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MEMORANDUM ON MINIMUM SAFETY STANDARDS

Marin County Department of Public Works
Objective Development and Design Standards

July 14, 2026

Contents

Background

State housing laws, including the State Density Bonus Law, allow qualifying housing developments which include affordable housing to request waivers or reductions from local development standards unless the local agency can demonstrate that the waived standard would result in a specific, adverse impact upon public health or safety which cannot otherwise be mitigated. As a result, establishing objective minimum roadway and active transportation standards necessary to protect public and safety that are grounded in nationally recognized guidance and peer-reviewed research is necessary to support consistent and legally defensible decision-making.

The recommended standards in this memorandum establish the County's minimum safety standards for typical projects. Applicants may propose alternative methods of compliance through a discretionary review process where equivalent or better safety outcomes can be demonstrated. These standards are intended to provide a consistent baseline for safe roadway design, reduce ambiguity in project review, and support legally defensible evaluation of waiver requests where there is substantial evidence that reductions below identified thresholds would result in significant safety impacts.

The standards evaluated in this memorandum are supported by both empirical research and nationally recognized design guidance. For purposes of this memo and exercise, peer-reviewed transportation safety and public health research generally establishes the safety and health benefits associated with the provision of facilities such as sidewalks, landscaped buffers, street trees, and bicycle infrastructure, while design guidance from Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), and National Association of City Transportation Officials (NACTO), Caltrans, and California Manual on Uniform Traffic Control Devices (CA MUTCD) generally establishes minimum dimensional and design criteria necessary for those facilities to function safely and effectively. These resources are grounded in nationally recognized engineering practice, empirical safety analysis, and established public health research.

Roadway safety is defined throughout this memorandum consistent with FHWA's Safe System Approach and Vision Zero principles, which prioritize reducing fatal and serious injury crashes for all roadway users. FHWA operationalizes safety through policy, program language, and the Safe System Approach, which is the agency's current governing framework that "aims to eliminate fatal & serious injuries for all road users." Similar Safe System and Vision Zero principles are also reflected in guidance published by AASHTO, NACTO, and the Institute of Transportation Engineers (ITE). Consistent with this framework, the standards evaluated in this memorandum are assessed based on their relationship to documented safety outcomes, including reductions in crash risk, fatality risk, and serious injury risk for all roadway users.

Sidewalks

Provision of Sidewalks

The presence of a sidewalk for pedestrian travel is a proven safety countermeasure identified by FHWA, which research has shown to reduce the likelihood of crashes involving pedestrians walking along roadways by 65-89%.[1] More recent research published in 2022 has concluded that “the likelihood of a pedestrian crash per mile along roadways with no sidewalk is three times greater than the likelihood of a crash per mile with the presence of a sidewalk.”[2] This study found that roadway segments with sidewalks had an approximately 40% lower likelihood of vehicle–pedestrian crashes compared to roadway segments with missing sidewalks. The analysis did not distinguish between sidewalks on one side of the roadway and sidewalks on both sides.

Public Health Outcomes

Recent public health research consistently demonstrates that sidewalks play a significant role in improving community health outcomes. A large-scale national study tracking more than two million Americans found that residents of neighborhoods with connected sidewalk networks engaged in substantially higher levels of physical activity, helping more people meet recommended exercise guidelines.[3] Additional research has shown that sidewalks serve as primary settings for routine moderate physical activity and active transportation, supporting healthier lifestyles and reducing sedentary behavior.[4] Systematic reviews of walkability and health impact assessments similarly conclude that sidewalks contribute to increased physical activity, lower chronic disease risk, and broader community health benefits.[5]

Design Guidance and Minimum Standards for Sidewalk Clearway Widths

The following minimum standards refer to the sidewalk clearway width, also called the pedestrian through zone. The following dimensions do not include amenity zones, buffer zones, or frontage zones.

Recommended Minimum Design Standards

Toole Design recommends the following minimum design standards for inclusion of pedestrian sidewalks having the following minimum widths for the four street/context types that Marin County is evaluating:

- Main Street: 6 feet
- Residential: 5 feet
- Collector/Arterial: 5 feet
- Industrial/Commercial: 5 feet

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[1] Gan et al. Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects. Florida DOT, (2005). https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bd015-04-rpt.pdf. Table 3-7.

[2] Abou-Senna, H., E. Radwan, and A. Mohamed. "Investigating the Correlation between Sidewalks and Pedestrian Safety". Accident Analysis and Prevention, Vol. 166, (2022). https://cmfclearinghouse.fhwa.dot.gov/study_detail.php?stid=665.

[3] Duncan, Glen E., et al. “Countrywide Natural Experiment Reveals Impact of Built Environment on Physical Activity.” *American Journal of Epidemiology*, 2024, doi:10.48550/arXiv.2406.04557

[4] Moudon, Anne Vernez, et al. “A Comprehensive Evaluation of Physical Activity on Sidewalks and Streets.” *Journal of Transport & Health*, vol. 24, 2022, article 101327, https://doi.org/10.1016/j.jth.2021.101327

[5] Badland, Hannah, et al. “Walkability and Urban Built Environments: A Systematic Review of Health Impact Assessments.” *BMC Public Health*, vol. 23, 2023, article 15394, https://doi.org/10.1186/s12889-023-15394-4

National Design Guidance

FHWA Road Diet Information Guide

Minimum design standards, for clear sidewalk widths (Table 5, page 31):

- Suburban Neighborhood: 5 feet
- Suburban Corridor: 5-6 feet
- Suburban Center: 5-6 feet
- Town/Village Neighborhood: 6-8 feet
- Town/Village Center: 6-10 feet
- Urban Core: 6-12 feet

NACTO Urban Street Design Guide

Minimum design standards (for pedestrian through zone only):

- Residential: 5-7 feet
- Downtown/commercial: 8-12 feet

Sidewalk Buffer/Street Trees

Provision of Sidewalk Buffer/Street Trees

Research and guidance from multiple transportation agencies indicate that roadside buffers between the sidewalk and vehicular travel lanes, often including landscaping elements or other street amenities like benches or bus shelters, provide meaningful pedestrian safety benefits. FHWA identifies landscaped buffers as an important safety feature because they increase separation from moving traffic, reduce pedestrian exposure to errant vehicles, and improve overall pedestrian comfort and walkability.[6] Similarly, sidewalks and walkways separated from traffic by planting strips or green space provide greater safety and comfort than sidewalks immediately adjacent to the roadway, particularly along higher-speed or higher-volume streets.[7] The Seattle Department of Transportation researched crash reductions on city streets and found that sidewalks with planting strips create safer pedestrian environments by improving separation and visibility while contributing to reductions in pedestrian-vehicle conflicts.[8] Research synthesized by the Texas A&M Transportation Institute (TTI) further concludes that vegetated roadside buffers enhance pedestrian safety and comfort by creating physical

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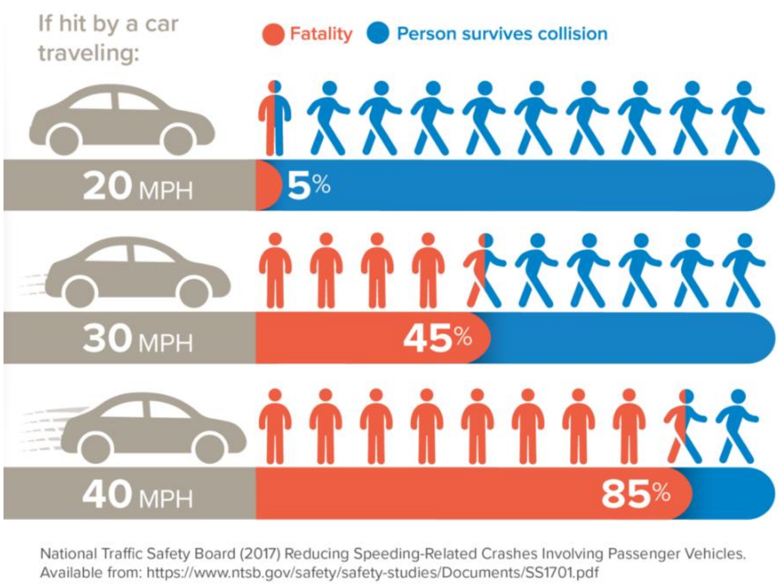
[6] Federal Highway Administration (FHWA), Guide for the Planning, Design, and Operation of Pedestrian Facilities (Washington, DC: U.S. Department of Transportation, 2014), https://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt9.cfm.
[7] FHWA, PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System – Sidewalks and Walkways, https://www.pedbikesafe.org/PEDSAFE/resources_guidelines_sidwalkswalkways.cfm
[8] Seattle Department of Transportation (SDOT), Pedestrian Project Toolkit (Seattle, WA: SDOT, 2017), https://www.seattle.gov/Documents/Departments/SDOT/PedestrianProgram/Pedestrian_Project_Toolkit_English.pdf

and psychological separation from traffic while also reducing noise and exposure to roadway pollutants.[9]

Roadside street trees are consistently associated with improved safety outcomes for all users, including pedestrians. Reported findings show that tree-lined boulevards were associated with overall crash reductions of up to 61%, reinforcing the conclusion that integrating street trees can contribute meaningfully to safer street environments.[10]

The use of landscaping and/or street trees along the street can provide separation between motorists and pedestrians, while also making a roadway appear narrower, which has been demonstrated to help reduce vehicle speeds.[11] Slower speeds directly reduce both the likelihood of a pedestrian crash, and the severity if a crash occurs, as shown in Figure 1.

Figure 1. Survivability of a Vehicle-Pedestrian Crash at Various Operating Speeds (National Transportation Safety Board, 2017)



Public Health Outcomes

Recent research consistently indicates that landscaped buffers and street trees between sidewalks and vehicular travel lanes provide measurable public health benefits by improving pedestrian comfort, safety, air quality, and mental wellbeing. One study found that sidewalks separated from traffic by landscaped buffers and street trees significantly increased perceived pedestrian safety and willingness

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[9] Texas A&M Transportation Institute (TTI), Develop and Increase Vegetation Barriers, Green Walls, or Buffers (2022), https://cem.tti.tamu.edu/strategy/develop-and-increase-vegetation-barriers-green-walls-or-buffers/
[10] University of Washington. “Safe Streets.” *Green Cities: Good Health*, https://depts.washington.edu/hhwb/Thm_SafeStreets.html
[11] FHWA Engineering Speed Management Countermeasures, https://highways.dot.gov/sites/fhwa.dot.gov/files/2024-10/Engineering-Speed-Management-Countermeasures-a-Desktop-Reference-of-Potential-Effectiveness-in-Reducing_Crashes_FHWA-SA-24-004.pdf

to walk, with wider vegetated separation producing stronger positive responses.[12] Another study further demonstrated that dense roadside vegetation barriers can reduce pedestrians' exposure to traffic-related air pollutants, including particulate matter associated with asthma, cardiovascular disease, and other respiratory illnesses.[13] There are strong associations between greener streetscapes (e.g., grass buffers, street trees, and wider pedestrian zones) and improved self-reported health and social wellbeing outcomes.[14] One study found that higher levels of tree canopy along pedestrian corridors was strongly associated with increased walking and bicycling for transportation, supporting healthier and more active lifestyles.[15] These findings are reinforced by broader evidence, which concluded that street trees are consistently linked to reduced stress, improved mental health, increased physical activity, and lower risks of cardiovascular disease and other chronic health conditions.[16]

Design Guidance and Minimum Standards for Sidewalk Buffer/Street Trees

The following minimum standards refer to the buffer zone between the sidewalk and vehicular travel lanes. These minimums assume there is no bikeway present. If a bikeway is present, the sidewalk buffer can be as narrow as 0.5 feet. Sidewalk buffers may be landscaped or vegetated, and may also include amenities such as bus shelters, street furniture, utility poles, signage, bike racks, and more.

Per Marin County Development Code Chapter 13.18, vegetation may not exceed 30 inches in height within the visibility triangle at intersections, as defined in Chapter 13.18.

Recommended Minimum Design Standards

Based on current urban forestry and arboriculture best practices to support long-term street tree health, survival, and canopy growth, Toole Design recommends a 4-foot minimum width for street trees in constrained conditions and if soil cells or engineered soil solutions are used, and/or if species are selected with the narrower width in mind.

Toole Design recommends a 4-foot minimum design standard for inclusion of a buffer zone between the sidewalk and vehicular travel lane when no intervening bikeway is present. Where a bikeway is present, the recommended minimum width of the buffer is 0.5 feet (the typical width of a curb).

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[12] Kweon, Byoung-Suk, et al. "The Effects of Pedestrian Environments on Walking Behaviors and Perception of Pedestrian Safety." *Sustainability*, vol. 13, no. 16, 2021, p. 8728, https://doi.org/10.3390/su13168728
[13] Stevens, Paul S., et al. "Resolving the Effect of Roadside Vegetation Barriers as a Near-Road Air Pollution Mitigation Strategy." *Environmental Science & Technology*, vol. 58, no. 35, 2024, pp. 15743–15755, https://doi.org/10.1021/acs.est.4c05379
[14] Wijnands, Jelle S., et al. "Streetscape Augmentation Using Generative Adversarial Networks: Insights Related to Health and Wellbeing." *arXiv*, 2019, https://arxiv.org/abs/1905.06464.
[15] Tsai, Wei-Lun, et al. "Street-Level Neighborhood Greenery Linked to Active Transportation." *Landscape and Urban Planning*, vol. 252, 2024, p. 105181, https://doi.org/10.1016/j.landurbplan.2024.105181.
[16] Harvard T.H. Chan School of Public Health. "Annotated Literature Review: Health Benefits of Urban Greenspace." *Harvard T.H. Chan School of Public Health*, https://hsph.harvard.edu/research/environmental-health-niehs/community-resources/annotated-literature-review-health-benefits-of-urban-greenspace/.

National Design Guidance for Buffers

FHWA Road Diet Information Guide

Minimum design standards for a buffer (Table 5, page 31):

- Suburban Neighborhood: 6 feet
- Suburban Corridor: 6-10 feet
- Suburban Center: 4-6 feet
- Town/Village Neighborhood: 4-6 feet
- Town/Village Center: 4-6 feet
- Urban Core: 4-6 feet

AASHTO Roadside Design Guide, 4th Edition (2011)

Minimum design standard (Page 10-10): 4 feet

Design Guidance for Street Trees

Urban forestry best practices recognize that street tree health depends on adequate rooting width, continuous soil area, and sufficient soil volume. Municipal urban forestry and streetscape standards commonly use approximately 4-foot planting or furnishing zones as a minimum width for street trees, while professional arboriculture guidance emphasizes that wider continuous soil zones are preferred and represent best practice to support canopy growth, longevity, stormwater performance, and compatibility with surrounding infrastructure.

Berkeley Tree Planting Location Standards

- “Large” tree minimum: 4-foot planting strip

Oakland Standard Specifications for Street Trees

- “Large” tree minimum: 4-foot planting strip

San Francisco Better Streets Plan

- Furnishing zones associated with trees and landscaping minimum: 4 feet

Casey Trees – Tree Space Design Report

- Minimum width for a 10-foot long planting strip: 4 feet

DeepRoot / Silva Cell Urban Forestry Guidance

- Urban forestry guidance emphasizing that constrained soil volumes and narrow planting strips reduce tree longevity and canopy performance, while wider continuous soil zones improve rooting conditions and long-term tree establishment.

Parked Vehicles

Provision of Parked Vehicles

Research indicates that parking lanes and parked vehicles can provide meaningful safety benefits when incorporated as part of a context-sensitive street design. Parking-protected bicycle lanes create separation between bicyclists and moving traffic, reducing conflicts and improving comfort for vulnerable road users.[17] Studies of cycle tracks have found substantially lower bicyclist injury risk compared to many other bicycle facility types because physical barriers, including parked vehicles used as buffers, reduce exposure to moving traffic and minimize opportunities for bicycle-motor vehicle conflicts.[18] Research on urban lane widths also notes that reallocating roadway space to provide on-street parking, bicycle facilities, sidewalks, and buffers can support safer multimodal street environments without increasing crash rates.[19] In addition, FHWA identifies on-street parking as a traffic-calming measure that can narrow the perceived roadway and contribute to lower vehicle speeds, a key factor in reducing the likelihood and severity of crashes.[20] Evaluations of protected bicycle lanes in U.S. cities have similarly found improvements in perceived safety and reductions in user conflicts where parked vehicles serve as a buffer between bicyclists and moving traffic.[21]

Design Guidance and Minimum Standards for Parked Vehicles

Recommended Minimum Design Standards

Toole Design recommends the following minimum design standards for inclusion of parked vehicles having the following minimum widths for the four street/context types that Marin County is evaluating:

- Main Street: 8 feet
- Residential: 7 feet
- Collector/Arterial: 8 feet
- Industrial/Commercial: 8 feet

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[17] National Association of City Transportation Officials (NACTO). Urban Bikeway Design Guide. National Association of City Transportation Officials, 2014, https://nacto.org/publication/urban-bikeway-design-guide/
[18] Teschke, Kay, et al. "Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study." American Journal of Public Health, vol. 102, no. 12, 2012, pp. 2336–2343, https://doi.org/10.2105/AJPH.2012.300762
[19] Hamidi, Shima, and Reid Ewing. Narrower Travel Lanes, Safer Streets: Findings from the National Study of Lane Width and Traffic Safety. Johns Hopkins Center for a Livable Future, 2023, https://narrowlanes.americanhealth.jhu.edu/report/JHU-2023-Narrowing-Travel-Lanes-Report.pdf
[20] U.S. Department of Transportation, Federal Highway Administration. Traffic Calming ePrimer: Module 3 – Traffic Calming Measures. Federal Highway Administration, https://highways.dot.gov/safety/speed-management/traffic-calming-eprimer/module-3-part-3
[2121] New York City Department of Transportation. Measuring the Street: New Metrics for 21st Century Streets. New York City Department of Transportation, 2012, https://www.nyc.gov/html/dot/downloads/pdf/2012-10-measuring-the-street.pdf and Monsere, Christopher M., et al. Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S. National Institute for Transportation and Communities (NITC), Portland State University, 2014, https://pdxscholar.library.pdx.edu/cengin_fac/474/ and Chicago Department of Transportation. Dearborn Street Two-Way Protected Bike Lane Study. Chicago Department of Transportation, 2014, https://chicagocompletestreets.org/wp-content/uploads/2014/06/Dearborn-Street-Two-Way-Protected-Bike-Lane-Study.pdf

Design Guidance for Parked Vehicles

FHWA Road Diet Information Guide (2022)

- Minimum design standards (Table 5):
    - Suburban Center: 8 feet (parallel parking)
    - Town/Village Neighborhood: 8 feet (parallel parking)
    - Town/Village Center: 8 feet (parallel parking)
    - Urban Core: 8 feet (parallel parking)

NACTO Urban Street Design Guide (2013)

- Minimum design standard for a parking lane (Lane Width):
    - 7-9 feet

AASHTO Guide for the Development of Bicycle Facilities, 5th Edition (2024)

- Minimum design standard for a parking lane (9.6.3):
    - In most situations: 7 feet
    - Where trucks are routinely present: 8-10 feet

Minimum Roadway Widths (Fire Code)

Provision of Roadway Widths to Meet Fire Code

The Marin County ordinance states that, in undeveloped areas (e.g., where buildings are under 30 feet or three stories), "fire apparatus access roads shall have an unobstructed width of not less than 20 feet, exclusive of shoulders."[22] Where aerial fire apparatus access is needed (e.g., where buildings are over 30 feet or three stories), "roads shall have a minimum unobstructed width of 26 feet." Obstructions are assumed to include parked vehicles and vertical barrier curbs over 4 inches tall. The fire code does not include any stipulations about the width of vehicular travel lanes or number of lanes. Unobstructed width could be inclusive of any general-purpose travel lanes, bus-only lanes, many types of bicycle facilities, and fire-truck mountable features.

Minimum Standards for Roadway Widths

Marin County Fire Department Code

Type of Response	Minimum Roadway Width	Code Section
Fire apparatus access roads (general)	20 feet unobstructed width (exclusive of shoulders)	Section 503.2.1
Aerial fire apparatus access roads (for buildings over 30 feet/ three stories)	26 feet unobstructed width	Section 503.1.5.1

[22] Marin County Fire Code Ordinance 3775, https://assets.marincounty.gov/marincounty-prod/public/2024-12/marin_county_fire_code_ordinance_3775_final.pdf

Bikeways

Provision of Bikeways

Providing bikeways improves safety by reducing conflicts between bicyclists and motor vehicles, increasing rider comfort, and encouraging more people to bicycle, which in turn creates a "safety in numbers" effect. A network of safe, comfortable, connected, and intuitive bikeways supports bicycling as a viable, convenient, and desirable mode of transportation for people of all ages and abilities.[23] Well-designed bicycle networks improve safety outcomes by giving users a comfortable place to ride over the course of their entire trip. Connected networks of low-stress bikeways increase bicycling rates, which improves motorist awareness and lowers crash risk through increased awareness. In addition, design features such as wider or buffered bicycle lanes can reduce crash risk and improve safety and comfort compared to narrow facilities, particularly on higher-speed roadways. A study by FHWA shows that converting from traditional bicycle lanes to separated bicycle lanes can reduce bicyclist-vehicle crashes by 50%.[24] Overall, properly designed bicycle facilities improve both perceived and substantive safety by minimizing exposure to vehicle conflicts, reducing crash severity, and creating conditions that encourage safer bicycling behavior.

Public Health Outcomes

Recent public health research consistently finds that the provision of bicycle facilities, particularly protected bike lanes and connected low-stress bicycle networks, produce measurable health benefits by increasing physical activity, improving safety, and encouraging healthier transportation behavior. One study concluded that transportation interventions that expand bicycling infrastructure are associated with higher cycling participation and increased overall physical activity, contributing to reduced chronic disease risk and improved population health.[25] Another study found that access to bike lanes is associated with greater physical activity among children and adolescents and may help reduce obesity prevalence.[26] A systematic review of cycling infrastructure interventions reports that dedicated bicycle facilities consistently increase bicycling rates and support healthier, more active communities.[27] Other research demonstrated that protected and low-stress bicycle facilities significantly increase bicycle commuting in U.S. cities, reinforcing the connection between infrastructure investment and routine physical activity.[28] Complementing these findings, a review found that cycling infrastructure

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[23] American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities*. 5th ed., AASHTO, 2024.
[24] Federal Highway Administration. *Separated Bike Lanes on Higher Speed Roadways: Safety and Design Guidance*. U.S. Department of Transportation, 2023, https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-23-078.pdf.
[25] Stankov, I., et al. "A Systematic Review of Empirical and Simulation Studies Evaluating the Health Impact of Transportation Interventions." *Environmental Research*, vol. 186, 2020, p. 109519, https://doi.org/10.1016/j.envres.2020.109519.
[26] Pan, Zhongming, et al. "Access to Bike Lanes and Childhood Obesity: A Systematic Review and Meta-Analysis." *Obesity Reviews*, vol. 22, no. S1, 2021, e13042, https://doi.org/10.1111/obr.13042.
[27] Pucher, John, Ralph Buehler, Dafna Merom, and Adrian Bauman. "Walking and Cycling in the United States, 2001–2009: Evidence from the National Household Travel Surveys." *American Journal of Public Health*, vol. 101, suppl. 1, 2011, pp. S310–S317, https://doi.org/10.2105/AJPH.2010.300067.
[28] Ferenchak, Nicholas N., and Wesley E. Marshall. "The Link between Low-Stress Bicycle Facilities and Bicycle Commuting." *Nature Cities*, vol. 2, 2025, pp. 1–9, https://doi.org/10.1038/s44284-025-00255-5.

supports not only physical health outcomes such as cardiovascular fitness and reduced chronic disease risk, but also mental wellbeing, social connectivity, and broader quality-of-life improvements.[29]

Design Guidance and Minimum Standards for Bikeway Widths

Bikeway widths vary by several different factors, including but not limited to roadway functional classification, posted vehicular speed limit, vehicular volume, bicyclist volume, and whether the bikeway is at street grade or not. The recommended minimum widths below assume the gutter pan is excluded, bicyclist peak hour volume is under 150, separated bikeways include vertical separation (e.g., flex posts/delineators, extruded curb, or barrier), and bikeways are at street grade.[30]

Recommended Minimum Design Standards

Toole Design recommends the following minimum design standards:

- Collector/Arterial: 10-foot, two-way shared-use path (Class I)

National and State Design Guidance

<u>AASHTO Guide for the Development of Bicycle Facilities, 5th Edition (2024)</u>

- Shared Use Path with under 150 users during the peak hour (see section 6.4.2)
    - Minimum (to achieve the recommended minimum level of service “C”):
        - 10 feet for approx. 150 path users or less during the peak hour
        - 11-14 feet for approx. 200-300 path users during the peak hour
        - 14-16 feet for approx. 400 path users during the peak hour
- Separated Bike Lane, at roadway grade with one vertical curb, under 150 bicyclists during peak hours in the peak direction, from edge of pavement, excluding gutter pan (see section 7.3.4)
    - One-way, minimum: 6 feet with 2 feet buffer
    - Two-way, minimum: 9.5 feet with 2 feet buffer
- Traditional Striped Bike Lane, at roadway grade, adjacent to one vertical curb, from edge of pavement, excluding gutter pan (see section 9.4.1)
    - One-way, minimum: 6 feet with 2 feet buffer

<u>NACTO Design Controls for Bicycle Facilities</u>

Minimum design standards:

- Protected bike lanes, one-way: 6 feet with 2 feet buffer
- Protected bike lanes, two-way: 8-10 feet with 2 feet buffer

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[29] Mertens, Lotte, et al. “Benefits, Risks, Barriers, and Facilitators to Cycling: A Narrative Review.” *Frontiers in Sports and Active Living*, vol. 5, 2023, article 1168357, https://doi.org/10.3389/fspor.2023.1168357.
[30] Bicyclist peak hour volume of under 150 is the lowest peak volume category in the AASHTO *Guide for the Development of Bicycle Facilities*, 5th ed.

Caltrans Highway Design Manual (HDM), Chapter 1000 – Bicycle Transportation Design (2025) and Chapter 300 – Geometric Cross Section (2020), and Caltrans Design Information Bulletin (DIB) 89-02 (2022)

Bicycle facility classification in California:

- Class I Bikeway (Bike Path): bicycle facilities separated from the street and not adjacent or parallel to the street. The most common application of Class I facilities are along rivers, ocean fronts, canals, utility right of way, abandoned railroad right of way, within school campuses, or within and between parks.
- Class II Bikeway (Bike Lane): bicycle facilities along streets in corridors where there is significant bicycle demand. Class II facilities are typically demarcated with pavement marking.
- Class III Bikeway (Bike Route): bicycle facilities on the street that are typically shared with motor vehicles. Class III facilities may consist of streets that have low vehicular volumes and speeds.
- Class IV Bikeway (Separated Bikeway): bicycle facilities that are for the exclusive use of bicycles and includes a separation between the bikeway and through vehicular traffic. Separation may include grade separation, flexible posts, inflexible posts, inflexible barriers, or on-street parking.

Minimum design standards:

- Class I Bike Path (see HDM Section 1003.1(1)(a)):
    - One-way: 5 feet
    - Two-way: 8-10 feet
- Class II Bike Lane (see HDM Section 301.2(1)):
    - Without curb & gutter:
        - 4 feet where posted speeds are 40mph or less
        - 6 feet where posted speeds greater than 40mph
    - When next to curb and gutter (relative to edge of pavement, excluding gutter pan): 3 feet
    - Adjacent to on-street parking: 5 feet
- Class IV Separated Bikeway (see Caltrans DIB 89-02, Section 3.4)
    - One-way: 5 feet
    - Two-way: 8-10 feet