CC-25-275

MEMORANDUM

An Ordinance of the City Council of Homer, Alaska Amending Homer City Code 11.04.050, Master Roads and Street Plans-Adopted, 11.04.058, Design Criteria Manual-Adopted, and 11.04.060 Geometric Design Requirements.

Item Type: Backup Memorandum

Prepared For: Mayor Lord and City Council

Date: November 13, 2025

From: Councilmembers Jason Davis & Brad Parsons

Issue: The purpose of this memorandum is to provide background and recommend adoption of Ordinance 25-71, which establishes maximum lane widths of 10 feet on residential streets and collectors to enhance safety and promote consistency.

Ordinance 25-71 amends HCC 11.04.050, 11.04.058, and 11.04.060 to establish maximum lane widths of 10 feet on residential streets and collectors. This measure represents a targeted, prudent step toward enhancing traffic safety and calming in our community, aligning with modern best practices from the National Association of City Transportation Officials (NACTO).

As Public Works emphasized in our October 28 council meeting, the current minimum lane widths in the Design Criteria Manual have so far been treated not as binding mandates but as general guidelines.

This flexibility is evident in our existing street network: many streets, such as Soundview, Mountain View, Fairview, and Bunnell, already feature safe and effective 10-foot lanes. However, others vary widely, with 11-foot lanes on streets like Hohe, Svedlund, and Ben Walters; 12-foot lanes on Greatland, Poopdeck, and much of Main; and even 13.5- to 14-foot lanes on Heath. These inconsistencies highlight the need for clearer guidance to promote uniformity and safety.

Even if lane widths specified in code are not binding, developers must begin their designs somewhere, and relying on our present outdated, overly wide, highway-based minimums as the City's preferred starting point for neighborhood streets and connectors is imprudent. Wide lanes encourage higher speeds, increase crash risks, and undermine pedestrian and cyclist safety—issues that NACTO guidelines address by recommending narrower lanes to calm traffic and reallocate space for multi-modal uses.

This ordinance provides the Council with a timely opportunity to adjust the City's preferred street widths downward, ensuring future developments prioritize safety even before we are able to complete the gargantuan project of overhauling the entire design manual. We urge its adoption to foster a more consistent, livable, and secure transportation network for all Homer residents.

Attached are excerpts and links to source materials informing Ordinance 25-71, including NACTO's chapter detailing Lane Width guidelines. Also included is a spreadsheet entitled "City of Homer Road Width Notes" that includes measurements conducted in Fall 2025 by Councilmembers Parsons and Davis. The spreadsheet also includes data points from AK DOT to contextualize design speed, traffic volume, and current lane width dimensions. AK DOT data can be found at: https://alaskatrafficdata.drakewell.com/publicmultinodemap.asp

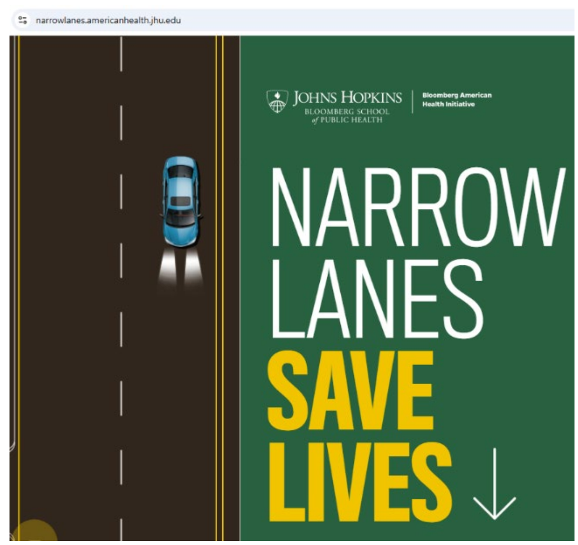
NACTO, "Urban Street Design Guide." National Association of Transportation Officials. Island Press, Washington, 2013. https://nacto.org/publication/urban-street-design-guide/

Hamidi, S, and R. Ewing. *A National Investigation on the Impacts of Lane Width on Traffic Safety*. Johns Hopkins Bloomberg School of Public Health, November 2023: 3. https://narrowlanes.americanhealth.jhu.edu/

"Chapter 5 - Roadway Design: Complete Streets," Iowa Statewide Urban Design and Specifications, Iowa State University Institute for Transportation, Revised: 2024 Edition. https://www.iowasudas.org/manuals/design-manual/

AASHTO, *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials, 2018 7th Edition. https://www.fhwa.dot.gov/programadmin/standards.cfm

An Interactive Website link summarizing the Johns Hopkins Bloomberg School of Public Health study.
https://narrowlanes.americanhealth.jhu.edu/



Public Works and Community Development comments:
In order to implement this new design direction, it will be necessary to paint a double yellow centerline and white outside edge lane line on all city streets to delineate the 10' wide lane (also referred to as the traveled way). There will still be a need for 4-foot-wide paved shoulders on both sides of the traveled way. This means any new collector and local roadways constructed in the city should ideally be built with a 28-foot-wide paved surface if the site conditions allow for that full width. If this direction changes in the future, we would still be able to re stripe the roadway to the more customary 11 or 12 foot lanes (traveled way) and still have a modest paved shoulder present to prevent wheel drop off the pavement.

Recommendation:
Adopt ordinance amending HCC 11.04

Lane Width Informational Materials

From **NACTO, "Urban Street Design Guide." National Association of Transportation Officials. Island Press, Washington, 2013.**
https://nacto.org/publication/urban-street-design-guide/

"Lane widths of 10 feet are appropriate in urban areas and have a positive impact on a street's safety without impacting traffic operations. For dedicated truck and transit routes, one travel of 11 feet may be used in each direction." (p34)

"Research has shown that narrower lane widths can effectively manage speeds without decreasing safety and that wider lanes do not correlate to safer streets. "Moreover, wider travel lanes also increase exposure and crossing distance for pedestrians at intersections and midblock crossings." (p34)

"Lane width should be considered in the overall assemblage of the street. Travel lane widths of 10 feet generally provide adequate safety in urban settings while discouraging speeding." (p35)

From **Hamidi, S, and R. Ewing. *A National Investigation on the Impacts of Lane Width on Traffic Safety*. Johns Hopkins Bloomberg School of Public Health, November 2023: 3. https://narrowlanes.americanhealth.jhu.edu/report/JHU-2023-Narrowing-Travel-LanesReport.pdf.**

"The most immediate candidates for lane width reduction projects are street sections with lane widths of 11 feet, 12 feet, or 13 feet in urban street in the class of 20—25 mph and 30—35 mph that do not serve a transit or freight corridor." (p5)

"More specifically, of these candidates, those that have lower traffic volume (AADT), no or small proportion of on-street parking, low degrees of street curvature, fewer numbers of lanes, and with no travelable (raised) median are the best candidates for the lane width reduction projects, according to our study." (p5)

From **"Chapter 5 - Roadway Design: Complete Streets," Iowa Statewide Urban Design and Specifications, Iowa State University Institute for Transportation, Revised: 2024 Edition. https://www.iowasudas.org/manuals/design-manual/**

"Lane Width: The AASHTO Green Book provides for lane widths from 9 to 12 feet wide. Narrower lanes force drivers to operate their vehicles closer to each other than they would normally desire and reduce overall speeds. The lane widths selected are subject to professional engineering judgment as well as applicable design standards and design criteria. The width of traffic lanes sends a specific message about the type of vehicles expected on the street, as well as indicating how fast drivers should travel." (p10)

"Collector and arterial streets in the urban and rural town context may have lane widths between 10 to 12 feet wide. Lane widths of 10 feet may be used where truck and bus volumes are relatively low and speeds are less than 35 mph. Collector street speeds should not exceed 35 mph. At least one 11 foot lane in each direction may be appropriate for streets where there is a heavy volume of truck traffic or buses." (p10)

"Lane widths for local streets in urban and rural town areas should be 10 feet, except in industrial areas, which should be 11 to 12 feet due to the larger volume of trucks expected with that land use. Local streets can have lane widths of 9 feet in residential areas where the available right-of-way imposes limitations. For low volume local residential streets, two free flowing lanes are generally not required. This creates a yield situation when two vehicles meet." (p11)

"It was previously thought lanes less than 12 feet could reduce traffic flows and capacity. New research has shown lane widths of 10 feet do not reduce capacity and the Highway Capacity Manual has eliminated capacity adjustments for lane widths between 10 and 13 feet. In addition, NCHRP 330 Effective Utilization of Street Width on Urban Arterials found the use of 10 feet lanes has resulted in lower or unchanged crash rates." (p11)

***From* AASHTO, *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials, 2018 7th Edition.**

"On lower-speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed" (2.3.6.3 Design Speed)

"The target design speed is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses, to provide both mobility for motor vehicles and a desirable environment for pedestrians, bicyclists, and public transit users." (2.3.6.3 Design Speed)

6.2.2.1 Width of Roadway

"For paved roadways, the minimum roadway width is the sum of the traveled way and shoulder widths shown in Table 6-5…"

Table 6-5. Minimum Width of Traveled Way and Shoulders

U.S. Customary			
Design Speed (mph)	Minimum Width of Traveled Way (ft) for Specified Design Volume (veh/day)		
	under 400	400 to 2000	over 2000
20	20[a]	20	22
25	20[a]	20	22
30	20[a]	20	22
35	20[a]	22	22
40	20[a]	22	22
45	20	22	22
50	20	22	22
55	22	22	22[b]
60	22	22	22[b]
65	22	22	22[b]
All Speeds	**Width of Shoulder on Each Side of Road (ft)**		
	2	4	6

Metric			
Design Speed (km/h)	Minimum Width of Traveled Way (m) for Specified Design Volume (veh/day)		
	Under 400	400 to 2000	over 2000
30	6.0[a]	6.0	6.6
40	6.0[a]	6.0	6.6
50	6.0[a]	6.0	6.6
60	6.0[a]	6.6	6.6
70	6.0	6.6	6.6
80	6.0	6.6	6.6
90	6.6	6.6	6.6[b]
100	6.6	6.6	6.6[b]
All Speeds	**Width of Shoulder on Each Side of Road (m)**		
	0.6	1.5	2.4

[a] An 18-ft [5.4-m] minimum width may be used for roadways with design volumes under 250 veh/day.

[b] Consider using lane width of 24 ft [7.2 m] where substantial truck volumes are present or agricultural equipment frequently uses the road.

City of Homer Road Width Notes, Fall 2025 / Parsons

Road Name	Section	Treatment	Lane Width	MPH	AADT (2024)	Notes
Soundview	Bartlett to Mullikin	Fog Faded Center	11’	25		Some Shoulders
Soundview	Mullikin to WHE School	Fog Faded Center	10’	25		Sidewalk / High Ped Use
Soundview	WHE School to Sterling	Centerlines Fog Line	11’	25		Short Distance to School Entry
Eric Lane	West Hill to gravel	Fog Faded Center	11’	25		Fog Lines Moved? Former Bike Lane? Sidewalk on South Side / Newer Development
Fairview	Mullikin to Bartlett	Fog	10’	25		Narrow Shoulders / Karen Hornaday Park / Moderate Ped Use
Fairview	Bartlett to Main	Centerlines Fog	10’	25	630	Narrow Shoulders / Moderate Ped Use
Bartlett	Entire Length	Centerlines Fog	11’	25	2060	Sidewalk on West Side / Hospital Access
Hohe	Entire Length	Centerlines Fog	11’	25	230	Sidewalk on West Side / Hospital Access
Main St	Pioneer to Bayview	Centerlines Fog	10.5’	25		Sidewalk on West Side / Medium Volume
Mountain View	Entire Length	Fog Lines Faded Center	10’	25		Minimal Shoulder / Moderate Ped Use
Danview	Main to Curve	Fog Lines Faded Center	10’	25		Minimal Shoulder / Moderate Ped Use
Svedlund	Pioneer to Danview	Centerlines Fog Lines	11’	25		Irregular Shoulders / Future HAPP Loop

Herndon	Entire Length	Centerlines Fog Lines	12’	15		Senior Center / Irregular Shoulders / Blind Corner Future HAPP Loop / Posted 15MPH
Greatland	Entire Length	Centerlines Fog	12’	25		Old-school “Complete Street” design / Bike Lanes / Sidewalks
Kachemak Way	Klondike to Fairview	Centerlines Fog Lines	11	25		Narrow Shoulders
Kachemak Way	Pioneer to Mountain View, including S Curve	Centerlines Fog	10’	25		Shoulder Width Varies / Known safety concern at Fairview Trail crossing
Heath	At Hazel	Centerlines Fog	14’	25		Sidewalk on west side / Moderate Ped Use Desired crosswalk location
Heath	At Klondike	Centerlines Fog	13’ 6”	25		Sidewalk on west side / Foot path on east side Modern Ped Use
Heath	At Library	Centerlines Fog	13’ 6”	25		Sidewalk on west side / Foot path on east side Moderate Ped Use
Hazel	Entire length	Centerlines Fog	11’	25		On-Street Parking
Poopdeck	Length	Centerlines Fog	12’	25		Shoulders
Ben Walters	East End to Smoky Bay	Fog Lines	11’	25		Wide Shared Use Sidewalk
Ben Walters	Lake to Smoky Bay	Centerlines Fog	11’	25		Wide Shared Use Sidewalk
Ohlson	Sterling to Bunnell	Centerlines Fog Lines	11’	25	740	Sidewalk / Speed Humps / On-street Parking
Bunnell	Old Town	Centerlines Fog Lines	10’	25	770	Shared Street Concept / Future HAPP Loop
Bunnell	Main to Beluga Pl	Centerlines Fog/Path	10’	25		Shoulder / Speed Hump / 15mph Advisory High Ped Use / Future HAPP Loop
Beluga Pl	Bunnell to Bishops Beach	Centerlines Fog Lines	10’	25		Minimal Shoulders / Speed Hump / 15mph Advisory / High Ped Use / Bishops Parking

FAA Rd	Ocean to Airport	Centerlines Fog lines	12’	25	790	North side narrow bike lane
STATE ROADS	**Section**	**Treatment**	**Lane Width**	**MPH**	**AADT (2024)**	**Notes**
Sterling Hwy	West Hill to Spit Road	Wide Multilane	Varies	35-45	9170	Relatively steady AADT for the last ten years. Summer Peak AADT 13,500+
Pioneer	Sterling to Main	3 Lane	12-13-12	25	3700	Wide Center Turn Lane / Sidewalks
Pioneer	Main to Lake	3 Lane	12-13-12	25	6490	Wide Center Turn Lane / Sidewalks
East End	Lake to Kachemak City	Wide Multilane	Varies	25 - 45	9660	High Speed / High Volume
Lake St	Pioneer to Sterling	Centerlines Bike Lanes	12’	25	5440	Old-School “Complete Street” design / Bike Lanes / Sidewalk east side
Main St	Sterling to Pioneer	Centerlines Fog	12’	25	2320	Minimal Shoulder / Future HAPP Loop
Main St	Oldtown to Sterling	Centerlines Fog	11’	25	1900	Minimal Shoulder / Future HAPP Loop
Ocean	Lake to Spit Rd	Centerlines Fog / Bike	12’	35	6490	South side wide shoulder / Bike Lane?
Kachemak Dr	Spit Rd to East End	Centerlines Fog	12’	35	2500	Minimal Shoulder
West Hill	Sterling to Skyline	Centerlines Fog	11’	30	1970	Minimal Shoulder
East Hill	Sterling to Skyline	Centerlines Fog	12’	35	1980	Minimal Shoulder

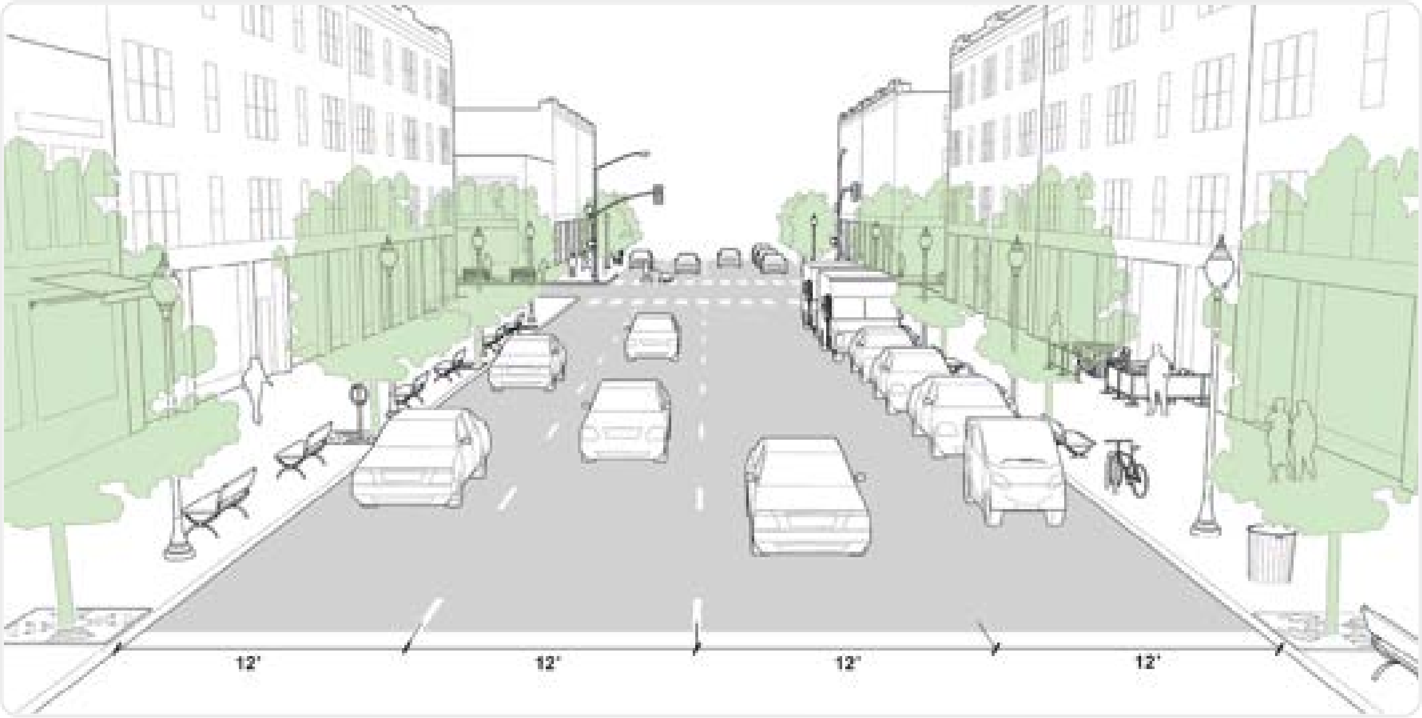
DESIGN GUIDE

Lane Width

CONTENTS Purchase

The width allocated to lanes for motorists, buses, trucks, bikes, and parked cars is a sensitive and crucial aspect of street design. Lane widths should be considered within the assemblage of a given street delineating space to serve all needs, including travel lanes, safety islands, bike lanes, and sidewalks.

Each lane width discussion should be informed by an understanding of the goals for traffic calming as well as making adequate space for larger vehicles, such as trucks and buses.



EXISTING

Travel lanes are striped to define the intended path of travel for vehicles along a corridor. Historically, wider travel lanes (11–13 feet) have been favored to create a more forgiving buffer to drivers, especially in high-speed environments where narrow lanes may feel uncomfortable or increase potential for side-swipe collisions.

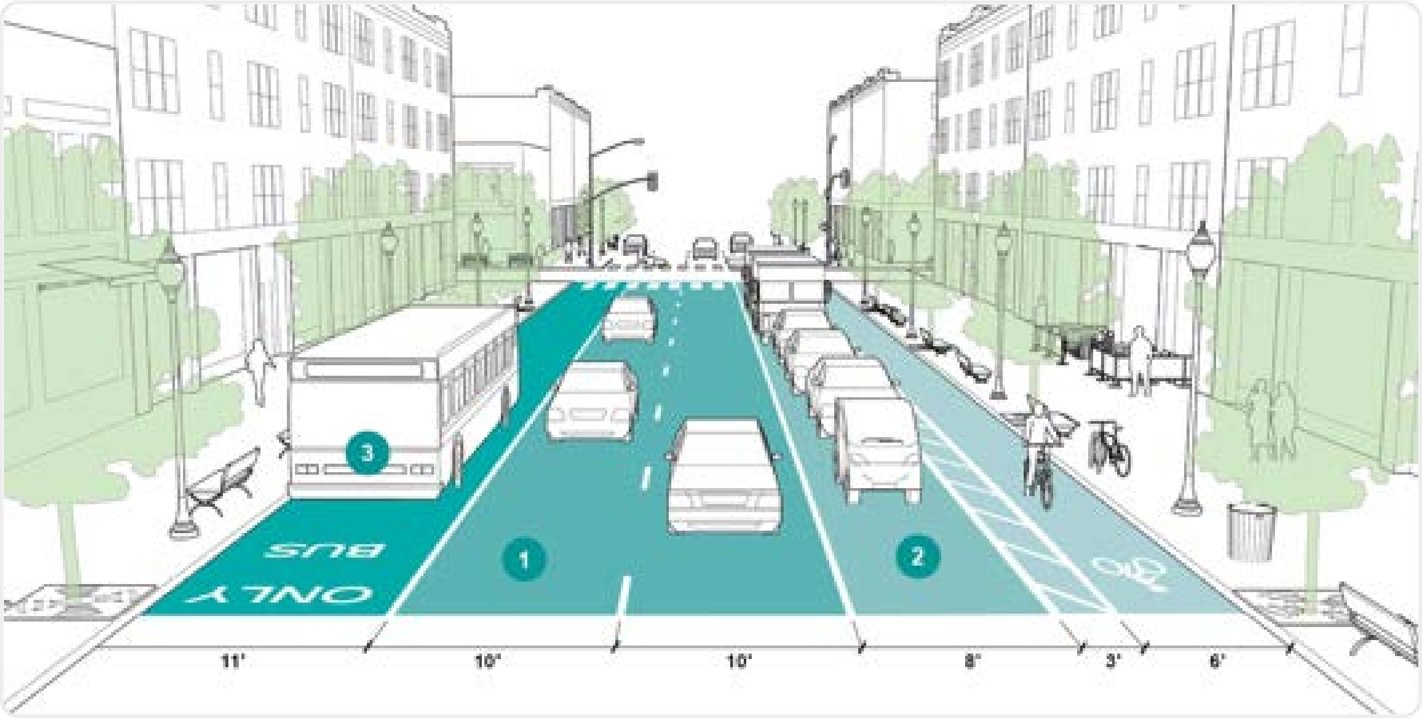
Lane widths less than 12 feet have also historically been assumed to decrease traffic flow and capacity, a claim new research refutes.[1]

Discussion

The relationship between lane widths and vehicle speed is complicated by many factors, including time of day, the amount of traffic present, and even the age of the driver. Narrower streets help promote slower driving speeds. which in turn reduce the severity of crashes. Narrower streets have other benefits as well, including reduced crossing distances, shorter signal cycles, less stormwater, and less construction material to build.

Lane widths of 10 feet are appropriate in urban areas and have a positive impact on a street's safety without impacting traffic operations. For designated truck or transit routes, one travel lane of 11 feet may be used in each direction. In select cases, narrower travel lanes (9–9.5 feet) can be effective as through lanes in conjunction with a turn lane.[2]

Recommended



REDESIGN

Lanes greater than 11 feet should not be used as they may cause unintended speeding and assume valuable right-of -way at the expense of other modes.

Restrictive policies that favor the use of wider travel lanes have no place in constrained urban settings, where every foot counts. Research has shown that narrower lane widths can effectively manage speeds without decreasing safety and that wider lanes do not correlate to safer streets.[3] Moreover, wider travel lanes also increase exposure and crossing distance for pedestrians at inter-sections and midblock crossings.[4]

Use striping to channelize traffic, demarcate the road for other uses, and minimize lane width.

SAN FRANCISCO, CA
Striping should be used to delineate parking and curbside uses from the travel lane.

1 Lane width should be considered within the overall assemblage of the street. Travel lane widths of 10 feet generally provide adequate safety in urban settings while discouraging speeding. Cities may choose to use 11-foot lanes on designated truck and bus routes (one 11-foot lane per direction) or adjacent to lanes in the opposing direction.

Additional lane width may also be necessary for receiving lanes at turning locations with tight curves, as vehicles take up more horizontal space at a curve than a straightaway.

Wide lanes and offsets to medians are not required but may be beneficial and necessary from a safety point of view.

Optional

2 Parking lane widths of 7–9 feet are generally recommended. Cities are encouraged to demarcate the parking lane to indicate to drivers how close they are to parked cars. In certain cases, especially where loading and double parking are present, wide parking

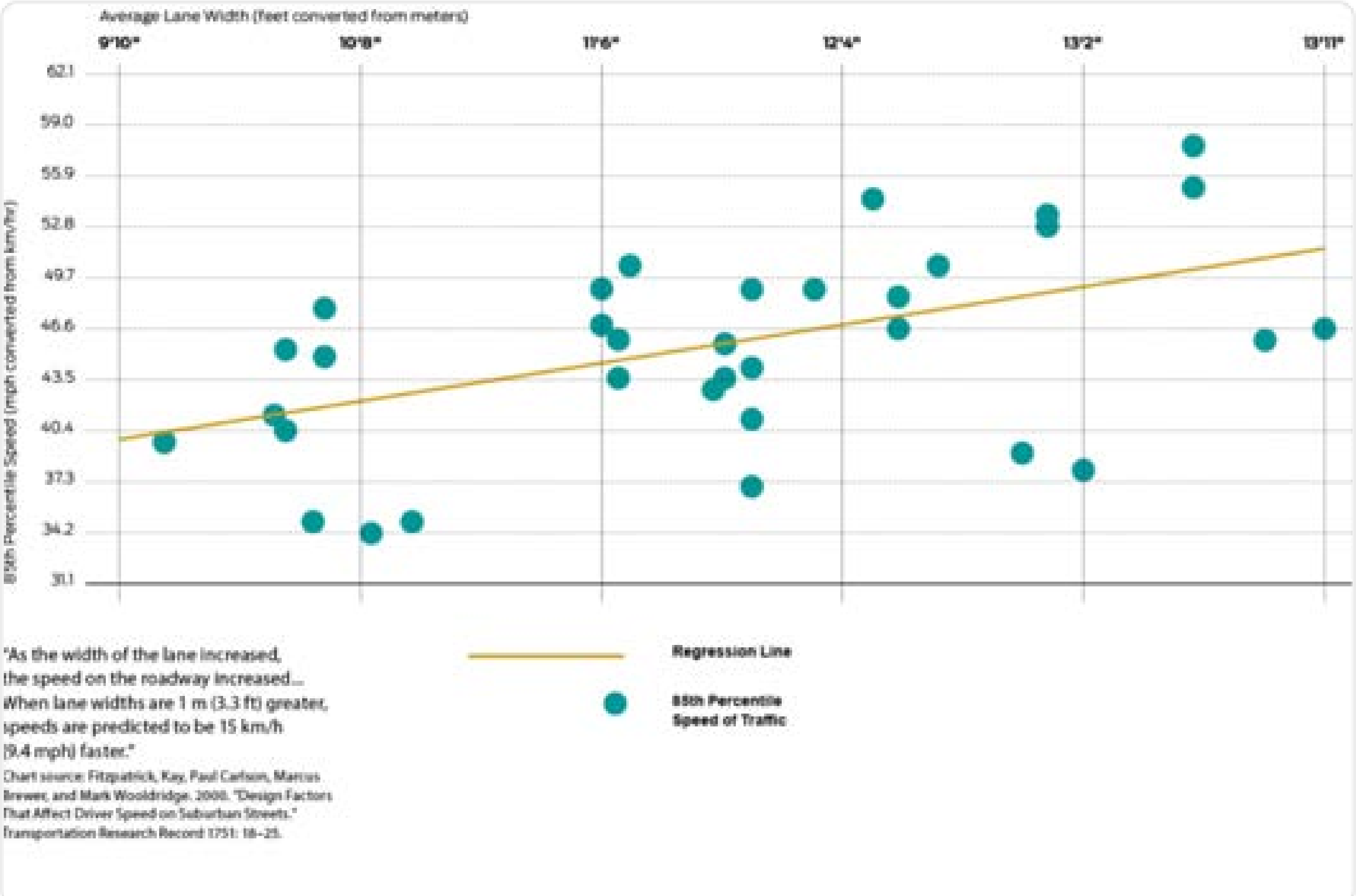
lanes (up to 15 feet) may be used. Wide parking lanes can serve multiple functions, including as indus-trial loading zones or as an interim space for bicyclists.

3 For multilane roadways where transit or freight vehicles are present and require a wider travel lane, the wider lane should be the outside lane (curbside or next to parking). Inside lanes should continue to be designed at the minimum possible width. Major truck or transit routes through urban areas may require the use of wider lane widths.

2-way streets with low or medium volumes of traffic may benefit from the use of a dashed center line with narrow lane widths or no center line at all. In such instances, a city may be able to allocate additional right-of-way to bicyclists or pedestrians, while permitting motorists to cross the center of the roadway when passing.

ELMORE, OH

Wider travel lanes are correlated with higher vehicle speeds.



1 Theo Petrisch, "The Truth about Lane Widths," *The Pedestrian and Bicycle Information Center*, accessed April 12, 2013, http://www.bicyclinginfo.org/library/details.cfm?id=4348. ↩

2 Research suggests that lane widths less than 12 feet on urban and suburban arterials do not increase crash frequencies.

Ingrid Potts, Douglas W. Harwood, and Karen R. Richard, "Relationship of Lane Width to Safety on Urban and Suburban Arterials," (paper presented at the TRB 86th Annual Meeting, Washington, D.C., January 21–25, 2007).

Relationship Between Lane Width and Speed, (Washington, D.C.: Parsons Transportation Group, 2003), 1–6.
↩

3 Eric Dumbaugh and Wenhao Li, "Designing for the Safety of Pedestrians, Cyclists, and Motorists in Urban Environments." *Journal of the American Planning Association* 77 (2011): 70.

Previous research has shown various estimates of the relationship between lane width and travel speed. One account estimated that each additional foot of lane width related to a 2.9 mph increase in driver speed.

Kay Fitzpatrick, Paul Carlson, Marcus Brewer, and Mark Wooldridge, "Design Factors That Affect Driver Speed on Suburban Arterials": *Transportation Research Record* 1751 (2000): 18–25.

Other references include:

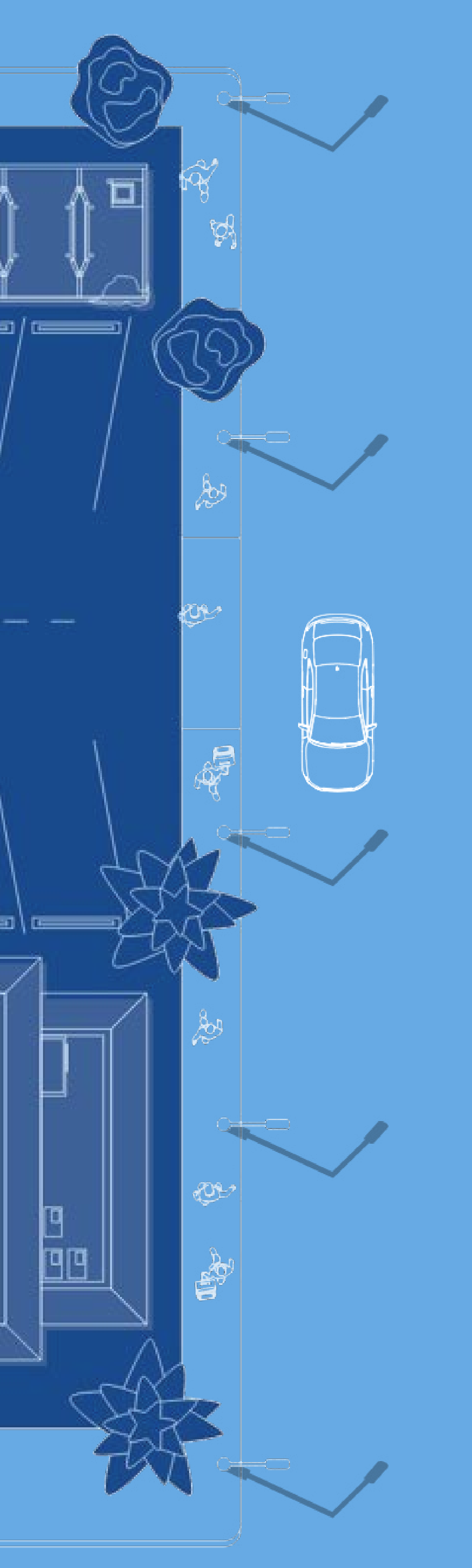
Potts, Ingrid B., John F. Ringert, Douglas W. Harwood and Karin M. Bauer. *Operational and Safety Effects of Right-Turn Deceleration Lanes on Urban and Suburban Arterials*. Transportation Research Record: No 2023, 2007.

Macdonald, Elizabeth, Rebecca Sanders and Paul Supawanich. *The Effects of Transportation Corridors' Roadside Design Features on*

User Behavior and Safety, and Their Contributions to Health, Environmental Quality, and Community Economic Vitality: a Literature Review. UCTC Research Paper No. 878. 2008. ↩

4 Longer crossing distances not only pose as a pedestrian barrier but also require longer traffic signal cycle times, which may have an impact on general traffic circulation. ↩

← **Street Design Elements** **Sidewalks** →



A NATIONAL INVESTIGATION ON THE IMPACTS OF LANE WIDTH ON TRAFFIC SAFETY:

Narrowing Travel Lanes as an Opportunity to Promote Biking and Pedestrian Facilities Within the Existing Roadway Infrastructure

November 2023

Johns Hopkins Bloomberg School of Public Health

Bloomberg American Health Initiative

ACKNOWLEDGMENTS

This report was supported by a grant from the
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Johns Hopkins Bloomberg School of Public Health

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EXECUTIVE SUMMARY

This project is one of the first and the most comprehensive efforts to date to address a long overdue built environmental challenge to health: the lack of conclusive quantitative evidence on the effects of lane width on safety which has led to unnecessarily wide travel lanes that are designed to accommodate fast and convenient driving.

This national study investigates the feasibility of narrowing vehicle lanes as the easiest and most cost-effective way to accommodate better sidewalk and bike lane facilities within the existing roadway infrastructure. The study asks whether, and to what extent, we can narrow existing vehicle lanes (for different road classifications) without adverselyimpacting traffic safety.

This study employed a sample of 1,117 street sections (a series of homogeneous road segments) from seven different cities and conducted one of the most comprehensive data collections on geometric and street design characteristics of street sections including bike lane type and width, median type and width, sidewalk type and width, street's sense of visual motion, on-street parking type, width and occupancy rates, number of lanes and number of bus stops, street trees, and the degree of street curvature.

We conducted a series of four negative binomial regression analyses to investigate the relationship between lane width and the number of non-intersection crashes, after controlling for the aforementioned confounding factors. This study, to our knowledge, is the largest and most comprehensive study focusing on the impacts of travel lane width on traffic safety outcomes such as the number of vehicle accidents.

Overall, this study found no evidence that narrower lanes are associated with the higher number of crashes and that narrow lanes (9-foot and 10-foot) increase the risk of vehicle accidents, after controlling for cross-sectional street design characteristics and other confounding variables. Quite contrary, our models confirm that in some cases (in the speed class of 30–35 mph), narrowing travel lanes is associated with significantly lower numbers of non-intersection traffic crashes and could actually contribute to improvement in safety. These findings are novel with groundbreaking and immediate policy/practical implications for identifying streets in each road class as the best candidates for lane width reduction projects.

Our in-depth interviews with state DOT officials in five states also offer valuable insights on the challenges of executing lane width reduction projects and revising existing guidelines to promote narrower lanes. We also offer a range of innovative solutions that have been adopted by these states to overcome this challenge and best practices that could be applicable to other state and local departments of transportation in the country. Practical implications and policy recommendations of these findings are further explained in the report.

KEY FINDINGS

- Our survey of AASHTO member state DOTs indicate that the majority of state DOTs prefer to follow the conventional design standards adopted by their DOT, and the context-sensitive design approach has not been widely used within their jurisdiction.
- In practice we are far from implementation of the context-sensitive design solutions by most state DOTs. The design exception for lane width reduction projects seems to be a rare event in most state DOTs that participated in our survey.
- Overall, the results of our AASHTO survey demonstrate the extent of the gap and highlight how little we know about the traffic safety impacts of lane width due to the lack of data and rigorous and comprehensive quantitative studies.
- This study is one of the first and the most comprehensive quantitative efforts on the relationship between lane width and the number of non-intersection crashes.
- With a sample of 1,117 street sections from seven cities and more than 20 geometric and street design variables, we found no evidence that wider lanes are safer in terms of the number of non-intersection crashes.
- We found that the number of crashes does not significantly change in streets with a lane width of 9 feet compared to streets with lane widths of 10 feet or 11 feet, after controlling for cross-sectional and street design confounding factors such as posted speed limit, traffic volume, on-street parking, median type, number of lanes, bus stops, and similar sense of visual motions, most likely because the difference in lane width is not noticeable to drivers.
- The difference becomes noticeable once changing the lane width from 9 feet to 12 feet which, in fact, increases the number of crashes.
- We also found that the relationship between lane width and the number of non-intersection crashes varies substantially across different speed classes.
- In the speed class of 20—25 mph, the driving speed is slow enough that drivers do not notice changes in lane widths. This hypothesis was confirmed by our findings that there is no significant difference in terms of the number of non-intersection crashes between 9-foot, 10-foot, 11-foot, 12-foot, or even 13-foot lanes.
- On the other hand, street sections with 10-foot, 11-foot, and 12-foot lanes have significantly higher numbers of non-intersection crashes than their counterparts with 9-foot lanes in the speed class of 30—35 mph.
- In other words, in the speed class of 30—35 mph, wider lanes not only are not safer, but exhibit significantly higher numbers of crashes than 9-foot lanes, after controlling for geometric and cross-sectional street design characteristics of street sections.
- Street sections in the speed classes of 20—25 mph and 30—35 mph have the greatest potential to be utilized by pedestrians and bicyclists due to their relatively lower speeds.

- This is not to say that 9-foot or 10-foot lanes are appropriate and recommended in different contexts. In streets in the speed class of >35 mph that serve as a transit or freight corridor, 11-foot lanes would be more appropriate to accommodate oversized trucks.
- The most immediate candidates for lane width reduction projects are street sections with lane widths of 11 feet, 12 feet, or 13 feet in urban street in the class of 20—25 mph and 30—35 mph that do not serve a transit or freight corridor.
- More specifically, of these candidates, those that have lower traffic volume (AADT), no or small proportion of on-street parking, low degrees of street curvature, fewer numbers of lanes, and with no travelable (raised) median are the best candidates for the lane width reduction projects, according to our study.
- In practice, justifying, designing, and implementing narrow travel lanes (9-foot to 10-foot) is very challenging as cited in our interview with several state DOTs.
- Our interview with VTrans (as the first state to adopt 9 feet as a minimum lane width standard in specific contexts) found that implementation of a minimum lane width of 9 feet has not been done in any case in the past couple of decades, which makes such standards stay in the book with very little success in execution.
- One way to address these challenges is to rethink and redesign the procedure for specifying lane width standards and guidelines in an urban setting to start with a 10-foot length and ask traffic engineers to justify for a wider lane. It counters the existing practice of lane width design in most states where lane width in the urban core (speed of 35 mph or less) starts with 12 feet and (if any) justification from design engineers aims to narrow it further. Florida DOT is one of very few states that follow this practice.
- Another innovative intervention would be to develop a context classification system for road design. The context classification system allows Florida DOT to look at the area's needs in picking the best road design measurements. Using context-based design guidelines substantially facilitates the design justification that engineers need to apply to roadways. Florida DOT is one of the pioneering states on developing its own context-sensitive system.
- In sum, the lane width reduction or any isolated roadway design improvement alone may not be sufficient to provide a design practice that is appropriate for the context or to adjust driver/user behavior. A holistic approach to street design is necessary, using all available context cues and design elements, to provide a design alternative that matches the context of the roadway segment and make it safer for all street users.

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Complete Streets

A. Background

Design professionals face an increasingly complex set of competing demands in development and delivery of street projects involving public rights-of-way. Designing a safe facility, completing construction, and installing various traffic control measures are only a part of a much larger picture. Street projects today also need to meet the objectives of regulatory, policy, and community requirements aimed at integrating the roadway into the existing natural and built environments. Among the many factors influencing the planning, design, and operation of today's streets are concerns about minimizing transportation costs; improving public health, creating and maintaining vibrant neighborhoods; accommodating the needs of the young, the physically challenged, as well as an aging population; and adopting greener and more sustainable lifestyles.

In the past, street design was focused on the need to move motor vehicles. The number and width of lanes was determined based on future projected traffic volumes or a set of standards based on the functional classification of the street. The functional classification and the adjacent land use also determined the general operating speed that was to be used for the design. Integration of facilities for pedestrians and bicyclists was not always a high priority. Some observers claim if you do not design for all modes of travel, then you preclude them.

Citizens within some cities are asking agencies to change the way they look at streets and the street function within each community. These agencies are looking to make their streets more "complete." Complete streets are designed and operated to enable safe access to all motorists, pedestrians, bicyclists, and transit users, regardless of age and ability. According to the National Complete Streets Coalition, there are in excess of 600 agencies that have adopted some form of a complete streets policy. Several Iowa agencies, both small communities and larger cities, have adopted complete streets policies. Many other Iowa communities are looking into the concepts of complete streets. Complete streets also complement the principles of context sensitive design by ensuring that streets are sensitive to the needs of all users for the land use within the area. Proponents of complete streets note that by rethinking the design to include all users, the "balance of power" is altered by indicating that streets have many purposes and are not exclusively for motor vehicle traffic. The objectives of the complete streets philosophy are met by slowing vehicles down and providing better facilities for transit, pedestrians, and bicyclists. It is important to understand that safe and convenient walking and bicycling facilities may look different depending on the context. Appropriate facilities in a rural area will be different from facilities in a dense urban area.

There is no one size fits all design for complete streets. Safety and accommodation of all users should guide decisions when evaluating different designs and tradeoffs between factors that may be in conflict with each other, such as:

- Number and types of users - cars, trucks, transit buses, pedestrians, bicyclists, and other modes
- Available right-of-way
- Existing improvements
- Land use
- Available budget
- Parking needs
- Community desires

In larger communities where the traffic volumes are heavy and land use density is greater, all of the above elements may be factors to consider. However, in smaller communities with lower traffic volumes and less dense developments, only a few may be important. The application of complete streets principles is most effective when neighborhoods are compact, complete, and connected to encourage walking and biking comfortable distances to everyday destinations such as work, schools, and retail shops. Past land use practices of large tracts for single use development are less effective in encouraging short walking or biking trips.

Complete streets are designed to respect the context of their location. For example, downtown locations may involve greater emphasis on pedestrians, bicyclists, and transit users than single family neighborhoods. Additionally, context includes social and demographic factors that influences who is likely to use the street. For example, low income families and those without their own vehicle have the need for an interconnected pedestrian, bicycle, and transit network serving important destinations in the community.

The U.S. DOT adopted a policy statement regarding bicycle and pedestrian accommodations in March of 2010. It states:

> "The U.S. DOT policy is to incorporate safe and convenient walking and bicycling facilities into transportation projects. Every transportation agency has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and biking into their transportation systems. Because of the numerous individual and community benefits that walking and bicycling provide – including health, safety, environmental, transportation, and quality of life – transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes."

In addition to the U.S. DOT policy, members from the U.S. House of Representatives and the U.S. Senate have introduced a bill entitled “Safe Streets Act of 2014” that calls for all state DOTs and TMAs/MPOs to adopt a complete streets policy for all federally funded projects.

B. Design Guidance

There are numerous ways to address the development of complete streets in terms of a planning function, but there are not specific complete streets design elements identified for engineers to use to develop construction or reconstruction projects. In addition to safety, complete streets planning and design works to address issues of health, livability, economic development, sustainability, and aesthetics. In the past, functional classification, traffic volumes, and level of service have been used as the critical factors for street design. However, a complete streets approach emphasizes safety for vulnerable users and identifies core goals for street design through stakeholder input. Public input may determine that sidewalk amenities, bicycle facilities, or transit accommodation are more important than the vehicular level of service. It is important to develop a spectrum of alternatives that consider the needs of various users and reach a design decision that addresses those needs.

Applying flexibility in street design to address the complete streets philosophy requires an understanding of each street’s functional basis. It also requires understanding how adding, altering, or eliminating any design element will impact different users. For instance, large radii may make it easier for trucks to navigate the street, but they create wider streets for pedestrians to cross. Designers of complete streets should understand the relationship between each criterion and its impact on the safety and mobility of all users.

Various manuals are available to provide design guidance including. For general guidance:

- AASHTO's A Policy on Geometric Design of Highways and Streets (the "Green Book")
- MUTCD
- The Highway Capacity Manual (HCM)
- ITE Traffic Engineering Manual
- FHWA *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts*

For designing streets in urban areas:

- ITE *Designing Walkable Urban Thoroughfares: A Context-Sensitive Approach*
- NACTO *Urban Streets Design Guide*
- NCHRP 880 *Design Guide for Low-Speed Multimodal Roadways*
- FHWA *Road Diet Information Guide*

For bikeway design guidance:

- AASHTO *Guide for the Development of Bicycle Facilities* (the "Bicycle Guide")
- NACTO *Urban Bikeway Design Guide*
- FHWA *Incorporating On-Road Bicycle Networks into Resurfacing Projects*

For pedestrian-specific design guidance:

- FHWA STEP *Guide for Improving Safety at Uncontrolled Crossing Locations* ("STEP Crossings Guide")
- US Access Board PROWAG

Other design guidance:

- NFPA Fire Code
- Local design ordinances

Some elements within these manuals are specific standards and some are guidelines with ranges of acceptable values. The MUTCD has been adopted as law; therefore, the standards within it need to be met. In addition, there may be different standards for facilities that are under the Iowa DOT's jurisdiction than those for local control. If federal or state funding is being used to assist in a project's financing, the standards may also be different. Local jurisdictions utilize the above manuals for design as a means of protection from lawsuits. Thus, from a liability standpoint, it is very important that the design guidance meet established standards or fall within the range of acceptable guidelines provided by the above manuals.

C. Design Elements

Many elements must be considered during the complete streets design process. Traditionally designers have focused on those related to motor vehicles. With a complete streets design, other elements are also addressed. Each of those elements will be discussed and design guidance presented.

1. **Land Use:** The type of adjacent land use provides insight into several factors. For instance, in industrial areas, the expectation is that truck volumes will be higher. In commercial/retail areas, there is an expectation that pedestrians, transit, and bicyclists will be present in larger numbers. In residential land use areas, the street and right-of-way should accommodate pedestrians of all ages and abilities, and shared use of the street by motorists and bicyclists should be expected.

   Five basic land use context classifications and three basic land use types are discussed in Section 5C-1, but many communities will have a broader range of both categories. Land use will influence speed, curb radii, lane width, on-street parking, transit stops, sidewalks, and bicycle facilities.

2. **Functional Classification:** Most jurisdictions classify their streets as a means of identifying how they serve traffic. Streets are generally classified as arterial, collector, or local facilities. Complete streets projects must take into consideration each street classification because it helps determine how the street and network needs to be treated to handle traffic volumes and other conflicts that may arise if design changes are made.

   Street classifications and the functions of each type are explained in detail in Section 5B-1. It is important to note that all jurisdictions, regardless of size have at least one street in each category. That means that in a larger community an arterial street may carry 20,000 vehicles per day, but in a smaller city the volume on their arterial street might be 2,000 vehicles per day. Similar differences exist in the collector classifications. Generally arterial streets are designated because their primary purpose is to move traffic. Collectors serve the traffic mobility function, but also provide access to adjacent property. Local streets are primarily there to serve adjacent property and should not have through traffic. Designs appropriate for low density residential areas are not likely to fit in the downtown commercial areas due to the likelihood of more pedestrians, bicyclists, trucks, and buses.

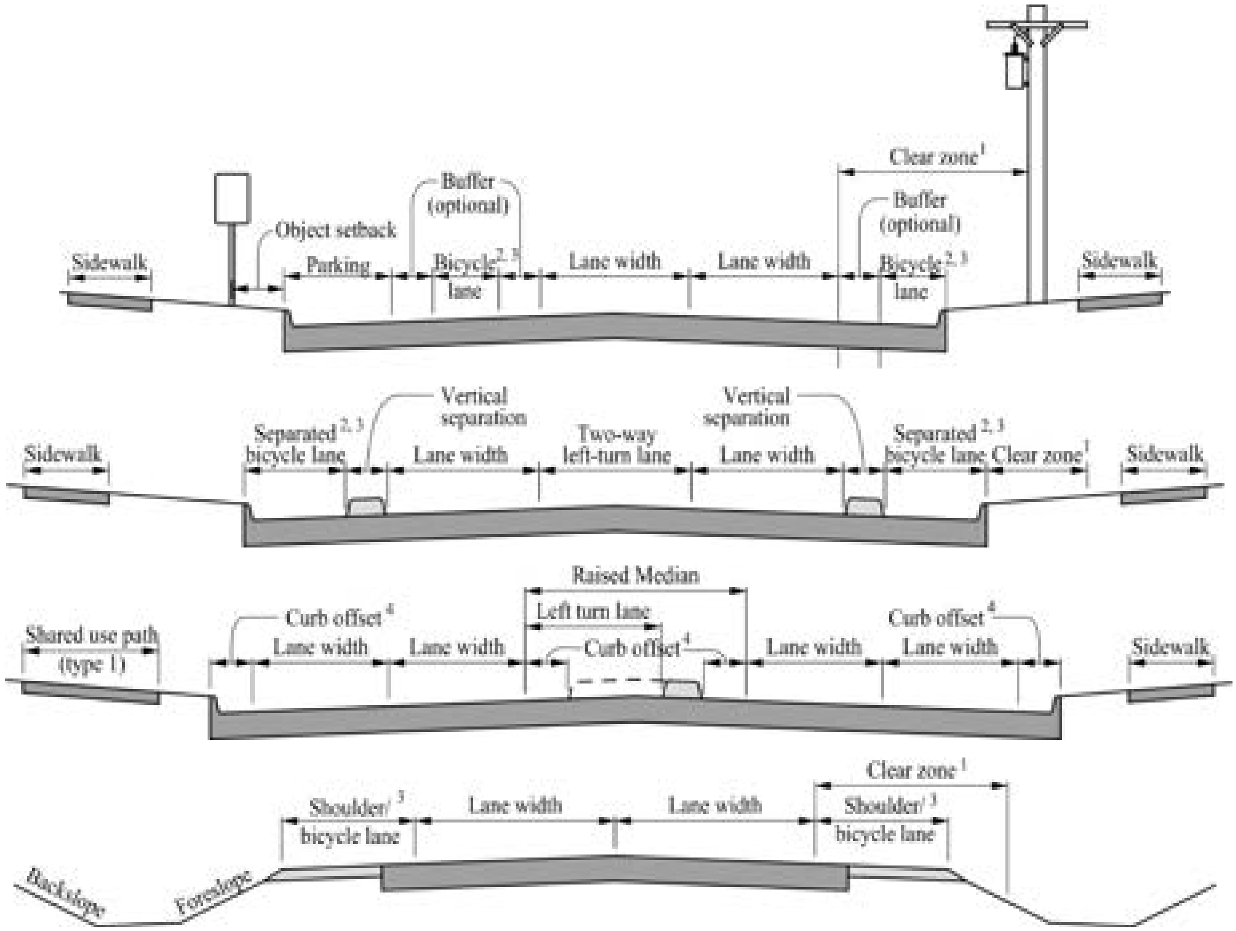
   Designers should also be cognizant of roadways that are transit routes, bikeways such as bicycle boulevards, truck routes, etc. as identified through state or local transportation plans as this influences the purpose and use of a roadway as well.

3. **Roadway Sizing:** Many communities have streets with excess lane capacity and oversized lane widths for motor vehicles. Multilane roads can take longer for pedestrians to cross, increase pedestrian exposure, and can facilitate faster speeds by motor vehicle traffic. During resurfacing and re-construction, designers should consider lane reductions and road reconfigurations (often called “road diets”) to decrease the number and widths of lanes. This can reduce vehicle speeds, reduce pedestrian crossing distances, and provide space for bicycle facilities. A typical “four-to-three lane” roadway reconfiguration converts an existing four-lane, undivided roadway into a roadway with one through lane in each direction and a center, two-way left-turn lane (TWLTL). This conversion can often provide space for bicycle lanes, as shown in Section 12B-3, G, or other users, including pedestrian refuge islands, on-street parking, or widened sidewalks and wider landscaped buffers (often called “the parking” in Iowa).

   Suitable candidates for a “four-to-three lane" roadway reconfiguration have an average daily traffic (ADT) equal to or less than about 20,000 vehicles per day. In some instances, roadway reconfigurations have been successfully applied on roads with ADTs as high as 25,000. FHWA’s Road Diet Information Guide further discusses the safety and operational benefits of road diets.

   For new roadway construction in urban, suburban, and rural town contexts, adequate sidewalk, sidewalk buffers, and bicycle facilities should be provided. Right of way may be reserved to accommodate longer term (10 years or greater) projected volumes, but roadways should not be overbuilt as wider than necessary roadways can encourage higher motor vehicle speeds and decrease overall safety. Overbuilt roadways also increase maintenance and life-cycle costs.

Figure 5M-1.01: Roadway Design Elements

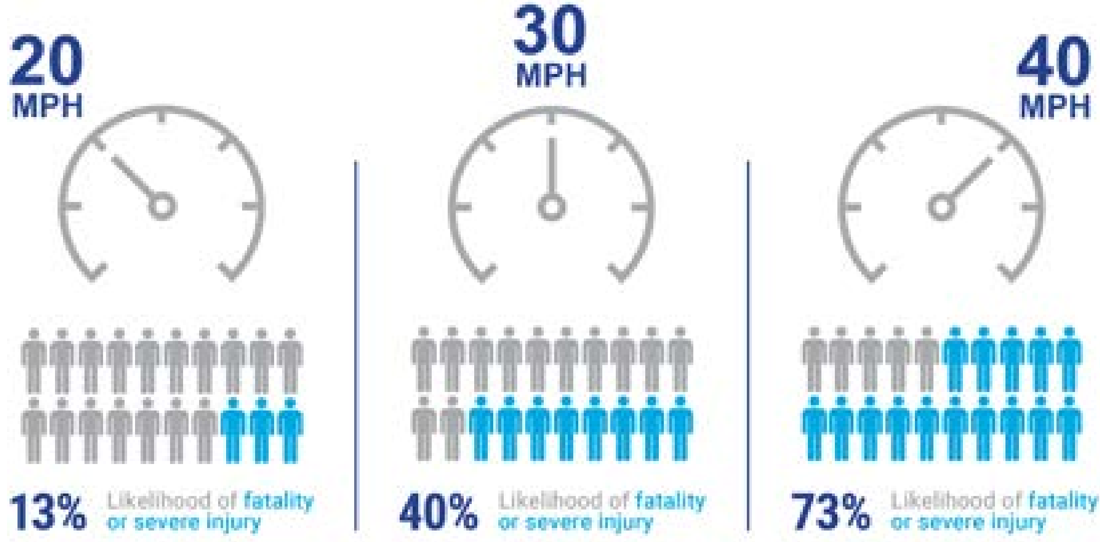


[1] Clear zone is measured from the edge of the traveled way.
[2] See Chapter 12 for bicycle lane requirements.
[3] Bicycles may be placed between the curb and parking on corridors with higher traffic volume and speed, see Sections 12B-1 and 12B-3 for separated bicycle lane design with on-street parking buffers
[4] For low-speed street conditions in urban and rural town areas, curbs may be placed at the edge of the traveled way.

4. **Speed:** Operating speeds influence the design of the roadway including stopping sight distance, passing sight distance, intersection sight distance, and horizontal and vertical curve elements. The design speed should therefore be equal to the posted speed to encourage operating speeds at or below the posted speed. Design values from the AASHTO Green Book are outlined in Tables 5C-1.01 and 5C-1.02 and for liability reasons should be met at all times, especially for new streets. If it is not possible for any design element to meet the geometric standards on existing streets, warning signs and other safety treatments must be used.

   In the past, it was considered best practice to set the design speed at the highest level that will meet the safety and mobility needs of motor vehicles using the street. One of the principles of complete streets provides for slowing vehicles down to improve safety for all users, especially pedestrians and bicyclists. People walking and bicycling are particularly vulnerable in the event of a crash, and vehicle speeds where conflicts occur are a primary factor in the likelihood of serious injuries and fatalities, see Figure 5M-1.01. In general, the speed chosen for design should reflect the network needs and the adjacent land use. On existing roadways with operating speeds that exceed the posted speed, roadway redesign and traffic calming measures should be considered to reduce speeds and improve safety and comfort for all users. Traffic calming or roadway redesign should also be considered on roadways where lowering the posted speed is desirable to reinforce to drivers that slow speeds are expected.

Figure 5M-1.02: Vehicle Speeds and Risks to Pedestrians



Source: Tefft, B.C.

In general, streets in urban areas should be designed and control devices regulated to allow speeds of 20 to 45 mph. Speeds in the lower portion of this range are applicable to local and collector streets through residential areas, and to arterial streets through more crowded business districts, while the speeds in the higher portion of the range apply to arterial streets in outlying suburban areas.

Iowa Statute 321.285 establishes the following statutory speed limits, although city councils may adopt by ordinance higher or lower speed limits upon the basis of engineering or traffic studies (§321.290):

- 20 mph in a business district
- 25 mph in any residence or school district
- 45 mph in any suburban district

The AASHTO Green Book provides further guidance on appropriate design speeds for specific roadway types.

5. **Intersection Design and Control Vehicle:** The selection of the design and control vehicle is an important element in complete streets design. Lane width and curb radii are directly influenced by the design vehicle. Section 5C-2, R provides guidance on selecting design vehicles, control vehicles, and typical curb radii for different roadways.

   All street designs must meet the minimum standards for fire departments and other emergency vehicle access and must consider the needs of garbage trucks and street cleaning equipment.

To achieve the smallest appropriate corner radius, designers should follow these strategies:

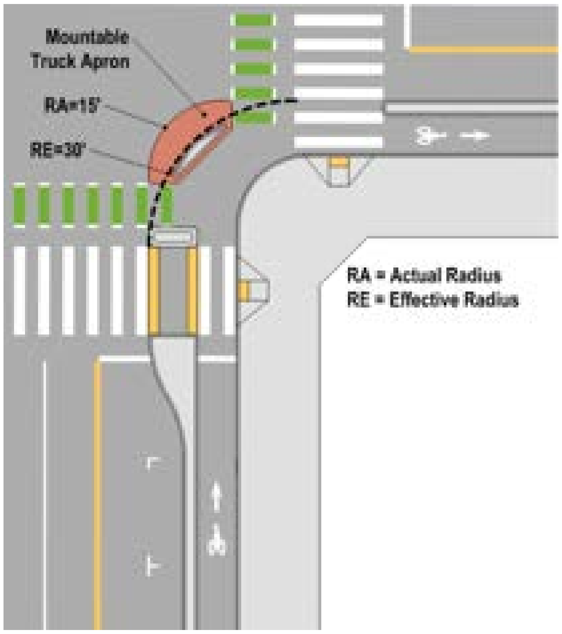
- Using vehicle turning software or turning templates, designers should minimize the actual corner radius while accommodating the effective turning radius of vehicles.
- Where pedestrians or bicyclists are expected and the effective turning radius exceeds 15 feet., consider the following:
  - Push back the stop line of the receiving street beyond the minimum 4 feet from crosswalks where appropriate. Ensure any encroachment does not conflict with overlapping phases at signalized intersections. In general, stop lines should not be pushed back more than 30 feet from crosswalks as motorist compliance may be diminished; however, the maximum distance from the stop line to traffic signals cannot exceed the sight distance and clear zone requirements established in MUTCD Chapter 4D.
  - Provide a truck apron to increase the effective radius for larger vehicles, including SU-30, while providing a smaller effective radius for the majority of vehicles (e.g., passenger car), see Section 5C-2, S for additional information and design guidance.
  - Provide a raised crossing, see Section 12A-5, D, 2.
  - At skewed intersections and where truck aprons would exceed 15 feet, consider a right-angle channelized island as described in the Iowa DOT Design Manual Section 6A-11. A raised crosswalk should be considered at channelized right turn lanes where motorists do not face stop or traffic signal control to encourage motorist yielding. They may also be beneficial at yield, stop, and signal control intersections where it is desirable to reduce encroachments into the crosswalk. When used at a channelized island, the crosswalk should be located to allow one vehicle to wait between the crosswalk and the cross street. Refer to Section 12A-5 for the design of pedestrian crossing islands with a refuge area.

As described in Section 12A-5, curb extensions are an FHWA approved countermeasure for improving pedestrian safety. It is acceptable to have a curb bulb with a larger curb radius that shortens crossing distances while accommodating large vehicles. For uncurbed roadways, care should be taken at corners to ensure proper design treatments are included to identify safer turning distances for large vehicles. Such treatments may include pavement coloring, different materials, and other features that provide a visual indication of the apex of the turn.

Flexible delineator posts or engineered rubber curbs may be used as an interim treatment to reduce larger corner radii. When used, they are often placed at least 1 foot offset from the turning radius of design vehicles at all intersections and driveways to decrease maintenance.

6. **Truck Aprons:** Truck aprons are most common within the center island of a roundabout, but can also be considered at intersection corners to accommodate the turning characteristics of larger vehicles while slowing the turning speeds of the design and smaller vehicles. The truck apron must be designed to be mountable by ICV to accommodate their larger effective turning radius while the IDV and smaller vehicles follow the smaller actual radius along the outside edge of the truck apron.

Figure 5M-1.03: Typical Truck Apron Layout at a Protected Intersection



The outside edge of a truck apron (i.e., closest to the travel lane) is constructed using a mountable curb and should be designed so passenger vehicles follow this mountable curbline at the desired speed. Larger vehicles, including SU-30, can traverse the truck apron if desired, but the intersection control vehicle should be used to determine the effective radius.

The truck apron is part of the motorist travel way. Do not extend truck aprons through bicycle lanes or crosswalks unless they are designed to accommodate these users. Bicycle stop bars and pedestrian accommodations (e.g., curb ramps, crosswalks) must be placed to prevent these users from waiting in the travel way. Colored concrete and/or pavement markings should be used within the truck apron area to provide a visual contrast from the adjacent roadway and sidewalk, communicating this is not an area to drive over. Where truck apron widths exceed 15 feet., the intended use of the apron may not be clear and designers may consider a channelizing island to limit the street crossing distance for pedestrians and bicyclists (see Section 5C-2, R, 5 and Iowa DOT Design Manual Section 6A-11).

In retrofit conditions, a truck apron extending all the way to the existing curb line may not be possible without significant stormwater system modifications. In these situations, truck pillows, which are the mountable portion of a curb extension which is designed to discourage smaller vehicles from tracking over it while allowing larger vehicles to do so while maintaining drainage along the existing curb line may be more practical and feasible.

An edge line should be provided along the outside edge of wider truck aprons and designers should consider reflective raised pavement markers, where appropriate, to ensure the path of travel is visible. Gore markings may be installed on the truck apron itself, but this is often unnecessary if colored pavement is used.

Where buses frequently make turns (such as transit or school bus routes), truck aprons should be designed to allow the bus to complete the turn without traversing the truck apron. A tiered truck apron with a curb reveal from 0 to 1 inch can be constructed for use by buses while the second tier can be designed with a 3 inch curb reveal for use by larger trucks.

Figure 5M-1.04: Truck Apron with Concrete and Pavement Markings (left) and Truck Pillow (right)

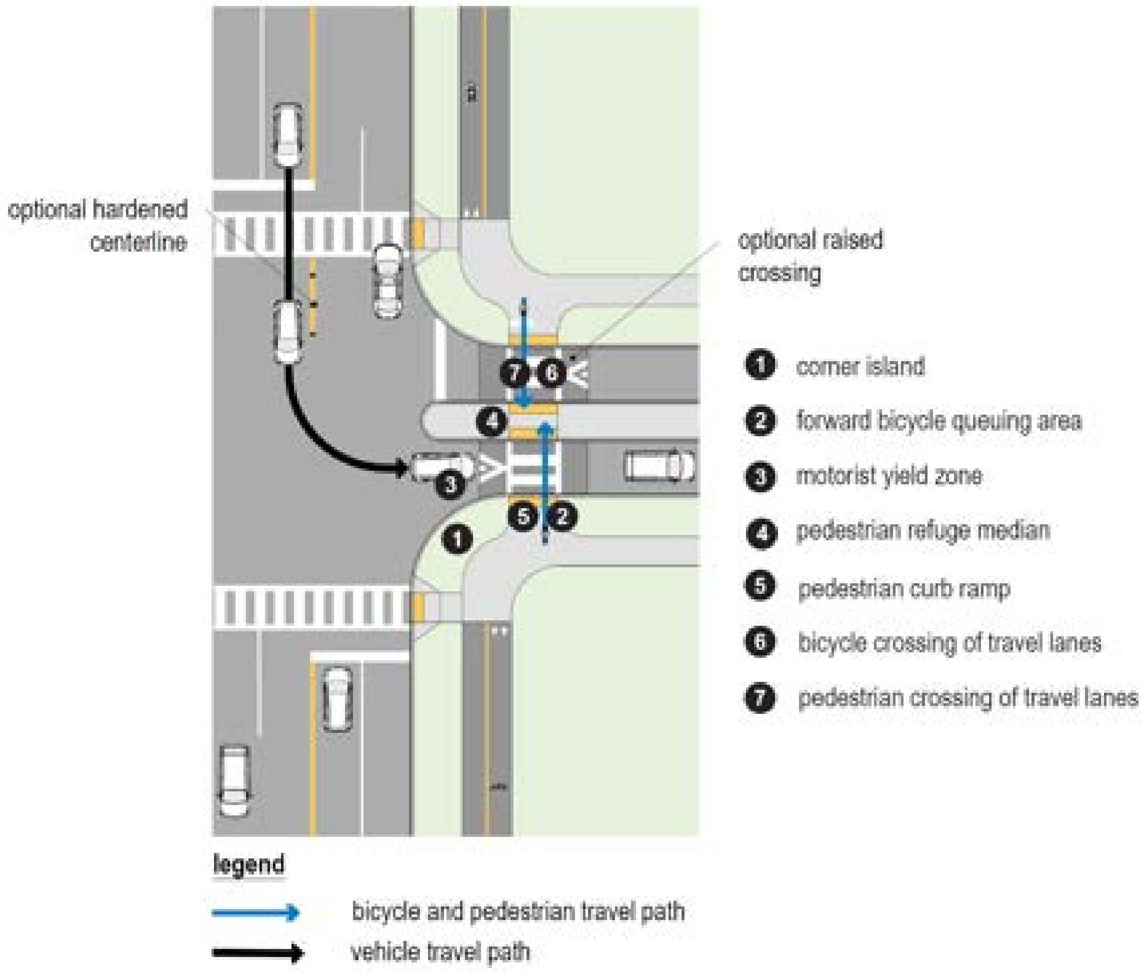
Source: City of Los Angeles, 2020

7. **Intersection Treatments for Minimizing Left Turning Vehicle Speeds:** Median islands, hardened centerlines, and raised crossings can be appropriate on both the departure roadway and the receiving roadway to control the left turning motorist's path of travel and reduce turning speeds, which can improve the safety for all roadway users. Section 12A-5 discusses how a raised median island can be used to provide pedestrian refuge space to cross a major street. In that situation, a minimum of 6 feet is required to accommodate a pedestrian or bicyclist waiting to cross the second portion of the crossing. When less than 6 feet in width is available, designers can still provide a center median of less than 6 feet or a hardened centerline, to channelize and slow the speeds of left turning motorists as they prepare to cross the path of pedestrians and bicyclists.

   A hardened centerline is comprised of a painted centerline supplemented by a dashed center or lane line extended along the turning path, flexible delineators, mountable curb, rubber curb, concrete curb, in-street pedestrian crossing signs (R1-6), or a combination of these treatments. The dimensions of a hardened centerline will depend on the intersection geometry and vehicle turning radius. Hardened centerlines should be considered where higher speed left turns occur concurrent with pedestrian and/or bicyclist movements, as they have been found to reduce the speed of left turning motorists by reducing the effective turning radius.

   For raised crossing design considerations, see Section 12A-5, D, 2.

Figure 5M-1.05: Example of Hardened Centerline Applications with Flexible Delineators on the Departure Roadway and a Pedestrian Crossing Island on the Receiving Roadway



8. **Lane Width:** The AASHTO Green Book provides for lane widths from 9 to 12 feet wide. Narrower lanes force drivers to operate their vehicles closer to each other than they would normally desire and reduce overall speeds. The lane widths selected are subject to professional engineering judgment as well as applicable design standards and design criteria. The width of traffic lanes sends a specific message about the type of vehicles expected on the street, as well as indicating how fast drivers should travel. With painted lane lines being 4 to 6 inches wide, the actual “feel” to the driver will be about 1 foot narrower than the design lane width. Wider lanes are generally expected on arterial and collector streets due to truck traffic, transit vehicles, and higher operating speeds. Snow plowing and removal practices must also be considered as lane width decisions are being made, especially for the curb lane. Narrower curb lane widths may necessitate different handling of snow because no space is available to store the snow and it may require loading and removing on a more frequent basis.

   Collector and arterial streets in the urban and rural town context may have lane widths between 10 to 12 feet wide. Lane widths of 10 feet may be used where truck and bus volumes are relatively low and speeds are less than 35 mph. Collector street speeds should not exceed 35 mph. At least one 11 foot lane in each direction may be appropriate for streets where there is a heavy volume of truck traffic or buses. It is preferable that bus- or transit-only lanes be 11 feet wide.

Lane widths for local streets in urban and rural town areas should be 10 feet, except in industrial areas, which should be 11 to 12 feet due to the larger volume of trucks expected with that land use. Local streets can have lane widths of 9 feet in residential areas where the available right-of-way imposes limitations. For low volume local residential streets, two free flowing lanes are generally not required. This creates a yield situation when two vehicles meet; see Section 5C-1, Tables 5C-1.01 and 5C-1.02.

It was previously thought lanes less than 12 feet could reduce traffic flows and capacity. New research has shown lane widths of 10 feet do not reduce capacity and the Highway Capacity Manual has eliminated capacity adjustments for lane widths between 10 and 13 feet. In addition, NCHRP 330 *Effective Utilization of Street Width on Urban Arterials* found the use of 10 feet lanes has resulted in lower or unchanged crash rates.

9. **Curb Radii:** The curb radius of intersection corners impacts turning vehicles and pedestrian crossing distances. Larger radii allow larger vehicles, such as trucks and buses, to make turns without encroaching on opposing travel lanes or the sidewalk, but increase the crossing distance for pedestrians and allows smaller vehicles to turn at faster speeds. Smaller curb radii slow turning traffic and create shorter crossing distances, but make it difficult for larger vehicles to safely navigate the intersection. Sections 5C-2, R and 5M-1, C, 5 provide guidance on selecting design vehicles, control vehicles, and typical curb radii for different roadways.

10. **Curb Extensions or Bump-outs:** Curb extensions or bump-outs are an expansion of the curb line into the adjacent street. They are traditionally found at intersections where on-street parking exists, but could also be located mid-block. Bump-outs narrow the street both physically and visually, slow turning vehicles, shorten pedestrian crossing distances, make pedestrians more visible to drivers, and provide space for street furniture. Use of curb extensions does not preclude the necessity to meet the turning radii needs of the selected design vehicle. Refer to Section 12A-5 for more design guidance on curb extensions.

11. **Bicycle Facilities:** Bicycle facilities provide opportunities for a range of users and are a fundamental element of complete streets design. In Iowa, bicycles are legally considered a vehicle and thus have legal rights to use any street facility unless specifically prohibited. They also have legal responsibilities to obey all traffic regulations as a vehicle. Bicycle facilities generally are one of the following three types:

    a. **Shared Use Paths:** Separate travel ways for non-motorized uses. Bicycles, pedestrians, skaters, and others use these paths for commuting and recreation. Generally used by less experienced bicyclists.

    b. **Shared Lanes:** These are lanes shared by vehicles and bicycles without sufficient width or demand for separate bicycle lanes. They may be marked or unmarked. Low speed, low volume residential streets generally will not have pavement markings. Shared lanes are not recommended for roadways with speeds over 35 mph or traffic volumes over 5,000 ADT. In addition, shared lanes on roadways with speeds greater than 25 mph or volumes over 3,000 ADT are unlikely to accommodate the “interested but concerned bicyclist” (see Section 12B-1).

    c. **Bicycle Lanes:** Dedicated bicycle lanes are used to separate higher speed vehicles from bicyclists to improve safety. These should be considered where there are frequent interactions between vehicles and bicyclists when conflicts in shared lanes become problematic, typically when vehicular volumes exceed 3,000 vehicles per day and operating speeds are 25 mph or greater. There are generally three types of bicycle lanes:

1) **Conventional:** Located between the travel lanes and the curb, road edge, or parking lane and generally flow in the same direction as motor vehicles. They are the most common bicycle facility in the United States.
2) **Buffered:** Conventional bicycle lanes coupled with a designated buffer space separating the bicycle lane from adjacent motor vehicle lanes and/or a parking lane.
3) **Separated:** An exclusive facility for bicyclists that is physically separated from motor vehicle or parking lanes by a vertical element. Separated bicycle lanes are also called cycle tracks or protected bicycle lanes.

Design information and selection guidance for each bicycle facility type is detailed in Sections 12B-1 through 12B-3. Bicycle parking facilities at destination points will assist in encouraging bicycle usage.

Snow and ice control activities impact vehicular lanes and bicycle lanes differently. Generally, plows will leave some snow on the pavement. Vehicles are able to travel through this material but bicyclists may have more difficulty. In addition, the material may refreeze and make bicycle use more treacherous.

12. **On-Street Parking:** On-street parking can be an important element for complete street design by calming traffic, providing a buffer for pedestrians if the sidewalk is at the back of curb, in addition to benefiting adjacent retail or residential properties. The width of parallel parking stalls can vary from 7 to 10 feet. Streets with higher traffic volumes and higher speeds should have wider parking spaces or a combination of parking space and buffer zone. Narrower parking spaces can be used if a 3 feet buffer zone is painted between the parking stall and a bicycle or traffic lane. The buffer zone will minimize exposure of doors opening into bicyclists, as well as facilitate faster access into and out of the parking space. Placement of parking stalls near intersections or mid-block crossings should be prohibited so as to not impede sight lines of pedestrians entering crosswalks; see Section 12A-5, D, 1 for parking restrictions near crosswalks. Snow plowing could impact the availability of on-street parking intermittently. Requirements for ADA accessible on-street parking numbers and stall design must be adhered to. Information on those requirements can be found in Section 12A-2.

13. **Sidewalks:** Sidewalks are the one element of a complete street that is likely to provide a facility for all ages and abilities. Often sidewalks are the only way for young and older people alike to move throughout the community. Sidewalk connectivity is critical to encourage users. Sidewalks should be provided on both sides of all streets unless specific alternatives exist or safety is of concern. All sidewalks are required to meet ADA guidelines or be a part of a transition plan to be upgraded. Sections 12A-1 and 12A-2 identify the specific ADA requirements for sidewalks.

    Sidewalks that are set back from the curb are more comfortable to the user than if the sidewalk is located at the back of curb. Sidewalks set back from the curb also provide space for the storage of snow plowed from the street and space for signs and other street furniture. It may be helpful to divide sidewalks in mixed-use (i.e., commercial and residential) urban areas into several "zones": the building frontage zone, next to the building, to allow for doors that open directly onto the sidewalk and other building appurtenances; the pedestrian walkway zone, which should be 5 feet or greater (preferred), 4 feet minimum per ADA; and the furnishing zone, where street furniture, landscaping seating areas, bus stops, bicycle racks, and café dining areas can further enhance the urban environment, support local business activities, and encourage pedestrian activity.

14. **Turn Lanes:** Turn lanes located at intersections provide opportunities for vehicles to exit the through lanes and improve capacity of the street. Two Way Left Turn Lanes (TWLTL) provide the opportunity to access midblock driveways, and thereby reduce common crash types such as rear-end crashes and sideswipes. Turn lanes also allow continuous movement and potentially

faster speeds in the through lanes, increased crossings distances for pedestrians, and increased conflict areas for bicyclists where merging and weaving areas intersect with bicycle lanes therefore designers should evaluate both the operations and safety of all modes when considering turn lanes. Where turn lanes are present, designers should work to minimize or eliminate conflicts through geometric design and traffic control.

Dedicated left and right turn lane widths and TWLTL lanes should match the width of the lanes on the street when complete street designs are chosen. Local streets should not provide separate turn lanes.

15. **Medians:** Medians provide for access management, pedestrian refuge, and additional space for landscaping, lighting, and utilities. Use of medians and the functions provided are dependent upon the width of available right-of-way and the other types of facilities that are included. The minimum width needed for pedestrian refuge is 6 feet; see Section 12A-5 for additional design guidance for pedestrian refuge islands. At shared use path crossings, the preferred minimum crossing island width is 10 feet, which accommodates bicyclists with trailers and wheelchair users more comfortably. The minimum width of a median for access control and adjacent to left turn lanes is 4 feet. However, greater widths provide more opportunities for more extensive landscaping. Low height plantings may be considered for all median widths provided that the plantings can be maintained. For landscaped medians that include trees, shrubs, or gateway features, designers should adhere to urban lateral offset clear zone requirements, 4 feet (acceptable) 6 feet (preferred).

16. **Transit:** Bus service within the state is limited to the larger metropolitan areas. Currently there are a number of fixed route systems in the state. Smaller communities do not have fixed route service due to lack of demand. Children, elderly, and low-income people are the primary users of a fixed route transit system. In addition to system reliability, use of transit systems as a viable commuting option is directly dependent on the frequency of service and the destinations within the fixed route. To have a successful transit system, stops must be within walking or biking distance of residential areas to attract riders and it must have major retail, employment, and civic centers along its route system.

    Transit stops should be located on the far side of intersections to help reduce delays, minimize conflicts between buses and right turning vehicles, and encourage pedestrians to cross behind the bus where they are more visible to traffic. Far side stops also allow buses to take advantage of gaps in vehicular traffic. Safe street crossings should be provided near bus stops, typically within 100 feet. For guidance on providing safe street crossings on a variety of road types, refer to Section 12A-5.

    Bus turn out lanes are also best located on the far side of intersections. These turn outs free up the through lanes adjacent to the bus stop. Transit bulb outs are more pedestrian friendly than turnouts because they provide better visibility of the transit riders, as well as potentially providing space for bus shelters without creating congestion along the sidewalk. With buses stopping in the through lane, bulb-outs also provide traffic calming for the curb lane.

17. **Traffic Signals:** Traffic signals are not usually considered an element of complete streets, but they have many components with direct implications for complete streets. The timing, phasing, and coordination of traffic signals impacts all modes. Well-planned signal cycles reduce delay and unnecessary stops at intersections, thus improving traffic flow without street widening, see Section 13A-4, E. Traffic signal timing can be designed to control vehicle operating speed along the street and to provide differing levels of protection for crossing pedestrians and bicyclists, see Sections 13A-4, F and 12B-3, L for signal timing strategies to minimize conflicts among pedestrians, bicyclists, and motorists.

The flashing don't walk pedestrian phase should be set using a 3.5 feet per second walking speed and the full pedestrian crossing time (walk/flashing don't walk) set using 3.0 feet per second. Some agencies representing the elderly are indicating that the overall walking speed should be 2.7 feet per second to cover a larger portion of the elderly population. ADA accessible pedestrian signal elements, such as audible signal indications, should be included in all new pedestrian signal installations and any installations being upgraded. See Section 13A-4, F for more information on accessible pedestrian signals.

18. **Summary:** The table below summarizes some of the critical design elements that should be examined if a complete streets project is implemented. Other geometric elements can be found in Table 5C-1.02. Some of the lane width values shown in the table below differ from the acceptable values from Section 5C-1 because the expectation is that the complete street environment includes the potential for on-street parking and/or bicycle lanes. Adjustments in the values may be necessary to accommodate large volumes of trucks or buses. Contact the Jurisdictional Engineer if design exceptions are being considered.

Table 5M-1.01: Preferred Design Elements for Complete Streets

Classification	Local		Collector				Arterial			
Posted Speed (mph)	< 25		< 35		35		< 35		35 to 45	
Land use[1]	*R/C*	*I*	*R/C*	*I*	*R/C*	*I*	*R/C*	*I*	*R/C*	*I*
Travel lane width (ft)	10[2]	11	10	11	10[3]	11	10[3]	11	11	12[4]
Turn lane width (ft)	--	--	10	11	10	11	10	11	11	12[4]
Two-way left-turn lanes width (ft)	--	--	10	11	10	11	10	11	11	12[4]
Curb Offset (ft)[5]	0	0	0	0	0 to 2	0 to 2	0	0	0 to 2	0 to 2
Parallel parking width (no buffer) (ft)[6]	8	8	8	9	8	9	8	9	9	9
Sidewalk Width (ft)	See Section 12A-1									
Bicycle lane width (ft)	See Section 12B-3									

[1] R = Residential, C = Commercial, I = Industrial
[2] For low volume residential streets, two free flowing lanes are not required. They can operate as yield streets if parking is allowed on both sides and vehicles are parked across from each other.
[3] When transit is present on a curbed four lane roadway, an 11 foot outside lane may be considered to better accommodate trucks and buses if present.
[4] Where additional width is necessary to accommodate the preferred bikeway, designers may consider using a lane width of 11 feet.
[5] Travel lane widths shown provide sufficient width for both the physical and operating space of a typical vehicle for each classification. A curb offset is not required for roadways with a posted speed of 35 mph or less or where on street parking is present. Where the gutter is a different material than the travel lane, it should not be included in the travel lane width. For posted speeds higher than 35 mph, curbs may be offset up to 2 feet from the edge of the travel lane. The gutter width should be considered a part of the curb offset width.
[6] For arterial or high speed collectors, the parallel parking stall width may be reduced if a minimum 3 foot buffer strip is included.

D. Traffic Calming

Traffic calming is related, but different from complete streets. Through retrofitted design measures, traffic calming aims to slow traffic down to a desired speed. By slowing vehicular traffic, biking and pedestrian activities are made safer.

It is absolutely critical that traffic calming measures recognize the need to maintain access for emergency vehicles. Traffic calming devices are intended to reduce motor vehicle volumes, speeds, or both and by doing so can create conditions appropriate for bicycle boulevards (Section 12B-3, H). However, traffic calming mitigation needs to be carefully considered to not divert vehicles to adjacent streets and just move the problem. A larger study area than just the street being considered may be needed when evaluating traffic calming measures.

Some traffic calming measures are proven safety measures that reduce crash risk for pedestrians and other road users. They are discussed in more detail in other sections. These include the following.

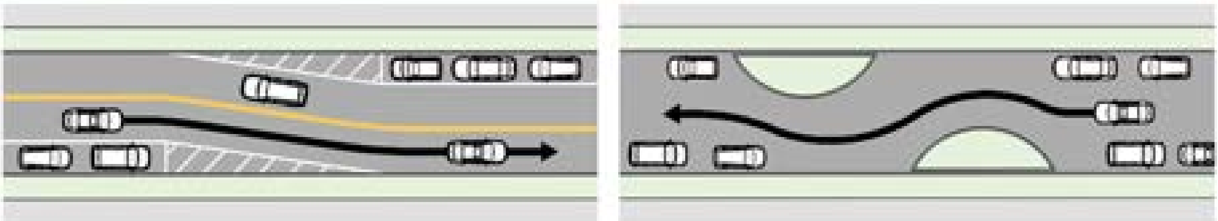
- Road diet (see Sections 5M-1, C, 3 and 12B-3, G)
- Curb extension (Section 12A-5)
- Raised crosswalk and raised intersection (Section 12A-5)
- Pedestrian refuge island (Section 12A-5)

In addition to those safety measures, designers can consider the following traffic calming elements to slow speeds or reduce traffic volumes:

1. **Horizontal Deflection:** These devices force a motorist to slow the vehicle in order to comfortably navigate the traffic calming measure. Horizontal deflection is most appropriate on local and collector streets. It is most effective when parking is robust throughout the day.

   a. **Lateral Shifts and Chicanes:** Lateral shifts cause travel lanes to shift in one direction, often by shifting on-street parking from one side of a street to the other side of the street. Chicanes are a series of curb extensions, pinch points, parking bays, or landscaping features that alternate from one side of the road to the other to establish a serpentine path of travel for motorists along a street. Chicanes can be implemented on local, collector, and minor arterial streets. The following design guidance should be considered for both treatments.
      - Lateral shifts and chicanes can be used on two-way streets with one lane in each direction, and one-way streets with no more than two lanes.
      - Traffic calming effects are greatest when deflection shifts vehicles back and forth by at least one full lane width.
      - The shifting taper of horizontal deflections should be based on the posted speed. Provide advisory speed plaques (W13-1P) where appropriate to supplement horizontal alignment signs (see MUTCD Section 2C.07). Otherwise, the design of chicanes generally follows curb extensions design (see Section 12A-5, D, 5).
      - Avoid using these horizontal deflection treatments along streets with bus, freight, or emergency response activity unless traffic volumes are very low and large vehicles can use the full roadway width.

Figure 5M-1.03: Examples of Lateral Shift (left) and Chicane (right)



b. **Traffic Circles:** Neighborhood traffic circles are primarily used at four-leg, two-lane local streets and are installed to reduce crash severity and slow traffic speeds. Splitter islands are not required on approaches (unlike a modern roundabout), and the central island is typically raised with a mountable apron to prevent a straight-through movement of the typical design vehicle. The occasional movement of a control vehicle should not be precluded from operating within the intersection with encroachment, if necessary, which may include going the “wrong way” to the left of the traffic circle to make a left turn. Landscaping may be planted in the center median if it does not need to be traversable.

2. **Vertical Deflection:** These devices include speed humps and raised crosswalks and are effective means for controlling the speeds of motor vehicles. Vertical deflection as a traffic calming measure is only appropriate on local and collector streets where posted speeds are less than 35 mph and where roadway grades do not exceed 8%. In general, all vertical traffic calming devices within roadways should be built with a bicycle friendly vertical deflection profile. The preferred profile is sinusoidal, which is easier for bicyclists to traverse than a circular or flat profile. Sinusoidal profiles are also easier for maintenance vehicles to traverse for street sweeping or snow plowing activities, and they have less of an effect on emergency vehicle access.

   Where speed humps are used to control speeds along a roadway, they are most effective when they are placed periodically along the route (every 200 to 400 feet) to reinforce speed control. These devices should be designed to maintain existing drainage patterns to avoid requiring additional inlets and storm sewer. Tapering the speed hump near the edge of pavement or curb line will minimize retrofit installation costs and allow stormwater to flow into existing gutters.

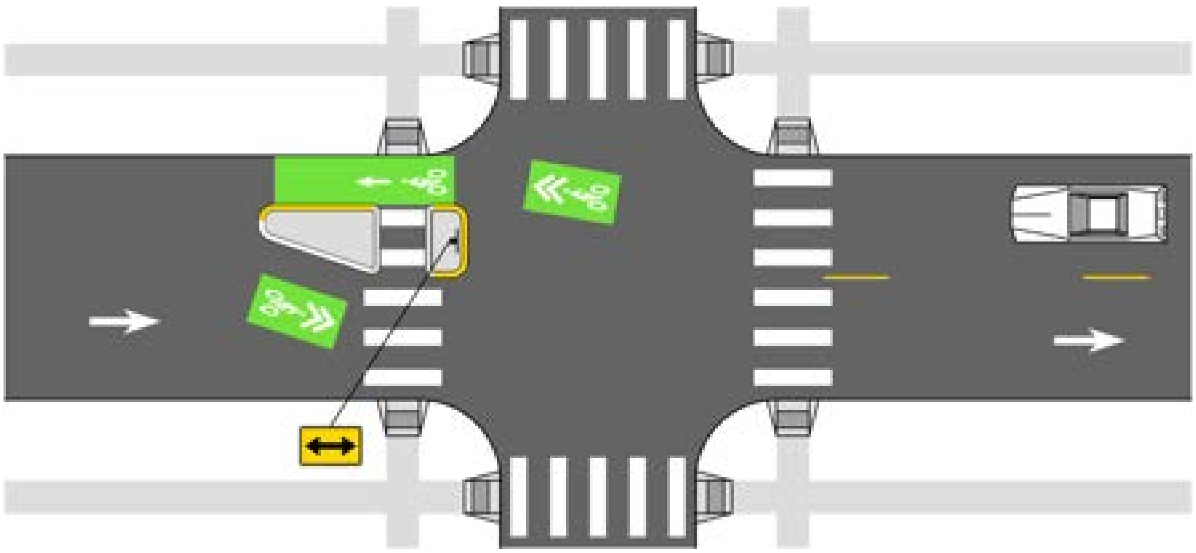
3. **Traffic Diversion:** Traffic diversion strategies are used to reroute traffic from one roadway onto other adjacent streets by installing design treatments that restrict motorized traffic from passing through. These are often used on bicycle boulevards (see Section 12B-3, H) to reduce motorist volumes to desired thresholds, and can be used on other roadways where volumes are above desired thresholds for bicycle or pedestrian accommodation.

   a. **Regulatory signage:** Signs can be used to prohibit vehicles from entering a roadway using movement prohibition signs (R3-1, R3-2, R3-3, R3-5, etc., or DO NOT ENTER signs (R5-1). These prohibitions can be for all hours or for peak hours only. Signs should be supplemented with an EXCEPT BICYCLES plaque when bicyclists are allowed to perform the movements that are prohibited for motorists. Signs may be supplemented by pavement marking arrows to emphasize the restriction, but pavement markings should not be used when restrictions vary by time of day. Signs and pavement markings alone may not be effective at discouraging motor vehicle access.

   b. **Diverters:** A diverter is an island built at an intersection to alter the movement of through and/or turning vehicle traffic. Diverters are commonly designed to maintain through travel for people walking and bicycling while altering routes for motor vehicles. The NACTO *Urban Bikeway Design Guide* provides examples of different types of diverters to reduce traffic volumes on bicycle boulevards. For all diverters, designers should consider the following.

- Diverter islands are designed to maintain bicycle and pedestrian access by providing cut-throughs. Standard cut-through width for bicyclists is 6 feet.
- Diverter islands can include a combination of public art or other vertical elements, so long as they keep sight lines clear. Other vertical elements such as signing, flexible delineator posts, etc. may be appropriate to make the features more visible to motorists and assist snowplow operators when clearing roadways.
- A diverter's effectiveness at limiting speeds is generally limited to the intersection where it is installed. The street may require additional traffic calming treatments in addition to the intersection treatments to achieve the desired operating characteristics.
- Diverters must be designed with transit and emergency vehicle navigation in mind. In some cases, emergency vehicles must be able to travel over or through the diverter if gaps are spaced to accommodate them or if breakaway gates are used.

Figure 5M-1.04: Diverter



Choosing the design elements to use for a particular area will depend on the neighborhood context and the specific concern to be addressed. Prior to evaluating alternative measures, stakeholders must be educated so they can have meaningful involvement. The evaluation needs to involve all stakeholders in the definition of the problem. If possible, all stakeholders, including drivers, pedestrians, bicyclists, and area property owners, would achieve some level of agreement on the traffic calming plan prior to implementation.

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AASHTO

A Policy on Geometric Design of Highways and Streets

2018
7th Edition

THE GREEN BOOK

6.2.2 Cross-Sectional Elements

6.2.2.1 Width of Roadway

For paved roadways, the minimum roadway width is the sum of the traveled way and shoulder widths shown in Table 6-5. Graded shoulder width is measured from the edge of the traveled way to the point of intersection of shoulder slope and foreslope. Where roadside barriers are included, a minimum offset of 4 ft [1.2 m] from the traveled way to the barrier should be provided, wherever practical. For further information, see Section 4.4, "Shoulders," Section 4.10.2, "Longitudinal Barriers," and Section 3.3.10, "Traveled-Way Widening on Horizontal Curves" for vehicle offtracking information.

Table 6-5. Minimum Width of Traveled Way and Shoulders

U.S. Customary			
Design Speed (mph)	Minimum Width of Traveled Way (ft) for Specified Design Volume (veh/day)		
	under 400	400 to 2000	over 2000
20	20[a]	20	22
25	20[a]	20	22
30	20[a]	20	22
35	20[a]	22	22
40	20[a]	22	22
45	20	22	22
50	20	22	22
55	22	22	22[b]
60	22	22	22[b]
65	22	22	22[b]
All Speeds	Width of Shoulder on Each Side of Road (ft)		
	2	4	6

Metric			
Design Speed (km/h)	Minimum Width of Traveled Way (m) for Specified Design Volume (veh/day)		
	Under 400	400 to 2000	over 2000
30	6.0[a]	6.0	6.6
40	6.0[a]	6.0	6.6
50	6.0[a]	6.0	6.6
60	6.0[a]	6.6	6.6
70	6.0	6.6	6.6
80	6.0	6.6	6.6
90	6.6	6.6	6.6[b]
100	6.6	6.6	6.6[b]
All Speeds	Width of Shoulder on Each Side of Road (m)		
	0.6	1.5	2.4

[a] An 18-ft [5.4-m] minimum width may be used for roadways with design volumes under 250 veh/day.

[b] Consider using lane width of 24 ft [7.2 m] where substantial truck volumes are present or agricultural equipment frequently uses the road.

Note: See text for roadside barrier and offtracking considerations.

6.2.2.2 Number of Lanes

The number of lanes should be sufficient to accommodate the design traffic volumes for the desired level of service. Normally, capacity conditions do not govern rural collector roads, and two lanes are appropriate. For further information, see Section 2.4, "Highway Capacity."

It is difficult to define the life of a roadway because major segments may have different lengths of physical life. Each segment is subject to variations in estimated life expectancy for reasons not readily subject to analysis, such as obsolescence or unexpected radical changes in land use, with the resulting changes in traffic volumes, patterns, and demands. Right-of-way and grading may be considered to have a physical life expectancy of 100 years; minor drainage structures and base courses, 50 years; bridges, 25 to 100 years; resurfacing, 10 years; and pavement structure, 20 to 30 years, assuming adequate maintenance and no allowance for obsolescence. Bridge life may vary depending on the cumulative frequency of heavy loads. Pavement life can vary widely, depending largely on initial expenditures and the repetition of heavy axle loads.

The assumption of no allowance for functional obsolescence is open to serious debate. The principal causes of obsolescence are increases in the number of intersections and driveways and increases in traffic demand beyond the design capacity. On non-freeway roadways, obsolescence due to addition of intersections and driveways is much more difficult to forestall; this occurs particularly in urban and suburban areas, but may occur in rural areas as well.

In a practical sense, the design volume should be a value that can be estimated with reasonable accuracy. Many designers believe the maximum design period is in the range of 15 to 24 years. Therefore, a period of 20 years is widely used as a basis for design. Traffic cannot usually be forecast accurately beyond this period on a specific facility because of probable changes in the general regional economy, population, and land development along the roadway, which cannot be predicted with any degree of assurance.

2.3.6 Speed

Speed is one of the most important factors considered by travelers in selecting alternative routes or transportation modes. Travelers assess the value of a transportation facility in moving people and goods by its reliability, convenience, and economy, which are generally related to its speed. The attractiveness of a public transportation system or a new roadway are each weighed by the travelers in terms of time, convenience, and money saved. Hence, the desirability of rapid transit may well rest with how rapid it actually is. In addition to driver and vehicle capabilities, the speed of vehicles on a road depends on five general conditions:

- physical characteristics of the roadway,
- amount of roadside interference,
- weather,
- presence of other vehicles, and
- speed limitations (established either by law or by traffic control devices).

Although any one of these factors may govern travel speed, the actual travel speed on a facility usually reflects a combination of these factors.

The objective in design of any engineered facility used by the public is to satisfy the public's demand for service in an economical manner, with efficient traffic operations and with low crash frequency and severity. The facility should, therefore, accommodate nearly all demands with reasonable adequacy and also should only fail under severe or extreme traffic demands. Because only a small percentage of drivers travel at extremely high speed, it is not economically practical to design for them. They can use the roadway, of course, but will be constrained to travel at speeds less than they consider desirable. On the other hand, the speed chosen for design should not be that used by drivers under unfavorable conditions, such as inclement weather, because the roadway would then be inefficient, might result in additional crashes under favorable conditions, and would not satisfy reasonable public expectations for the facility.

There are important differences between design criteria applicable to low- and high-speed designs. To implement these differences, the upper limit for low-speed design is 45 mph [70 km/h] and the lower limit for high-speed design is 50 mph [80 km/h].

2.3.6.1 Operating Speed

Operating speed is the speed at which drivers are observed operating their vehicles during free-flow conditions. The 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed associated with a particular location or geometric feature. The following geometric design and traffic demand features may have direct impacts on operating speed:

- horizontal curve radius,
- grade,
- access density,
- median treatments,
- on-street parking,
- signal density,
- vehicular traffic volume, and
- pedestrian and bicycle activity.

2.3.6.2 Running Speed

The speed at which an individual vehicle travels over a highway section is known as its running speed. The running speed is the length of the highway section divided by the time for a typical vehicle to travel through the section. For extended sections of roadway that include multiple roadway types, the average running speed for all vehicles is the most appropriate speed measure for evaluating level of service and road user costs. The average running speed is the sum of the distances traveled by vehicles on a highway section during a specified time period divided by the sum of their travel times.

One means of estimating the average running speed for an existing facility where flow is not interrupted by signals or other traffic control devices is to measure the spot speed at one or more locations. The average spot speed is the arithmetic mean of the speeds of all traffic as measured at a specified point on the roadway. For short sections of roadway, on which speeds do not vary materially, the average spot speed at one location may be considered an approximation of the average running speed. On longer stretches of rural highway, average spot speeds measured at several points, where each point represents the speed characteristics of a selected segment of roadway, may be averaged (taking relative lengths of the roadway segments into account) to provide a better approximation of the average running speed.

The average running speed on a given roadway varies during the day, depending primarily on the traffic volume. Therefore, when reference is made to a running speed, it should be clearly stated whether this speed represents peak hours, off-peak hours, or an average for the day. Peak and off-peak running speeds are used in design and operation; average running speeds for an entire day are used in economic analyses.

The effect of traffic volume on average running speed can be determined using the procedures of the *Highway Capacity Manual* (HCM) (*43*). The HCM shows the following:

- **Freeways and multilane highways in rural areas—**there is a substantial range of traffic volumes over which speed is relatively insensitive to the volume; this range extends to fairly high volumes. Then, as the volume per lane approaches capacity, speed decreases substantially with increasing volume.
- **Two-lane highways—**speed decreases linearly with increasing traffic volume over the entire range of volumes between zero and capacity.
- **Streets in urban areas—**speed decreases with increasing traffic volume over the entire range of volumes between zero and capacity; the decrease in speed with increasing volume is non-linear at higher volumes.

2.3.6.3 Design Speed

Design speed is a selected speed used to determine the various geometric design features of the roadway. The selected design speed should be a logical one with respect to the anticipated operating speed, topography, the adjacent land use, modal mix, and the functional classification of the roadway. In selection of design speed, every effort should be made to attain a desired combination of safety, mobility, and efficiency within the constraints of environmental quality, economics, aesthetics, and social or political impacts. Once the design speed is selected, all of the pertinent roadway features should be related to it to obtain a balanced design. On lower-speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed. Some design features, such as curvature, superelevation, and sight distance, are directly related to, and vary appreciably with, design speed. Other features, such as widths of lanes and shoulders and clearances to walls and rails, are not directly related to design speed but they do affect vehicle speeds. Thus, when a change is made to design speed, many elements of the roadway design will change accordingly.

The selected design speed should be consistent with the speeds that drivers are likely to travel on a given roadway. Where a reason for limiting speed is obvious, drivers are more apt to accept lower speed operation than where there is no apparent reason. A roadway of higher functional classification may justify a higher design speed than a lesser classified facility in similar topography. A low design speed, however, should not be selected where the topography is such that drivers are likely to travel at high speeds. Drivers do not adjust their speeds to the importance of the roadway, but to their perception of the physical limitations of the highway and its traffic.

Lower speeds are desirable for thoroughfares in walkable, mixed-use urban areas and this desire for lower speeds should influence the selection of the design speed. For design of such streets, a target speed should be selected (*29*). The target speed is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses, to provide both mobility for motor vehicles and a desirable environment for pedestrians, bicyclists, and public transit users. The target speed is intended to be used as the posted speed limit. In some jurisdictions, the speed limit is established based on measured speeds. In these cases, it is important for the design of the thoroughfare to encourage an actual operating speed that equals the target speed (*16, 35*).

The selected design speed should reflect the needs of all transportation modes expected to use a particular facility. Where traffic and roadway conditions are such that drivers can travel at their desired speed, there is always a wide range in the speeds at which various individuals will choose to operate their vehicles. A cumulative distribution of free-flow vehicle speeds typically has an S-shape when plotted as the percentage of vehicles versus observed speed. The selected design speed should be a high-percentile value in this speed distribution curve (i.e., inclusive of nearly all of the desired speeds of drivers, wherever practical).

It is desirable that the running speed of a large proportion of drivers be lower than the design speed. Experience indicates that deviations from this desired goal are most evident on sharper horizontal curves. In particular, curves with low design speeds (relative to driver expectation) are frequently overdriven and may have higher crash frequencies. Therefore, it is important that the design speed used for horizontal curve design be a conservative reflection of the expected speed on the constructed facility.

Table 2-1 shows the corresponding design speeds in metric and U.S. customary units in 5-mph [10 km/h] increments. This table should be used in converting the units of measurement of design speeds.

Although the selected design speed establishes the limiting values of curve radius and minimum sight distance that should be used in design, there should be no restriction on the use of flatter