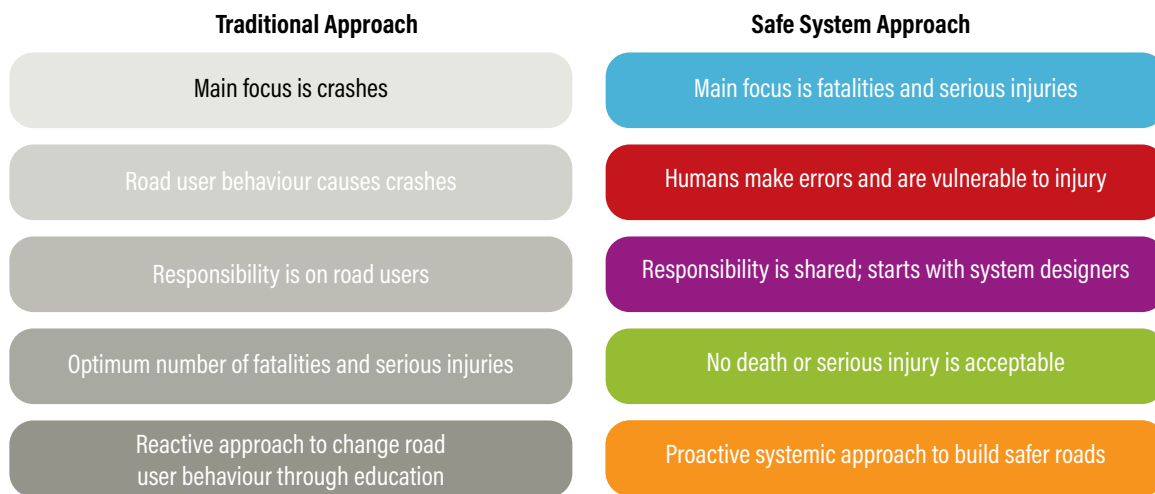
In the 1980s, European governments began recognizing the need for speed management in urban areas, where traffic patterns are more complex and where the number of vulnerable users is high. Governments started shifting to approaches that used infrastructure to influence road user behavior. In the early 1980s, the Netherlands pioneered the implementation of low-speed zones with physical traffic-calming measures. This was followed in the early 1990s

by the Vision Zero and the Sustainable Safety initiatives in Sweden and the Netherlands, respectively (Vision Zero Initiative 2017).

These initiatives transformed the traffic safety paradigm from one focused on addressing individual behavior through enforcement, education, and marketing campaigns to a more systemic approach in which responsibility for traffic safety is considered a responsibility shared by all who contribute to the mobility system. This includes street and transportation designers and those working in related land use fields as well as political decision-makers,

vehicle manufacturers, private fleet operators, and individual road users. This approach is referred to as the “Safe System approach” and is based on the principle that human error is inevitable and should be anticipated and accommodated in the design of the mobility system. For more information on the Safe System approach, see WRI’s guidance *Sustainable and Safe: A Vision and Guidance for Zero Road Deaths*, published in 2018. Figure 3.3 below, from the aforementioned guide, compares the principles of the Safe System approach to the traditional approach.

Figure 3.3 | Comparison between Traditional and Safe System Approaches to Road Design

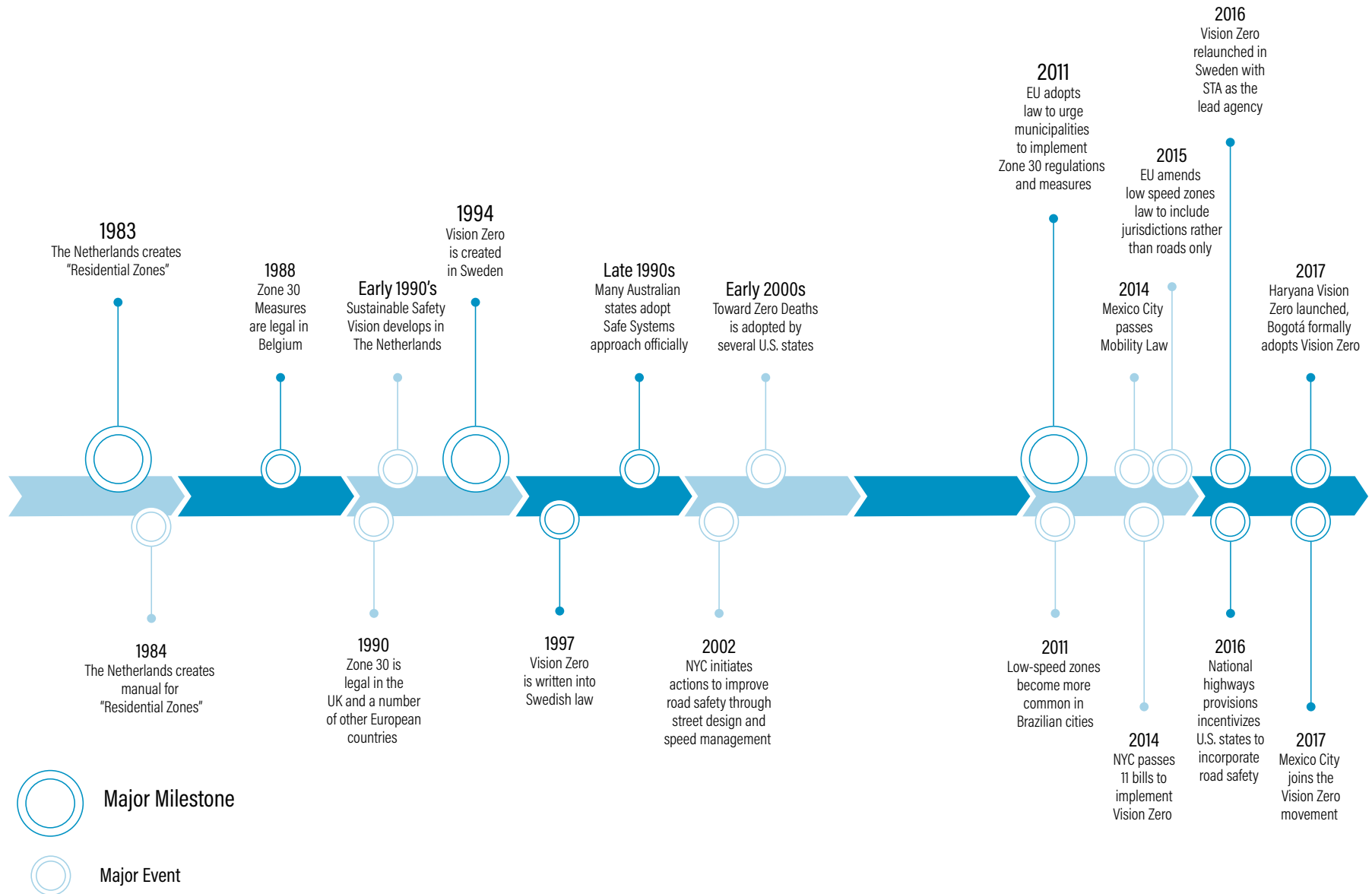


In the last two decades, Safe System approaches to traffic safety have evolved and spread around the world, especially in Europe, the Americas, Australia, and New Zealand (Mooren et al. 2011; SWOV Institute for Road Safety Research 2009). Low-speed zones have been a vital parallel development to the Safe System, with 30 km/h zones first introduced in the 1980s (Figure 3.4).

Sources: Belin 2015; Belin et al. 2012; Welle et al. 2018.



Figure 3.4 | Time Line of the Evolution of Low-Speed Zones and Other Safe System Initiatives throughout the World



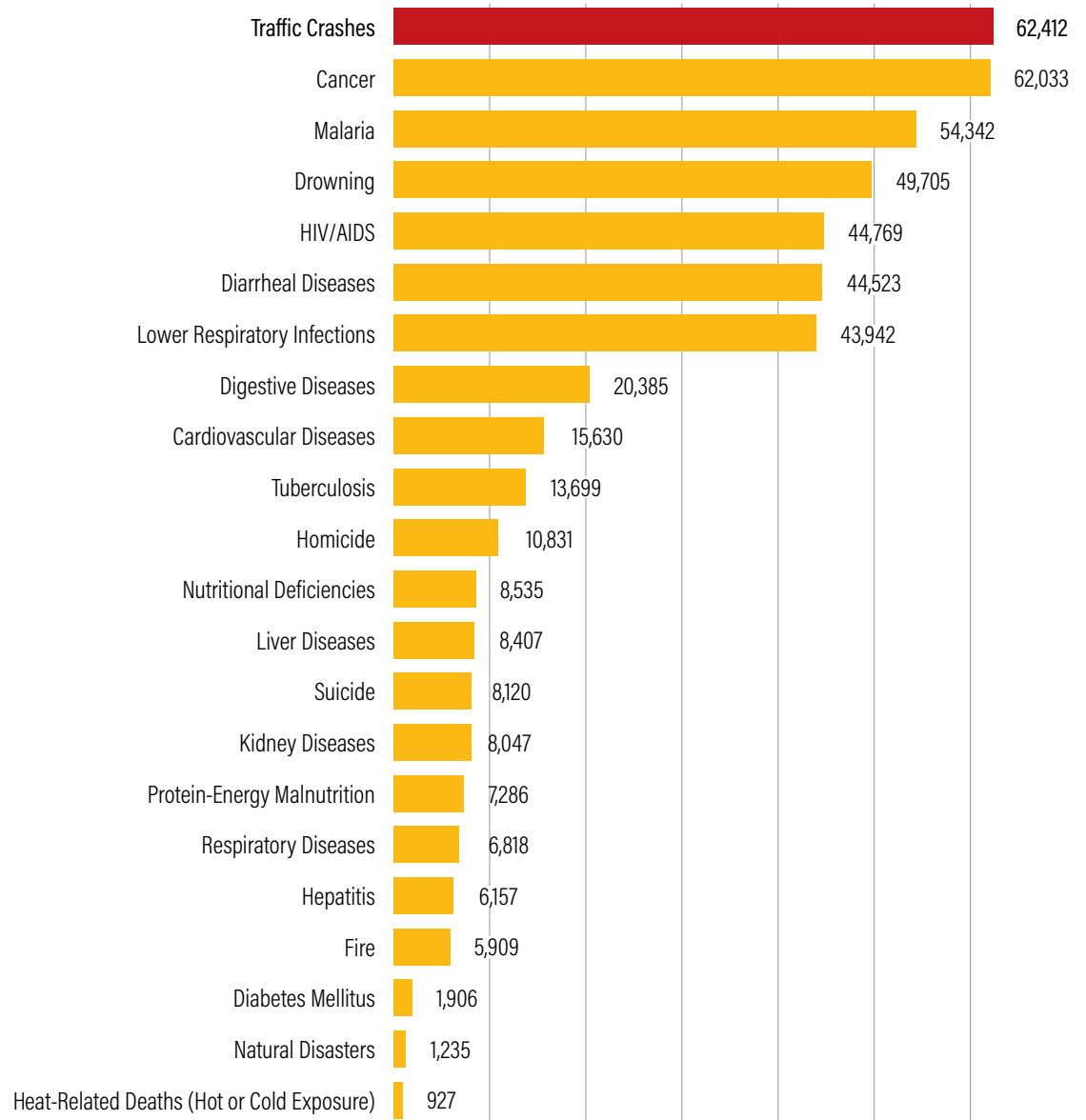
Notes: STA = Swedish Transport Administration; EU = European Union.

Sources: Compiled by authors using information from SWOV Institute for Road Safety Research 2009; ITDP 2015; Vision Zero Initiative 2017; Welle et al. 2018.

THE CURRENT ROAD SAFETY SITUATION

Despite this progress, traffic crashes are still a leading cause of death and serious injury, particularly among people aged 15–29 (Figure 3.5). In addition, the WHO estimates that road traffic injuries will be the fourth-largest cause of healthy life years lost in developing and emerging countries by 2030. From 2015 to 2030, the WHO estimates that road traffic deaths will be the biggest cause of healthy life years lost for children aged 5–14 at nearly one in four deaths unless measures are taken to prevent them (Mathers and Loncar 2006). In the vast majority of countries, street design continues to prioritize motor vehicle speed and volume over human life and safety (NACTO 2016). Low-speed zones are a tool for reversing this trend.

Figure 3.5 | Causes of Death among People Aged 5–14 around the World



Source: IHME, Global Burden of Disease 2017.





WHAT TO CONSIDER WHEN PLANNING A LOW-SPEED ZONE

This chapter discusses the fundamental stages in low-speed zone planning, including defining goals and objectives; identifying key laws, policies, and guidelines; selecting sites; mapping stakeholders; creating an evaluation plan; collecting baseline data; determining key parameters; and developing recommendations for design and implementation.

This section discusses key steps in low-speed zone planning, including defining goals and objectives; identifying key laws, policies, and guidelines; selecting sites; mapping stakeholders; creating an evaluation plan; collecting baseline data; determining key parameters; and developing recommendations for design and implementation (Box 4.1).

The information reflected in this section is based on the firsthand experience of the authors in supporting and guiding cities and states to facilitate, design, and implement low-speed zones, based on the literature and studies demonstrating the benefits and supplemented by the additional findings in case studies.

Box 4.1 lists key steps for planning a Low-Speed Zone, as explained in this chapter.



Box 4.1 | Planning Checklist

- Establish the overall framework for the zone:
 - Determine goals, objectives, and performance indicators
 - Identify key laws, policies, and government agencies
 - Identify key source(s) of funding
- Gather information on the local context:
 - Identify and engage with stakeholders
 - Take the wider street network into consideration
- Select site or sites
 - Collect baseline data and conduct site visits
- Set key parameters for the design and operation of the zone
 - Determine the size of the zone
 - Define the zone's boundaries
 - Set the target speed
 - Estimate impacts of the zone
 - Assess the feasibility of implementing the zone
- Develop recommendations for implementation
 - Create an evaluation plan
 - Evaluate the need and options for speed enforcement

Note: The planning process may be iterative rather than linear. For example, stakeholder engagement might redefine goals and objectives.
Source: Authors.

Box 4.2 | Examples of Goals and Objectives

- Goal: Improve safety
 - Objective: Motor vehicle operating speeds of 30 km/h and below
 - Objective: No killed and seriously injured (KSI) crashes
- Goal: Improve environmental sustainability
 - Objective: Increased walking, bicycling, and public transport use
 - Objective: Increased green infrastructures, such as bioswales,* permeable pavements, and trees
- Goal: Improve equity
 - Objective: Stakeholders from low-income and minority populations engaged in all phases of low-speed zone development
 - Objective: Low-speed zone design meets the needs of minority and vulnerable community members (real and perceived safety and accessibility)

- Goal: Improve economic development
 - Objective: Increased business revenue

Note: Bioswales are landscape elements designed to serve as stormwater runoff systems that provide an alternative to storm sewers by infiltrating the first flush of stormwater through select vegetation.

Source: Authors.

ESTABLISH THE OVERALL FRAMEWORK FOR THE ZONE

DETERMINE GOALS, OBJECTIVES, AND PERFORMANCE INDICATORS

It is important to determine the goals, objectives, and performance indicators of a low-speed zone development process early in the planning phase. Goals define the broader aspirations of the project, while objectives define measurable attainments that relate to the goal and are needed to achieve it (Box 4.2). Together, goals and objectives provide a roadmap for the planning, design, construction, and postconstruction phases of the project.

When formulating goals and objectives, consider the following questions: What prompted the low-speed zone project? What problems is it meant to resolve? Who has a stake in the outcome? Do some stakeholders have different objectives?

Involving key stakeholders in the goal-setting process is another way to build support, as well as to identify and resolve any objections or conflicts that may emerge.

Also, consider goals and objectives that have already been established in your city or community that may also support low-speed zone development. Linking low-speed zone goals to broader community goals can help build support for the project.

IDENTIFY KEY LAWS, POLICIES, AND GOVERNMENT AGENCIES

At the outset of the planning process, it is important to understand how existing laws, plans, policies, and design guidelines relate to low-speed zones:

- **National and local laws** often set relevant legal parameters. For example, they may prescribe a minimum speed limit or establish specific requirements for low-speed zones (Box 4.3).

Box 4.3 | Achieving Safe Speed Limits around Schools in Dar es Salaam, Tanzania

The legal speed in Dar es Salaam, Tanzania, on most urban roads is 50 km/h. The national law does not specify the need for slower speeds in higher priority areas like school zones. Although the law does not restrict slower speeds, it does not facilitate implementing them either. For the School Area Road Safety Assessments and Improvement (SARSAI) team to be able to implement a 30 km/h speed around schools, they had to meet with the local authorities, present their case, and convince them of the need for slower speeds due to the high risk of traffic crashes involving schoolchildren.

Source: Kalolo 2018b.

- **Plans and policies** may provide support for low-speed zones, even if low-speed zones are not explicitly mentioned. For example, if the local or national government has adopted goals related to traffic safety in a Vision Zero or road safety plan, an effective strategy might be to show how low-speed zones align with them. In addition to road safety, low-speed zones may also be aligned with other local goals such as environmental improvement plans and/or efforts to boost tourism or other economic activity.

- **National and local road design guidelines** may also influence how low-speed zones are designed. These guidelines may establish standards for things like travel lane widths, signs, signals, pavement markings, traffic-calming measures, and accessibility requirements. Be aware that some design guidelines may not support low-speed zone design. In such cases, it may be necessary to change the guidelines or seek exceptions. It is also important to understand where existing guidelines allow design flexibility.

IDENTIFY KEY SOURCE(S) OF FUNDING

Securing funding, either public, private, or a combination, is key to both the installation and maintenance of a low-speed zone. The funding source(s) will vary depending on the institutional set up of local public and private organizations, as well as the scale and cost of the project. In some cases, such as New York City, there is a clear application process to receive city resources for implementing a low-speed zone, or the entire process is led by a city department that already has a budget for such activities.

In other cities where the concept may be less developed, or it is being driven by organizations external to government, identifying funding opportunities will be a more complex process. As a starting point, it is important to identify the department that has control over a road safety or capital improvement budget, as it will be the most likely entity. It can also be helpful to explore lateral options and seek flexible sources of funding. For example, low-cost projects may be eligible for funding from maintenance budgets, while temporary or medium-term projects may be eligible for event or socially oriented funding. Private or community-level funding sources such as business associations or improvement districts can also be explored.

GATHER INFORMATION ON THE LOCAL CONTEXT

IDENTIFY AND ENGAGE WITH STAKEHOLDERS

Stakeholders and stakeholder engagement practices vary considerably by context and culture. However, stakeholder engagement and public participation is typically a necessary step in determining where low-speed zones should be implemented, deciding between alternative configurations, understanding other potential impacts, and building support for low-speed zone implementation (Box 4.4).

Government representatives are particularly important to engage. When thinking about which agencies to involve, consider:

- Which agencies have authority over the zone's physical infrastructure, including vehicular lanes, sidewalks, streetlights, drainage systems, landscaping, utilities, and other elements.
- Which agencies have an interest in the zone's design and function. Examples include public transit agencies and agencies that oversee cultural and historical resources.
- Which agencies have authority and jurisdiction to provide funding to the project design, implementation, or maintenance.
- Which agencies will be responsible for key elements of the zone's planning and implementation, such as public outreach, construction, maintenance, and evaluation.
- Which agencies will be responsible for enforcing laws and regulations within the zone, including speed limits.
- Which agencies will be operating emergency services within the zone, and what influence will they have over the street design process.
- How to ensure the engagement of officials with enough seniority to have decision-making power.
- How the respective agencies' incentive structures (e.g., mandates, budget, performance goals, etc.) align with the project.
- How to engage high-level political leadership to ensure that agencies know there will be upward accountability.

Box 4.4 | Involving Local Stakeholders in Low-Speed Zone Planning in Bogotá, Colombia

The team working on implementing a low-speed zone in Tunjuelito, Bogotá, made sure to involve the local road safety engineer, the social management team, the roads and markings team, the local borough administration, the hospital director, school principals, local shop owners, and residents. The main reason the Tunjuelito neighborhood was selected for attention by the project team was that it was identified as a high-risk location based on the city's road crash data. In stakeholder meetings, it emerged that community members were also well aware and concerned about traffic safety risks in the area. For example, the community had named one of the critical road crash locations the "Devil's Crossing." Involving the community as well as multiple city departments in the project generated public support for the development of both the temporary pilot project phase with cones and chalk and the subsequent implementation of more durable plastic materials.

Source: Lleras (WRI), Personal Interview, February 21, 2018.

Public agencies/officials to engage with, as a starting point, are as follows:

- Public transport authorities and public transport or paratransit operator collectives
- Local government representatives (particularly from agencies involved in the planning, facilities)

- Parking management agencies and/or informal parking monitors
- Organizations involved in promoting public health and injury prevention
- Institutional representatives (if the zone is located near schools, hospitals, or other institutions)

Other likely stakeholders include the following:

- Residents and communities, ensuring the inclusion of representatives from low-income and minority populations and people of different age groups (e.g., seniors, caregivers of children, children themselves)
- Neighborhood and business groups
- Advocacy groups representing pedestrians, bicyclists, motorcyclists, and drivers
- People with disabilities and the advocacy groups that represent them
- Adjacent property and business owners, including street vendors
- Media representatives such as journalists, and other local thought influencers

Once the key stakeholders have been identified, think about when to bring specific stakeholders into the process and what level of involvement may be appropriate. For example, some government stakeholders may need to be involved continuously from the beginning, whereas others may only need to be consulted or simply kept informed at

key points (Box 4.5). Furthermore, separate strategies may be necessary to manage the engagement of certain organized groups with clear representatives, as well as to provide opportunities for any member of the public to engage in a wider public participation process.

Box 4.5 | Learning from Mistakes and Building Trust with Stakeholders in Mexico City

During the planning process for the low-speed zone project on 16 de Septiembre Street in Mexico City's Historic Center, the team organized several stakeholder meetings. The meetings aimed to inform stakeholders of the latest progress and hear their feedback, input, and concerns. However, these meetings did not include a major stakeholder group for 16 de Septiembre: its street vendors. The vendors protested their exclusion from the process, especially as the project impacted them and their livelihoods directly.

As a result, after choosing intervention locations, the team invited the street vendors' elected leaders to join the conversation. Once the 16 de Septiembre intervention started, project team members provided their phone numbers to the public and were ready to answer their questions. This accessibility created trust between the parties throughout the project.

Source: Martinez et al., Personal Interview, March 2, 2018.



Tips for Stakeholder Engagement

The following are some tips for engaging stakeholders as part of a low-speed zone development process:

Dedicate sufficient time and resources to stakeholder engagement

Stakeholder engagement is a critical aspect of most significant transportation projects. This is especially true in the case of low-speed zone projects, which may be controversial due to concerns about traffic diversion to adjacent streets, increased crashes on adjacent streets, traffic delays, noise, economic impacts, changes to parking, impacts on fuel consumption, and emissions and other issues. As a result, it is important to dedicate sufficient time and resources to the stakeholder engagement process. Time must be allotted to obtain regular input from the full spectrum of stakeholders, explain the rationale for the low-speed zone, fully respond to concerns, and build trust and

support. Resources are needed to cover the additional expenses that a lengthier process entails and to develop multiple design concepts to share and discuss with stakeholders.

Engaging the full spectrum of stakeholders to the same depth, while desirable, may not be feasible. To balance the competing time and information demands of multiple stakeholder groups, it can be helpful to not only map stakeholders but also evaluate them in terms of the level of influence over the project, and the level of impact the project will have on them. Some have high influence, while others may have very low influence. Some may also experience the high impact of any changes in the project area, while other groups will be less impacted. A common strategy is to target engagement efforts at the highly influential and/or impacted groups (dedicating more time and resources), and only monitor/inform the less influential and/or impacted groups (or to include them in the activities focused on the key target groups).

Resources are also needed for innovative engagement techniques. For example, a temporary pilot (see Appendix, case studies on Mexico City, São Paulo, and Bogotá) is an excellent way to simulate potential impacts of a low-speed zone concept, collect input, increase awareness and appreciation, and build support. Also, photo-realistic graphics or animations are highly effective in helping stakeholders visualize proposed designs and can also build support and excitement. However, both of these strategies require additional time and funding to implement.

Be prepared to respond to stakeholder concerns

Stakeholders may have a number of potential concerns about low-speed zones. Despite their benefits, low-speed zones can be controversial due to concerns about traffic diversion to adjacent streets, traffic delays, economic



impacts (Box 4.6), and other issues. Consider these concerns carefully and be prepared to respond to each of them with facts.

Concerns about travel times: It may alleviate concerns to point out the experiences of other comparable communities. For example, a study by the French city of Grenoble showed that decreasing the speed limit from 50 to 30 km/h led to a relatively insignificant 18-second increase of travel time between two intersections located 1 km apart (Grenoble.fr 2015). Similarly, the city of Bogotá, Colombia, conducted a study to determine the potential impact of reducing and enforcing the speed limits from 60 to 50 km/h on two of the five most dangerous arterial roadways. The study found that during peak hours travel times at the more congested of the two arterials would only increase by 14 seconds in the most congested direction and by just 1 second in the other direction. Travel times would not be affected by the speed limit change, while delays during

off-peak times would *decrease* by 10 percent. In the case of the less congested arterials, travel times increased by about 8 percent during peak hour but dropped by 9 percent at off-peak times (Alcaldía Mayor of Bogotá 2019).

Concerns about fuel consumption and air pollution emissions: Another argument often raised against low-speed zones is that vehicles have less efficient fuel consumption at lower speeds and can also generate more emissions, reducing air quality. This usually stems from the understanding that traditionally, motor vehicles were designed to maximize fuel consumption when operating at around 50 km/h (30 mph). However, urban areas with such speed limits typically generate patterns of rapid acceleration and deceleration for intersections, turns, and congestion. Research has found that this type of travel pattern is worse for fuel consumption and emissions than traveling at a slower but more consistent operating speed, which lowers the amount of

acceleration and deceleration between stops. The research found that “reducing speeding, lower speed limits and modifying driving style were found to improve fuel economy and other environmental outcomes in addition to improving safety” (Haworth and Symmons 2001). This is another reason why the spacing and combination of physical traffic-calming devices selected (Section 5.2.) is so important; designs that require drivers to maintain a more consistent low-speed, rather than rapidly accelerating and decelerating, are not only better for safety but also for fuel consumption and emissions (Ahn and Rakha 2009).

Take a multipronged approach

As key stakeholders may have constraints on their ability to contribute to public participation processes, a multipronged approach to stakeholder engagement is usually best. For example, a common stakeholder constraint is the lack of time or a constrained schedule. To

address this, consider conducting meetings on different days and times or collecting feedback from stakeholders through other means, such as local community group meetings, street intercept surveys, online surveys, focus groups, and individual interviews.

Engagement techniques should be tailored to the specific audience they aim to reach. For example, materials should be provided in multiple languages in multiethnic neighborhoods, and childcare should be provided at meetings if families or parents are a key audience. In communications with stakeholders, it is also important to use plain language that everyone can understand. Technical jargon should be avoided.

TAKE THE WIDER STREET NETWORK INTO CONSIDERATION

There is often a concern that a low-speed zone will create a “bottleneck” that results in traffic diverting to other nearby streets. For this reason, it is important to consider a **network** approach to low-speed zones to ensure that motor vehicles do not speed through other parts of the community. Ideally, the network approach should consider the classification or function of the streets selected for the low-speed zone, as well as adjacent streets. Low-speed zones are most appropriate for streets with an *access function*; that is, where people are accessing residences, institutions, or commercial areas, with larger nearby streets performing more of a *thoroughfare* function and offering slightly higher speed limits and volume capacity.

Sometimes there is an assumption that traffic will divert to other streets when in reality this does not happen. There are several reasons for this: The street may operate more efficiently at lower speeds; for example, if intersections are designed to reduce wait times. Additionally, lower motor vehicle speeds may result in reduced motor vehicle volumes, as people find other modes more attractive, especially if they are coupled with improvements to pedestrian, bicycle, or public transit access; or finally, if other alternative routes are not convenient, traffic diversion is less likely (Ewing 2001; European Commission 2004).

It is important to consider the likelihood of traffic diversion during the planning process of low-speed zones and to monitor traffic patterns before and after implementation of low-speed zones. If traffic diversion is a concern, measures should be taken to ensure adjacent residential streets are not adversely impacted. Solutions can include extending the boundaries of the low-speed zone to incorporate adjacent streets and establishing turn restrictions at street entrances along potential alternative routes.

Some circumstances may warrant active measures to divert traffic away from the low-speed zone. This strategy should be used with caution, however, because it is likely to result in increased motor vehicle traffic volumes in other nearby streets, thus creating problems in other parts of the community.

Active diversion may be appropriate if the low-speed zone incorporates a shared street, where pedestrian and vehicular traffic are intended to mix in the same space since pedestrians generally avoid walking in the street if motor vehicle volumes are too high. Similarly, active diversion may be appropriate if the low-speed zone incorporates a bicycle boulevard (bicycle priority street), where bicyclists are expected to use the motor vehicle travel lane and maintaining bicyclist comfort is a high priority. If alternative streets to which traffic will be diverted are more suitable for thoroughfare traffic—for example, by having better roadside protection or fewer pedestrians and other vulnerable road users—then diversion can be beneficial. Other examples of cases where traffic diversion might be appropriate include streets where children use the streets as play space as well as streets adjacent to senior centers and schools.

Traffic diversion can be accomplished by implementing measures that prevent or discourage motor vehicle traffic from entering the low-speed zone and/or encourage or force motor vehicles to turn out of the low-speed zone once they are in it. Examples include turn restrictions and physical measures such as channelized right-in/right-out islands, partial street closures, and median islands that restrict turning movements.

Box 4.6 | Economic Benefits Help Build the Case for Low-Speed Streets in Mexico City

One of the first interventions in the Historic Center in Mexico City that transformed Madero Street into a pedestrian street resulted in significant benefits for adjacent businesses. The pedestrian flow increased from 250,000 to 400,000 per day, the shopping rate increased by 65 percent, and sales increased 150 percent (WRI Mexico 2018). These results were of great help in promoting neighboring low-speed zone interventions on 16 de Septiembre Street to benefit local businesses.

Source: Martinez et al., Personal Interview, March 2, 2018.

SELECT SITE OR SITES

Low-speed zone candidate sites can be identified and prioritized in a variety of ways depending on community context, goals and objectives, and other factors, but they should generally take into account three components—need, suitability, and feasibility.

These components are often addressed in sequence—that is, first need, then suitability, then feasibility—but a different order is also possible and may be appropriate in some circumstances. For example, New York City’s Neighborhood Slow Zone program relies on an application process to identify an initial set of candidate zones (Hagen 2018). In Dar es Salaam Tanzania, the nongovernmental traffic safety

organization Amend has a specifically targeted implementation of low-speed zones near schools. Amend’s school focus is partly based on suitability (high numbers of child pedestrians) and partly based on feasibility (greater potential for community and political support due to the involvement of children) (Kalolo 2018a).

Need

The determination of whether a low-speed zone may be *needed* is generally based on an assessment of safety risks. There are three main approaches to conducting this assessment: the traditional approach, the proactive approach, and the combined approach.

- The traditional approach often referred to as “black spots” or “hot spots” analysis, involves assessing historical crash data to identify locations where crashes are concentrated. One weakness of this approach is that it can deemphasize or miss locations that pose significant safety risks but have limited or no historical crash data. This approach may miss changes in risk due to demographic shifts of population and associated use of streets.
- The proactive approach involves using mathematical models to estimate where potential future crashes may be concentrated. These models typically include variables related to the potential for a crash, such as pedestrian, bicycle, and motor vehicle volumes; the extent to which vulnerable road users and motorized traffic are already separated; and/or roadway characteristics like number and

width of motor vehicle travel lanes, motor vehicle operating speeds, and posted speed limits (WHO 2013).

- The combined approach takes into account both historical crash data and proactive estimates of a location’s future safety performance (FHWA 2018).

Depending on goals and objectives, the need may be assessed citywide, within a particular district, or corridor, or in proximity to particular land uses (e.g., schools).

Suitability

Determining the *suitability* of a low-speed zone in a given location depends on a range of considerations, including the street type and its role in the overall street network, adjacent land uses, the presence of vulnerable users, equity considerations, potential positive and negative impacts, and other factors. Examples of locations that may be suitable for a low-speed zone include the following:

- Locations with significant pedestrian and bicyclist volumes (existing or potential)
- Locations with high percentages of children, older people, or people with disabilities (existing or potential)
- High-density commercial or mixed-use districts
- Historic or tourist districts
- Residential streets or districts



- School zones
- Hospital zones
- Areas around places of worship

The “need” is distinguished from “suitability” because not all city streets with the *need* for a safety intervention will also have *suitability* for the application of a low-speed zone. These are typically arterial type streets with high volumes of through traffic, sometimes referred to under a functional hierarchy of streets as those that have a key “flow” function, as opposed to a “distributor” or “access” function. In many locations, streets are formally classified by the national, state, or local government, and these classifications should be considered when determining the suitability of a particular street or area for a low-speed zone. However, it is important to note that sometimes the classification of the road and its usage do not match due to changes in population and roadside development. In many countries, for example, roads built as and classified as highways become congested shopping roads as populations grow and city boundaries expand. In these cases, the usage of the road should be a major consideration. In situations where safety, flow, and access needs conflict with one another (e.g., if a school is located on an arterial road), other solutions should be sought, such as a combination of design and signal control to safely separate different types of road users, with a particular focus on protecting pedestrians and cyclists and assuring safe and convenient crossing options are available.

Another common circumstance in which a low-speed zone may not be suitable, but design features may still be added to reduce the target speed, is when length of the zone is shorter than the minimum length required for a speed zone. Many countries and states set minimum lengths for speed zones, such as 0.5 miles, to avoid changing speed limits too frequently, which would make it difficult for drivers to comply (Gardiner et al. 2012).

Feasibility

The *feasibility* of low-speed zone candidate sites is another important aspect of site selection and prioritization. Considerations that affect feasibility include available budget, cost, legal authority, public support (Box 4.7), environmental impacts, and impacts on historic features and structures. Although it will not be possible to fully assess feasibility at the conceptualization stage, with key design details yet to be determined, a high-level feasibility assessment is still helpful to screen out locations that are unlikely to be viable.

Another aspect to be considered when developing the specific configurations of the zone is the existence of other street design or speed management projects that are under proposal or development in the area. If another project is identified that is compatible with the LSZ, it may affect the design choices made and the time line for implementation (see Section 4.4, Develop Recommendations for Implementation). If the projects are

incompatible and the other project is a greater priority, then the LSZ is not feasible in that location, and a new location must be selected.

Early wins

The ongoing and expanded support of the community, politicians, and key decision-makers for low-speed zones can be enhanced by making

Box 4.7 | Public Support and Feasibility

Public support is an important consideration in determining the feasibility of low-speed zones. Public support is a key factor in generating political support, and this is important because political support is key to bringing about any significant street-level change and will likely have a direct impact on the budget and institutional support available for the project. Locations such as school and hospital zones, or locations with a record of traffic deaths and serious injuries usually have greater community and political support for speed reduction and street improvements. If a city is starting to implement low-speed zones, it might be a good strategy to target areas where the public support is higher, and wins can be clearly demonstrated (e.g., a reduction in deaths or serious injuries can be tangibly measured). Once people have directly experienced the benefits, it is easier to build support for low-speed zones elsewhere. This strategy can work regardless of who is instigating the project, whether it is a public or civil society group trying to convince senior political leaders and decision-makers to take the risk of testing low-speed zones, or political leaders trying to get the general public on board.

Source: Authors.

wise choices in the first low-speed zones to be implemented in a city or town. Although there are other indicators that are also appropriate to guide the selection of a low-speed zone, the first locations to be tackled should have a clear safety issue, demonstrated by a record of traffic deaths or serious injuries. The first locations selected as zones should have strong baseline data to ensure that the success of the zone can be demonstrated in evaluations.

COLLECT BASELINE DATA AND CONDUCT SITE VISITS

Baseline data is needed to understand existing conditions, inform low-speed zone design, and evaluate future low-speed zone performance. The specific data required depends on the goals and objectives established for the zone, the performance measures included in the evaluation plan, and the nature of the proposed design. Some baseline data may already be available from official sources; however, it should be noted that in many countries, even where data (such as road crash injuries, deaths, and serious injuries) are recorded, they may be significantly undercounted, and there may also be a long lag time before such data are publicly available. So, data may need to be collected in the field, and in some cases, proxies may need to be considered to compensate for unavailable or unreliable data. Some data, such as motor vehicle speeds and volumes and killed and seriously injured (KSI) crashes, will likely need to be collected both inside and outside the zone to enable evaluation of spillover effects, such as traffic diversion and safety impacts in adjacent areas.



Table 4.1 | Examples of Baseline Data Types and Reasons to Collect

DATA TYPE	REASONS TO COLLECT
KSI Crashes	<ul style="list-style-type: none"> ▪ To inform the placement of traffic safety countermeasures ▪ To enable evaluation of the zone's safety performance in the long term^a ▪ To enable evaluation of long-term safety impacts in adjacent areas
Motor vehicle operating speeds (under both free flow and peak conditions, at midblock and intersections) and speed limits, by vehicle type	<ul style="list-style-type: none"> ▪ To inform the placement and design of countermeasures aimed at producing safe motor vehicle speeds within the zone ▪ To inform the design of transitions from adjacent areas to the low-speed zone ▪ To enable evaluation of the zone's safety performance in the near term ▪ To enable evaluation of near-term safety impacts in adjacent areas ▪ To understand any speed variations between midblock and intersections ▪ To understand any speed variations between vehicle types that may need to be addressed
Frequency of motor vehicles yielding to pedestrians	<ul style="list-style-type: none"> ▪ To inform the placement and design of countermeasures to increase motor vehicles yielding to pedestrians ▪ To enable evaluation of the zone's safety performance in the near term.
User perceptions of safety, by mode, gender, and age	<ul style="list-style-type: none"> ▪ To understand locations that existing street users perceive to be unsafe ▪ To understand the variation in safety perceptions between different types of road users ▪ To enable evaluation of the zone's impact on user perceptions of safety
Pedestrian and bicycle volumes	<ul style="list-style-type: none"> ▪ To inform aspects of the design that address or impact pedestrian and bicycle travel (e.g., sidewalk and bike lane widths) ▪ To enable evaluation of the zone's impact on pedestrian and bicycle volumes
Motor vehicle volumes and intersection turning movements	<ul style="list-style-type: none"> ▪ To inform aspects of the design that address or impact motor vehicle travel (e.g., the number of motor vehicle travel lanes, type of traffic control, traffic diversion strategies) ▪ To model future motor vehicle volumes and flows ▪ To enable evaluation of the zone's impact on traffic volumes inside the zone and in adjacent areas
Motor vehicle travel times	<ul style="list-style-type: none"> ▪ To enable evaluation of the zone's impact on motor vehicle travel times through the zone
Land uses, including transit stops and stations	<ul style="list-style-type: none"> ▪ To identify the distribution of land-use types ▪ To identify the locations of services and trip generators such as schools, hospitals, and police and fire stations ▪ To understand the potential for increasing walking, biking, and public transit trips ▪ To inform aspects of the design meant to increase these trip types

Table 4.1 | Examples of Baseline Data Types and Reasons to Collect, continued

DATA TYPE	REASONS TO COLLECT
Speed limits	<ul style="list-style-type: none"> To inform the selection of the target speed
Street characteristics (number and width of motor vehicle travel lanes, traffic controls, sidewalks, bike lanes, etc.)	<ul style="list-style-type: none"> To understand how much street space is available, how it is currently divided between modes, and how conflicts are currently managed To understand any special uses for the streets in the zone, such as emergency evacuation routes and delivery access needs
Parking occupancy rates	<ul style="list-style-type: none"> To understand the potential for using parking as a traffic-calming measure To understand the turnover of visitors who arrive by driving to the location To understand the existing level of demand for parking
Property values	<ul style="list-style-type: none"> To understand the value currently placed on the location in relation to other locations in the city To enable long-term evaluation of the zone's impact on the economic viability of the area
Local store or vendor income	<ul style="list-style-type: none"> To understand the value currently placed on the location in relation to other locations in the city To enable short- to medium-term evaluation of the zone's impact on the economic viability of the area

Notes: KSI = Killed or seriously injured.

^a Changes in serious injuries and fatalities can be difficult to assess in the short term due to low overall numbers and random year to year variation.

Source: Authors.

In addition to collecting baseline data, it will be important to conduct a site visit or visits to experience the dynamics of the proposed site firsthand, observe the behavior of different street users, measure important roadway dimensions, and capture photographs and videos for reference during design and public engagement.

SET KEY PARAMETERS FOR THE DESIGN AND OPERATION OF THE ZONE

After identifying the general location of a low-speed zone, key parameters should be set, such as how large it will be, where the boundaries will be drawn, and what the target speed should be. This process involves estimating the potential impacts and feasibility of different low-speed zone configurations.

DETERMINE THE SIZE OF THE ZONE

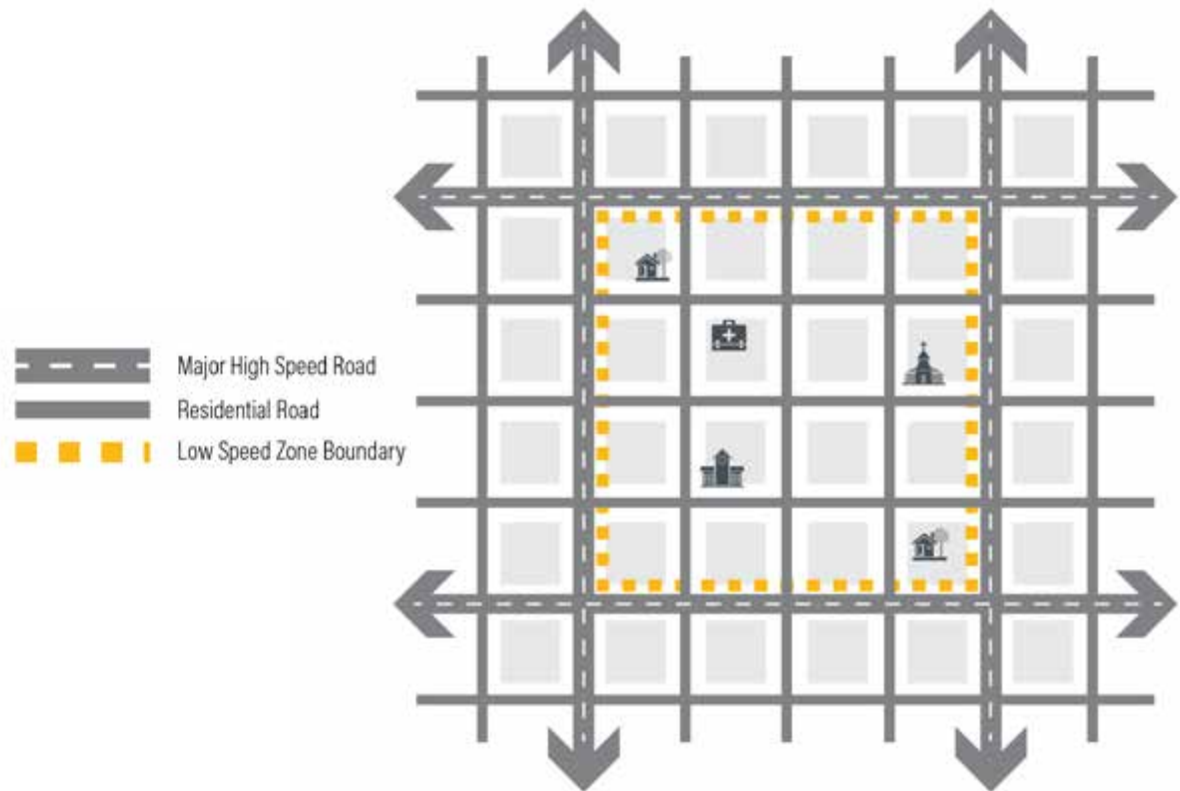
Low-speed zones can vary in size from a single block to an entire neighborhood or urban district. Design guidance on zone size varies depending on the locality, the features of the specific location under consideration, and in some cases the budget that is available. In New York, the city encourages proposals for speed zones of approximately one-quarter square miles (~ 650,000 m²) or five by five blocks (PBIC March 2020). The US Federal Highway

Administration (FHWA) recommends that in urban areas school zones begin at least 200 feet (ft) (60 m) in advance of the school grounds or any school-related crossings. This distance should be increased if the reduced school speed limit is 30 mph (50 km/h) or more below the speed limit on the approach (ITE 2012). Like all other features of a low-speed zone, the need can vary according to the context. For example, in countries and cities with higher rates of walking (such as African countries where children tend to walk much longer distances to school), a larger low-speed zone may be appropriate to accommodate the catchment area of walking trips, rather than just the entrances to the school.

Ultimately the size of the zone is a decision that should be made based on a variety of factors including:

- Goals and objectives of the zone
- Existing land uses, such as the location of schools, retail zones, hospitals, and significant pedestrian destinations such as sporting fields for children or public transport hubs
- Areas where pedestrian and bicycle activity is concentrated or is likely to be concentrated once the low-speed zone is implemented
- How crashes are distributed, or dangers are perceived by users
- Available funding (since a larger zone will be costlier to implement, especially if it includes physical traffic-calming measures)

Figure 4.1 | Example of a Logical Boundary for a Low-Speed Zone



Source: Authors.

- Location of appropriate boundaries, such as major streets or parks
- Location of transport infrastructures such as bike lanes and public transit stops and routes

DEFINE THE ZONE'S BOUNDARIES

It is generally recommended that low-speed zone boundaries align with significant features of the urban landscape. This makes it easier

to mark and easier for drivers to anticipate. Examples of potential boundaries include major streets, train tracks, large parks, and existing neighborhood, commercial, or village boundaries (Figure 4.1). The classification and use of streets outside the boundaries of the zone should also be well understood, to ensure there are other options for traffic flow if an objective of the zone is to reduce through traffic.

Note that laws and regulations may also govern or influence where boundaries should be drawn. For example, a city's zoning ordinance may specify important characteristics of new development, such as use or density, that should be considered as part of the boundary-setting process.

It is also worth noting that many cities that have seen success with small-scale low-speed zones are now experimenting with expanding such speed limits to wider areas of their city or to more significant corridors. This is discussed in Box 4.8.

SET THE TARGET SPEED

The goal is to develop a design that ensures most if not all drivers drive at or below the target speed. The target speed for a low-speed zone should not exceed the legal speed limit for the street and may be lower if circumstances warrant, for example, if the speed limit cannot be reduced, but there is a demonstrated need for lower motor vehicle operating speeds.

It is recommended that communities select target speeds of 30 km/h or lower due to the safety benefits of such streets, particularly for pedestrians (Rosen and Sander 2009). Target

speeds lower than 30 km/h may be appropriate in several circumstances; for example, if the low-speed zone includes a shared space where pedestrians, bicyclists, and motor vehicle drivers mix, then target speed for the shared space should generally be 10–20 km/h, depending on motor vehicle volumes, pedestrian volumes, and other factors. A target speed lower than 30 km/h may also be appropriate for school zones, residential areas where children play in the street, near senior centers, in areas where people with disabilities are concentrated, and in commercial zones where pedestrians are likely to cross midblock at unmarked locations.

Box 4.8 | Scaling Up Low-Speed Zones in Cities

As the benefits of lowering speeds in cities have been demonstrated through the implementation of dedicated low-speed zones, cities in the United Kingdom, Ireland and France such as London, Birmingham, Bristol, Dublin and Paris, among others have now scaled up their approach by expanding lowered speed limits across larger areas or corridors in their cities.

The first widespread evaluation of 20 mph zones in the United Kingdom was carried out by Transportation Research Lab (TRL) in 1996. It found that injury crashes were reduced by 60 percent, and child injury crashes were reduced by 67 percent. From 1994, there was a widespread introduction of 20 mph zones in Hull, and by 2003, there were 120 zones covering 500 streets. In the 20 mph zones in Hull, there was a decrease in total crashes of 56 percent and in fatal and serious injuries of 90 percent.

A total of 399 20 mph zones were implemented across London between 1991 and 2008. The number of 20 mph zones implemented in London had increased from about 5 per year (up to 1999) to over 30 per year by 2002. By 2016, 25 percent of the streets in London were categorized as 20 mph zones or with 20 mph speed limits. In 2018, a 20 mph speed limit was set to be enforced throughout central London's Congestion Charge Zone, as part of the mayor's plans to reduce the number of road fatalities. The city is seeking to reduce the speed limit to 20 mph in many other town centers and high-fatality areas to a total of 93 miles of roads by 2024.

The Dublin City Council has progressively introduced a 30 km/h speed limit to many areas in the city. The Phase 1 expansion to the 30 km/h speed zones was introduced in 2017 in certain Dublin residential and school areas. Soon after, the City Council announced the Phase 2 expansion of 30 km/h Slow Zones

in nine neighborhoods. In 2019, city councilors considered expanding 30 km/h zones to 31 more areas across the city after receiving public support for the change during a consultation process. The draft plans, released in early 2019, also proposed the introduction of temporary 30 km/h zones in front of seven schools.

In 2013, approximately 560 km of city streets in Paris, about one-third of the total, were zones with 30 km/h speed limits. The concept is now being taken citywide. With the introduction of the recent Smart and Sustainable City project by the mayor of Paris, at least 85 percent of the city's streets will be converted to 30 km/h zones by the end of 2020. Further, Paris plans to increase the number of pedestrian priority zones with a 20 km/h speed limit for vehicles.

Source: Transport Research Laboratory 1997, 2003; *theJournal.ie* 2018; Schmitt 2014; Beissmann 2014; Webster and Mackie 1996.

Finally, keep in mind that specific streets within a low-speed zone can have a lower target speed than the rest of the zone. For instance, a zone with a target speed of 30 km/h might include a street with a target speed of 20 km/h near a school, or a network of low-speed streets may have varied speed and design treatments. For example, in Hong Kong’s central commercial and retail Causeway Bay Area, the city has tackled limited street space and traffic safety issues since 2000 by creating a network of low speed streets, which contain full-time and part-time pedestrian streets, as well as traffic-calming measures for vehicles (Hong Kong Transport Department 2006). The city of Seoul has implemented widespread limits of 50 km/h on arterial roads, with 30 km/h and 20 km/h zones for residential streets, schools, and other sensitive areas (see Figure 4.2).

Potential scenarios and the appropriate target speeds are summarized in Table 4.2.

ESTIMATE IMPACTS OF THE ZONE

When estimating impact, consider all existing and potential street user types (not just motor vehicles) and include impact both within the zone and in adjacent areas.

Key questions include the following:

- How might each possible configuration of the zone (size, boundaries, and target speed) influence travel patterns within the zone and in adjacent areas, considering planned future development? (Box 4.9)

- Which configuration is most likely to result in the greatest reduction in killed and seriously injured (KSI) crashes?
- Which configuration prioritizes vulnerable road users?
- Which configuration is most likely to reduce the amount of driving people do (also referred to as vehicle kilometers traveled [VKT]) or the number of local motor vehicle trips?
- Which configuration is most likely to achieve the goals and objectives established for the zone?

Figure 4.2 | Seoul: Examples of 30 km/h and 20 km/h Streets



Source: Soames Job 2020.

Table 4.2 | Different Street Circumstances and Appropriate Target Speeds

APPROPRIATE TARGET SPEED	CIRCUMSTANCES
30 km/h	<ul style="list-style-type: none"> ■ Streets with sidewalks and people walking and biking
10-20 km/h	<ul style="list-style-type: none"> ■ Shared street space where pedestrians, bicyclists, and motor vehicles mix, and there are multiple points where pedestrians may want or need to cross the road ■ School zones ■ Residential areas where children play in the street ■ Areas with concentrations of seniors or people with disabilities ■ Commercial zones where pedestrians are likely to cross midblock

Source: Authors, drawing from Rosen and Sander 2009, Hong Kong Transport Department 2006.

Box 4.9 | Using Vehicle Miles Traveled to Evaluate Transportation Impacts in California, USA

The state of California is changing how it evaluates the transportation impacts of new development. Rather than judging new developments solely by how they impact motor vehicle level of service (LOS), California is now using vehicle miles traveled (VMT), which considers transportation impacts more holistically.

The motor vehicle LOS analyzes data, such as the study area, peak hour vehicle volume, free flow speed, urban street type and class, and running and delay time to find the average travel speed for motor vehicles during peak hours and nonpeak

hours. The LOS approach prioritizes motor vehicle speeds, density, comfort, and convenience, and the minimization of traffic interruptions over safety and accessibility for other modes of travel, and has resulted in car-oriented roadway designs and development patterns in the United States as well as in other countries that have followed this model.

The VMT approach has several advantages over LOS. It establishes the impact of reducing vehicle miles traveled as the metric for evaluation, rather than maintaining or increasing vehicle travel speeds. Because of this, VMT shifts design and

planning considerations away from the emphasis on motor vehicle speeds and car-oriented congestion mitigation, and focuses on transport demand management and strategies to reduce the need for driving and improve safety for vulnerable road users. As a result, the VMT approach supports safer and more sustainable multimodal roadway designs and mixed-use development (State of California, Governor's Office of Planning and Research 2017).

Source: State of California, Governor's Office of Planning and Research 2017.

ASSESS THE FEASIBILITY OF IMPLEMENTING THE ZONE

Feasibility should already have been assessed at a high level during the site selection phase but should be revisited in greater detail once alternative low-speed zone configurations have been identified. The costs associated with the selection, development, and implementation of a particular configuration should be weighed against its potential positive effects. Additionally, studies show the benefits of shifting from costly infrastructures such as urban highways to well-designed streets with safe, attractive public transport and safe pedestrian and bicycling infrastructure, come at a much lower price (Bocarejo et al. 2012). Such

positive effects can include immediate safety benefits, such as lives saved and serious injuries prevented, but also wider cobenefits such as increased business revenue (Box 4.10), reduced greenhouse gas emissions, and reduced air and noise pollution. One way to make the shift is through cost-effectiveness analysis. Cost-effectiveness analysis differs from a cost-benefit analysis in that effects like lives saved, serious injuries avoided, or improved health are not quantified in monetary terms. Cost-effectiveness analysis fits better with a Safe System or Vision Zero approach to traffic safety because it is based on the principle that no death or serious injury is acceptable in the mobility system.¹



Box 4.10 | Economic and Business Benefits of the Daxue Road 30 km/h Zone in Yangpu District, Shanghai, China

Daxue Road is located in the Yangpu District of Shanghai, China. In the 1980s and 1990s the district was mainly residential and industrial. In the early 2000s it was developed into an urban office, retail, and mixed-use community (known as a Knowledge and Innovation Community [KIC]). Daxue Road, the main road inside the KIC, was renovated in 2012. Some major improvements included changing the road from one-way to two-way accessibility to improve access to the businesses along the street; refurbishing sidewalks to encourage restaurants to open outdoor seating areas to revitalize street activities; setting the speed limit to 30 km/h, enforced with speed cameras; using corners with a small turning radius of 5 m to physically slow vehicle speeds; and installing planters and bike parking racks on the sidewalks. During the planning phase, intervals between intersections were set to between 70 to 150 m, which reduced

the block sizes and created more signalized intersections, reducing the opportunity for excessive vehicle speeds at midblock. Changes were also made to surrounding streets to make the wider KIC area walking- and biking-friendly. For example, some sidewalk curbs were extended to visually narrow streets (“choker” design), pocket parks were constructed, and flower boxes were used to block excessive parking spaces in addition to other parking management mechanisms. The main measured impacts of these changes were on local businesses. Through such improvements, the area has attracted more than 400 small businesses and 200 start-ups. The rent in the KIC is 30 percent higher than in other business areas in Yangpu District, and among the highest in Shanghai. This road is now a well-known example of urban road revitalization in China (Qian 2017; Li 2014; Xu and Kaiyun 2015).

Figure 4.3 | Daxue Road 30 km/h Zone in Yangpu District, Shanghai, China



Photo: Wei Li 2019.

DEVELOP IMPLEMENTATION RECOMMENDATIONS

This step in the planning process (Box 4.1) involves developing recommendations for handling a range of issues associated with low-speed zone implementation, presenting them to stakeholders, and refining them based on stakeholder feedback. Key issues include the following:

- How speeds within the low-speed zone will be enforced
- How to use street design to achieve target speeds

- The timing of low-speed zone construction and whether it will be phased
- How members of the public will be informed of the zone
- How the performance of the zone will be evaluated

Enforcement is discussed in Section 4.4.b. The timing and phasing of low-speed zone construction, stakeholder education, and evaluation and monitoring are discussed in Section 8, Construction and Postconstruction.

CREATE AN EVALUATION PLAN

An evaluation plan describes how the performance of a low-speed zone will

be evaluated. Evaluation is critical for understanding whether a low-speed zone is successfully achieving the goals and objectives established for it and whether any adjustments are needed to improve performance. Also, positive results from an evaluation process can help make the case for low-speed zones elsewhere.

An evaluation plan should clarify the purpose and time line for the evaluation process, specify roles and responsibilities, establish performance measures, and detail data needs and methods.

The plan should also describe how and with whom evaluation results will be shared. Involving key stakeholders in the development

of an evaluation plan and making the plan and evaluation results available to the public can help develop a shared understanding of what success looks like and build support for the project.

Finally, the plan should establish evaluation priorities, in case collecting data relevant for judging low-speed zone performance is unavailable or infeasible. Evaluation priorities should generally be based on the relative importance of the goals and objectives established for the project. For example, if the top goal of a project is improved safety, then data on safety will need to be collected. Keep in mind that there are a variety of ways goals like improved safety can be measured. Change can be measured against both the baseline for that location, the situation in comparable locations without low-speed zones, and targets set at a local level. Points of comparison should

be established prior to implementation so that improvement over time can be measured. Adjacent areas may also be included in the evaluation, to understand whether the low-speed zone has generated any wider changes in travel or crash patterns. Examples of typical performance measures are provided in Box 4.11.

EVALUATE THE NEED AND OPTIONS FOR SPEED ENFORCEMENT

Ideally, low-speed zones are self-enforcing. That is, the physical design of the zone allows people to drive no faster than the target speed. The ultimate goal of a low-speed zone is to achieve safe speeds without the need for police enforcement.

In some instances, however, it may be necessary to conduct promotional campaigns, enforcement or speed feedback activities, in the low-speed

zone, in particular, if the concept of a low-speed zone is new and unfamiliar to road users. When needed, these activities should occur soon after implementation and be repeated as necessary. Note that evaluations indicate that speed feedback is most effective while these activities are in place; once they stop, operating speeds go back up (Anon 2002).

Whether or not enforcement is anticipated, the appropriate law enforcement agency should be engaged from the outset of the low-speed zone development process (see stakeholder engagement). Efforts to engage law enforcement personnel should include education about the impacts of speed on safety and the value of low-speed zones. These efforts should also give law enforcement a sense of ownership in the low-speed zone development process.

Box 4.11 | Examples of Low-Speed Zone Performance Measures

Low-speed zone performance should be compared to performance in the same zone, pre-implementation, and compared to similar locations without low-speed zones or against local targets. Performance measures include the following:

- Number and frequency of crashes
- Severity of crashes (number of deaths and level of injuries)
- Percentage of vehicles exceeding the speed limit
- Percentage of drivers driving below the target speed
- Average vehicle speeds at peak and off-peak times
- Average vehicle speeds by vehicle type
- Number of pedestrians at peak and off-peak times
- Number of people biking at peak and off-peak times
- Average motor vehicle volume
- Vehicle miles traveled within the Low-Speed Zone
- Rate of motor vehicles yielding at pedestrian crossings
- Average motor vehicle travel time within the Low-Speed Zone
- Average property value
- Gross business receipts
- Average user perception of safety, broken down by factors such as mode, gender, and age
- Air quality
- Noise levels and surveys of acceptability/annoyance

Source: Authors.

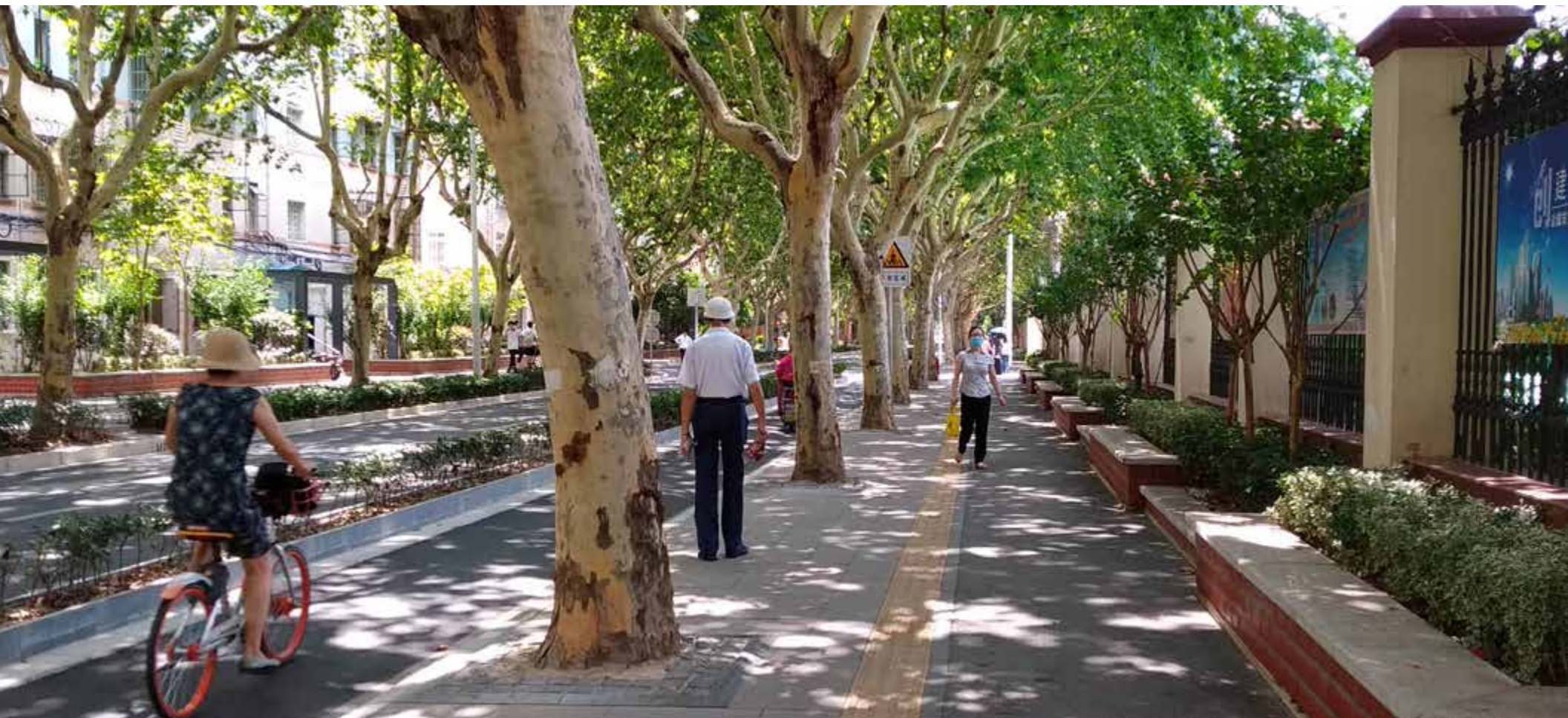
Traffic enforcement practices vary widely by country and jurisdiction. Depending upon the resources that are available locally, potential strategies for enforcement can be selected from a spectrum of options ranging from informational activities such as police-led promotional campaigns in support of the low-speed zone, speed feedback signs, and police warnings (“stop and advise”), through to active enforcement and economic incentives for compliance such as police ticketing or speed cameras. Taking a phased approach, beginning with a period of awareness-raising prior to active enforcement, followed by a period of

the enforcement where formal warnings are issued rather than tickets, can help reduce any public or political backlash to the introduction of a new low-speed zone. These processes promote legitimacy and acceptance of low-speed zones by generating a sense of fairness.

- **Police warnings** have some advantages over tickets. They require less time to issue, meaning officers can educate more people in the same amount of time. They are also less likely to provoke a public backlash. Warnings may be particularly relevant immediately after a low-speed zone has been imple-

mented to educate drivers about the new conditions. The combination of warnings and tickets can be particularly effective.

- **Police ticketing** is a common method of enforcement and sometimes necessary; however, there are several drawbacks. One is the amount of officer time required to issue each ticket, which can be quite high and can limit the number of people officers interact with. Another drawback is its potential to create public backlash if tickets are perceived to be unfair or if the police have a poor relationship with the community.



■ **Speed cameras**, if permitted by law, are another approach to enforcing speeds within the speed zone. Speed cameras use photo radar technology to monitor and enforce posted speed limits. They are relatively expensive to install but can issue tickets much more efficiently than police officers and are less vulnerable to bias or corruption. Initial costs can be offset by establishing a public-private partnership with a company that supplies and operates the cameras in return for deferred payment to be drawn from the fine revenue. It is important, however, to limit the involvement of that company in the complete enforcement process, to avoid real or perceived corruption and concerns about privacy and fairness. For example, the company may supply camera images to the police for adjudication, processing, and issue of tickets.

■ **Speed feedback signs** inform drivers of how fast they are going and whether their speed exceeds the limit. They are a valuable education and promotional tool that can be implemented alongside other enforcement strategies. These work best when a speed limit change is newly introduced, in part because their effects continue while in place but are not sustained after the feedback is removed. Thus, they are best targeted to the period when a zone is first introduced and should complement or enhance other longer-term measures. They can also be moved within a zone to target specific locations.

It is important to be strategic about enforcement locations and timing. Timing should be considered both in terms of what and when enforcement strategies should be applied during the process of the low-speed zone implementation and operation, as well as what times of day the deployment of police officers would have the most beneficial impact. Locations where automated or in-person enforcement may be needed within or around low-speed zones include the following:

- Low-speed zone transitions and gateways
- Near schools, senior centers, and other land use that involves vulnerable road users
- Locations where high volumes of pedestrians cross the street at uncontrolled locations
- Locations where observations indicate, or resident/stakeholder feedback suggests, drivers are exceeding the speed limit

Because police officers in several countries have been killed or seriously injured when attempting to stop speeding drivers, the selection of locations for in-person enforcement should include detailed consideration of the safety of officers conducting the enforcement (Box 4.12.). Factors to consider include the following:

- Visibility of the officer stepping out of his vehicle to stop a driver
- Allowing space for the officer to move out of the path of an oncoming vehicle that fails to stop

Box 4.12 | Provision of Space for Enforcement in New South Wales

In the state of New South Wales, Australia, after the death of a police officer attempting to stop an offending driver, police practices to stop drivers were revised and, in some locations, “enforcement bays” were built to ensure the safety of police conducting enforcement. These allowed police space for enforcement activities, an escape space to avoid a driver who does not stop, and space for a police vehicle to follow and catch drivers who do not stop.

Source: Soames Job 2020.

- Space for a police vehicle to follow and catch a driver who fails to stop
- Sufficient sight distance to allow a speeding driver to stop (noting this distance is longer than required for the speed limit because of the driver’s higher speed), though this should not allow the driver to avoid the officer by taking an alternative street when the officer ahead signals the driver to stop.

It is vital that police are involved in planning for enforcement.



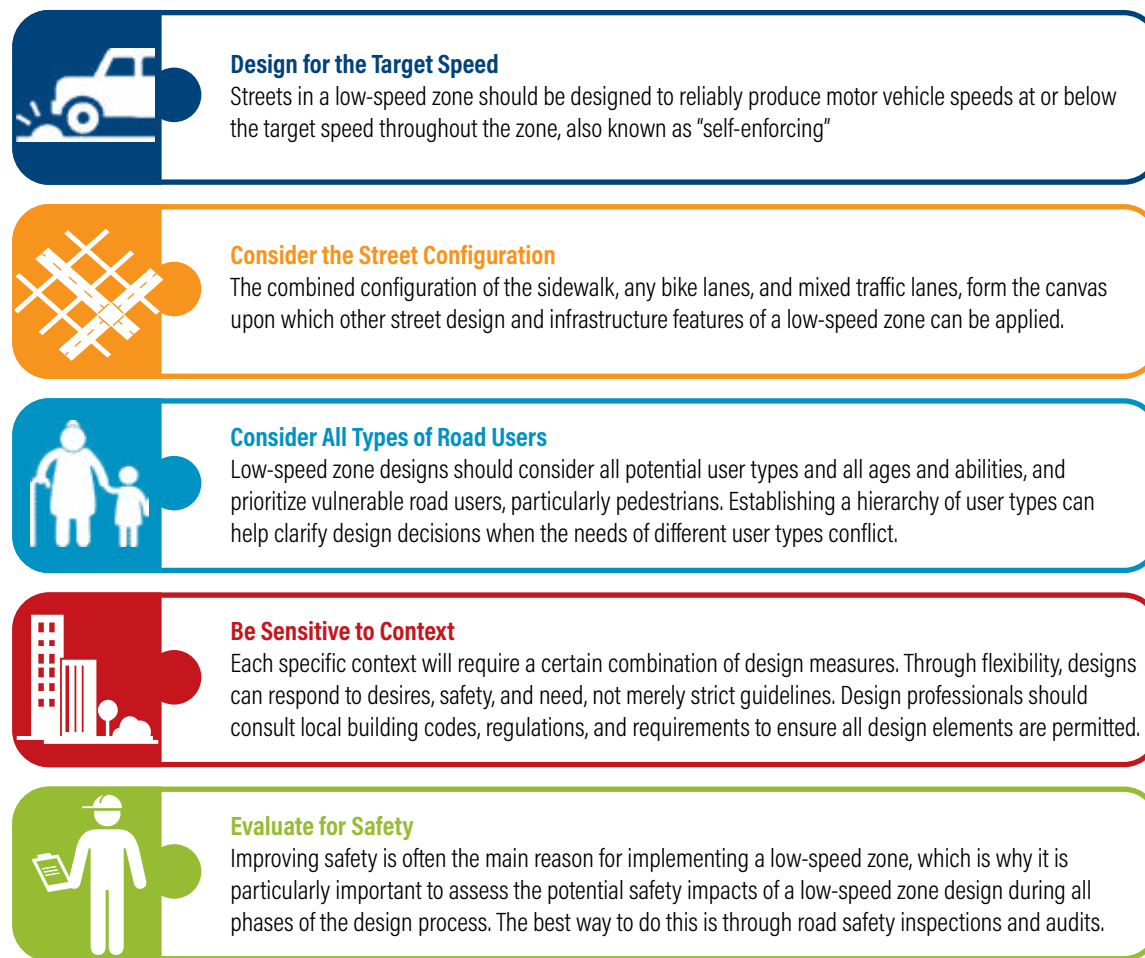
DESIGNING A LOW-SPEED ZONE

Well-designed streets can change the road safety, health, and economic trajectory of a community. This section discusses the basic principles for good street design, specifically, how to properly design a low-speed zone. It provides a breakdown of low-speed zone components for designers to use as a guide when designing both new and reconstruction street projects.

Streets make up the largest portion of the public realm in urban environments. The character and allocation of space on a street plays a key role in user experience. Streets should be attractive, inviting, accessible, safe, and comfortable for all users. Although improvements for pedestrians and bicyclists should be a major consideration in street design and redesign, all transportation modes must be accommodated. The design of streets should focus on a holistic approach that is context-sensitive to produce streets that not only deliver a balanced quality of service to all modes of transportation but also a high quality of life for the surrounding community. In essence, properly designed streets can change the road safety, health, and economic trajectory of a community.

This section discusses basic principles for proper street design, specifically, how to properly design a low-speed zone (Figure 5.1). It provides a breakdown of low-speed zone components for designers to use as a guide when designing both new and reconstruction street projects. This section concludes with illustrations of low-speed zones in different contexts, including a mixed-use street, a neighborhood street, a school zone, and a shared street or woonerf. Readers are encouraged to review *Cities Safer by Design* for additional information on many of the treatments discussed.

Figure 5.1 | Key Principles of Low-Speed Zone Design



Source: WRI 2019.

KEY PRINCIPLES OF LOW-SPEED ZONE DESIGN

DESIGN FOR THE TARGET SPEED

Streets in a low-speed zone should be designed to reliably produce motor vehicle speeds at or

below the target speed throughout the zone (see Box 5.1 for an explanation of terms). This is counter to conventional practice in some countries, where streets are regularly designed for speeds higher than the posted speed limit. However, designing for target speeds is essential

for maximizing the safety benefits of a low-speed zone (see Figure 5.2). The target speed for low-speed zones should be 30 km/h or less.

Box 5.1 | Common Speed-Related Terms and How They Apply to Low-Speed Zones

Target speed This is the highest speed at which vehicles should operate on a roadway consistent with the level of multimodal activity and adjacent land uses to provide both mobility for motor vehicles and a safe environment for pedestrians, bicyclists, and public transit users (ITE 2010). In the context of a low-speed street, the target speed is the maximum speed a motor vehicle operator would feel comfortable driving.

Design speed In the context of a low-speed street, the design speed should be the same as the maximum target speed. The geometry and design criteria used for the street produce a speed that is no higher than the target speed.

Legal speed limit This is the speed at which motor vehicles are legally allowed to operate. In some countries, this is set at a regional or national level and may be higher than the target speed in a low-speed zone. While ideally the speed limit and target speed should match, it is more important to design the street to produce the desired low-speeds, regardless of what the regulations may be. In cases where the target speed is lower than the speed limit, the speed limit should not be posted.

Source: Authors.

Figure 5.2 | Vehicle and Pedestrian Collision Speed and Survival (Percentage)

» When a vehicle is traveling at...



» this is the driver's field of vision.



» It takes...

14 m TO



26 m TO



44 m TO



» and pedestrians hit at this speed have a...

13% Likelihood of fatality or severe injury



40% Likelihood of fatality or severe injury



73% Likelihood of fatality or severe injury



Source: Elaborated by authors based on Tefft 2011; FHWA 2016.

CONSIDER THE STREET CONFIGURATION

The street configuration, particularly the lane width and the number of lanes on the roadway are among the most important considerations when designing a low-speed zone. The combined configuration of the sidewalk, any bike or micromobility lanes, and mixed traffic lanes form the canvas upon which other street design and infrastructure features of a low-speed zone can be applied. The degree to which the street configuration can and should be adjusted to both integrate and allow for physical traffic-calming devices should be considered at the outset of the design process. For example, narrow vehicle lanes help improve the level of comfort and safety for vulnerable users, allow for wider sidewalks and bicycle lanes with buffers, encourage street-side activities, reduce pedestrian crossing distances, and contribute to lower operating speeds. The sidewalks must be maintained as available for pedestrian use, by ensuring through regulation and enforcement that sidewalks are not taken over

for commerce, parking, or other activities. In low-speed environments of 30 km/h without buses, lane widths of 3 m should be considered the maximum, with 2.5–2.7 m being more desirable for achieving self-enforcement of the target speed. Like other street design elements, lane width is determined by considering the context of the street and daily users, as well as any local regulations. For example, in the case that public buses are operating in a low-speed zone, lane widths must not exceed 3 m. Also, roads in a low-speed zone must only have one lane per the direction of travel.

A study of crashes on urban streets in Tokyo and Toronto found that impact speeds and crash severity was 33 percent higher in lanes over 3.3 m. In contrast, “Narrower lanes in urban areas result in less aggressive driving” (Masud Karim 2015). Narrower lanes also improved stopping, perhaps by increasing the vigilance of drivers and/or the proximity and visibility of pedestrians.

Table 5.1 | Suggested Lane Widths for Low-Speed Zones

SPEED LIMIT/TARGET SPEED	MAXIMUM LANE WIDTH	RECOMMENDED LANE WIDTH
30 km/h	3 m	2.5-2.7 m
10-20 km/h*	2.5 m	2.5 m

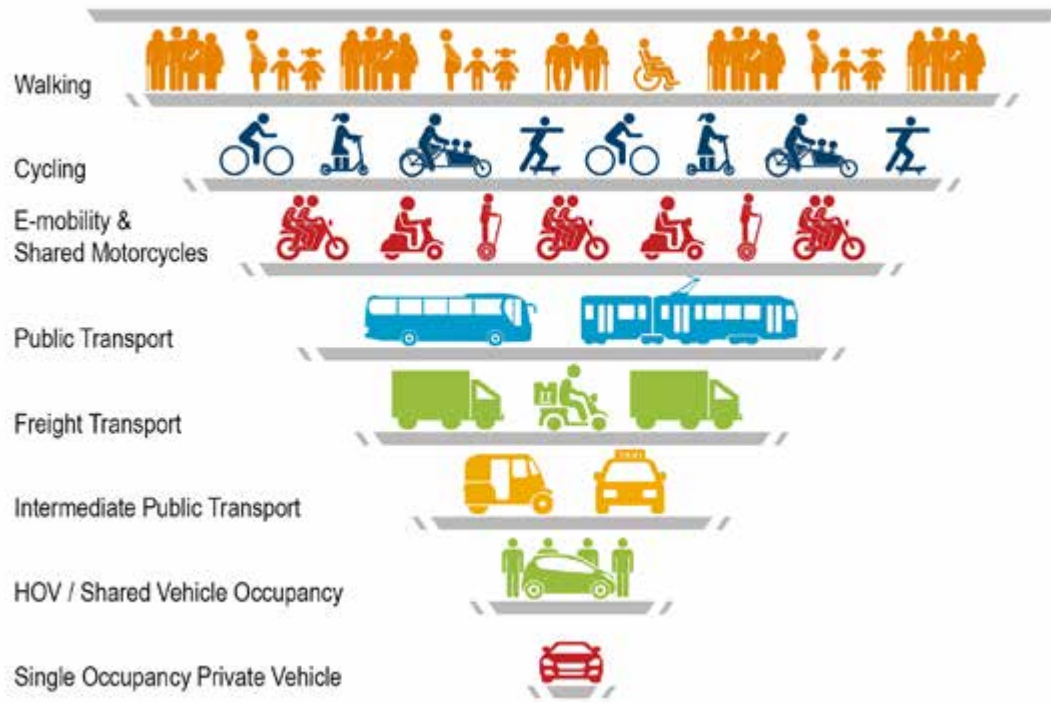
Note: *No heavy vehicles allowed.

Source: Danish Road Standards, Cross Sections in Urban areas, 2019.

Streets in low-speed zones generally have one or two travel lanes (i.e., one lane per the direction of travel), and sometimes include a center turn lane for increased turning movements. If a turn lane is only needed at an intersection, it should be converted into a landscaped median to physically and visually narrow the roadway. Removing turn lanes improves safety, especially for pedestrians, by reducing the speed at which



Figure 5.3 | Street User Hierarchy



Note: Pedestrians, cyclists, and motorcyclists are considered vulnerable because they lack external protection.
Source: Adapted from the Green Transportation Hierarchy proposed by Chris Bradshaw in 1994.

a turn can be negotiated. Having more than two lanes per direction is not recommended as that encourages higher speeds. This is especially dangerous in off-peak hours, when the traffic flow is low, as drivers will use all the available space to drive faster. If the road has more than one lane per direction, the other lane should be reconfigured for parking, a bike lane, or to increase the sidewalk width/public space.

CONSIDER ALL TYPES OF ROAD USERS

Low-speed zone designs should consider all potential user types and all ages and abilities. Establishing a hierarchy of user types can help clarify design decisions when the needs of different user types are in conflict (Figure 5.3). The specifics of this hierarchy will vary based on the goals and objectives established for the project and the vehicle types prevalent in the locality. However, it is generally recommended that low-speed zone designs prioritize vulnerable road users, particularly pedestrians.



Table 5.2 | Considerations for Low-Speed Zone User Types

USER TYPE	UNIQUE CONSIDERATIONS
Pedestrians	<ul style="list-style-type: none"> ▪ The need for a separate walking area or sidewalk depends on motor vehicle speeds and volumes. Pedestrians generally do not feel comfortable mixing with motor vehicle traffic at speeds greater than 10 km/h. When considering motor vehicle speeds and volumes, be sure to take into account daily and seasonal fluctuations. ▪ A buffer area between the sidewalk and street can increase pedestrian safety and comfort. ▪ Designs should include pedestrian amenities, such as pedestrian scale lighting, street trees, and benches. ▪ Designs should accommodate pedestrians using assistive mobility devices (e.g., wheelchairs, seated electric scooters, crutches, and canes), pedestrians with vision and hearing disabilities, and parents with strollers or children. ▪ Designs should minimize out-of-direction travel and crossing wait times for pedestrians.
Bicyclists and micromobility users	<ul style="list-style-type: none"> ▪ Need for bike lanes depends on motor vehicle speeds and volumes. A rule of thumb is that bicycle lanes should be provided if motor vehicle speeds are greater than 30 km/h or volumes are greater than 3,000 vehicles per day. Bicycle lanes should be physically separated from motor vehicle traffic by curbs, flexible delineator posts, landscaping, and/or other devices. If there is insufficient space for separated bike lanes, striped (painted) bicycle lanes can be installed to visually narrow the street. ▪ Designs should include convenient bicycle parking accommodations and micromobility docking zones at key destinations to meet or exceed expected bicycle parking demand. ▪ Designs should minimize out-of-direction travel and crossing wait times for bicyclists.
Motorcycle drivers	<ul style="list-style-type: none"> ▪ Different traffic-calming measures may impact motorcycle speeds and safety in various ways and those impacts should be considered. ▪ Horizontal traffic-calming measures such as chicanes, chokers, and lane narrowing may not reduce motorcycle speeds as effectively as car speeds. ▪ Vertical traffic-calming measures such as speed humps, raised crosswalks, and raised intersections may be difficult for motorcycle drivers to negotiate. Using horizontal traffic-calming measures such as traffic circles/roundabouts, medians, curb extensions, or bump-outs help motorcyclists slow down in advance of such features. ▪ All traffic-calming measures should be highly visible to enable motorcyclists to avoid late and sudden changes of direction. ▪ Road surfaces must provide adequate grip and must be free from defects. At the design and construction phases, potential hazards for motorcyclists must be avoided.
Public transport	<ul style="list-style-type: none"> ▪ Low-speed zones that include public transport routes must be traversable by public transit vehicles. ▪ Designs should provide for pedestrian and bicyclist access to public transport, including amenities like bus shelters and bicycle parking.
Fire and Emergency Medical Service	<ul style="list-style-type: none"> ▪ Fire and emergency medical services (EMS) vehicles should be able to negotiate the physical traffic-calming measures used in a low-speed zone. If not, consider whether access can be provided via side streets or if smaller fire and EMS vehicles can be purchased.
Cargo and delivery	<ul style="list-style-type: none"> ▪ Designs should designate loading and unloading zones for cargo and delivery vehicles and prescribe appropriate days and times for loading and unloading. ▪ Loading and unloading zones should not conflict with pedestrian routes or block sightlines to pedestrian crossings. ▪ Designs should consider the potential opportunities for and impacts of diverted or time-restricted cargo and delivery traffic, as well as the possibility of alternative delivery mechanisms, such as cargo bicycles.

Table 5.2 | Considerations for Low-Speed Zone User Types, continued

USER TYPE	UNIQUE CONSIDERATIONS
Private cars	<ul style="list-style-type: none"> ▪ Designs should designate zones for car parking. ▪ On-street parallel or back-in angle parking can be used to narrow the roadway and create chicanes. If the street section is wide enough, angle parking is more efficient in terms of space utilization and safety. ▪ The effectiveness of using parking for traffic-calming measures is contingent on high parking occupancy. ▪ Parking locations should not conflict with pedestrian routes or block sightlines to pedestrian crossings or bike lanes. ▪ Bollards may be helpful to prevent vehicles from parking on sidewalks.
Intermediary and paratransit	<ul style="list-style-type: none"> ▪ Intermediary and paratransit public transport vehicles such as rickshaws and privately operated minibuses may also use a low-speed zone. ▪ It may be appropriate to designate loading and unloading zones for some of these types of public transport vehicles.
Taxis and ride-sharing	<ul style="list-style-type: none"> ▪ Provide pick-up and drop-off zones that do not conflict with pedestrian routes.

Source: Authors.

BE SENSITIVE TO CONTEXT

Communities desire their streets to contribute to vibrancy and quality of life. Low-speed zone designs must respond to this desire and balance it with the context in which they are being planned or implemented. The context may include surrounding land use, existing travel patterns, user and vehicle type, transit, and community values and appetite for change (Figure 5.4). Designers must evaluate the travel experience for all users—drivers, bicyclists, pedestrians, public transport users, and commercial drivers—throughout the life of the design. All the design treatments discussed below may not be appropriate in every situation. Each specific context will require a certain

combination of design measures. Through flexibility, designs can respond to desires, safety, and need, not merely strict guidelines. Design professionals should consult local building codes, regulations, and requirements to ensure all design elements are permitted. Properly designed streets will embrace community values and enhance their quality of life, rather than simply providing a means of travel from one destination to another. Examples of a variety of context-sensitive approaches to low-speed zones are presented in the case studies (see Appendix, case studies on Mexico City, São Paulo, Bogotá, and Dar es Salaam).

Figure 5.4 | Street Type and Target Speed Based on Context and Desired Outcome



Source: Google Street Maps 2019.

EVALUATE FOR SAFETY

Improving safety is often the main reason for implementing a low-speed zone, which is why it is particularly important to assess the potential safety impacts of a low-speed zone design during the design process. The best way to do this is through road safety inspections and audits.

A road safety inspection (RSI) is a qualitative evaluation of safety conditions along an existing roadway, carried out by an experienced road

safety auditor. A road safety inspection can help identify issues not evident in the study area crash data, based on the auditor's expertise, best practices, and more systemic studies. Such an inspection should be carried out in the planning stages of a low-speed zone, to identify key risks and recommend solutions, and again later on in the process, to review the final design after implementation.

A road safety audit (RSA) is a qualitative evaluation of safety conditions for a roadway or transport project that is currently in the design phase, carried out by an experienced road safety auditor or a multidisciplinary auditing group. Unlike an RSI, an RSA evaluates the design drawings, not just the existing infrastructure. Road safety audits should be conducted after completion of the preliminary design as well as after completion of the detailed design (Road Safety Audit-UK 2018).

Table 5.3 | Recommended Resources

GUIDEBOOK	CATEGORY	ORGANIZATION	LINK
WRI <i>Cities Safer by Design</i>, 2015	Street design	World Resources Institute (WRI)	https://www.wri.org/
NACTO <i>Urban Street Design Guide</i>, 2013	Street design	National Association of City Transportation Officials (NACTO)	https://nacto.org/
NACTO <i>Global Street Design Guide</i>, 2015	Street design	National Association of City Transportation Officials (NACTO)	https://nacto.org/
ITDP <i>Better Streets, Better Cities: A Guide to Street Design in Urban India</i>, 2011	Street design	Institute for Transportation and Development Policy (ITDP)	https://itdpdotorg.wordpress.com/wp-content/uploads/2011/12/Better-Streets-Better-Cities-ITDP-2011.pdf
NUTP <i>Street Design Guidelines</i>, 2010	Street design	National Urban Transport Policy, Government of India	http://smartcities.gov.in/upload/uploadfiles/files/StreetGuidelines_DDA.pdf
<i>Boston Complete Streets</i>, 2013	Street design	The city of Boston	https://bostoncompletestreets.org
FHWA: <i>Achieving Multimodal Networks</i>, 2016	Planning and design	Federal Highway Administration (FHWA)	https://www.fhwa.dot.gov/
MassDOT <i>Separated Bike Lane Planning and Design Guide</i>, 2015	Planning and design	Massachusetts Department of Transportation	https://www.mass.gov
<i>Home Zones: Challenging the Future of Our Streets</i>, 2005	Planning and design	UK Department of Transport	https://www.gov.uk/government/organisations/department-for-transport
WRI <i>Sustainable and Safe</i>, 2018	Planning	World Resources Institute (WRI)	https://www.wri.org/
CROW <i>Design Manual for Bicycle Traffic</i>, 2017	Design	CROW, Netherlands	https://www.crow.nl
"8 Principles of Sidewalks," 2015	Design principles	World Resources Institute (WRI)	https://wrirosscities.org/sites/default/files/8-Principles-of-Sidewalks.pdf

Table 5.3 | Recommended Resources, continued

GUIDEBOOK	CATEGORY	ORGANIZATION	LINK
WHO <i>Pedestrian Safety: A Road-Safety Manual</i>	Pedestrian safety	WHO	https://www.who.int/publications-detail/pedestrian-safety-a-road-safety-manual-for-decision-makers-and-practitioners
AASHTO <i>Guide for the Development of Bicycle Facilities, 2012</i>	Bikeway design	American Association of State Highway and Transportation Officials (AASHTO)	https://www.transportation.org/
AASHTO <i>The Green Book, 2018</i>	A Policy on Geometric Design of Highways and Streets	American Association of State Highway and Transportation Officials (AASHTO)	https://www.transportation.org/
City of Bogotá <i>Speed Management Program, Base Document (Spanish), 2019</i>	Speed management	Vision Zero, City of Bogotá	https://www.movilidadbogota.gov.co/web/
FHWA <i>Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), 2012</i>	National standards for all traffic control devices	Federal Highway Administration (FHWA)	https://mutcd.fhwa.dot.gov/kno_2009r1r2.htm
<i>Traffic Engineering Manual, MnDOT, 2015</i>	Traffic engineering	Minnesota Department of Transportation	http://www.dot.state.mn.us/trafficeng/publ/tem/
United States Pavement Markings	National standards		https://mutcd.fhwa.dot.gov/services/publications/fhwaop02090/uspavementmarkings.pdf
Tools for Measuring Public Life, Gehl Institute	Measuring baseline data		https://gehinstitute.org/public-life-tools/
Health Economic Assessment Tool (HEAT) for Cycling and Walking	Measuring health and economic impacts		http://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/activities/guidance-and-tools/health-economic-assessment-tool-heat-for-cycling-and-walking

Source: Authors.

STREET DESIGN COMPONENTS OF A LOW-SPEED ZONE

Low-speed zone design involves coordination of four components—transitions, gateways, streets, and intersections—to ensure motor vehicle operating speeds at or below the target speed for the zone and to achieve other low-speed zone goals and objectives (Box 5.2).

TRANSITIONS AND GATEWAYS

Transitions and gateways provide visual and physical cues to motorists before they enter a lower speed environment. Transitions become particularly vital when motorists move from a higher speed roadway to a slow street. The length of a transition is variable and based on the motor vehicle's current operating speed and the slow street's target speed. In locations where the surrounding speeds are substantially higher, such as rural areas or expressways entering urban areas, transition zones will need to be longer than in urban areas where the speed differential between zones is smaller. For example, if the target speed for the slow street is 30 km/h and drivers are approaching the zone from a rural area or expressway and entering an urban area at 70 km/h, the transition length should be at least 150 m long (NCHRP 2012, 61). Even when the speed differential is lower, such as where drivers are moving from an urban arterial of 50 km/h into the low-speed zone, the distance required for perception/reaction time and deceleration should be taken into account and provided for in a transition zone. For example, a driver traveling at 50 km/h will need approximately

14 m minimum to react to the posted speed limit change and 10 m minimum for a sudden deceleration. In this case, a minimum transition length would be 25 m, but ideally, it would be longer to allow for a gentle deceleration.

To achieve proper transitions and gateways, designers must first warn drivers of the upcoming speed limit and the need to slow down, then employ specific design traffic-calming measures that encourage motorists to begin decelerating. The warning can be delivered through a variety of visual and physical cues, including gateway treatments; pavement markings; tapering of street width; a special intersection type (such as a roundabout), change in landscaping density; and use of bollards, speed bumps, and advanced warning signs and markings. Other factors to consider include street alignment, intersection geometry, and intersection density and control.

Gateways are specific types of transition treatments that provide a clear demarcation of where a low-speed street starts. The goal of the gateway is to reduce speeds and to convey a sense of arrival into a special zone where low motor vehicle speeds are expected (Box 5.3).

Gateways should be installed at all low-speed zone entry points (Figure 5.5) and coordinated with other treatments to ensure drivers' speed is at or below the target speed for the zone before entering. Gateways should include signage or pavement markings indicating the zone's speed limit (preferably both), plus coordinated physical slow street design elements.

Box 5.2 | The Importance of Creating a Transition and Gateway to a Low-Speed Zone

When entering a low-speed zone, in particular after a period of driving at a high speed, drivers will generally underestimate their speed and thus not reduce their speed adequately to comply with the lower speed limit.

Source: ECMT 2006.

Box 5.3 | The Impact of Gateways on Speed Reduction

Gateways can be very effective traffic-calming measures. Research suggests that well-designed gateways can result in speed reductions of 11–17 km/h (Lamberti et al. 2009) and can reduce injury crashes by 28 percent (Andersson et al. 2008). Gateway treatments produce larger reductions in pedestrian crashes than in other crash types (Makwasha and Turner 2013).

Figure 5.5 | Example of a Low-Speed Zone Gateway in the Liberdade Neighborhood, São Paulo, Brazil



Source: Google Street Maps.

STREETS

Pedestrians are the lifeblood of our urban areas, especially in downtown or other retail spaces. Hence, they are a crucial element in the design of a low-speed street. Slow streets place emphasis on pedestrians and bicyclists and are designed to discourage motorists from driving faster than the design and target speed. Slow streets should be designed for a maximum speed of 30 km/h or lower, depending on the surrounding context and desired application. This can be achieved by implementing physical traffic-calming measures at regular intervals throughout the low-speed zone. The appropriate interval varies depending on the desired target speed (Table 5.4).

Table 5.4 | Recommended and Maximum Distances between Physical Traffic-Calming Measures to Achieve Desired Target Speeds

SPEED LIMIT/TARGET SPEED	RECOMMENDED DISTANCE BETWEEN INTERVENTIONS	MAXIMUM DISTANCE BETWEEN INTERVENTIONS
30 km/h	75 m	100 m
10-20 km/h	20 m	50 m

Source: Danish Road Standards, Handbook on Speed reducing measures, 2013.

Low-speed street design begins with physically and visually narrowing the street. In low-speed environments, a maximum lane width of 3 m is recommended, but 2.50–2.75 m is preferred (see Table 5.1). The exact lane width should be based on the street context, target speed, and types of vehicles that will be present. Narrow travel lane widths produce slower motorist speeds, create shorter pedestrian crossing distances, and provide opportunities to reallocate street space for wider sidewalks, bike lanes, landscaping, and street buffers. On-street parking, by introducing the uncertainty around parking vehicles, can be used to lower speeds, aid in the narrowing of the roadway, and provide a physical barrier between the vehicle travel lane and the sidewalk. Physical design measures such as chokers or landscape

bulb-outs with street trees can be utilized intermittently with on-street parking to ensure speed compliance and visual narrowing when parking space is unoccupied. Separated bike lanes may also be used to narrow the roadway, increase the separation between pedestrians and vehicles, and provide dedicated spaces per street user type if the volume of vehicle traffic necessitates it. Vertical elements located in close proximity to the street such as street trees, lighting, bollards, and buildings can be intentionally introduced to discourage drivers from driving fast. In some cases, streets may also require midblock crossings (Box 5.4).

Slow streets may also benefit from a change in pavement material. A physical color change and the addition of texture can provide both a visual and physical cue for a motorist to slow down. Often pavement markings are removed to create uncertainty for motorists and require added caution. This increases motorists' awareness of their surroundings and encourages safe, slow driving techniques. Pedestrian activity and visibility alongside the street also encourage safe driving habits. Additional slow street design elements and techniques are listed below.

Box 5.1 | Common Speed-Related Terms and How They Apply to Low-Speed Zones

- Pedestrian street crossings are not always limited to existing intersections. Midblock crossings help facilitate pedestrian movements to a destination not served by an existing intersection or between intersections that appear too far away and inconvenient to use. Prior to the installation of a midblock crossing, an evaluation of the need and context must be performed to warrant the crossing; that is, pedestrian volumes, traffic counts, sightlines, speed, and regulatory laws.
- Midblock crossings are often accompanied by a median or island refuge to allow pedestrians to safely cross one direction of vehicular travel at a time. If on-street parking is incorporated or present, bulb-outs or chokers help reduce the crossing distance and aid in improving visibility and slowing traffic speeds. Midblock crossings can also be raised to provide a vertical visual element for the motorist and a physical speed reduction measure, and keep pedestrians at eye level. They may be electronically signalized or unsignalized using pedestrian-activated buttons, stop or yield sign-controlled, and always have enhanced and highly visible crosswalk pavement markings. Sightlines must be unimpeded at midblock crossings. Parked vehicles, landscaping, and street-side activations should be outside of sightlines or under 1 m (3 ft) in height.

INTERSECTIONS

Intersections are a major source of conflict between pedestrians, bicyclists, and motorists. Designers must carefully study intersections and conflict points to ensure safety for all users (Box 5.5). Traditionally, intersections are designed to accommodate a turn by the largest type of vehicle that could use the road, no matter how infrequently, and disregard the needs of the most vulnerable user, the pedestrian. This creates a large intersection geometry and allows standard vehicles to make fast and unsafe turning movements. Curb radii should be designed for the most frequently passing vehicle to move at a safe speed. At low-speed intersections, radii should be between 3.0 and 4.5 m. This facilitates slower turning movements, provides a shorter crossing distance, and positions the pedestrian in a more visible location. Tight curb radii can be combined with a raised intersection that promotes optimal pedestrian visibility and slows speeds. They can also be combined with curb extensions, which provide shorter crossing distances and more public space for placemaking, public art, street-side activity, and landscape. Designers should consider large vehicle frequency and can provide mountable truck aprons (see intersection treatments below) or allow the vehicle to utilize an additional receiving lane (lane that accepts through/turning traffic on the opposite side of an intersection) to make a turning movement without encroaching on pedestrian space.

Intersections provide for the orderly movement of traffic; however, in some low-speed zones, intersections are intentionally designed to introduce uncertainty, so that drivers slow down. To produce this uncertainty, traffic control devices can be replaced with traffic circles, which are small-scale roundabouts. These types of traffic circles have their best safety outcomes for pedestrians and cyclists when at least one of the intersecting roads has only a single lane in each direction, speeds are low, and clear pedestrian crossing and refuge island facilities are provided (UASFHWA 2014a, 2014b). These facilities give pedestrians and bicyclists priority, as motor vehicles yield to both the vulnerable users and other vehicles within the facility, and safety through the intersection is greatly increased (compared to a traditional intersection) with the minimization of head-on collisions, and the change to a more forgiving angle for side-impact crashes. When traffic circles are not an option, designers should consider using stop signs to slow the progression of traffic through an area and improve conditions for pedestrians.

Intersection designs should prioritize pedestrian safety and access and indicate to all street users when and where they are expected to yield. Pavement markings such as high visibility crosswalks and bicycle conflict markings should be carried through the intersection to establish where vulnerable users will be crossing travel lanes to minimize conflicts and motorist confusion. Sightlines must be left open



at intersections to provide optimal pedestrian visibility to motorists. On-street parking should be stopped a minimum of 6 m from a crosswalk (on either side for a midblock crossing), and landscaping should be no taller than 1 m. Landscaping should be even shorter at school zones, due to the shorter stature of children.

Box 5.5 | Speed and Number of Lanes Change Driver Responses to Pedestrians

Speed and number of lanes are key determiners of yielding to pedestrians at marked crosswalks. Bertulis and Dulaski (2014) found that at 20 mi/h (32 km/h) 75 percent of drivers yielded to pedestrians, whereas at 37 m/h (60 km/h) the yield rate dropped significantly to only 17 percent. Yielding dropped even further (to 9 percent) where there were four lanes instead of two.

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds




THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Narrowing motor vehicle travel lanes: Travel lanes should be narrowed to 3 m over a proper taper distance based on the design speed using physical concrete curbs, reduction of pavement material, or painted narrowing of the travel lane.</p>
	<p>Reallocation of street space: Usually accomplished by reducing the number of through motor vehicle travel lanes and adding median or bike lanes or wider sidewalks.</p>
	<p>Pavement markings: Pavement markings provide drivers with physical cues that they are entering a different setting and can communicate appropriate speed. Some pavement marking treatments include the following:</p> <ul style="list-style-type: none"> ▪ Standard: Standard pavement markings can help reduce the visual width of a travel lane. ▪ Text: In certain situations, it may be appropriate to write text across the travel lane such as "School Zone" or "XING," and to establish the new speed limit. ▪ Transverse: Transverse pavement markings are placed perpendicular to the direction of travel and provide visual (and sometimes audible) feedback to warn drivers of the impending need to slow down.

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued

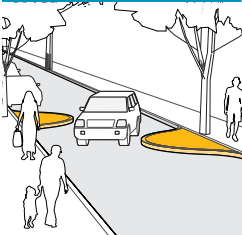
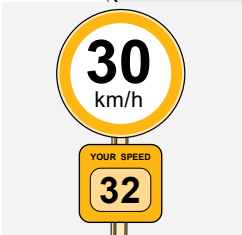



THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Chicanes: Straight roads may allow or encourage drivers to speed. Chicanes introduce changes to the alignment of the travel lane that require drivers to weave through a designated area at slower speeds. These can be implemented using either pavement markings or physical measures.</p>
	<p>Speed feedback signs: These make drivers aware of their current speed and can be used to collect motor vehicle speed and volume data.</p>
	<p>Advanced warning signage: This warns drivers of an upcoming change in the environment.</p>
	<p>Speed limit signage and pavement markings: These announce the speed limit for the zone as drivers are entering it. They should be prominently displayed. The placement of signs does have some impact on speed control. Further information on sign placements can be found in recommended resources.</p> <p>Additionally, it is best if both signs and pavement markings are used to reinforce the message.</p>
	<p>Monument signage: These indicate arrival to a community, neighborhood, or district.</p>

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued

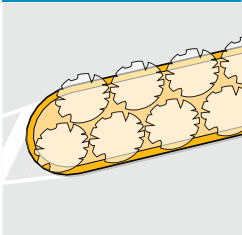
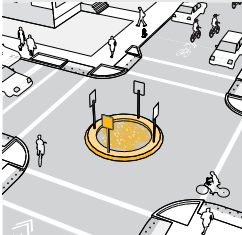

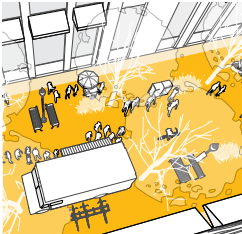

THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Medians: Medians are raised vertical elements between opposing directions of travel that help physically narrow the roadway. They can be landscaped or hardscaped, accommodate pedestrian crosswalks to become pedestrian refuge islands, and are sometimes traversable by emergency vehicles. Medians help manage access and can provide horizontal deflection to slow down motorists and provide visual and physical cues of arrival.</p>
	<p>Traffic circles: Circular central islands are placed in the middle of existing intersections. Also called rotaries, mini roundabouts, and neighborhood traffic circles, this treatment is primarily used on streets with lower motor vehicle volumes and speeds.</p>
	<p>Landscaping: This can be layered to enhance a sense of arriving in a new place and visually reduce the perceived width of the roadway at a gateway entrance.</p>
	<p>Shared street: A shared street, also known as a woonerf, prioritizes pedestrian and bicycle movements by slowing vehicular speeds and clearly communicates, through design features, that motorists must yield to all other users (FHWA 2017). Shared streets have a target speed and a maximum target speed of 10 km/h.</p>
	<p>On-street parking: Designated parking spaces along the roadway that can be either parallel or angled, depending on the design. Parking helps visually narrow the street and provides a physical barrier between the sidewalk and travel way, increasing user comfort. On-street parking can also be utilized to reduce the number of travel lanes in a retrofit application. If possible, different material should be used in parking spaces than for the roadway and sidewalk to clearly designate the space. In low-speed zones designated parking spaces can be alternated either side of the road with space between so that the parking spaces themselves also act as a speed control device by forcing drivers to make regular horizontal direction changes, like a chicane.</p>

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued

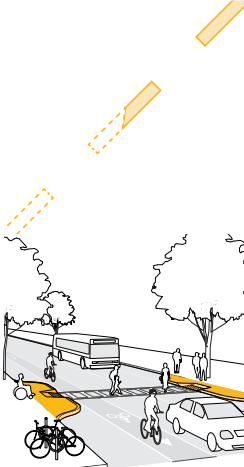
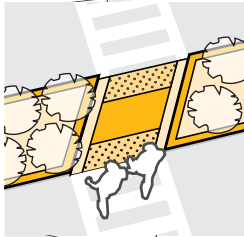
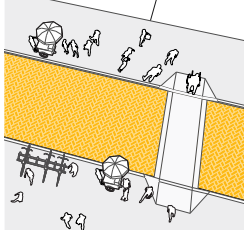


THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Pavement marking removal: Removing pavement markings, such as a centerline strip, creates a sense of uncertainty of the motorists' perceived travel lane width and encourages slower travel speeds. This treatment should only be considered on shared streets or streets that are designed for 10 to 20 km/h speeds and have two-way traffic.</p>
	<p>Chokers (bulb-outs): Curbs located midblock to create a pinch point that can accommodate a midblock crosswalk and provide an area for landscape.</p>
	<p>Pedestrian refuge islands: A similar concept to a median, but these provide a shorter raised "island" with the inclusion of a pedestrian refuge space for pedestrians to stop and wait in the middle, allowing the crossing of a lane or lanes in one direction of travel at a time.</p>
	<p>Paving treatments or materials: Pavement treatments such as brick, cobblestone, and concrete pavers are traditionally used in areas with high pedestrian volumes to provide a visual and physical cue to the motorist of the need to slow down.</p>
	<p>Sidewalks: These should be wide enough to comfortably accommodate expected pedestrian volumes, including pedestrians using mobility devices such as strollers and wheelchairs. Depending on the context, sidewalks should also provide space for pedestrians to gather and engage in community events. Sidewalks can be utilized to narrow travel lane widths.</p>

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued

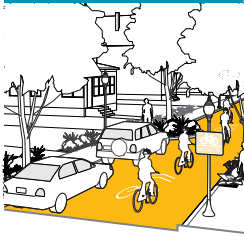
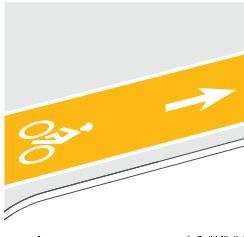
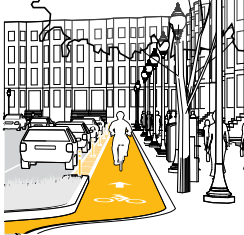
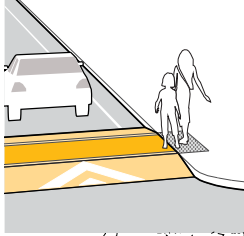
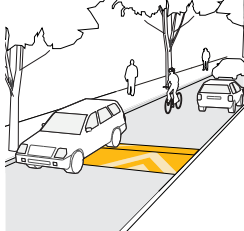
THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Shared bicycle streets/Bicycle boulevards: These are streets with lower motor vehicle speeds that allow bicycles to travel comfortably on the roadway in a low-stress environment. Bicycle boulevards use signs, pavement markings, and speed-calming measures throughout low-speed streets (30 km/h or less) to encourage lower motor vehicle speeds and allow for narrow travel lanes.</p>
	<p>Bike lanes: Bike lanes provide a dedicated space for bicyclists utilizing pavement markings along the roadway. Separated bike lanes are not typically necessary in streets with operating speeds of 30 km/h or lower because at this speed cyclists can share the road with vehicles relatively safely and comfortably. However, they may be considered under some circumstances, such as in areas with high motor vehicle traffic volumes or at very wide street sections, where they may have a traffic-calming impact. Painted bike lanes may be counterproductive on a low-speed street as they increase the curb-to-curb width, thus visually increasing the roadway width.</p>
	<p>Separated bike lanes: Separated bike lanes narrow travel lanes with a raised buffer between the bike lane and travel lane, accommodate all modes with dedicated space for bicyclists, prevent parking within the bike lane, and provide an opportunity for additional landscape. This is the preferred bicycle treatment for safety when higher vehicle speeds or traffic volumes are present.</p>
	<p>Raised crosswalks: A similar concept to both a speed hump and speed cushion, the crosswalk is raised to sidewalk level, providing a safer crossing for people with disabilities and increasing the visibility of people walking, while also requiring reduced vehicle speed. The raised crosswalk also demonstrates pedestrian priority.</p>
	<p>Speed humps: A raised section of pavement with a parabolic or flat top that extends across the road to maintain the intended speed and cause abrupt discomfort when traversed at higher speeds. These are the most commonly used traffic-calming devices.</p>

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued


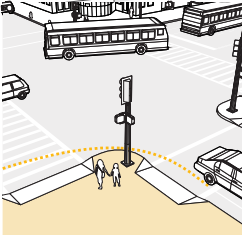
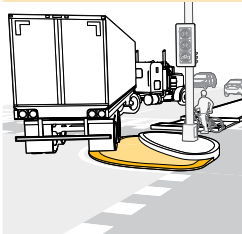
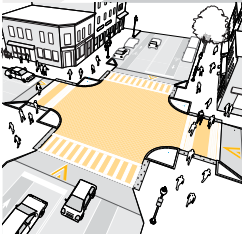
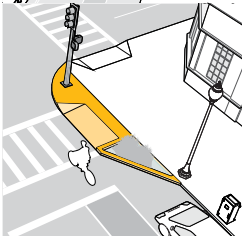
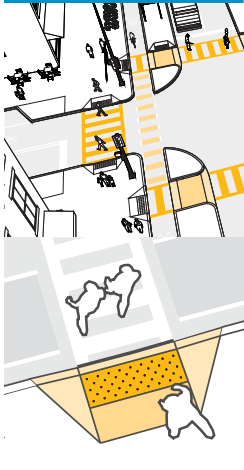


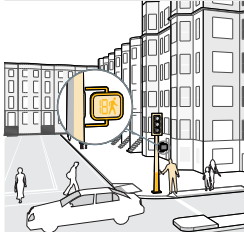
THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Speed cushions: Speed cushions are speed humps with wheel cutouts to allow large vehicles such as emergency vehicles and public transport vehicles to pass unimpeded. The cutouts also allow bicyclists to pass with minimal risk of falling, and they increase stormwater conveyance, as they are often made of rubber. In areas with high rates of motorcycle use, the design may need to be reviewed to ensure that it also slows motorcycle speeds.</p>
	<p>Radii: Curb radii must strike a careful balance between the needs of pedestrians and of vehicles, while creating slow yet effective turning movements for vehicles that reduce overall speed. Smaller curb radii place the pedestrian in a more visible location.</p>
	<p>Truck aprons: Truck aprons ensure large vehicles and trucks that make occasional turns can do so without intruding into pedestrian space and ensure standard vehicles make a safe and slow turning movement. Similar to a mountable apron found in the center of roundabouts, a truck apron has a maximum 7.5 centimeter (3 inch) mountable curb and surface that the rear wheels of a truck (off-tracking) mount.</p>
	<p>Raised intersections: A similar concept to a raised crosswalk, the full intersection is raised to sidewalk level providing a safer crossing for people with disabilities, increasing the visibility of pedestrians to motorists, and requiring motorists to reduce their speed as they move through the intersection.</p>
	<p>Curb extensions: Curb extensions provide additional space along sidewalks, decrease pedestrian crossing distance, provide an area for landscape, slow vehicular speeds, and have reduced curb radii to facilitate safe turning movements.</p>

Table 5.5 | Specific Design Elements and Techniques That Can Be Used to Achieve Desired Target Speeds, continued

THUMBNAIL	TREATMENT AND DESCRIPTION
	<p>Safe bicycle intersection treatments:</p> <ul style="list-style-type: none"> ▪ Protected intersections: Protected intersections provide safer movements at intersections, assigning user priority of all modes, promoting predictability of movement, and minimizing points of conflict between all users. ▪ Pavement markings: To provide higher visibility to bike lanes, the bike lane or conflict markings should carry through the intersection. <p>High visibility or enhanced crosswalks: Crosswalks establish the pedestrian travel way across a street and must be highly visible, can be unique and based on context, and must be the width of the approaching and receiving sidewalk.</p>
	<p>Two-, three-, and four-way stops: Stop conditions at intersections slow the progression of traffic through an area and improve conditions for pedestrians. All-way stop signs provide the best safety because these slow the speeds of approach on all arms of the intersection and thus minimize the risk of a higher-speed vehicle having a right-angle crash with another vehicle.</p>
	<p>Traffic signals: These can effectively assign a priority of users at an intersection using electronic traffic signals, bike signals, and pedestrian signals. Pedestrians should have dedicated phases. Traffic signals can also be counterproductive as they do not encourage vehicles to stop voluntarily for a pedestrian along a slow-speed zone, creating a cue through the intersection and rendering the traffic control device useless. Careful consideration should be given to this traffic control measure prior to implementation.</p>
	<p>Leading pedestrian interval: Pedestrians are given the walk sign 3–7 seconds before vehicle travel in the same direction is given the green signal, allowing pedestrians a head start to cross the road, increasing the visibility of pedestrians to right-turning vehicles. Local engineering standards should be consulted to see if this is an allowable treatment in a particular area.</p>

Source: Authors.





BRINGING LOW-SPEED ZONE DESIGNS TOGETHER TO FIT THE CONTEXT

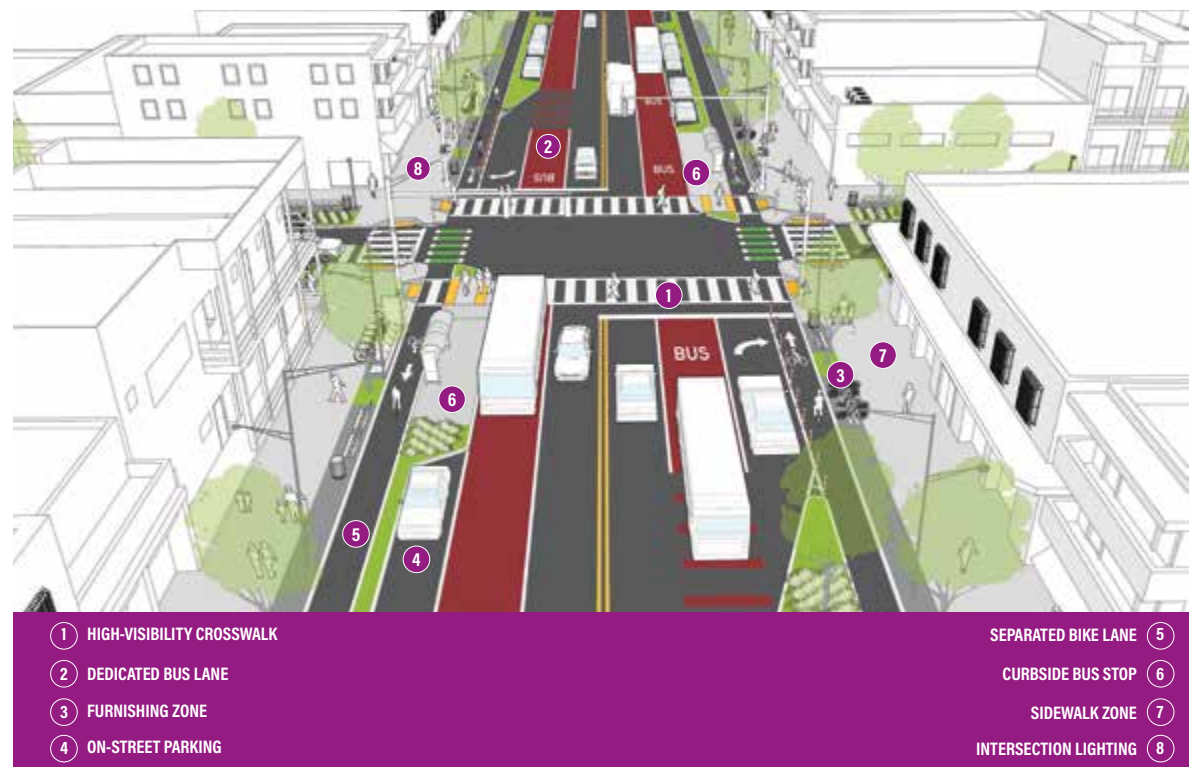
This chapter presents graphics that exemplify possible low-speed street design configurations in several urban settings.

These designs are intended to be representative of possible applications of street design treatments to achieve target vehicle speeds and improve access and safety for people walking and biking.

Designers of low-speed zones must carefully balance the desire of a community, political will, transportation needs, safety concerns, and economic impacts to design a street that is not only contextually sensitive but one that creates a sense of place and identity for a community. This can sometimes seem a daunting task; however, by applying this guide’s basic principles and the findings of additional research, a slow-speed street that achieves the goals and objectives established for the project can be attained. Street design for new street construction or retrofitting existing streets should be customized for each community, employing the general principles outlined here. Furthermore, design principles for slow streets can be applied to a variety of street types, including one-way and two-way streets. Low-speed zones in streets with only one lane in either direction have greater safety benefits, but with appropriate design and in certain contexts, low-speed zones can also be implemented in streets with a higher number of lanes. The following pages present graphics that exemplify possible low-speed street design configurations in several contexts that utilize these principles.

These designs are intended to be representative of possible applications of street design treatments to achieve target vehicle speeds and improve access for people walking and biking. They are not exhaustive. The appropriate combination and frequency of treatments (refer to Section 5.2.) should be selected for a given area based on the processes outlined in this guide and then refined using detailed technical guides on materials and measurements.

Figure 6.1 | Example of Low-Speed Zone Features in a High-Density, Mixed-Use Street



Source: Authors.

HIGH-DENSITY, MIXED-USE STREET

High-density mixed-use streets are often filled with life and are centers for activity and user interaction. In some cases, this is a visitor’s first impression of a community. Travel lanes are generally to be kept to 3 m with one lane in each direction, although exceptions may be made, if necessary, for wider public transport vehicles, such as buses. Wide sidewalks provide easy access to destinations, allow for social interaction, contribute to a sense of

place, and in a retrofit, aid in the narrowing of travel lanes. Center medians provide both visual and physical cues of a narrowing roadway. The additional space can be used for landscaping, street trees, and pedestrian refuge islands. Turn lanes can be introduced in the landscape median at intersections to accommodate higher turning volumes more safely with turn radii designed to limit speed. Transit may be accommodated through far-side floating bus stops, and delivery trucks should still be able to serve their customers.

Figure 6.2 | Example of Low-Speed Zone Features in a High-Density, Mixed-Use Street



Source: Authors, 2020.

A proper intersection design is critical to ensure safety for all users. Pedestrians must be given visual priority at intersections through high-visibility crosswalks communicating the pedestrian and other multimodal users’ anticipated points of crossing. If available, the provision of pedestrian signals assists in altering vehicular behavior and safely increases crossing times. Curb extensions, when provided, reduce crossing distances; increase landscaped area; allow for additional useable

space; minimize inappropriate parking, which reduces sight distance at intersections; reduce overall intersection size; and facilitate safe, slow turning movements for vehicular traffic. Street furnishings, landscape, and lighting all create a sense of place and encourage slower vehicle speeds. Figures 6.1 and 6.2 provide examples of a high-density, mixed-use street that brings together different elements of a low-speed zone appropriate to this context.

Designs for high-density, mixed-use streets should do the following:

- Encourage low motor vehicle speeds with a design speed and target speed of 20–30 km/h.
- Have no more than one lane of travel per direction and may include a center median.
- Curb radii should be no more than 4.5 m to facilitate slower turning movements. If transit and delivery vehicles need accommodation, truck aprons should be installed.
- Consider the use of on-street parking for accessibility, as a physical barrier between the roadway and sidewalk, for physical and visual narrowing of the roadway, and to encourage slow speeds.
- Prioritize pedestrians and bicyclists through high visibility crossings and pavement markings that extend through intersections and at midblock crossings, as well as bicycle parking.
- Include design elements that suggest a pedestrian and cyclist priority and the function of the street as a place for social, economic, and cultural exchange (i.e., street furnishings, gathering areas, lighting, etc.).

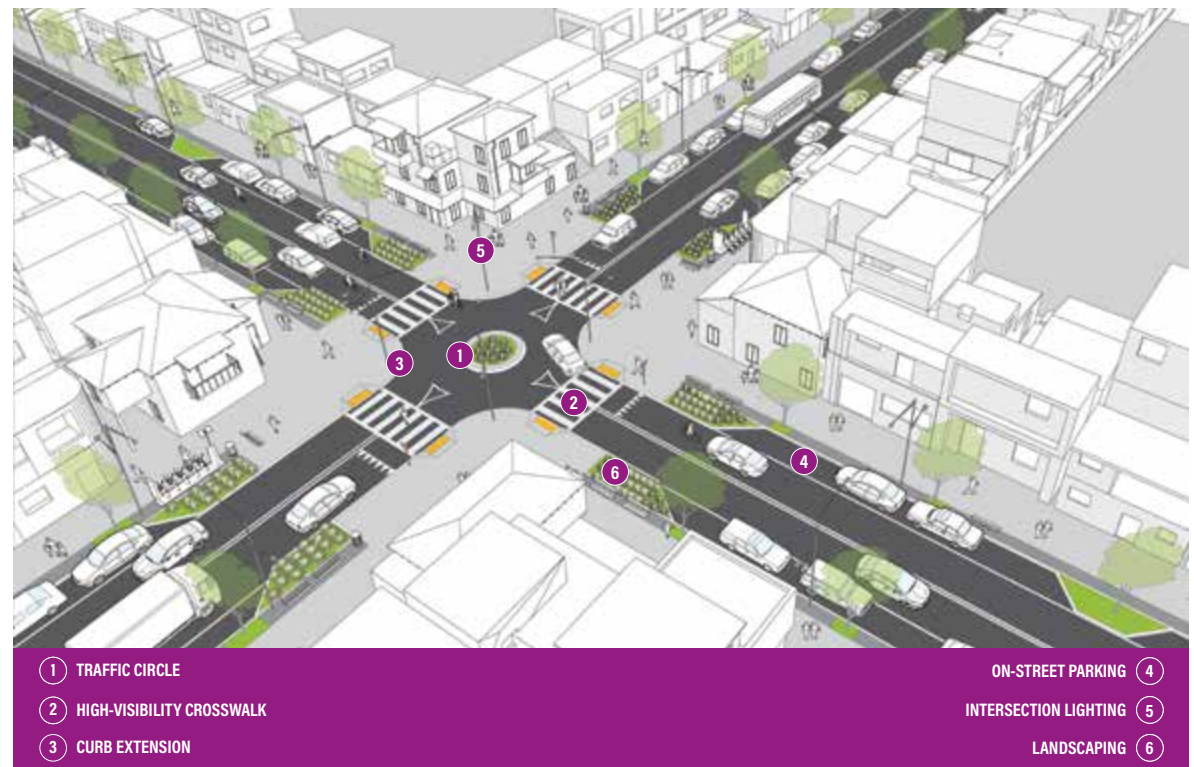
RESIDENTIAL STREET

For most people leaving their homes, residential streets are their daily first impressions of the public realm. These streets should provide spaces for social interaction, gathering, and travel for all forms of users. Prioritizing the users of residential streets is a key consideration for low-speed street design. Wide sidewalks, layered landscape, and appropriate street lighting encourage low-stress social interaction. On-street parking can provide easy access for tenants and create a buffer between bike lanes or sidewalks, all while physically and visually narrowing the roadway. Due to frequency in travel in residential settings, chokers should be considered at regular intervals to keep streets visually narrow when cars are not present. Separated bike facilities should be considered along with protected intersection designs that separate all modes and clearly define crossing locations. Access to transit should be carefully considered and accommodated through bus stops and public bike share docking stations or parking areas.

Design of residential streets should do the following:

- Encourage low motor vehicle speeds with a design and target speed of 20–30 km/h.
- Include an appropriate bike facility based on context; that is, separated bike lane, sidewalk-level bike lane, parking-protected bike lane, etc.

Figure 6.3 | Example of Low-Speed Zone Features in a High-Volume Residential Street with a Traffic Circle



Source: Authors.

- Include protected intersection designs that assign each mode a designated space and crossing location. This allows the crossing movements to be more predictable for all modes.
- Consider the use of on-street parking for accessibility, a physical barrier between the roadway and a bicycle facility, physical and visual narrowing of the roadway, and encouragement of slow speeds.
- Consider including chokers at regular intervals.
- Consider including street trees at regular intervals.
- Signal pedestrian and bicycle priority through high-visibility crossings and pavement markings that extend through intersections and at midblock crossings.

Figure 6.4 | Example of Low-Speed Zone Features in a High-Volume Residential Street with Protected Bike Lanes



Source: Authors.

■ Include design elements that suggest a pedestrian priority and the function of the street as a place for social, economic, and cultural exchange (i.e., street furnishings, gathering areas, lighting, etc.).

Figures 6.3 and 6.4 provide examples of two residential streets that bring together different elements of a low-speed zone appropriate to this context. Both treatments—the neighborhood

traffic circle and the protected bike lane—provide varying levels of protection to all modes and encourage slow speeds. Note that the figures show a wider residential street that may combine some thoroughfare purpose with an access purpose. As with any context, the width of the street and its functions will vary from city to city and even within neighborhoods, and this should be taken into account when developing design specifications.



Box 6.1 | Impact of High Speeds and Unsafe Streets on Children

Road traffic injury is now the leading cause of death for children and young adults aged 5–29 years globally (WHO 2018). The number of children injured or disabled as a result of road traffic crashes is estimated to be around 10 million each year (WHO/ UNICEF 2008). Children in low- and middle-income countries are more likely to walk to school, most often on roads that are in poor condition and dangerous, even along major highways, and often without available footpaths. A study in Hyderabad, India, finds that 11 percent of boys and 6 percent of girls reported a road traffic injury in 2014. (Tetali et al. 2015).

SCHOOL ZONE

School zones are low-speed zones around school locations. Low motor vehicle speeds are particularly needed near schools, due to the concentration of children and their unique vulnerability to serious injury and death in traffic crashes (Box 6.1). This vulnerability is related to children’s physical characteristics as well as their limited impulse control, slower reaction time, and poorer perception of risk.

In some countries, laws prescribe the maximum size of school zones and what signs and markings must be used. In others, this will be determined in the planning phase in coordination with government authorities.

Figure 6.5 | Example of Low-Speed Zone Features in a School Zone



Source: Authors.

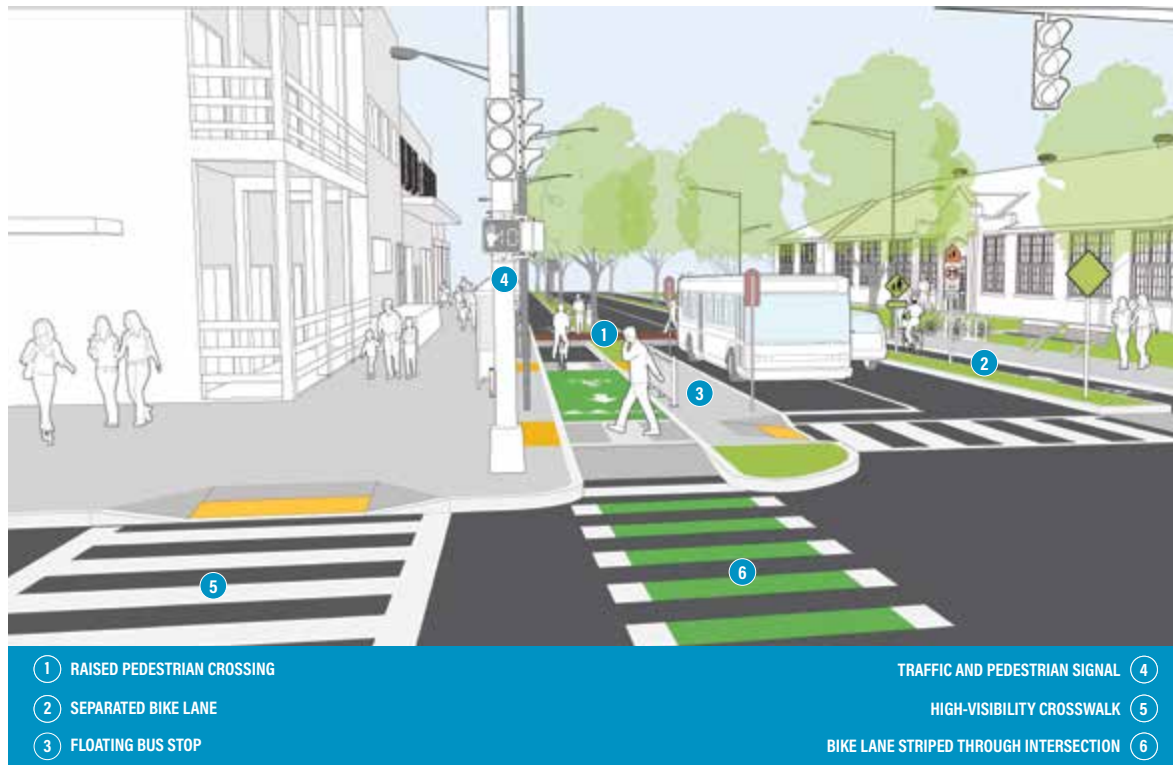
Figures 6.5 and 6.6 illustrate a school zone that brings together different elements of a low-speed zone appropriate to this context.

School zone designs should do the following:

- Prioritize the mobility of children walking or biking to school.
- Encourage very low motor vehicle speeds throughout the zone, with a maximum design and target speed of 20 km/h.

- Ensure proper lane widths—3 m is the recommended maximum unless context dictates otherwise—that accommodate all users without sacrificing safety.
- Alert drivers to the presence of children.
- Maximize pedestrian visibility by ensuring clear sightlines leading up to the school zone from all approaches and throughout the school zone.

Figure 6.6 | Example of Low-Speed Zone Features in a School Zone



Source: Authors.

- Take into account the existing routes and desire lines children use to access the school.
- Include safe crossing locations, where visual, physical, and regulatory cues prompt drivers to yield.
- Incorporate strategies that make children more visible to drivers, including raised crosswalks, curb extensions, and parking restrictions near crossing locations, and very low-profile landscaping. Because children

are shorter than adults and can be obscured by parked cars or other sidewalk features, design for visibility is particularly important in areas with a high presence of children, such as school zones.

- If crossing signals are included, ensure that the amount of time allocated for pedestrians crossing is appropriate for children’s walking speed (i.e., these are lower than a typical crossing speed).

Low motor vehicle speeds are particularly needed near schools, due to the concentration of children and their unique vulnerability to serious injury and death in traffic crashes.

SHARED STREET

A shared street, also known as a woonerf, prioritizes pedestrian and bicycle movements by slowing vehicular speeds and including design features that communicate that motorists must yield to all other users (FHWA 2017). Shared streets allow for pedestrians, bicyclists, and motor vehicles to mix within the same space. This is accomplished by a design that encourages low motor vehicle volumes and speeds; does not have elements such as vertical curbs, signs, and pavement markings that separate modes; uses material color and texture changes to define clear zones for pedestrians; and establishes uncertainty of pedestrian and bicyclist movements. This encourages caution by all users, slowing motorist speeds, and indicates pedestrian priority. The gateway or transition to a shared street should slow motor vehicle speeds and clearly communicate the entrance through changes in surface material color or texture, raised crosswalks, raised intersections, and vertical elements that aid in the visual narrowing of the street.

Shared streets may be appropriate in commercial areas with high pedestrian volumes, where pedestrians are likely to cross midblock, or on neighborhood streets with low motor vehicle volumes to create more flexible space

Figure 6.7 | Example of Low-Speed Zone Features in a Shared Street



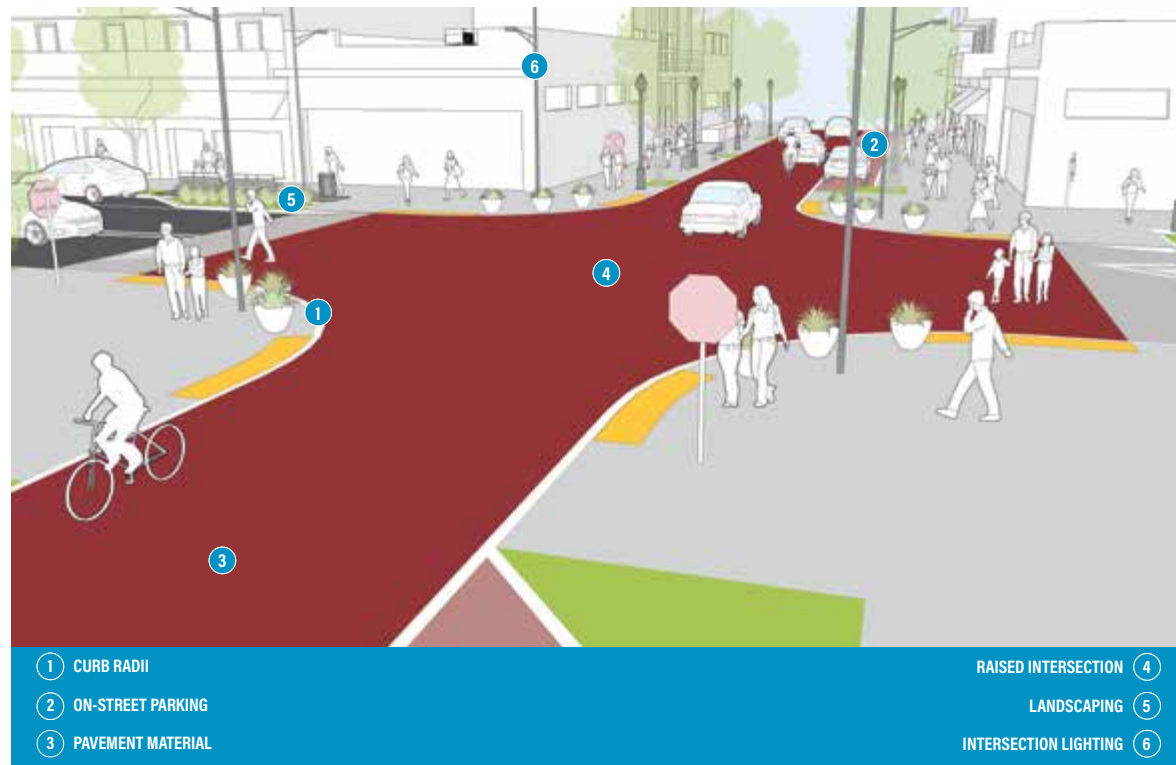
Source: Authors.

for children's play and other activities. Shared zones may also be appropriate for old city streets that are too narrow for a travel lane and footpath. Figures 6.7 and 6.8 illustrate a shared street that brings together different elements of a low-speed zone appropriate to this context.

Shared street designs should do the following:

- Encourage very low motor vehicle speeds and volumes with a design and target speed of 10 km/h.
- Distinguish the shared street from conventional streets through changes in surface texture and color.

Figure 6.8 | Example of Low-Speed Zone Features in a Shared Street



Source: Authors.

- Avoid elements that suggest motor vehicle priority or segregation of modes, such as curbs, pavement markings, etc.
- Include design elements that suggest pedestrian priority and the function of the street as a place for social, economic, and cultural exchange, such as street furnishings, gathering areas, lighting, etc.
- Address and carefully consider the navigational needs of people with disabilities. For more information regarding this subject, see the FHWA’s *Accessible Shared Streets guide*.
- Provide a way for people with mobility impairments to access buildings.
- Include appropriate drainage designs for shared streets that do not have curbs to channel rainwater (see the WRI’s, “8 Principles of Sidewalks” guide).





CONSTRUCTING A LOW-SPEED ZONE

This chapter discusses the approach a community must take and the key factors responsible behind the construction of a low-speed zone, such as available funding, level of support for the project, urgency of the need, and desired speed of implementation.

There are a variety of ways a low-speed zone can be constructed. For example, a low-speed zone may be constructed over a relatively brief period or phased in over several years. Low-cost interim measures can be implemented quickly in the short term and more permanent solutions installed later as support for the low-speed zone builds and funding becomes available (Box 7.1). The approach a community takes will depend on a range of factors, including available funding, level of support for the project, urgency of the need, and desired speed of implementation.

STAKEHOLDER ENGAGEMENT DURING CONSTRUCTION

Stakeholder engagement may be necessary during construction, particularly with the residents, businesses, and institutions that will be impacted most. Outreach is needed for the following purposes:

- Informing and receiving feedback from stakeholders about the construction plan.
- Explaining street closures and other impacts and describing alternative accommodations.
- Providing updates on construction progress.
- Provide a way for stakeholders to ask questions and report concerns related to construction; for example, by nominating a dedicated person to be responsible for community liaison.

INTERIM CONSTRUCTION OPPORTUNITIES

An interim approach to construction may be appropriate if low-speed zones need to be implemented quickly or if funding is insufficient to pursue costlier approaches right away. Interim approaches typically involve less expensive materials that can be installed quickly. Interim approaches differ from temporary ones (see Box 7.1: Temporary Pilot Projects) in that they are intended to last a few years rather than a few days or weeks. Examples of lower-cost materials that might be used for interim construction include the following:

- Flexible delineator posts: These can be used for curb extensions, chicanes, medians, and other traffic-calming measures. They can also be used to separate a bike lane from the adjacent street.

- Premanufactured curbs: These can be used for curb extensions, chicanes, and medians, and to provide separation between a street and an adjacent bike lane.
- Rubber speed cushions: These are used in place of asphalt speed cushions or humps.
- Signage: This provides speed limit information and warns people they are entering a low-speed zone.
- Paint or thermoplastic: This can be used for pedestrian crossings, bike lanes, narrower motor vehicle travel lanes, and pavement markings. (It should be noted that when selecting the paint type, avoid types that may be slippery for motorcycles and bicycles.)

When selecting materials for interim construction, consider how well they will hold up under local traffic and weather conditions. For example, thermoplastic is generally more durable than paint and may be more suitable in

Box 7.1 | Temporary Pilot Projects

If there is concern about a low-speed zone project, consider implementing it on a temporary or pilot basis before constructing it permanently. This approach is a way to test out how a concept works and build support while demonstrating benefits. Pilot projects may be in place for a few hours or a few weeks. For pilot projects to be effective, the following temporary measures are important:

- Simulating the ultimate proposed design as closely as possible.
- Including education, outreach, and enforcement, as necessary.
- Installing for long enough to enable public officials and community members to become familiar with the changes.
- Collecting metrics of acceptance/performance of the zone, including after the community has had time to adjust to the new zone.

Pilot phases were included in low-speed zone implementation processes in Bogotá, Mexico City, and São Paulo, as featured in this guide (pages 99, 96, and 97, respectively).

Temporary pilot projects are sometimes referred to as “tactical urbanism.” For ideas on implementing tactical urbanism, see Street Plans Collaborative’s, *Tactical Urbanism: Short-Term Action, Long-Term Change* (Lyndon 2012).

Source: Authors.

locations with high motor vehicle traffic. In some circumstances, removable temporary materials may be more at risk of damage, vandalism, or theft. This will be the communities' first look at the new design before it becomes permanent. If it fails because of poor material choices, community support and hence project momentum may be adversely affected.

Potential sources of funding for interim construction include business improvement and tourist district organizations. If sufficient funding is not available, consider implementing sign-only speed limit reductions in portions of the zone where motor vehicle operating speeds are already relatively close to the target speed. This is the approach taken in the United Kingdom, where the UK Department of Transport allows jurisdictions to lower speed limits to 32.2 km/h (20 mi/h) without physical traffic-calming measures in cases where the mean motor vehicle speed for the street is 38.6 km/h (24 mi/h) or less (UK Government, Department for Transport 2013).





TRIPLE FRONTIER

SELECTION

10 YEARS

OPERATING AND EVALUATING A LOW-SPEED ZONE

This chapter discusses postconstruction follow-up actions for a low-speed zone. These actions include continued stakeholder engagement, implementation of speed enforcement measures, maintenance, and monitoring and evaluation to determine the zone's effectiveness.

Because of the planning and engagement required, implementation of speed enforcement measures have already been covered in earlier sections. The remainder of the topics are discussed below.

STAKEHOLDER ENGAGEMENT

In the postconstruction phase stakeholder engagement is needed to achieve the following:

- Meet community needs and goals.
- Collect feedback on how successfully the low-speed zone has been implemented and whether any adjustments are needed (e.g., to address safety concerns or traffic diversion).
- Educate decision-makers about the value of low-speed zones.
- Address any opposition to the project that still exists.
- Educate the public about expectations within the low-speed zone, including enforcement actions.

EDUCATE DECISION-MAKERS

Decision-makers include politicians, local government staff, and others who influence the built environment. It is important to educate them about the impact of speed on safety and about the value of low-speed zones. The process of educating decision-makers should begin at the outset of the development process. After the low-speed zone is constructed, it may be a good idea to take a group of decision-makers on a tour of the low-speed zone, so they can see the benefits firsthand. NGOs may be valuable allies in educating and persuading decision-makers.

EDUCATE THE PUBLIC

Low-speed zones receive more support when implementation is accompanied by a marketing

Figure 8.1 | Transport for London's "Watch Your Speed" Campaign



Note: In 2019, Transport for London unveiled the "Watch Your Speed" campaign, highlighting the negative impact of speeding on passengers.
Source: TFL 2019.

campaign that increases awareness of project goals and objectives and the impact of speed on safety and well-being, and communicates expectations for driver behavior within the zone. Marketing campaigns require sufficient resources to be effective. Campaigns must also be based on sound specific research. The underlying beliefs and attitudes of the audience, which may be creating a reluctance to support a low-speed zone, must be known so that the campaign addresses relevant issues rather than presumed ones. The campaign may incorporate a variety of media (e.g., print, broadcast, and online), as well as person-to-person engagement. Messages should be tailored to subgroups within the community. London public service announcements are an example of effective messaging on the topic of speed (See Figure 8.1).

MAINTENANCE

Operations of the zone must include maintenance to ensure the quality of the public space and that the safety impacts of operating speeds continue over time. Maintenance planning, budgeting, and schedules should include all physical elements that were implemented to create the zone, including speed limit and other signs, pavement markings, traffic signals, and landscaping (maintenance of landscaping is even more important if it also has a use-purpose such as preventing pedestrians crossing at an unsafe location, or ensuring plant growth is controlled to a certain height to allow visibility of pedestrian infrastructure and signage). Maintenance is extremely important to ensure that applied measures continue to perform properly throughout the life of the design. Responsible

city government agencies should ensure that this is adequately budgeted and planned for. Local road safety, public space, or business advocacy groups may also play a role in monitoring the status of maintenance programs or the need for any urgent maintenance, and in pressuring the city to be accountable for this.

MONITORING AND EVALUATION

Quantifying lives saved, serious injuries avoided, and other compelling low-speed zone effects can help make the case for low-speed zones elsewhere.

The goal of evaluation is to determine if the low-speed zone meets the goals and objectives that were originally established for it, and if not, to determine what can be done to improve outcomes. Evaluation can also inform the development of other low-speed zones in the future. Box 8.1 gives case-based examples of measurable impacts of low-speed zones.

The specifics of evaluation should have been worked out during the planning phase through the development of an evaluation plan. Among other things, the plan should have defined what baseline and postconstruction data would be needed and when, where, and how data collection would proceed.

METHODS FOR ASSESSING LOW-SPEED ZONE SAFETY PERFORMANCE

- **Speed Studies:** These studies are used to evaluate the distribution of motor vehicle speeds at a specific location.

- **Yielding Studies:** These are used to evaluate motor vehicles yielding at key pedestrian crossing locations.
- **Road Safety Inspection:** A formalized process for identifying postconstruction road safety hazards that involves an interdisciplinary road safety inspection team.
- **Traffic Conflict Analysis:** A method for assessing roadway safety through the formal observation of conflicts at key locations, which can provide insights more quickly than crash analysis.
- **Crash Analysis:** This is a method for assessing roadway safety by analyzing the type and distribution of crashes.

For a medium-term or permanent intervention, it is best to conduct a series of post evaluation studies at defined increments starting 30 days after implementation, as it often takes time for people to become familiar with the zone (Table 8.1). Note that the zone's impact on killed and seriously injured crashes may take several years to determine due to random year-on-year fluctuations. In the shorter term, the zone's safety performance can be assessed through stakeholder feedback, walk audits, road safety inspections, speed and yielding studies, and traffic conflict and crash analyses.

Evaluation should cover both the zone itself and adjacent areas. Evaluation of adjacent areas is necessary to understand any spillover effects, whether positive or negative.

Box 8.1 | Real-life Impacts of Low-Speed Zones

Many look to the example of Bristol to support the introduction of 20 mph limits. In 2014, Bristol, UK, introduced a 20 mph speed limit in zones in six wards, including on two main traffic routes. Research by the University of the West of England (UWE) has found that more than four lives have been saved per year since the introduction of these zones. Average speeds on roads where the limit was introduced fell by 4 km/h (2.7 mph). Furthermore, about 170 injuries were prevented, saving £15m a year (BBC 2014, 2018).

The "Neighborhood Slow Zone" program in New York launched the city's first 20 mph zone in the Claremont section of the Bronx in 2011 (Kazis 2011). The introduction of the slow zone resulted in a 10 percent reduction in the worst speeding in the neighborhood. Due to its rising success rate, 13 additional zones, besides the Claremont slow zone, have been completed under the first round of neighborhood applications for "slow zone" treatment. Slow zones now cover more than 65 miles of the city's streets (NYC 2013).

Finally, evaluations are required on the impact of the low-speed zone on various user groups, including pedestrians; bicyclists; motorcycle, car, and bus drivers; buses; emergency medical services; cargo and delivery services; and others. This can be accomplished through intercept surveys of zone users and field observations of user behaviors.

Table 8.1 | Matrix of Evaluation Strategies and Time Lines

GOAL	EVALUATION STRATEGY	TIME LINE
Drivers are aware of the low- speed zone and slow to the target speed or below prior to entry	Conduct speed studies at gateway locations (e.g., by using automated traffic recorders).	30 days and 90 days after installation, ideally for at least 7 days
Drivers maintain a speed that is at or below the target speed throughout the low-speed zone	Conduct speed studies on streets within the zone (e.g., by installing automated traffic recorders at midblock locations).	30 days and 90 days after installation, ideally for at least 7 days
Drivers yield to pedestrians at pedestrian crossing locations	Conduct yielding studies at pedestrian crossing locations (see Bertulis and Dulaski 2014 for an example methodology).	30 days and 90 days after installation
Sightlines between drivers and pedestrians improve	Conduct field observations and interviews with residents and visitors at locations where daylighting features have been installed.	30 days after installation
Drivers make fewer illegal left turns	Conduct turning movement counts at locations where illegal left turns are a concern.	30 days and 90 days after installation, ideally for at least 7 days.
Motor vehicle volumes decrease	Install automated traffic recorders at strategic locations to capture traffic volumes.	30 days and 90 days after installation, ideally for at least 7 days.
Pedestrian and bicycle volumes increase	Install automated pedestrian and bicycle counters or conduct manual counts.	Seasonally or yearly, ideally for at least 7 days
Serious injuries and fatalities are reduced	Conduct traffic conflict analyses at strategic locations throughout the zone.	30 days after installation
Serious injuries and fatalities are reduced	Conduct crash analyses for streets within the zone and streets in adjacent neighborhoods. Review serious injury and fatalities that determine five-year averages.	Yearly
Gross business receipts go up	Evaluate data on gross business receipts for businesses within the low-speed zone.	After two years
User perceptions of safety improve	Conduct interviews with residents and visitors to understand perceptions of safety within the zone and to identify any safety concerns.	Yearly

Source: Authors.





CONCLUSION

Deaths and serious injuries are the painful and highly visible result of a lack of road safety, but more has been lost to high car speeds than we realize. One solution to this growing problem is **Low-Speed Zones**. Low-speed zones can protect all users and save lives. Implementable design principles of a low-speed zone are not new, but rather a simple methodology weaving traditional roadway elements with more innovative solutions to best accommodate all street users in a safe and cohesive manner. The solution starts with one voice, the encouragement and empowerment of the principles and recommendations in this guide, and a desire to act and make change.

An epidemic has swept silently across the globe and has become the leading cause of death among people age 15–29 (WHO 2018). The global killer is traffic fatalities. With the addition of over 78.6 million new passenger cars to the world's roads in 2018 alone, this dire problem must be alleviated. Reducing traffic deaths by managing speeds began to gain traction in the early 1980s when the Netherlands began experimenting with low-speed residential zones, leading to the development of the Vision Zero or Safe System movement in the early 1990s in Sweden and the Netherlands.

Despite growing awareness of traffic death statistics and data, the vast majority of countries' street designs continue to give priority to motor vehicle speed and volume over human life and safety (NACTO 2016). One cure for this growing and devastating problem is Low-Speed Zones. Low-speed zones have the power to

protect all users—they have the power to save lives. The implementable design principles of a low-speed zone are not new, but rather a simple methodology weaving traditional roadway elements with more innovative solutions to best accommodate all street users safely and cohesively. The solution starts with one voice, the encouragement and empowerment of the principles and recommendations of this guide, and a desire to act and make a change.

Motor vehicle speed is a factor in almost every crash. Research shows a reduction of speed both increases life expectancy in a pedestrian or bicycle crash and decreases the risk of crashes occurring. However, simply reducing the speed limit of a street and relying on enforcement will not realistically slow vehicle speeds in most countries. Design measures must be used to visually and physically narrow the roadway and create a self-enforcing operating speed. While

this guide focuses on “retrofitting” existing urban areas, the same principles hold for the development of new streets or neighborhoods with commercial, residential, or social functions.

Streets can be attractive, inviting, and vibrant public spaces or continue to be deadly roadways. This guide is meant to inform, educate, and empower community leaders, designers, and government officials on planning, design, and construction of low-speed zones in their community. While the subject of design is approached in brevity, more detailed design documents have been developed and should be consulted. Case studies from communities of many nations, cultures, and sizes currently implementing low-speed zones have been presented here to show research and progress, and to provide examples of implementation. Are low-speed zones a solution for your community?





THE POWERBALL
THE POWERBALL
THE POWERBALL

HAVAS

Lids

CAUTION
STEEL
PLATES
AHEAD

Starbucks

172025011



APPENDIX: **CASE STUDIES**

To further strengthen the research in this guide, four case studies from Mexico, Brazil, Colombia, and Tanzania are presented in this chapter. The authors of the featured case studies have been involved in the planning and implementation of the low-speed zones. The information included has been collected by the authors via interviews with local city planning staff and experts.

These case studies, as well as other examples, are featured throughout the guide, at points where they are relevant to specific aspects of low-speed zone planning. Additional information on case studies from Dar es Salaam, Tanzania; Bogotá, Colombia; and Mexico City, Mexico, can be found in Box 4.3, Box 4.4, and Box 4.5, respectively.

HISTORIC CENTER, MEXICO CITY, MEXICO

Figure 10.1 | AVENIDA 16 DE SEPTIEMBRE
Converted to a Pedestrian Priority and Calm Transit
Zone Area in 2014



Source: Project for Public Spaces, 2019.es.

Size: 3.3 Km²

Land use: Mostly commercial, cultural, and government uses with some residential

Key partners: Historic Center Authority (ACH), the Mobility Secretariat (Secretaría de Movilidad, SEMOVI), with the construction and participation of the Public Space Authority (Autoridad del Espacio Público, AEP), WRI, local businesses, and street vendors.

Funding sources: Funding for the first phase was provided by Bloomberg Associates. Mexico City provided funding for later phases.

Since 2009, Mexico City has developed a network of low-speed zones and pedestrianized streets in its Historic Center. These changes are part of a larger vision

to transform the Historic Center, a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site and home to the Zocalo (the largest plaza in Latin America). The changes are intended to revitalize the area, increase transportation options, and improve traffic safety.

The process began with Madero Street, which was pedestrianized. Then the plan was to approach adjacent corridors differently by implementing interventions to encourage slower speeds but keep the traffic flowing. AEP, ACH, and SEMOVI collaborated to start a pilot project on 16 de Septiembre Street to demonstrate to city staff and businesses, residents, and street vendors in the Historic Center the benefits of lower speeds and answer their concerns about similar projects. An engineering study preceded the pilot project, and a series of meetings with government agencies were arranged after. In the case of 20 de Noviembre Street, city agencies collaborated with WRI and Bloomberg Associates as advisors for the project. The process for 20 de Noviembre went more smoothly, as stakeholders had already seen the positive impacts of the previous project.

STAKEHOLDER ENGAGEMENT

Throughout the process of implementing changes along Historic Center corridors, the team held a series of meetings with major stakeholders to discuss possible interventions and existing concerns. In the beginning, they faced some pushback from local businesses that were apprehensive about losing clientele. In addition, some city agencies with offices in

the area were concerned about losing parking space and easy access. The team shared the positive results from the Madero Street project with participants and explained the new street-specific interventions and their benefits. Later in the process, street vendors objected to not being involved in a process that directly impacts them and their livelihoods. After choosing intervention locations, the team invited the street vendors' elected leaders to join the conversation. As the 16 de Septiembre intervention started, a team was assigned to respond to the public's concerns and questions, which included queries about parking spaces, delivery times for restaurant supplies and commercial goods, access to public sanitary and emergency services, and access for people with physical disabilities. Project team members provided their phone numbers to the public and were ready to answer their questions. This accessibility created trust between the parties as the project proceeded. In the case of the 20 de Noviembre Street project, the team launched an advertising and communications campaign to share project details and updates with the public.

DESIGN

For 16 de Septiembre, reflective traffic cones were used in the two-week-long pilot stage, while later several permanent traffic-calming designs were introduced. Some designs included a reduction in turning radii as well as the addition of speed humps, rumble strips, bollards, chicanes, benches, inverted U bicycle racks, curb extensions, and traffic signals. For 20 de Noviembre, designs included a bike

lane separated from traffic by parking spaces, a painted extension to the pedestrian zone, planters, seating, and other street furniture. The street is set to have a weekend scenario, where it is pedestrian-only and furniture is added for various street events and activities (Figure 10.1).

RESULTS

The interventions resulted in fewer crashes. For example, on 16 de Septiembre crashes dropped from 15 annual crashes preimplementation to 5 annual crashes postimplementation. In addition, pedestrian accessibility, flow rates, tourism, and sales all increased significantly in the historic center, while crime decreased.

KEY TAKEAWAYS

These visionary changes to Mexico City's iconic historical center have proved the value of pop-up demonstrations to build support, understand the need, and disarm critics. The project demonstrated the benefits to be gained by establishing a technical working group involving key agencies and highlighted the importance of including less formal stakeholders who are often overlooked, such as street vendors, alongside

other key actors. From a design perspective, the project was able to demonstrate the feasibility of installing traffic-calming measures, even within local design constraints (in this case due to controls over certain features such as lighting and sign colors since the area is a UNESCO World Heritage Site), by using semipermanent materials such as plastic bollards for bicycle lanes and plastic speed humps to control vehicle speed. Finally, it demonstrated the value of collecting baseline and postimplementation data to prove successes and win over critics.

SÃO MIGUEL PAULISTA, SÃO PAULO, BRAZIL

Size: 0.5 Km²

Land use: Mixed-use neighborhood

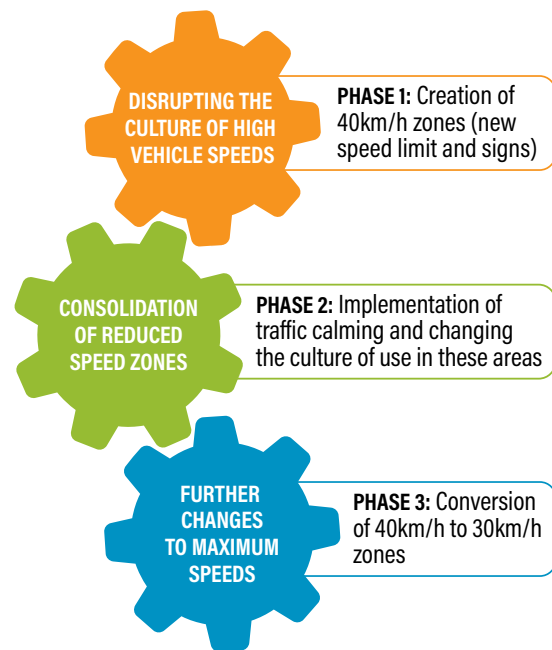
Key partners: Traffic Engineering Company (Companhia de Engenharia de Tráfego, CET), SPTrans, Permanent Accessibility Committee, SP Urbanism, and São Miguel Borough, WRI, Bloomberg Initiative for Global Road Safety (BIGRS), NACTO-Global Designing Cities Initiative (GDCI)

Funding sources: Revenue from speeding tickets

Between 2013 and 2015, CET implemented several 40 km/h zones known as “40 Zones” (“Zonas 40”) throughout São Paulo to reduce speeds from 50 km/h to a limit of 40 km/h in high crash areas. These zones represented 1 percent of the urban area and 2 percent of the urban population but concentrated 5 percent of injury and fatal crashes and 7 percent of pedestrian crashes registered between 2011 and 2014. The city adopted a phased strategy for implementation of the low-speed zones, to garner public support (Figure 10.2). The first phase was to create the “40 Zones” in key locations to gradually shift the culture of high speed in the city. The zones feature signage and pavement markings and are enforced through automated speed cameras. However, this phase did not include physical traffic-calming measures. Implementing physical traffic-calming measures to achieve lower speeds and consolidate the LSZs was planned by CET for phase 2, once funding became available. The third and final planned phase is to reduce speed limits to 30 km/h, once the public has had time to experience and adjust to the concept of lower urban speeds.



Figure 10.2 | CET's Three-Stage Plan to Achieve Cultural, Behavioral, and Infrastructural Change on Vehicle Speeds in the City



Source: CET 2016.

In 2015, in collaboration with WRI, NACTO-GDCI, and BIGRS, CET (the São Paulo Traffic Engineering Company) started planning for “Calm Areas” with physical traffic-calming measures and 30 km/h speed limits within some of the 40 Zones in the neighborhood of São Miguel.

São Miguel is one of São Paulo’s most important and busiest commercial and cultural centers in the East Zone of the city. Despite its designation

Figure 10.3 | Before the Pop-Up Intervention



Source: Miguel Jacob/ITDP Brazil.

as a 40 Zone, the area continued to see a high number of road traffic crashes (Figure 10.3). In 2014, Marechal Tito Avenue, the most important road in the region, had the highest number of fatal pedestrian crashes (11 deaths) among the city’s avenues. Thus, identified as a high-risk area, and with the support of BIGRS, São Miguel’s 40 Zone was chosen as a pilot location for physical traffic-calming interventions to lower speeds to 30 km/h. Additionally, WRI along with BIGRS and NACTO organized a design competition for a permanent project on three of the existing 40 Zones: Lapa, Brás, and Santana, apart from São Miguel. A number of public sector agencies were on the judging committee. The final design for São Miguel proposed 18 interventions in the neighborhood, and it was assessed and approved by CET and the partnering team. To engage the local population in the importance of road safety measures and as a way to assess the impact of planned interventions on the site, BIGRS partners led by NACTO-GDCI, Institute for Transportation and Development Policy (ITDP)

Figure 10.4 | Getúlio Vargas Square, Final Design



Source: Miguel Jacob/ITDP Brazil.

Brasil, and city officials created a one-day temporary pop-up intervention based on the design (Figure 10.4). Experiences from the São Miguel project, including best practices in safe street design and the pop-up intervention, paved the way for advancing implementation of phases 2 and 3 of CET’s strategy for LSZ.

In 2016, CET implemented the first low-speed zone with a speed limit of 30 km/h in a pilot project in Lapa. The reduction of the speed limit in the region was accompanied by improvements in vertical and horizontal signage, according to the first phase of CET’s strategy.

Launching of the São Paulo Road Safety Plan in April 2019 helped create momentum for the transformation of São Miguel and other areas in the city, since implementation of LSZ is part of the plan’s strategy.

Projects for physical traffic-calming elements have been developed for 13 low-speed zones in the city and we are to be implemented in 2019 and 2020, as part

Figure 10.5 | Getúlio Vargas Square during Pop-Up



Source: Fabio Nazareth/ITDP Brazil.

of the São Paulo Road Safety Plan.

STAKEHOLDER ENGAGEMENT

The community had a big role in this project, via coordinated community engagement processes. WRI governance specialists and NACTO-GDCI led the community outreach effort. They worked with schools and the local community to include students in the pop-up installation (Figure 10.5), as well as with residents and local shop owners. The public was included and kept informed using banners and frequent updates about the project during the design period and upcoming stages. Engaging the local community was key to ensuring public support for the project during political transitions and changes in the city administration.

DESIGN

For the pop-up project, the team used chalk, paint, cones, planters, umbrellas, and beach chairs to create an additional 850 m² pedestrian space within the 1,600 m² intervention area at Getúlio Vargas Square (Figure 10.4). The aim

Figure 10.6 | Selected Location in Tunjuelito, Prior to the Pilot Project



Source: Ricardo Arévalo, 2019.

was to transform a roundabout into a plaza. The permanent intervention includes raised crossings and intersections, refuge islands, curb extensions, tighter turning radii, and pedestrian plazas. It also features pavement markings, signage, and traffic-calming measures. The goal of these interventions is to widen the pedestrian area, decrease pedestrian crossing distance, and indicate to drivers that they are entering a new pedestrian-priority environment where lower speeds are expected.

KEY TAKEAWAYS

The main lesson from this project is the importance of physical design interventions in achieving slower speeds. As the city tried signage and pavement markings in the first stage, they noticed the need for additional physical interventions in certain higher-risk areas to achieve slower speeds. In addition, this process is one of a kind in the city, so it serves as a precedent that is used to implement more Calm Areas in the city.

TUNJUELITO, BOGOTÁ, COLOMBIA

Size: 1.05 km² with density of 22,000 inhabitants/km²

Land use: Dense, mostly residential with education and health institutions

Key partners: Secretaria Distrital de Movilidad (SDM)/District Secretariat of Mobility, WRI, residents of Samoré neighborhood, local schools, local businesses and restaurants, local parish, El Carmen Hospital

Funding source: City of Bogotá

The Action Plan for the Bogotá Speed Management Program (Programa de Gestión de la Velocidad, PGV) was managed by the Office of the Mayor of the City of Bogotá and developed by the District Secretariat of Mobility (SDM) and WRI, and includes implementation of low-speed zones in critical areas in the city. As part of this program, WRI collaborated with SDM to implement a pilot project and an interim intervention in a key location in the Tunjuelito District. The site was selected based on a WRI analysis of road safety data of local streets throughout the city. A series of workshops with community stakeholders were also held to identify high-risk locations, where traffic safety is a concern as well as to educate the public about speed management techniques. The project team selected the Tunjuelito location (Figure 10.6) from among 20 priority locations due to the high concentration of traffic crash fatalities and injuries, especially among children

Figure 10.7 | Proposed Traffic-Calming Locations



Source: Secretariat of Mobility of Bogotá, 2018.

in a school zone. SDM and WRI worked together to develop the pilot design to achieve operating speeds under the existing speed limit, which was already 30 km/h but largely ignored. The design proposed traffic-calming measures that had not been implemented in the city before, such as give way streets (two-way streets with space for cars to pass in only one direction at a time), chicanes, and an hourglass bus stop (a bus stop located between chokers or a lane reduction so that traffic cannot overtake the bus while it is stopped for passengers to embark/disembark).

During the three-day “pop-up” pilot, which used temporary materials to test different traffic-calming measures on each side of the block, city and WRI staff were on-site to monitor speeds. They recorded results that showed a significant increase in compliance with speed limits, especially around the school. SDM

Figure 10.8 | Neighborhood during Pop-Up Intervention



Source: Secretariat of Mobility of Bogotá, 2018.

used the data to justify support for interim implementation of the measures after the pilot project ended, such as using paint and durable plastic bollards and segregators bolted to the road (Figures 10.9, 10.10, and 10.11).

STAKEHOLDER ENGAGEMENT

The community was skeptical of the project due to their general distrust of the government. They became more active as the project team invited them to take part in public workshops and provide input on potential challenges and solutions.

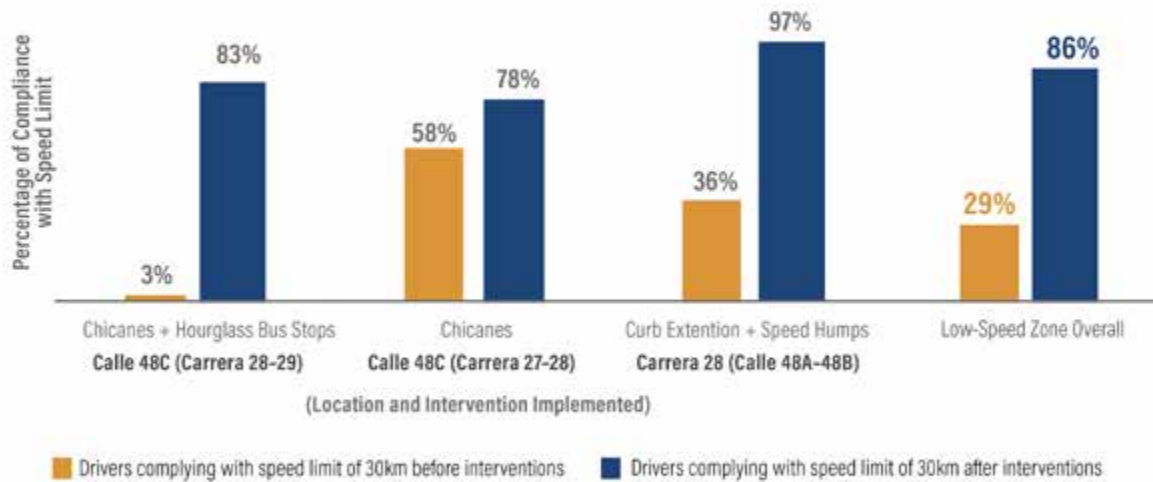
DESIGN

The speed limit for residential areas and school zones throughout the city of Bogotá was already set to 30 km/h. However, drivers often ignored the existing speed limit signage and exceeded the safe speed limit. This increased risks on local residential roads, especially from traffic that used the roads to avoid congestion on major roads. The intervention aimed to

test traffic-calming measures to retrofit road design to match operating speeds with the posted speed limit. A series of traffic-calming measures were proposed along six blocks in the neighborhood. Some measures that were implemented like chicanes, chokers, and hourglass bus stops had never been tested in the city. The city decided to implement a pilot for two of the high-risk intersections and for a road in front of Raphael Uribe School, to test the proposed measures (Figure 10.7).

The team placed informational banners at the entrances to the intervention zones to describe the project and its details. They used cones, reflective tape, chalk, and paint on one-way streets to slow traffic and improve pedestrian visibility with chicanes, road narrowing, chokers, and curb extensions at the intersections (Figure 10.8). They used parking on the two-way street as a measure to narrow lane widths. In addition, all measures were accompanied by traffic signs and pavement markings.

Figure 10.9 | Change in the Proportion of Vehicles Complying with the Speed Limit before and during the Tunjuelito Traffic-Calming Pilot Project



Source: WRI, 2019.

RESULTS

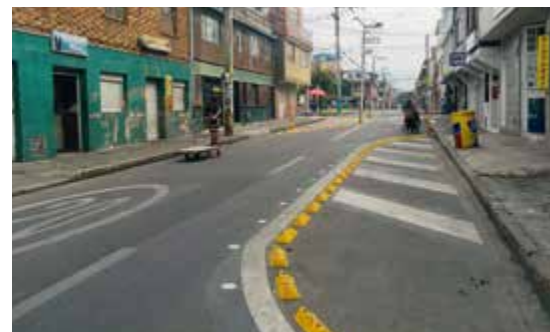
During the pilot intervention, driver compliance with the speed limit soared from 29 to 86 percent, including from 36 to 97 percent in front of one school where chicanes and chokers were installed (Figure 10.9). As for the community’s experience on the road, 32 and 54 percent of children felt protected and relaxed/comfortable (respectively) and 17 and 75 percent of adults felt protected and relaxed/comfortable (respectively). These results also helped secure both community and city support for medium-term measures, which were subsequently implemented using paint, durable plastic bollards, and segregation (Figures 10.10, 10.11, and 10.12).

Figure 10.10 | Medium-Term Materials Installed in Tunjuelito to Form a Choker after Success of the Temporary Pilot Project



Source: Segundo Lopez, 2018.

Figure 10.11 | Medium-Term Materials Installed in Tunjuelito to Form a Chicane after Success of the Temporary Pilot Project



Source: Natalia Lleras, 2018.

Figure 10.12 | Medium-Term Materials Installed in Tunjuelito to Form a Choker after Success of the Temporary Pilot Project



Source: Natalia Lleras, 2018.

KEY TAKEAWAYS

Even though the posted speed limit in the area was safe (30 km/h), drivers were not complying with it. Speed limits should always be complemented with road designs that enforce the posted speed limits.

The pop-up pilot lasted three-days and offered a learning experience for the District Secretariat of Mobility. The impact of each measure was evaluated and documented for future reference; these results are key for the implementation of new traffic-calming measures in Bogotá.

The community also learned and experienced firsthand the different types of traffic-calming measures and their impact on reducing speeds and increasing safety. The local administrative board is now more willing to take over funding and to implement permanent traffic-calming measures that have proved to help drivers comply with speed limits in Bogotá.

DAR ES SALAAM, TANZANIA

Size: Varies per location

Land use: Residential/Mixed-use neighborhoods

Key partners: Amend; Fédération Internationale de l'Automobile (FIA) Foundation; Centers for Disease Control and Prevention (CDC); local authorities in Dar es Salaam; and primary school administrators from Ilala, Kinondoni, and Temeke Municipalities

Funding sources: FIA Foundation

Amend's School Area Road Safety Assessments and Improvement (SARSAI) program works to implement low-speed zones near schools. It started in Dar es Salaam as a pilot project and has since expanded to 10 African countries. For the projects in Dar es Salaam, the Amend team met with city engineers, primary school administrators, students, parents, local stakeholders, and neighboring shop owners to collect data and impressions about existing road conditions. Over the next two years, in collaboration with local authorities, the Amend team proposed and implemented a series of low-budget traffic-calming measures near schools identified as high-risk for crashes involving child pedestrians. Typically, the traffic-calming measures that were proposed and implemented outside high-risk schools included signage, speed humps, zebra crossings, slabs, road safety murals, and a pedestrian gate. These measures were installed on busy paved roads outside the school to mark a safe school zone. In 2014, the program received additional funding from FIA Foundation and collaborated with CDC to conduct a comprehensive population-based study of school catchment areas. The study identified a group of nine treatment schools and another group of nine control schools. The team collected baseline data, including the number and severity of injuries, the age of those injured, level of medical attention, and police reports for both groups for three months. They then proposed and implemented physical interventions in the treatment group and went back to evaluate and collect results after the interventions had been in place for three months. A report of

findings was produced indicating significant reductions in speed and associated crashes in the treatment group schools. In general, there was a 26 percent reduction in all injuries among school-going children. Treatment schools saw a reduction in head injuries by 58 percent, and notably, motorcycle-related injuries were reduced by 26 percent. For ethical reasons, the team then implemented traffic-calming measures at all control group schools based on the outcome of the assessments.

STAKEHOLDER ENGAGEMENT

Community groups were heavily involved throughout the Dar es Salaam process. The SARSAI team spoke to different members of the community and schools to collect their impressions, observations, concerns, and feedback. The community showed support and provided positive feedback for the interventions. They recognized the need for slower speeds to protect children walking to school in neighborhoods surrounding the schools.

DESIGN

The team identified areas of approximately 500 m around each school for a 30 km/h speed zone, installed speed limit signage and school zone signage, designated clear paths demarcated with bollards or a curb to protect pedestrians from vehicles and prevent motorcycles from avoiding speed humps, and installed designated high visibility zebra crossings outside school gates, along with speed humps on either side of the crossing (Figures 10.13 and 10.14). The team also added road safety murals on school walls to reinforce road safety messaging for

Figure 10.13 | Designated sidewalks demarcated with bollards to enhance pedestrian safety



Source: Kyle LaFerriere/WRI, 2019.

schoolchildren and draw attention to a school for drivers. In addition to physical interventions and speed reductions, the treatments included a tailored road safety education program to increase knowledge of important road safety lessons and safety patrols, a job that was typically performed by school staff.

RESULTS

The program, comprehensive study, and the numerous interventions created a strong foundation for advocating for 30 km/h speed limits near schools by providing a successful precedent and real-life example. By collecting baseline data from a large

Figure 10.14 | Designated high-visibility crossings outside school gates



Source: Kyle LaFerriere/WRI, 2019.

number of school zones around the city, the project presents concrete evidence of the impact of low-speed zones on reducing risk for students.

KEY TAKEAWAYS

This project takes a highly innovative approach that is not yet common in Tanzania, or in sub-Saharan Africa. Indeed, the project was awarded the 2018–2019 WRI Ross Center Prize for Cities by an expert jury, explicitly because of its evidence-based, highly replicable approach. As a pioneering effort, the project faced several challenges yet still significantly impacted road safety. One main challenge was the absence of guidelines or regulations addressing street design and motor vehicle speeds in the school

zone. This was exacerbated by bureaucratic and political obstacles that required the team prove to local authorities the need for 30 km/h around each school. Tanzania, like most countries in the Africa Region, does not have a law that requires 30 km/h speed around schools, hospitals, residential neighborhoods, etc. This makes implementing 30 km/h zones more challenging. Now that the precedent has been set by the success of this pilot project, road safety stakeholders such as NGOs can use both the case study and evidence from other regions to advocate for changes in the National Traffic Act so that 30 km/h speed limits around such areas become law.

ENDNOTES

1. For additional information on cost-effectiveness analysis, see <https://www.its.leeds.ac.uk/projects/WBToolkit/Note4.htm>.

REFERENCES

- AASHTO (American Association of State Highway Transportation Officials). 2011. *A Policy on Geometric Design of Highways and Streets*, 6th Ed. https://bookstore.transportation.org/collection_detail.aspx?ID=110.
- Ahn, K., and H. Rakha. 2009. "A Field Evaluation Case Study of the Environmental and Energy Impacts of Traffic Calming." *Transportation Research Part D: Transport and Environment* 14 (6): 411–24.
- Alcaldía Mayor de Bogotá. 2019. Programa de Gestión de Velocidad. Documento Base, 2019. <https://www.movilidadbogota.gov.co/web/sites/default/files/Paginas/2019-03-18/Programa%20de%20Gesti%C3%B3n%20de%20la%20Velocidad%20para%20Bogot%C3%A1.pdf>.
- Andersson, P. K., B. la Cour Lund, P. V. Greibe, and L. Herrstedt. 2008. "Byporte: de trafikikkerhedsmaessige effekter, Trafitec Scion-DTU, 116, July. [Online]. <http://www.trafitec.dk/pub/byporte%20vejforum08.pdf>.
- Anon. 2002. Evidence and Conclusions from the Sixth Annual Local Government Road Safety Conference, Newcastle, UK, August.
- Archer, J., N. Fotheringham, M. Symmons, and B. Corben. 2008. "The Impact of Lowered Speed Limits in Urban/Metropolitan Areas." *Transport Accident Commission (TAC)*. January 2008. https://www.monash.edu/___data/assets/pdf_file/0007/216736/muarc276.pdf.
- Banks, M. D. 2009. "Safety on the Roads: Joining Forces to Save Lives." *Multilateral Development Banks Joint Statement*. <https://www.iadb.org/en/news/news-releases/2009-11-11/safety-on-the-roads-joining-forces-to-save-lives%2C5958.html>.
- BBC (British Broadcasting Corporation). 2014. "20 Mph Zones Are Introduced in Bristol." <https://www.bbc.com/news/uk-england-bristol-25825019>.
- BBC. 2018. "Bristol 20mph Zones: Four Lives a Year Saved, Study Finds." <https://www.bbc.com/news/uk-england-bristol-43050841>.
- Belin, M. A. 2015. Presentation to the Swedish Transport Administration Vision Zero Academy, Vilnius, Lithuania, September 10.
- Belin, M. A., P. Tillgren, and E. Vedung. 2012. "Vision Zero: A Road Safety Policy Innovation." *International Journal of Injury Control and Safety Promotion* 19 (2): 171–79.
- Bertulis, T., and D. M. Dulaski. 2014. "Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks." *Transportation Research Record* 2464 (1): 46–51.
- Bocarejo, Juan Pablo, Juan Velásquez, Claudia Díaz, and Luis Tafur. 2012. "Impact of Bus Rapid Transit Systems on Road Safety." *Transportation Research Record*. *Journal of the Transportation Research Board* 2317: 1–7. 10.3141/2317-01.
- Boston Government. 2017. "Neighborhood Slow Streets: Scoring and Evaluation Methodology." https://www.boston.gov/sites/default/files/imce-uploads/2017-07/2017_neighborhood_slow_streets_methodology_and_score_score_sheets.pdf.
- Bray Sharpin, A., S. R. Banerjee, C. Adiazola, and B. Welle. 2017. "The Need for (Safe) Speed: 4 Surprising Ways Slower Driving Creates Better Cities." WRI (World Resource Institute), May 9, 2017. <http://www.wri.org/blog/2017/05/need-safe-speed-4-surprising-ways-slower-driving-creates-better-cities>.
- Beissmann, Tim. 2014. "Paris' New Mayor Proposes City-Wide 30km/h Speed Limit." *Caradvice*, June 2.
- The City of New York, Department of Transportation (NYCDOT). 2019. "Neighborhood Slow Zones." <https://www1.nyc.gov/html/dot/html/motorist/slowzones.shtml>.
- Danish Road Standards, Cross Sections in Urban areas, 2019. <http://vejregler.lovportaler.dk/ShowDoc.aspx?schultzlink=-vd20190006#pkt3.2.3>
- Danish Road Standards, Handbook on Speed reducing measures, 2013: <http://vejregler.lovportaler.dk/ShowDoc.aspx?schultzlink=-vd-anlaeg-fart-daempere2013#pkt4.211>
- Duduta, N., C. Adiazola-Steil, C. Wass, D. Hidalgo, L. A. Lindau, and V. S. John. 2015. "Traffic Safety on Bus Priority Systems: Recommendations for Integrating Safety into the Planning, Design, and Operation of Major Bus Routes." Washington, DC: EMBARQ/World Bank Group.
- ECMT (European Conference of Ministers on Transport). 2006. "Speed Management." <https://www.itf-oecd.org/sites/default/files/docs/06speed.pdf>.
- European Commission. 2004. *Reclaiming City Streets for People: Chaos or Quality of Life?* Luxembourg: Office for Official Publications of the European Communities.
- Ewing, Reid. 2001. "Impacts of Traffic Calming." Surface Transportation Policy Project. *Transportation Quarterly* 55 (1): 33–46, Washington, DC: Transportation Research Board. https://nacto.org/docs/usdg/impacts_of_traffic_calming_ewing.pdf.
- FHWA (Federal Highway Administration). 2016. "Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts." Washington, DC: U.S. Department of Transportation FHWA Office of Planning, Environment, and Realty. www.fhwa.dot.gov/environment/.
- FHWA. 2018. "Guidebook on Identification of High Pedestrian Crash Locations." Washington, DC: U.S. Department of Transportation FHWA Office of Planning, Environment, and Realty. <https://www.fhwa.dot.gov/publications/research/safety/17106/17106.pdf>.

- Gardner, T., H. McGee, and R. Srinivasan. 2012. *Methods and Practices for Setting Speed Limits: An Informational Report*. Washington, DC: U.S. Department of Transportation FHWA.
- Gavin, A., E. Walker, R. Fernandes, A. Graham, R. F. S. Job, and J. Sergeant. 2011. "Creation and Validation of a Tool to Measure the Real Population Risk of Speeding." *Proceedings of the 2011 Australasian Road Safety Research, Policing and Education Conference*. <http://casr.adelaide.edu.au/rsr/RSR2011/6BPaper%20002%20Gavin.pdf>.
- Grana, A., T. Giuffrè, and M. Guerrieri. 2010. "Exploring Effects of Area-Wide Traffic Calming Measures on Urban Road Sustainability Safety." *Journal of Sustainable Development* 3 (4). <http://www.ccsenet.org/journal/index.php/jsd/article/view/6880>.
- Grenoble.fr. 2015. "Ville apaisée: Grenoble à 30 km/h depuis le 1er janvier 2016." Grenoble.fr. September 15. <https://www.grenoble.fr/actualite/75/103-ville-apaisee-grenoble-a-30-km-h-depuis-le-1er-janvier-2016.htm>.
- GRSP (Global Road Safety Partnership). 2008. *Speed Management: A Road Safety Manual for Decision-Makers and Practitioners*. Geneva: GRSP.
- Grundy, C. 2009. "Effect of 20 mi/h Traffic Speed Zones on Road Injuries in London, 1986–2006: Controlled Interrupted Time Series Analysis." *BMJ* 339: b4469. <https://www.bmj.com/content/339/bmj.b4469>.
- Hagen, J. X. 2018. "Traffic Calming and Environmental Justice: New York City's Neighborhood Slow Zones." *Transportation Research Record* 2672 (3): 175–84. <https://doi.org/10.1177/0361198118796005>.
- Haworth, N., and M. Symmons. 2001. "The Relationship between Fuel Economy and Safety Outcomes." Monash University Accident Research Centre. Victoria, Australia.
- Howard, E., L. Mooren, G. Nilsson, A. Quimby, and A. Vadeby. 2008. "Speed Management: A Road Safety Manual for Decision Makers." Geneva: GRSP (Global Road Safety Partnership), May. http://www.unroadsafetyweek.org/uploads/tekstblok/speed_management_english.pdf.
- Hong Kong Transport Department. 2006. "Pedestrian Schemes for Causeway Bay." https://www.td.gov.hk/en/transport_in_hong_kong/pedestrianisation/pedestrianisation/causeway_bay/index.html.
- Hussain, Q., H. Feng, R. Grzebieta, T. Brijs, and J. Olivier. 2019. "The Relationship between Impact Speed and the Probability of Pedestrian Fatality during a Vehicle-Pedestrian Crash: A Systematic Review and Meta-Analysis." *Accident Analysis and Prevention* 129: 241–49.
- IHE (Institute of Highway Engineers). 2017 "Guidelines for Motorcycling." <http://www.motorcyclingguidelines.org.uk/the-guidelines/3-0-road-design-traffic-engineering/3-6-traffic-calming/>.
- Institute of Transportation Engineers. 2010. "Designing Walkable Urban Thoroughfares: A Context Sensitive Approach." <http://library.ite.org/pub/e1c43c-2354-d714-51d9-d82b39d4dbad>.
- Institute of Transportation Engineers. 2012. "Safe Routes to School Briefing Sheets: Reduced School Area Speed Limits." <https://www.ite.org/pub/?id=e26610b5%2D2354%2Dd714%2D51f1%2Dc266857615f0>.
- ITDP (Institute for Transportation and Development Policy). "Mexico City Joins the Vision Zero Movement," August 25, 2015. <https://www.itdp.org/2015/08/25/mexico-city-joins-the-vision-zero-movement/>.
- Job, R. F. S. 1988. "Community Response to Noise: A Review of Factors Influencing the Relationship between Noise Exposure and Reaction." *Journal of the Acoustical Society of America* 83: 991–1001.
- Job, R. F. S., and C. Sakashita. 2016. "Management of Speed: The Low-Cost, Rapidly Implementable Effective Road Safety Action to Deliver the 2020 Road Safety Targets." *Journal of the Australasian College of Road Safety* 27 (2): 65–70. [http://acrs.org.au/wp-content/uploads/Vol27No2_Web.pdf].
- TheJournal.ie*. 2018. "More 30km/h Zones Planned for Dublin after Public 'Strongly' Backs €235,000 Proposals." September 11.
- Jurewicz, C., A. Sobhani, J. Woolley, J. Dutschke, and B. Corben. 2016. "Exploration of Vehicle Impact Speed—Injury Severity Relationships for Application in Safer Road Design." *Transportation Research Procedia* 14: 4247–56.
- Kalolo, Simon. 2018a. Amend Road Safety NGO, Personal Interview, April 4, 2018.
- Kalolo, Simon. 2018b. Amend Road Safety NGO, Personal Interview, April 13, 2018.
- Kazis, N. 2011. "Neighborhood Slow Zone Opens in Claremont, Perhaps the First of Many." Streetsblog. <https://nyc.streetsblog.org/2011/11/21/neighborhood-slow-zone-opens-in-claremont-perhaps-the-first-of-many/>.
- Lamberti, R., D. Abate, M. L. De Guglielmo, G. Dell'Acqua, T. Esposito, F. Galante, F. Mauriello, et al. 2009. "Perceptual Measures and Physical Devices for Traffic Calming along a Rural Highway Crossing a Small Urban Community: Speed Behavior 43 Evaluation in a Driving Simulator," TRB Annual Meeting CD-ROM, Transportation Research Board, Washington, DC.
- Lazo, L. 2017. "15 mph Speed Limit Might Be Coming to a DC Street Near You." *Washington Post*, February 9. https://www.washingtonpost.com/news/dr-gridlock/wp/2017/02/09/coming-to-a-d-c-street-near-you-a-15-mph-speed-limit/?utm_term=.0a2e2a28856f.
- Li, Qing. 2014. 李晴 "Juyou shehui ningjuli daoxiang de shequ gonggong kongjian texing yanjiu-yi Shanghai Chuangzhifang he Caoyang yicun weili" 具有社会凝聚力导向的社区公共空间特性研究——以上海创智坊和曹杨一村为例 ["A Study on the Properties of the Public Space with the Orientation of Social Cohesion in Residential Area: Two Cases of Chuangzhifang and Caoyangyicun in Shanghai"]. *Chengshi huihua xuekan 城市规划学刊* 4 (2014): 88–97.
- Lleras, Natalia (World Resources Institute). 2018. Personal Interview, February 21.

- Mackie, A. 1998. "Urban Speed Management Methods." Transportation Research Lab (TRL) Report 363, January. <https://trl.co.uk/reports/TRL363>.
- Makwasha, T., and B. Turner. 2013. "Evaluating the Use of Rural-Urban Gateway Treatments in New Zealand." *Journal of the Australasian College of Road Safety* 24, no. 4 (Dec. 2013): 14–20.
- Martinez, Ana Laura (Public Space Authority [AEP]), Ricardo Jaral (Authority of the Historic Center [ACH]), and Erick Cisneros (World Resources Institute [WRI]). 2018. Personal Interview, March 2.
- Masud Karim, Dewan. 2015. "Narrower Lanes, Safer Streets." Paper accepted for Canadian Institute of Transportation Engineers Conference and Annual General Meeting, Regina, June 7–10.
- Mathers, Colin, and Dejan Loncar. 2006. "Projections of Global Mortality and Burden of Disease from 2002 to 2030." *PLoS Med* 3 (11): e442. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1664601/>.
- Mooren, L., R. Grzebieta, R. F. S. Job, and A. Williamson. 2011. "Safe System—International Comparisons of This Approach." *A Safe System—Making It Happen: Proceedings of the Australasian College of Road Safety Conference, Melbourne*, September.
- NACTO (National Association of City Transportation Officials). 2016. *Global Street Design Guide*. Washington, DC: Island Press.
- NCHRP (National Cooperative Highway Research Program). 2012. *NCHRP Report 737: Design Guidance for High-Speed to Low Speed Transition Zones for Rural Highways*. Washington, DC: Transportation Research Board (TRB). https://safety.fhwa.dot.gov/speed-mgt/ref_mats/fhwas1304/resources2/42%20-%20Design%20Guidance%20for%20High-Speed%20to%20Low-Speed%20Transition%20Zones%20for%20Rural%20Highways.pdf.
- Newton, D., and M. Currie. 2014. "California Has Officially Ditched Car-centric 'Level of Service.'" *StreetsBlog*, August 7. <https://la.streetsblog.org/2014/08/07/california-has-officially-ditched-car-centric-level-of-service/>.
- Nilsson, G. 2004. "Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety." *Bulletin Lund University* 221. <https://lup.lub.lu.se/search/publication/b0b1data-1971-4524-8f51-3909c8cf8d43>.
- NYC (New York City). 2013. "Mayor Bloomberg, Commissioner Sadik Khan Announce Citywide Expansion of Neighborhood Slow Zones to Combat Speeding on Residential Streets and Further Improve Record Traffic Safety." <https://www1.nyc.gov/office-of-the-mayor/news/329-13/mayor-bloomberg-commissioner-sadik-khan-citywide-expansion-neighborhood-slow-zones-to/>.
- PBIC (Pedestrian and Bicycle Information Center). Pedbikeinfo. http://www.pedbikeinfo.org/examples/example_details.cfm?id=4844. Accessed on 18th March 2020 "Slow Zones."
- Qian, Chen 钱晨. "Daxuelu shinian yanbian dui jiedao fuxing de qishi" 大学路十年演变对街道复兴的启示 ["Implication of the 10-Year Daxue Road Evolution on Street Revival"]. *Shidai jianzhu 时代建筑* 6, no. 11 (Sept. 2017): 55–61.
- Road Safety Audit. 2018. "Stages of a Road Safety Audit." *Road Safety Audit*. http://www.road-safety-audit.co.uk/stages_of_a_road_safety_audit.html.
- Rosen, E., and U. Sander. 2009. "Pedestrian Fatality Risk as a Function of Car Impact Speed." *Accident Analysis and Prevention* 41: 536–42. <https://www.ncbi.nlm.nih.gov/pubmed/19393804>.
- Schmitt, Angie. 2014. "Paris to Set Default Citywide Speed Limit below 20 mph." *StreetsBlog* USA, May 21.
- Shefer, D., and P. Rietveld. 1997. "Congestion and Safety on Highways: Towards an Analytical Model." *Urban Studies* 34 (4): 679–92. https://www.researchgate.net/publication/248973452_Congestion_and_Safety_on_Highways_Towards_an_Analytical_Model.
- Sorrentino, F., and F. Aletta, L. Maffei, J. Kang, and M. Masullo. 2015. "Effects of Different Urban Traffic Mitigation Actions on Cities' Noise Levels." *Rivista Italiana di Acustica* 39: 23–41. https://www.researchgate.net/publication/301955652_Effects_of_different_urban_traffic_mitigation_actions_on_cities_noise_levels.
- State of California, Governor's Office of Planning and Research. *Technical Advisory on Evaluating Transportation Impacts in CEQA*. November 2017. http://opr.ca.gov/docs/20171127_Transportation_Analysis_TA_Nov_2017.pdf.
- Steer Davies Gleave. 2014. "Research into the Effectiveness of 20mph Speed Limits and Zones." London Borough of Merton on behalf of LEDNet. October 2014. <https://www.steergroup.com/insights/20mph-speed-limits-their-effectiveness>.
- Stoker, P., A. Castro-Garfinkel, M. Khayesi, W. Otero, M. N. Mwangi, M. Peden, and R. Ewing. 2015. "Pedestrian Safety and the Built Environment: A Review of the Risk Factors." *Journal of Planning Literature* 30 (4): 377–92. <https://journals.sagepub.com/doi/10.1177/0885412215595438>.
- SWOV Institute for Road Safety Research. 2009. "SWOV Fact Sheet Zones 30: Urban Residential Areas." SWOV: The Hague, the Netherlands. https://www.swov.nl/sites/default/files/publicaties/gearchiveerde-factsheet/uk/fs_residential_areas_archived.pdf.
- Tefft, B. C. 2011. *Impact Speed and a Pedestrian's Risk of Severe Injury or Death*. Washington, DC: AAA Foundation for Traffic Safety. <http://aaaafoundation.org/impact-speed-pedestrians-risk-severe-injury-death/>.
- Tolley, R. 2011. "Good for Business: The Benefits of Making the Streets More Walking and Cycling Friendly." *National Heart Foundation of Australia*. November 22. <https://www.heartfoundation.org.au/images/uploads/publications/Good-for-business.pdf>.
- Transportation and Environment. 2001. "Lower Urban Speed Limits: Better for Citizens, Better for the Environment, Better for All." Brussels. *Transportation and Environment*. <https://www.transportenvironment.org/sites/te/files/media/11-01-T30.pdf>.
- Turley, M. 2013. South Central Edinburgh 20mph Limit Pilot Evaluation, Transport and Environment Committee, August 2013. http://www.edinburgh.gov.uk/downloads/file/7820/south_central_edinburgh_20mph_limit_pilot_evaluation_2013.

UK Government, DETR (Department of Environment). 1996. "Transport and the Regions: Review of Traffic Calming Schemes in 20 mph Zones." DETR: London.

UK Government, DETR. 2013. "Setting Local Speed Limits." Department of Transport Circular. London. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/63975/circular-01-2013.pdf.

Vision Zero Initiative. 2017. Making Mobility Safe from the Start. <http://www.visionzeroinitiative.com/about-us/>. Accessed December 15.

Wambulwa, W. M., and R. F. S. Job. 2019. *Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles*. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/447031581489115544/pdf/Guide-for-Road-Safety-Opportunities-and-Challenges-Low-and-Middle-Income-Country-Profiles.pdf>.

Ward, D., and S. Billingsley. 2011. "Make Roads Safe: Time for Action." *Commission for Global Road Safety*. <http://towardszerofoundation.org/wp-content/uploads/2016/05/3rd-Commission-Report-2011.pdf>.

Webster, D. C., and A. M. Mackie. 1996. "Calming Configurations in 20 MI/H Zones." Transportation Research Lab (TRL), January 1996. <https://trl.co.uk/reports/TRL215>.

Welle, B., A. B. Sharpin, C. Adiazola-Steil, R. F. S. Job, Marc Shotten, Dipan Bose, Amit Bhatt, et al. 2018. "Sustainable and Safe: A Vision and Guidance for Zero Road Deaths." World Resources Institute (WRI). <http://wrirosscities.org/research/publication/sustainable-and-safe>.

WHO (World Health Organization) and UNICEF (United Nations Children's Fund). 2008. "World Report on Child Injury Prevention." https://www.who.int/violence_injury_prevention/child/en/.

WHO. 2013. "Pedestrian Safety: A Road Safety Manual for Decision-Makers and Practitioners." Geneva: WHO.

WHO. 2015. "Global Status Report on Road Safety 2018." Geneva: WHO. https://www.who.int/violence_injury_prevention/road_safety_status/2015/en/.

WHO. 2017. "Save Lives: A Road Safety Technical Package." Geneva: WHO. <http://apps.who.int/iris/bitstream/handle/10665/255199/9789241511704-eng.pdf;jsessionid=8C021F-7669396F39E529E98FDF2D64EE?sequence=1>.

WHO. 2018 "Global Status Report on Road Safety 2018." Geneva: WHO. https://www.who.int/violence_injury_prevention/road_safety_status/2018/English-Summary-GSRRS2018.pdf.

World Bank. 2017. *The High Toll of Traffic Injuries: Unacceptable and Preventable*. Washington, DC: World Bank. <https://openknowledge.worldbank.org/bitstream/handle/10986/29129/High-TollofTrafficInjuries.pdf?sequence=5&isAllowed=y>.

World Bank. 2019. *Guide for Road Safety Opportunities and Challenges: Low- and Middle-Income Countries Country Profiles*. Washington, DC: World Bank.

Wrangborg, P. 2005. "A New Approach to a Safe and Sustainable Road Structure and Street Design for Urban Areas." Paper presented at Road Safety on Four Continents Conference, 2005, Warsaw, Poland.

WRI (World Resources Institute) Mexico. 2018. "Mexico City Case Study." Material compiled by WRI Mexico, provided by Historic Center Authority, and Public Space Authority.

Xu, Miao 徐淼, and Kaiyun Zhang 张凯云. *Chuangke tiandi 创客天地 [Innospace]*. Shanghai: Urban Land Institute Case Study, 2015. http://asia.sandbox.uli.org/wp-content/uploads/sites/126/2013/04/KIC_SC_2015-8-7_L.pdf.

ADDITIONAL RESOURCES

Lyndon, Mike. 2012. "Tactical Urbanism 2: Short-Term Action, Long Term Change." New York and Miami: Street Plans Collaborative.

Mackie, Peter, John Nellthorp, and James Laird. 2005. "Where to Use Cost-Effectiveness Techniques Rather than Cost-Benefit Analysis." Transport Notes Series (TRN) No. 9. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/11795> License: CC BY 3.0 IGO.

Transport for London. "Toolkit to Support the Launch of the New "Watch Your Speed" Campaign. October 18, 2019. <https://www.bpet.co.uk/wp-content/uploads/2019/10/TfL-Watch-your-speed-campaign-stakeholder-toolkit-Oct-2019.pdf>.

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