Chapter 3: Strategies, Approaches, and Emerging Trends

This Chapter summarizes strategies, approaches, and emerging trends in active transportation that may be well established in the NFRMPO region, relatively new, or somewhere in between. The topics that are highlighted are important for local, regional, and state agencies to consider in the transportation planning process. As much as possible, the principles in these topic areas should be applied consistently across the region.

Infrastructure

Basic types of active transportation infrastructure were introduced in **Chapter 2**. This section highlights some of the nuances and standards that, in the right context, can contribute to a safer, more reliable, and more resilient transportation network.

Facility Design Standards

> ***What would help you walk or bike more?*** *Safer routes, pedestrian underpasses, bridges, [traffic] signal cyclist recognition, skinnier streets, more bike lanes offered throughout the city, better driver behavior and slower vehicle speeds*
>
> *-NFRMPO Residents, 2020*

The NFRMPO encourages local agencies to strive for active transportation facility design consistent with or above the minimum acceptable standards outlined in the Larimer County Urban Area Street Standards (LCUASS). The LCUASS (undergoing updates to be effective by August 1, 2021) apply to all development within the jurisdiction of the Cities of Fort Collins and Loveland and their Growth Management Areas (GMA). The LCUASS encourages consistent design across jurisdictions and contains specific sections for pedestrian facilities (Chapter 16) and bicycle facilities (Chapter 17), with additional bike/ped design guidance scattered throughout other sections. The LCUASS is considered a best practice in intergovernmental coordination. Per guidance within LCUASS, for design or construction methods and materials not specified within the LCUASS, the following resources should be considered:

- AASHTO - *A Policy on Geometric Design of Highways and Streets*; *Guide for the Development of Bicycle Facilities*
- ADA - *2004 ADA Accessibility Guidelines*
- APWA – *Manual of Standard Plans*
- ASTM - American Society for Testing and Materials
- CDOT - *Standard Specifications for Road and Bridge Construction*; *Standard Plans (M&S Standards)*; *Roadway Design Manual*
- FHWA - *Standard Plans (M&S Standards)*; *Roundabouts: An Informational Guide*.
- ITE - *Trip Generation Volumes 1 through 3*; other appropriate design publications
- NACTO - *Urban Street Design Guide*
- NCHRP - *Report 279, Intersection Channelization Design Guide*
- USDOT - *Manual on Uniform Traffic Control Devices (M.U.T.C.D.)*

It is increasingly important to consider how micromobility solutions (e-scooters, e-bikes, skateboards, etc.) are accommodated in the active transportation network. People will choose to use these devices whether they are accommodated or not, so design standards and policies should be adjusted to facilitate and encourage safe use.

Additional Resources and Considerations

The following resources may provide supplemental support for decision-making when weighing design and facility selection. The guidance and examples can accompany the information found in the resources listed in the previous section. Additional resources can be found in **Appendix A: Resource Library**, such as the Pedestrian and Bicycle Safety Guides and Countermeasure Selection Systems (PEDSAFE and BIKESAFE). NFRMPO staff are available to assist local agencies in identifying appropriate strategies and countermeasures.

Sidewalks

Sidewalks are essential infrastructure for pedestrian movement, and often serve bicyclists and other active modes. Although LCUASS defines sidewalk standards for various street classifications, local context should determine whether the minimum acceptable standard meets the needs of common users. For instance, the LCUASS specifies a minimum width of 4.5-5 feet for sidewalks along residential local streets, but this may not be adequate in areas with higher-than-average concentrations of older adults and individuals with disabilities. Five feet is the minimum width needed for circular wheelchair turns or for two wheelchairs to safely pass one another, and six feet is the minimum width needed for two people using walking aids or service animals to pass one another. Many sidewalks across the region do not currently meet ADA standards and are unusable or unsafe for many community members. The full extent to which the sidewalk network meet current ADA standards is not full known across the NFRMPO region. Documenting and quantifying this information could allow the NFRMPO and its partners to better analyze disparities across communities and prioritize limited federal funding based on a project's accessibility impacts.

Other considerations such as vertical versus rollover curbs, see **Figure 3-1**, can have significant impacts on user experience and safety. Although a rollover curb may be cheaper to build than a vertical curb, rollover curbs more easily allow vehicles to park on the sidewalk, errant vehicles to enter the sidewalk, or plowed snow to be stored on the sidewalk.

Sidewalk buffers (or parkways, according to LCUASS) provide increased separation from motor vehicle traffic, generally increasing the comfort of the facility and increase space for shade trees and other pedestrian amenities. **Figure 3-1** illustrates attached (no buffer) and detached (buffer) sidewalks.

Figure 3-1: Basic sidewalk Characteristics: Buffers and Curb Types

Above:
Attached (no buffer), Rollover Curb

Above:
Attached (no buffer), Vertical Curb

Above:
Detached (buffer)

Shared-Use Paths

Above: A participant in the Poudre River Trail Challenge runs with a fire hose. Image credit: City of Greeley.

Shared-use paths (often referred to as trails or multi-use paths) are typically distinguished from sidewalks by having a consistent width that allows for two-way travel and safe passage of different types of users (foot traffic, wheelchair users, bicyclists, roller skaters, etc.). Shared-use paths are often characterized by more separation from traffic than sidewalks. Shared-use paths can be paved (hard surface) or unpaved (soft surface). The NFRMPO maintains a database of all paved shared-use paths, and some unpaved paths, such as the Great Western Trail, that meet the accessibility standards of the Americans with Disabilities Act (ADA). Future efforts will be made to identify and inventory other accessible unpaved paths. Generally, provision of shared-use paths should be a requirement for all new residential developments. Provision of active transportation facilities through development is typically more cost-effective than adding facilities at a later time and ensures consistency within and across communities as the region continues its rapid growth.

The Regional Active Transportation Corridor (RATC) Network consists mainly of shared-use paths. **Table 3-1** includes high-level design guidance for shared-use paths that serve regional traffic or see very heavy local usage.

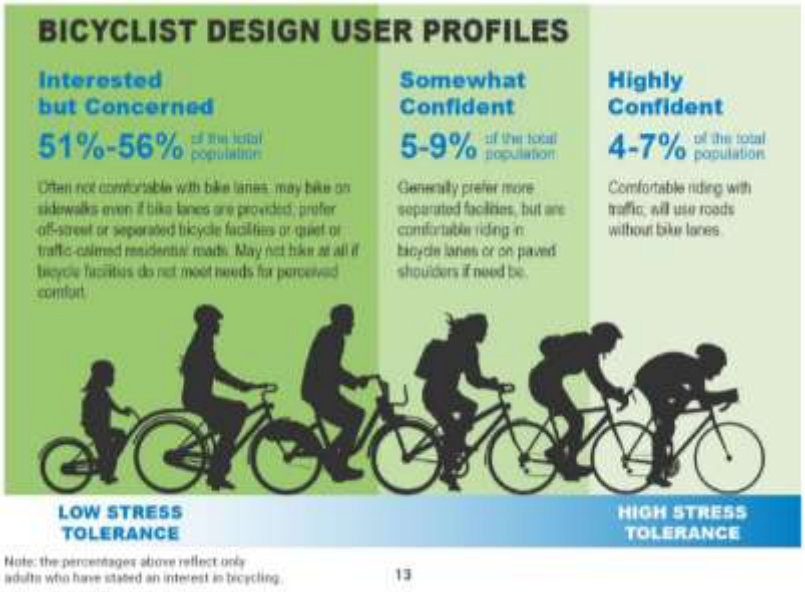
Table 3-1: Basic Design Guidance for Regional and/or High-Usage Shared-Use Paths	
Design Consideration	**Guidance**
Uses	Connects several community destinations such as residential, commercial, and recreation areas, and other active transportation facilities; Used by bicyclist, pedestrians, and other mobility devices, including electric assist; Used for transportation and recreation
Preferred Location	Through residential, commercial, and recreation areas; along right-of-way corridors such as irrigation canals, drainage corridors, railroads, utilities, or roads; separated from hazards to provide a safe and pleasurable experience
Corridor Width	50-feet preferred; 30-feet minimum
Trail Width	12-feet preferred; 10-feet minimum
Trail Surface	Concrete (preferred) or asphalt; crusher fines acceptable for interim surface
Vertical Clearance	10-feet preferred; 8-feet minimum
Horizontal Clearance	Minimum 3-feet clear on both sides of trail, minimum bridge width of 10-feet
Lighting	At trailheads, access points, underpasses, at-grade road or trail crossings, intersections
Trail Waysides/Rest Areas	1 major wayside/rest are per mile, or as available; combine amenities with trailheads; preferred amenities (as appropriate/feasible) include shelter, benches/seating, picnic areas, potable water, informational kiosks, wayfinding, restrooms, trash/recycling receptacles
Wayfinding	Consistent with guidance in **Appendix E: Wayfinding Guidance**. Basic principles to follow include providing clear wayfinding at major access points, trailheads, and ½-mile marker and/or confirmation sign ½-1 mile and after major decision points; turn or decision signs in advance of and at major decision points, intersections, network gaps, major destinations, or hazards
Grade	Consistent with the U.S. Access Board's ADA Accessibility Guidelines (ADAAG)
Trailheads	At major access points, in parks, open spaces, or other parking areas where possible; preferred amenities (as appropriate/feasible) include shelter, benches/seating, picnic areas, potable water, informational kiosks, restrooms, trash/recycling, entry signs, wayfinding, regulatory information
Connecting path width	8-foot minimum wherever possible

On-Road Bicycle Facilities

The appropriateness of on-road bike facility types depends largely on the land use context and nearby destinations, available space, vehicle volumes, vehicle speeds, anticipated user type, intuitiveness of the area, and more. On-road bicycle infrastructure should be designed with a specific user type in mind. Three bicycle

user types are referenced by FHWA in their guidance on bikeway design. These user types include Interested but Concerned, Somewhat Confident, and Highly Confident.[16] These three user types are shown in **Figure 3-2** and generally correspond to the roadway profiles shown in **Figure 3-3.**

Figure 3-2: Bicyclist Design User Profiles



According to the FHWA Bikeway Selection Guide, the three most important principles in bikeway selections are safety, comfort, and connectivity. **Figure 3-3** illustrates how safety and comfort translate into level of traffic stress (LTS) for different types of bicyclists, where "LTS 1" represents the lowest stress and "LTS 4" represents the highest stress. As traffic volumes increase and separation between bicyclists and motorists decrease, the LTS goes up. Connectivity can be addressed by ensuring low LTS facilities are connected to one another without significant gaps or pinch points of high LTS.

[16] A fourth bicyclist user type of "No Way, No How" is often referenced as the portion of the population that will not ride a bicycle under any circumstances.

Figure 3-3: Bicycle Level of Traffic Stress (LTS)

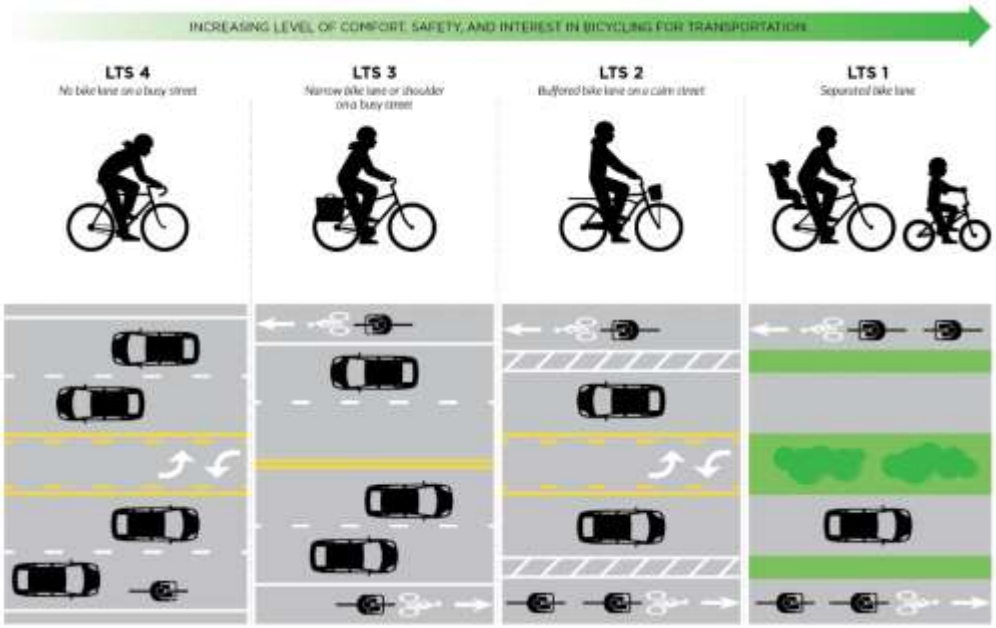
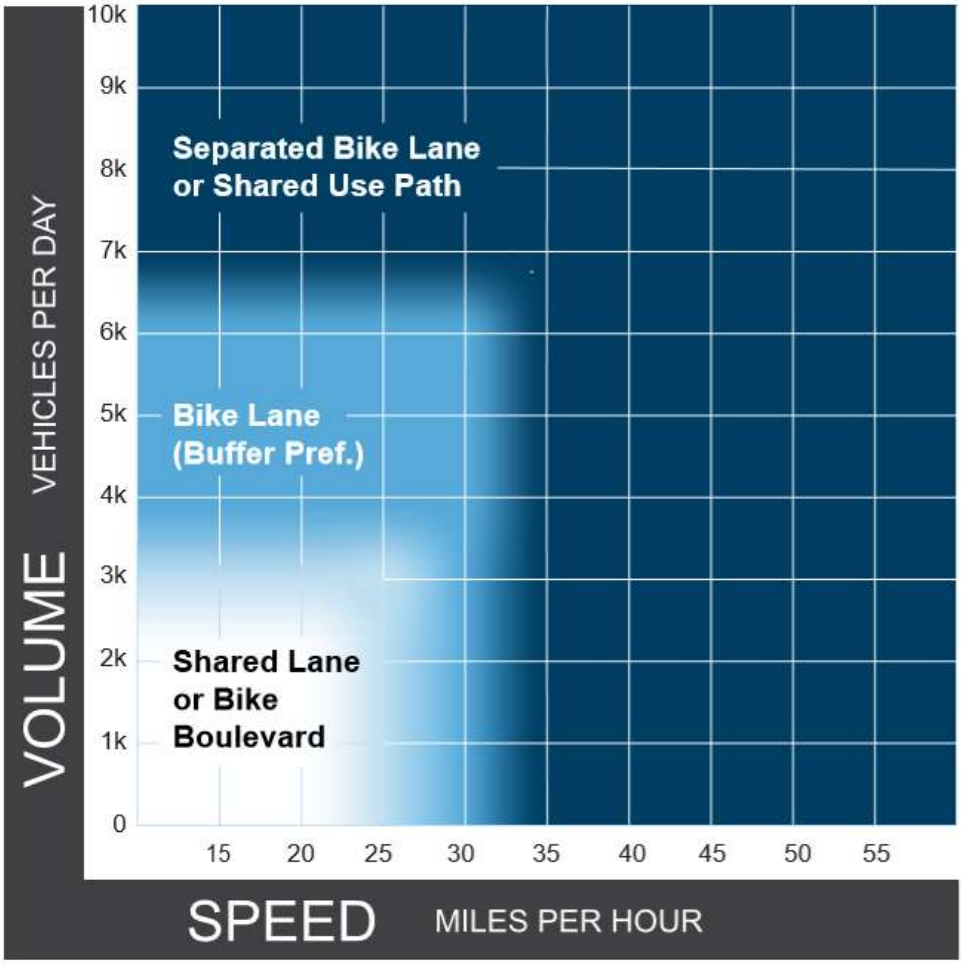


Image credit: Alta Planning

Future efforts should be made to assign LTS across the entire NFRMPO roadway and active transportation networks. This could be used as a tool to identify and prioritize improvements in areas of low safety, comfort, and connectivity, as well as those with high rates of crashes and/or near misses.

Figures 3-4 and **3-5** highlight high-level guidance from FHWA on the types of facilities that align best with the safety and comfort principles in urban and rural settings. Generally, the higher the speed and volume of a road, the more protective the recommended bikeway. Shared lanes or bicycle boulevards are recommended for the lowest speeds and volumes; bike lanes for low speeds and low to moderate volumes; and separated bike lanes or shared use paths for moderate to high speeds and high volumes. When the design user is the Interested but Concerned cyclist, the most appropriate recommendation may be a more protective facility than necessary for a Highly Confident or Somewhat Confident design user. The preferred bikeway types and shoulder widths in **Figures 3-4** and **3-5** should be considered the standard minimums for sections of roadway designated as part of the Regional Active Transportation Corridor (RATC) Network. Additional guidance on RATC design considerations can be found in **Chapter 4.**

Figure 3-4: Preferred Bikeway Types for Urban Core, Suburban, and Rural Town Contexts

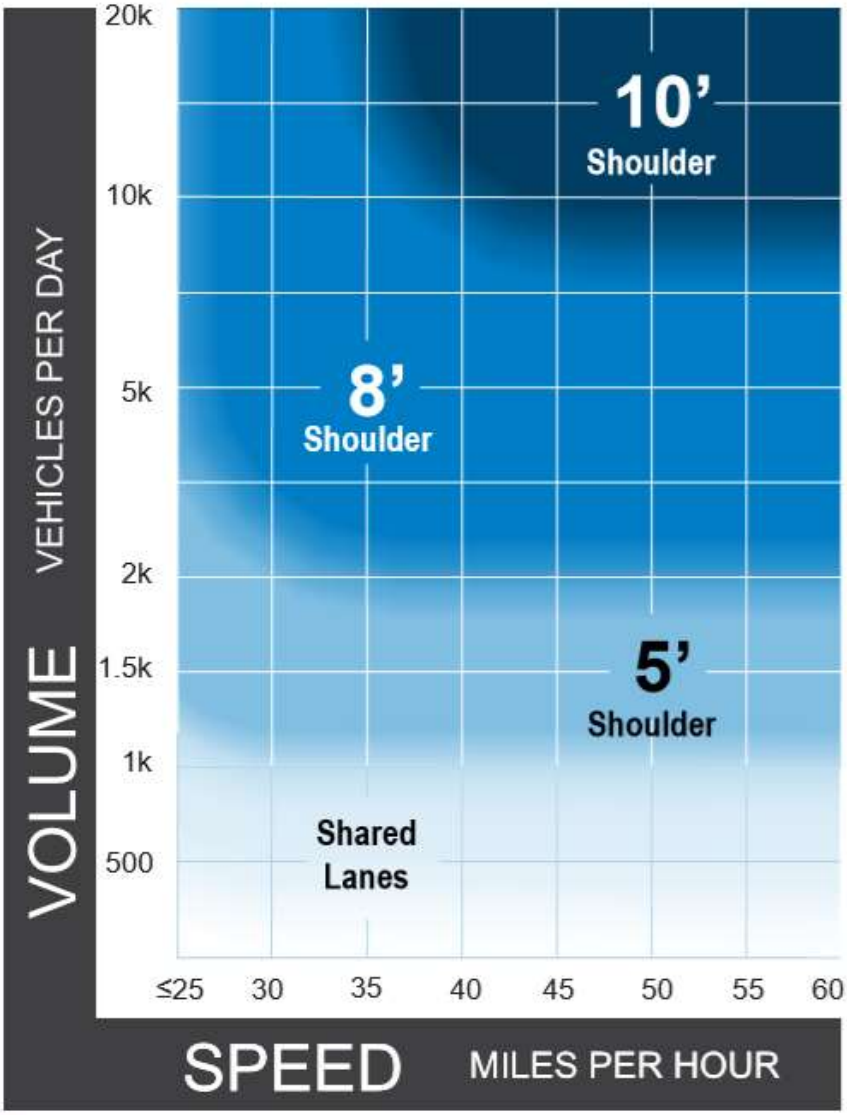


Notes

1 Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.

2 Advisory bike lanes may be an option where traffic volume is <3K ADT.

Figure 3-5: Preferred Shoulder Widths for Rural Roadways



Notes

1 This chart assumes the project involves reconstruction or retrofit in constrained conditions. For new construction, follow recommended shoulder widths in the AASHTO Green Book.

2 A separated shared use pathway is a suitable alternative to providing paved shoulders.

3 Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.

4 If the percentage of heavy vehicles is greater than 5%, consider providing a wider shoulder or a separated pathway.

Narrowing and Removing Travel Lanes

Providing on-road bicycle facilities requires a reallocation of space among the various modes that will use a given roadway. This may mean narrower or reduced number of travel lanes for motor vehicles. Lanes as narrow as 10 feet do not result in an increase in crashes or reduce vehicle capacity on roads with speeds of 45 mph or less.[17] Narrowing lane widths can result in slower vehicle speeds and improved safety for all users with only negligible impacts on travel times. Additionally, travel lanes are not required to be of equal width. For example, some agencies use an 11-foot-wide outer lane to accommodate buses and trucks, with inner travel lanes at 10 feet wide.[18]

Above: Maximum implementation thresholds for road diets across three cities. Image credit: FHWA Road Diet Informational Guide

Removing lanes and reconfiguring the space to accommodate all users is commonly known as a "road diet." Many roads have excess capacity and encourage fast speeds. Road diets can often have operational benefits if a new center turn lane is provided, keeping left turning vehicles from impeding through traffic. The FHWA Road Diet Informational Guide should be referenced across the region to identify opportunities to better accommodate all users. Although many factors other than volumes should be considered, road diets in major metropolitan areas have been implemented successfully on roadways with relatively high volumes. These reconfigurations can be achieved using paint as part of a regularly scheduled resurfacing project. More intensive treatments such as physical barriers can also be used. Narrower roadways can also reduce the right-of-way needed and the costs associated with land acquisition.

Crossings

Design considerations can become complicated quickly for active transportation crossing facilities at controlled and uncontrolled intersections with the roadway and railroad networks, or with other active transportation facilities. Lack of safe crossings for active modes can represent the shortest but most significant gaps in the network. They are often overlooked due to the complexity of turning movements and signalization. **Appendix F: Crossing Countermeasure Matrices** includes detailed considerations from the NCHRP Research Report 926: Guidance to Improve Pedestrian and Bicyclist Safety at Intersections for reference in the decision-making process. These matrices can be used as tools to narrow down the range of appropriate crossing treatments. The need for a safe crossing where one does not already exist should not be determined based solely on observed demand for active mode crossings at that location via a simple count. "In many situations, a latent demand for places that feel safe to walk and bike is revealed after pedestrian- and bicyclist-focused

[17] Potts, I. B., D.W., Harwood, and K.R., Richard. Relationship of Lane Width to Safety on Urban and Suburban Arterials. Presented at the 86th Annual Meeting of the Transportation Research Board, Washington DC, 2007.
18 FHWA Bikeway Selection Guide page 26

improvements are made."[19] For a more simplified approach, FHWA promotes their "Spectacular Seven" proven pedestrian safety countermeasures at uncontrolled crossings. The Spectacular Seven include Crosswalk Visibility Enhancements, Leading Pedestrian Interval (LPI), Pedestrian Hybrid Beacon (PHB), Pedestrian Refuge Island, Raised Crosswalk, Road Diet, and Rectangular Rapid-Flashing Beacon.

At-Grade Crossings

Appropriate at-grade crossing treatments or countermeasures along the active transportation network can vary widely in character. Available countermeasures include traffic signs, pavement markings, traffic signals, lighting, signal timing changes, and bicycle or pedestrian recognition/detection treatments. The appropriateness of the various available treatments depends on a combination of the traffic speeds, traffic volumes, number of travel lanes, presence of street lighting, observed and latent pedestrian/bike demand, and other factors.

Above: A pedestrian waits for the signal along the Pitkin Bikeway in Fort Collins. Image credit: City of Fort Collins.

Grade-Separated Crossings

Grade-separated crossings (overpasses / bridges or underpasses / tunnels) are often the safest treatment but are usually the costliest and may not be the most convenient treatment for active modes if careful consideration is not given to the distance it may add compared with another treatment. Bridges or tunnels which are perceived as less convenient or less secure to use will often result in people crossing a roadway or railroad at grade, even if at-grade crossing is prohibited.

Above: Poudre River Trail users pass under a county road. Image credit: Larimer County

Chapter 4 identifies existing crossings and high-level crossing improvement needs along the RATC Network. CDOT Region 4's upcoming bicycle and pedestrian study will present an opportunity to identify these improvements in more detail. The NFRMPO also maintains an inventory of existing crossing types on the RATC Network. CDOT Headquarters will also be developing statewide bicycle and pedestrian crossing guidance.

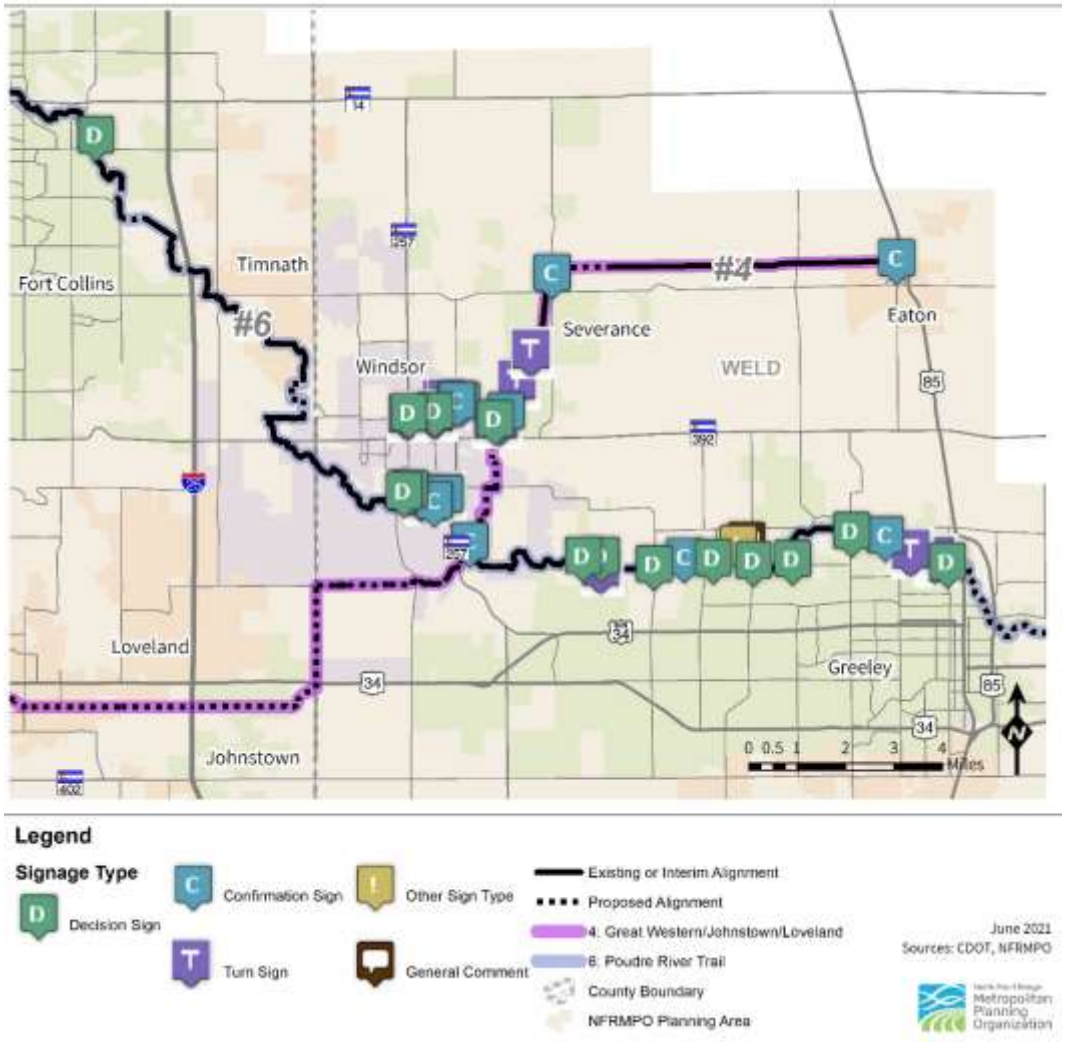
[19] Associates, Inc., William W. Hunter, and Peter Koonce; National Cooperative Highway Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine National Academies of Sciences, Engineering, and Medicine 2020. Guidance to Improve Pedestrian and Bicyclist Safety at Intersections. Washington, DC: The National Academies Press. https://www.nap.edu/catalog/25808/guidance-to-improve-pedestrian-and-bicyclist-safety-at-intersections.

Wayfinding and Other Signage

Wayfinding and other signage are crucial infrastructure elements to direct and inform active mode users and alert other road users to the presence and/or rights of pedestrians and cyclists. Bicycle and pedestrian wayfinding guidance is included in **Appendix E: Wayfinding Guidance.** Signage related to active transportation must be compliant with the Manual on Uniform Traffic Control Devices (MUTCD) and should be designed to meet the needs of older adults and individuals with visual disabilities.

There are two ongoing initiatives related to wayfinding and other signage currently underway in the NFRMPO region. Partners along the Poudre River Trail and Great Western Trail, with assistance from NFRMPO Staff and the NoCo Bike & Ped Collaborative, are working to identify locations for various wayfinding element needs along each corridor. The goal is to create a seamless wayfinding experience across jurisdictions with consistent messaging across each corridor. The partners are using the NFRMPO's Community Remarks webpage to identify the needs and will be conducting workshops to refine the recommendations and further develop an implementation plan for the signage. **Figure 3-6** shows locations identified on these two trails as of May 2021.

Figure 3-6: Preliminary Wayfinding Needs along two Regional Corridors

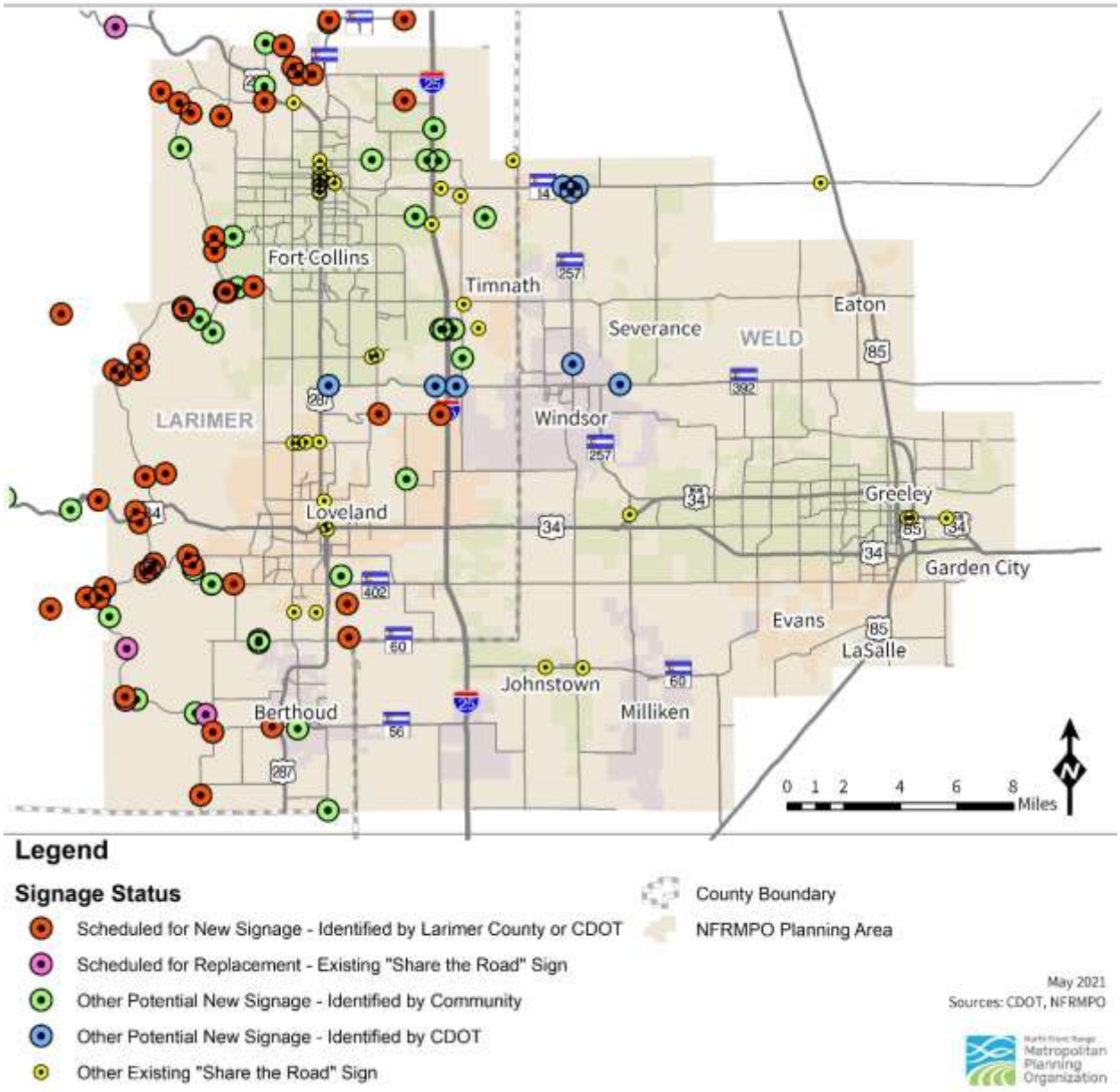


Above: Bicycle safety signage installed in 2021 in rural Larimer County. Image credit: Your Group Ride.

Northern Colorado partners have also been working together to improve bicycle safety through signage. Larimer County and CDOT Region 4 are in the process of identifying priority locations to install "State Law: Motorists Must Give 3-FT Clearance" signs across the region. The agencies have worked closely with Bike Fort Collins, Your Group Ride, the Scott Ellis Memorial Fund, and other leaders to identify high-priority locations, including locations that currently have "Share the Road" signage that is often interpreted as a message to cyclists rather than motorists. The effort will culminate in 80 new signs on state highways and county roads by summer 2022, and in part has inspired Bicycle Colorado's 2021 legislative agenda. Other local agencies have joined the discussion. Many of the signs may be installed as a permanent solution where topography or other physical constraints limit other improvements. Some signs will be installed temporarily as a short-term solution until other infrastructure improvements can be made. Other signs will simply replace existing "Share the Road" signage. **Figure 3-7** is a map of the locations that have been identified as of May 2021. Additional locations will be identified in Weld County as conversations progress. A 2015 study found respondents to an online survey who saw a "Bicycle May Use Full Lane" sign were twice as likely to conclude that cyclists are allowed to ride in the center of the lane than those who saw a "Share the Road" sign on a four-lane road. There was no significant difference between those who saw a "Share the Road" sign and those who saw no sign.[20]

[20] "Bicycles May Use Full Lane" Signage Communicates U.S. Roadway Rules and Increases Perception of Safety Hess G, Peterson MN (2015) "Bicycles May Use Full Lane" Signage Communicates U.S. Roadway Rules and Increases Perception of Safety. PLOS ONE 10(8): e0136973. https://doi.org/10.1371/journal.pone.0136973

Figure 3-7: Priority Locations for "State Law: Motorists Must Give 3-FT Clearance" Signs



Transit-Oriented Walkability

Accessibility to the active transportation network can have a major impact on mobility, specifically for use of transit. The NACTO Transit Street Design Guide highlights a transit trip is door-to-door, not stop-to-stop, meaning the entire trip goes beyond just riding the bus. [21] People must be able to connect from their origin to the bus stop and from the bus stop to their destination. A safe and connected sidewalk network improves access to transit, providing an alternative to single-occupant vehicle travel (SOV).

NFRMPO member communities are investing in making streets more multimodal. For example, Transfort continues to invest in its American with Disabilities (ADA) Bus Stops Upgrade program, acknowledging transit and walkability are mutually beneficial in improving the mobility of people of all abilities and ages. In 2020, Transfort upgraded 72 bus stops in Fort Collins.[22] Bus stop upgrades are funded through a Federal Transit Administration (FTA) grant and the City's Community Capital Improvement Program (CCIP).

The National Aging and Disability Transportation Center (NADTC)[23] identifies architectural and environmental factors that can prevent travel as being one component of paratransit eligibility. According to 2019 National Transit Database data, the average paratransit trip costs $39, while the average fixed-route trip costs $4 in the North Front Range. Converting some paratransit trips to fixed-route trips can save communities and transit agencies funding, and can be accomplished by addressing some of the following issues:

- Lack of curb ramps or a reasonable alternative accessible path of travel
- Lack of sidewalks or alternative safe accessible path of travel
- Snow and/or ice
- Major intersections or other difficult-to-negotiate street crossings
- Temporary construction projects

Some transit funds may be used to support the buildout of sidewalk networks, including FTA Section 5310 funds.[24] According to FTA, "building an accessible path to a bus stop, including curb-cuts, sidewalks, accessible pedestrian signals, or other accessible features…[and] improving signage, or way-finding technology" are nontraditional eligible projects. Additionally, the Coordinating Council on Access and Mobility (CCAM) identified 130 federal programs which can be used to improve mobility.[25] Combining multiple federal funding programs with local funds, or "braiding," can expand the reach of a program and bring in more funding for projects.

For example, combining Recreational Trails Program funds, FTA Section 5310 funds, and local funding could help connect a Regional Active Transportation Corridor (RATC) to the sidewalk network and the transit network. In doing so, a person could ride their bicycle along the Poudre River Trail, then connect to a Poudre

[21] https://nacto.org/publication/transit-street-design-guide/transit-system-strategies/network-strategies/pedestrian-access-networks/
[22] http://www.ridetransfort.com/img/site_specific/uploads/Planned_Bus_Stop_Upgrades_5.28.20.pdf
[23] https://www.nadtc.org/wp-content/uploads/NADTC-Determining-ADA-Paratransit-Eligibility.pdf
[24] https://www.transit.dot.gov/funding/grants/enhanced-mobility-seniors-individuals-disabilities-section-5310
[25] https://www.transit.dot.gov/regulations-and-guidance/ccam/about/ccam-program-inventory

Express stop, and take their bicycle on the bus back to their trip origin. This can expand the reach of the trail and create a more seamless regional multimodal network.

Quick Win Projects

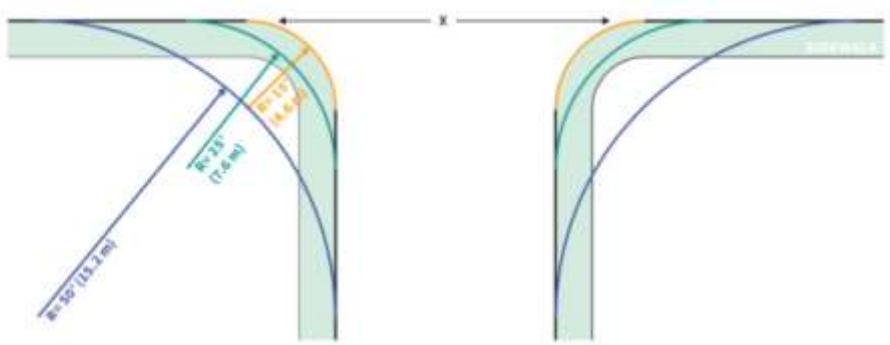
"Quick win" active transportation projects involve elements requiring small financial investments that can be implemented relatively quickly to make immediate improvements for active modes. Potential quick win improvements include strategies such as, but not limited to:

- **Parklets and pedlets** – parklets are public platforms or designated spaces that convert curbside parking spaces into spaces that can be used in a variety of ways by community members. They may incorporate design elements such as seating, greenery, or bike racks and can help meet demand for public space in certain high-use areas. Pedlets are a similar reallocation of curbside space to expand the sidewalk or walking area, allowing more maneuverability in high-use areas.

Above: A parklet in Old Town Fort Collins provides additional outdoor seating while preserving sidewalk space. Image credit: The Coloradoan

- **Curb extensions** – a visual and physical narrowing of the roadway for safer and shorter pedestrian crossings, increasing the available space for street furniture, benches, plantings, street trees, public art, etc. Low-cost curb extensions can require minimal materials such as paint and bollards. Curb extensions can serve as a visual cue to drivers that they are entering a neighborhood street or area.

Above: An example of a painted curb extension with bollards in a residential area in Portland, OR. Image Credit: BikePortland



Curb Radius (R_1)	Crossing Distance (X)	Crossing Time*	Effective Turning Radius (R_2)**	Vehicle Turning Speed***
15 ft (4.6 m)	37 ft (11.3 m)	10.6 seconds	41 ft (12.5 m)	14 mph (22.5 kph)
25 ft (7.6 m)	50 ft (15.2 m)	14.3 seconds	52 ft (15.8 m)	16 mph (25.7 kph)
50 ft (15.2 m)	89 ft (27.1 m)	25.4 seconds	74 ft (22.6 m)	18 mph (29.0 kph)

*Assumes an average crossing speed of 3.5 fps (3.8 kph)

** Assumes the following widths: 6 ft (1.8 m) bike lane, 10 ft (3.0 m) travel lane, 7 ft (2.1 m) vehicle, 2 ft (0.6 m) clear from corner. $R_2 = r^2/(15(F))$, where F = 0.32, 0.31, and 0.29, respectively

*** Average speed in middle of turn

Above: This image illustrates the decreased crossing distance and time for pedestrians as well as the reduced vehicle speed that can be associated with curb extensions that decrease the curb radius. Decreased curb radius can be achieved through low-cost improvements such as planters, bollards, tires, and other low-cost barriers accompanied by paint. Image credit: Global Designing Cities Initiative.

- **Pop-up protected bike lanes** – low-cost reallocation of space to create a dedicated bike lane with a physical separator, such as bollards, planters, or jersey barriers, or other readily available materials. Pop-up bike lanes can encourage mode shift by creating safer alternatives where space is currently underutilized.

Above: A pop-up bike lane in Downtown Denver. Image credit: Downtown Denver Partnership

- **Street furniture** – Where there is adequate sidewalk space, amenities such as lighting, benches, newspaper kiosks, utility poles, tree pits, and bicycle parking can be provided to enhance the pedestrian experience and create a more welcoming environment.

Above: Street furniture in Downtown Greeley includes information kiosks, benches, planters, trees, trash cans, street lighting, and more. Image credit: Colorado Public Radio.

Various other types of infrastructure, some of which are mentioned throughout the *ATP*, can also be great candidates for quick-win projects. Some additional elements that have proven successful in the NFRMPO region include bike and pedestrian wayfinding, trail access improvements, bicycle parking or repair stations, on-street bollards or warning signs for traffic channelization, and more. Local agencies are encouraged to reach out to NFRMPO staff and/or the NoCo Bike & Ped Collaborative to seek assistance with walk audits or workshops to brainstorm quick win (as well as long-term) solutions with community members and leaders. Communities that identify potential projects through exercises such walk audits are often more competitive than other communities for grant opportunities. Additional resources on topics such as walk audits can be found in **Appendix A: Resource Library.**

Trail Accessibility Information

Ensuring information is available on the accessibility of trail facilities can help individuals with disabilities and older adults determine if the facility is navigable for them. Certain users are unlikely to explore these facilities if they are not confident the experience will be safe and comfortable. Information that can be helpful includes the availability of accessible restrooms, trail surface type, the grade/steepness along various sections of the trail. Information should be available in various media such on a landing webpage for the trail, digital interactive map, printable map, and/or postings at trailheads.

Above: An informative trail sign at Fort Ross State Historic Park in California informs users of trail accessibility. Image credit: Dal Leite

The City of Fort Collins maintains a "Natural Areas Finder" webpage that allows visitors to filter down the list of

natural areas based on characteristics such as accessibility, presence of restrooms, dogs on leash, and presence of picnic facilities.

Winter Maintenance Plans

Image credit: MDH

Snow and ice can add significant barriers to travel. The Americans with Disabilities Act (ADA) requires public entities to maintain in operable working conditions those features of facilities and equipment that are required to be readily accessible and usable by persons with disabilities. In some instances, proper winter maintenance of pedestrian and bicycle facilities requires additional time and resources; however, there are various low- or no-cost solutions that can help keep facilities clear and usable following snow and/or ice events. These solutions include developing priority routes, reminders to property owners regarding their sidewalk maintenance responsibilities, additional or modified training for maintenance crews on techniques to keep crosswalks, bus stops, and other important access points clear of obstruction. The Minnesota Department of Health published the Sidewalk Snow Clearing Guide in 2018 to identify options for keeping sidewalks and crosswalks clear year-round, along with case studies on how communities around have turned these options into public policy. Additional resources on maintenance can be found in **Appendix A: Resource Library**.

Best Practices

Above: Berthoud walk audit participant attempts to navigate inaccessible sidewalk in Old Town. Credit: NFRMPO Staff

In 2019, members of the NoCo Bike & Ped Collaborative held a walking audit workshop with Town of Berthoud staff, elected leaders, and community members. The participants identified quick win priorities to immediately improve walkability in the Old Town Berthoud area.

Due in part to these efforts, the Colorado Department of Public Health and Environment (CDPHE) identified Northern Colorado as a 2020 focus area for implementing quick win bikeability and walkability projects under $5,000. Staff from CDPHE, Weld County Department of Public Health and Environment (WCDPHE), and Larimer County Department of Health and Environment worked together to identify projects across seven communities that could create “quick win” improvements for active modes. The recipients included Berthoud, Greeley, the Great Western Trail Authority (GWTA), Loveland, Milliken, Severance, and Wellington. The projects included fencing for better defined trail access, wayfinding to parks, painted curb extensions, bicycle repair stations, “Bike May Use Full Lane” signage, trailhead enhancements, and trail surface improvements.

Pilot Projects

Active transportation pilot projects allow communities to conduct a small-scale implementation of a concept or strategy to estimate and analyze the feasibility, cost, drawbacks, and benefits of that treatment. In 2005,

funding from a one-time $25M federal transportation bill was awarded to four communities nationwide to monitor the impact of active transportation improvements on travel choices. Projects included bikeways, pedestrian walkways, sidewalks, education and outreach programs, and bike parking. All projects were focused on equitable access in demographically diverse areas. The year following completion, the improvements resulted in a 22.8 percent increase in walking trips and a 48.3 percent increase in bicycling trips; avoided 85.1M vehicle miles traveled (VMT), saving an estimated 3.6M gallons of gasoline and avoiding approximately 34,629 tons of carbon dioxide emissions. They also expanded quarter-mile access to the bicycle network for approximately 240,000 people, 106,000 housing units, and 102,000 jobs. The projects were followed by a 20 percent decline in the number of pedestrian fatalities, despite increases in walking and bicycling, and improved public health including a reduced economic cost of mortality (death) of $46.3M from increased bicycling in 2013.[26]

Pilot projects have also been employed across Northern Colorado. In 2018, the City of Fort Collins installed various protected bike lane treatments and a new signal along a 1.8-mile section of West Mulberry Street. An evaluation one year after the improvements demonstrated a 15-20 percent reduction in total crashes, a 4-11 percent reduction in vehicle speeds, minimal to negligible travel time increases for motor vehicles (10-12 seconds westbound, no change for eastbound), a 50 percent increase in on-street bike traffic, and an 81 percent decrease in sidewalk bike traffic where pedestrian conflicts were a major concern. A survey of the public indicated 61-65 percent believe the project improved travel conditions along the corridor. Although initial annual maintenance costs are estimated at $5,000 (winter operation, sweeping, replacing damaged rail), these costs are anticipated to drop as design treatments and maintenance methods are improved.

Above: Before (left) and after (right) on a section of West Mulberry Street in Fort Collins, where buffers and bollards were chosen as the treatment. Other section received concrete curbs, steel rails, and green paint. Image credit: City of Fort Collins.

[26] Nonmotorized Transportation Pilot Program Yields Striking Results. Volpe. United States Department of Transportation. December 16, 2014. https://www.volpe.dot.gov/policy-planning-environment/transportation-planning/nonmotorized-transportation-pilot-program-yields

Maintenance

> ***What would help you walk or bike more?*** *Clean roads, street sweeping/repairs, better maintenance of bike lanes. -Johnstown and Greeley Residents, 2020*

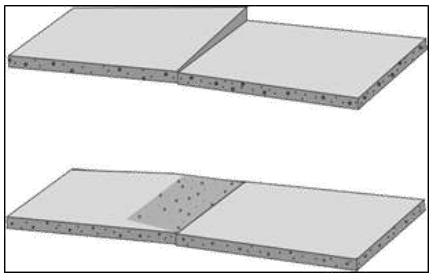
A simple approach to encouraging active transportation is maintaining existing facilities. Facilities that are not well maintained can create a safety hazard and a barrier to many users, particularly those with limited physical mobility, older adults, or individuals with disabilities. Uncleared sidewalks, patches of ice, or other obstacles can force people with limited mobility to take unnecessary risks or remain inside. Heaving or uneven sidewalks, flooded or muddy curb ramps, unplowed bike lanes, paths, or shoulders, and broken glass or other roadway debris all pose barriers to safe and reliable active transportation. Studies suggest maintenance is a larger barrier to biking in cold weather months than the cold weather itself. Improved winter surface maintenance of bike facilities (plowing, sweeping, etc.) can help retain an additional 12 to 24 percent of commuters who bike to work in warmer months.[27]

Above: Sidewalk Prioritization Criteria for the City of Fort Collins

Maintenance also includes code enforcement. Cars can commonly be parked across the sidewalk at driveway access or in areas with rollover curbs, or in dedicated bikes lanes. Trash and recycling bins may also be placed on sidewalks on collection day. When these barriers force bicyclists and pedestrians into busy traffic lanes, it creates unnecessary danger and may be enough to deter people from biking and walking for various trips.

Best Practices

Maintenance best practices include:



Above: Uneven sidewalk slabs can be ground to provide a smoother transition. Credit: FHWA

- Routine maintenance plans that prioritize demand, health, equity, and safety
- Streamlined maintenance reporting and request tools for community members, such as the Greeley Problem Reporting webpage and Access Fort Collins
- Grinding heaving sidewalk segments and patching gaps
- Snow plowing route prioritization and scheduling (school zones and business districts first)
- Small snow removal vehicles that fit active transportation facilities (small tractors/mowers, ATVs, and other utility vehicles)
- Recessed thermoplastics pavement markings to better withstand snowplow activity
- Designing bike lanes, sidewalks, and other facilities with buffers for adequate snow and/or debris storage

[27] Fisher C. "Cycling Through Winter." Urban Strategies, Inc. 2014.

Additional maintenance best practices can be found in documents such as FHWA's Guide for Maintaining Pedestrian Facilities for Enhanced Safety and Alta Planning and Design's Winter Bike Lane Maintenance: A Review of National and International Best Practices report. Additional resources can be found in **Appendix A: Resource Library**.

Above: More than two days following a snow event, an unplowed bike lane on a major bike route (left), unplowed crosswalk (middle), and a sidewalk obstruction (right) all pose barriers to active transportation. Image credit: NFRMPO Staff.

Programming

Programming focused on active transportation can refer to a wide variety of educational workshops, promotional initiatives or events, data and information sharing practices, and more. Active transportation programs are often coordinated on a local level to respond to the specific needs of the community. Other programs may be coordinated at a regional, state, or national level for local implementation. Some of the best-known active transportation programs in the NFRMPO region include the City of Fort Collins' Safe Routes to School (SRTS) Program, the City of Greeley's Full Moon Bike Rides, and Loveland's Bike and Walk Month. Programs the NFRMPO has most recently been involved with include the 2020 Active Transportation Challenge, Bike to Work Day events, walking audits, educational workshops, the regional bike/ped counting program, and the 2015 NoCo Bike & Walk Conference. Due to the wide array of program types, these programs

What would help you walk or bike more?
Awareness campaigns. Challenges like these are great reminders. -Greeley Resident, 2020

Above: Regional Stakeholders participate in a workshop in Loveland focused on conducting infrastructure assessments.

and many others are highlighted in more detail in **Appendix C: Additional Best Practices**. In collaboration with local partners, NFRMPO Staff should continue to assess opportunities to support and expand local programs for the benefit of the entire region through coordination, facilitation, and/or financial means.

Policy

Emerging Micromobility Solutions

New variations of electric-powered transportation devices, whether personal or shared, are rapidly coming to market, bringing with them opportunities and challenges for communities to consider. This section does not address all forms of micromobility devices and places more emphasis on devices with electric assist capabilities. The micromobility devices referenced in this section all share three common characteristics:

- **Human- or Electric-Powered** – Fully capable of movement without human power, or motor-assisted (the rider provides some sort of propulsion)
- **Low speed** – Top travel speed of 30 mph, according to definitions by the Society of Automotive Engineers (SAE). Many operate below 20 mph and are regulated down to 8 mph
- **Small size** – a typical width of three feet or less and weight of less than 100 pounds

Such devices include electric bikes (e-bikes), standing or sitting e-scooters, and other technologies such as e-skateboards, hoverboards, Onewheel®, Solowheel®. In urban areas, e-bikes and e-scooters can commonly be rented as part of a private, shared-use system. All types of micromobility devices can be personally owned. Learn more about the various technologies through the Pedestrian and Bicycle Information Center's (PBIC) Brief on Micromobility Typology. Motorized wheelchairs and personal mobility devices, or Electric Personal Assistance Mobility Devices (EPAMD), used by people with disabilities can also fall under the micromobility device term. These solutions can increase mobility, equity, and sustainability, especially when combined with quality public transit.

Image credit: Pedestrian and Bicycle Information Center (PBIC)

The following sections describe these solutions, with reference to some of the best practices in managing their use and for establishing successful share programs. Best practices are constantly evolving and should be analyzed further over next several years. The City of Fort Collins is the only Northern Colorado community with a shared e-bike/e-scooter system in place. The City's new program will focus on refining dismount zone

polygons, hours of operation, reestablishing the community bike library, intersection treatment, sufficient stock/density, increasing low-income user ridership by decreasing cost, encouraging longer trips to encourage vehicle trip replacement, mobile app integration with Transfort app, improved adaptive program, and establishment of mobility hubs/downtown designated parking areas.

Electric Assist Bicycles (E-Bikes)

Above: An e-bike and e-trike demonstration at CSU in Fort Collins. Image credit: PeopleForBikes.

Under Colorado law, e-bikes are defined as bicycles with two or three wheels, fully operable pedals, and an electric motor. Currently, local laws and regulations around e-bikes vary across Northern Colorado. Although e-bikes represent a small percentage of bicyclists today (1.15 percent in Fort Collins in 2020), their use is likely to increase as price points drop and as aging baby boomers look for ways to stay active. As the technology evolves, it will be increasingly difficult to distinguish some e-bikes from conventional bikes. Although there are three distinct classifications of e-bikes, they do not have outwardly defining characteristics. Furthermore, roughly half of e-bike owners do not know what class of e-bike they own.[28] **Table 3-2** summarizes e-bike classification definitions according to the State of Colorado.

Table 3-2: E-Bike Classification Definitions

Class 1 E-bike	Class 2 E-bike	Class 3 E-bike
Provides electrical assistance only while the rider is pedaling, up to 20 mph	Provides electrical assistance regardless if the rider is pedaling or not, up to 20 mph	Provides electrical assistance while the rider is pedaling, up to 28 mph. Class 3 e-bikes must be equipped with a speedometer and may not be ridden by people under 16 (unless as a passenger). People under 18 must wear a helmet.

Equity

At their current price point, many e-bike models are cost prohibitive for some community members. In early 2021, the Colorado Energy Office (CEO) released a Request for Applications to solicit proposals to develop and implement e-bike deployment projects. The program sought to increase e-bike access for low-income essential workers while maximizing air quality benefits. Additional program objectives include piloting a variety of e-bike distribution models including individual ownership and shared deployment and laying a foundation for future

[28] https://assets.bouldercounty.org/wp-content/uploads/2019/11/e-bikes-recommendation-bocc-11-13-2019.pdf

scalability and replicability. Localized assistance programs like these should be considered within the NFRMPO region.

Mobility

Requiring less effort than standard bikes, e-bikes effectively flatten hills, reduce energy needed to start and stop, and increase the amount of cargo a bicyclist can carry. For older adults and individuals with disabilities or other factors limiting their mobility, e-bikes can provide a mobility and independence option that standard bikes cannot. E-bikes can extend the riding range of all cyclists, making key destinations more accessible. A 2018 nationwide study of e-bike owners in the U.S. found that 28.7 percent had physical limitations that make riding a standard bicycle difficult and 67.2 percent of owners were over the age of 45. The top three barriers to cycling identified by the respondents were hills, lengthy distances to desired destinations, and not wanting to arrive at destinations sweaty. Physical limitations, physical ability, and weather conditions were also common barriers. E-bike designs that are adaptive to a variety of mobility needs are becoming more available. Providing adaptive e-bike options should be an essential part of any shared e-bike program.

Research suggests the average e-bike trip length is 50-60 percent longer than a conventional bike. In some European cities, e-bikes are facilitating average trip lengths of 9 miles for commute trips, 18 miles for trips on shared systems, and 18.6 miles trips for tourism trips.[29]

Safety

A 2019 pilot study of e-bikes in Boulder County found that average e-bike speeds (13.8 mph) are typically lower than standard bikes (14.5), which may be attributed to the demographic of e-bike riders and the information presented to them. E-bike riders tend to be older than standard bike riders and many are presented with their speed via a speedometer on the e-bike. The study found that e-bike speeds were typically faster than standard bikes when going uphill, while standard bikes were faster going downhill.[30] A 2019-2020 pilot study of e-bikes in Fort Collins found a negligible difference in speeds between e-bikes and standard bikes. Although e-bikes are typically perceived as less safe than standard bikes, observed behaviors of e-bicyclists are often better than those of standard cyclists.[31] Nationally, a vast majority (80 percent) of e-bike owners have not experienced crashes while on their e-bikes. Of those who have, only 19 percent believe the e-bike contributed in a significant way.[32] Literature also suggests e-bikes have no greater impacts on trail condition or wildlife than standard bikes.

Best Practices

The best practices highlighted in **Table 3-3** may refer to either or both personal or shared e-bike ownership models. These practices may be helpful for local agencies when considering their individual approach to micromobility and serve as a basis for achieving consistency across the region.

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[29] S. Cairns, F. Behrendt, D. Raffo, C. Beaumont, C. Kiefer, Electrically-assisted bikes: Potential impacts on travel behaviour, Transportation Research Part A: Policy and Practice, Volume 103, 2017, Pages 327-342, ISSN 0965-8564, https://doi.org/10.1016/j.tra.2017.03.007.

[30] https://assets.bouldercounty.org/wp-content/uploads/2019/11/e-bikes-recommendation-bocc-11-13-2019.pdf

[31] https://www.fcgov.com/bicycling/files/fort-collins-e-bike-pilot-program-draft-report_march-2020.pdf?1586191761

[32] https://ppms.trec.pdx.edu/media/project_files/NITC_RR_1041_North_American_Survey_Electric_Bicycle_Owners.pdf

Table 3-3: E-Bike Best Practices		
Consideration	**Practice**	**Source**
Pilot study	Allowing e-bikes on certain facilities during a trial period while collecting data to assess safety, trail experience impacts, public opinion, and trail etiquette awareness.	Larimer County Natural Resources City of Fort Collins
Trail access	Class 1 and 2 e-bikes are allowed on all shared-use trails (hard or soft surface) that are open to non-motorized biking on state lands.	Colorado Parks and Wildlife
Regulating speeds	15 mph trail speed limit for all trail users, with "High Traffic Bicycle Slow Zones" on certain trail segments.	City of Fort Collins
	E-bike motors shall cease to provide assistance when the bike reaches a speed of 20 mph.	City of Aurora, CO
Incentives	Austin Energy offers qualifying rebates up to $300 per e-ride vehicle (e-bike, e-scooter, e-moped, e-motorcycle) for individuals and $400 per e-ride fleet vehicles.	Austin Energy – City of Austin, TX
	The Can Do Colorado eBike Pilot Program sought proposals to increase access to e-bikes for low-income essential workers while maximizing air quality benefits, pilot a variety of eBike distribution models including individual ownership and shared deployment, and lay a foundation for future scalability and replicability.	Colorado Energy Office (CEO)

CDOT is currently working with federal land managers to identify consistent e-bike regulation across jurisdictions, specifically along the I-70 corridor. Lessons learned from these conversations should be referenced and incorporated into similar regulatory discussions conversations in the NFRMPO region, beginning with the NoCo Bike & Ped Collaborative.

Electric Scooters (E-Scooters)

E-scooters are most common as part of a shared system. Other micromobility devices such as e-skateboards are most commonly owned individually. How these devices are classified by law varies by place. As of 2019, e-scooters were excluded from the State of Colorado's definition of a "toy vehicle," authorizing their use on roadways and affording them the same rights as e-bikes.

Above: An e-scooter user begins a ride in Old Town Fort Collins. Image credit: City of Fort Collins

Equity

In shared systems, scooters typically are more expensive on a per ride basis than a standard bike; however, some companies offer reduced fares based on income (more information in **Table 3-4**). When priced and distributed equitably, scooters can provide a transportation option that fills crucial gaps, especially for those without the ability to drive or without access to a vehicle. NFRMPO partners should factor equity considerations into any future decisions related to shared e-scooter programs.

Mobility

E-scooter designs that are adaptive to a variety of mobility needs are becoming more and more popular (wider tires, three wheels, and/or a seat for stability, etc.). Providing adaptive e-scooter options should be an essential part of any shared e-scooter program. For older adults and individuals with certain disabilities or other mobility difficulties, e-scooters may provide a mobility and independence option that e-bikes cannot. E-scooters can extend the travel range of pedestrians, effectively making key destinations, such as grocery stores or bus stops, more accessible.

Above: An example of an adaptive e-scooter. Image credit: SFMTA, Spin.

Safety

The technology and geometry of e-scooters is ever-changing, impacting their safety. Studies have found that the majority of e-scooter crashes occur on sidewalks and e-scooter injuries are most likely to occur due to potholes, cracks, or other infrastructure such as signposts or curbs. E-scooter riders suffer more injuries per mile than bike riders, but bike riders are three times more likely to be hit by a motor vehicle.[33] Planning partners in the region should continue to monitor the safety considerations associated with e-scooters and make decisions that promote safe use.

[33] https://www.iihs.org/news/detail/most-e-scooter-rider-injuries-happen-on-sidewalk-study-finds

Best Practices

The best practices highlighted in **Table 3-4** may refer to either or both personal and shared e-scooter ownership models. These practices may be helpful for local agencies when considering their individual approach to micromobility and may serve as a basis for achieving consistency across the region.

Table 3-4: E-Scooter Best Practices

Consideration	Practice	Source
Deployment in underserved areas *(shared-system only)*	The City of Portland, OR requires a minimum of 100 shared scooters, or 20 percent of the fleet (whichever is less) to be deployed in historically underserved neighborhoods each day.	Portland Bureau of Transportation (PBOT)
Pricing and payment *(shared-system only)*	Through its permit applications, Washington D.C requires dockless scooter and bike providers to offer a cash payment option, and the ability to be located and unlocked without a smartphone.	Washington D.C. DOT
	The Lime Access program gives any rider who is qualified for a federally run assistance program, a 50 percent discount on e-scooter or e-bike rental. Qualified riders can also unlock a bike or scooter via text and pay through a system called PayNearMe®, eliminating the need for a smartphone or credit card.	Lime
	Bird Access program provides anyone who is qualified for a federally run assistance program the first 50 rides per month (of 30 minutes or less) free of charge after a $5 monthly fee, and allows riders to pay with cash at CVS and 7-11 retailers.	Bird
Regulating speeds	E-scooters are required to be slowed to 8 mph in designated Slow Zones and walked through Dismount Zones on CSU's main campus. Using geofencing technology[34], the scooters will slow or stop themselves safely when entering these zones.	Colorado State University (CSU)
	If operated on the sidewalk, it shall be the rider's responsibility to operate at the maximum speed limit of 6 mph.	City of Aurora, CO
	E-scooter motors shall cease to provide assistance when it reaches a speed of 15.5 mph.	City of Aurora, CO
Parking requirements	Parking is permitted upright on the sidewalk against the curb, beside bike parking, and other designated areas. Parking is not permitted if it blocks or impedes the pedestrian zone, fire hydrants, bus benches, use of window/sign displays or building access, use of a bike rack or news rack, or access to transit/loading/disabled	City of Fort Collins

[34] Geofencing technology triggers a pre-programmed action when a device or tag enters or exits a virtual boundary.

	parking zone, street furniture, curb ramps, entryways, or driveways	
Riding on roadways	Treat e-scooters the same as bicycles. Riding is permitted in bike lanes and on roadways as far to the right as practicable.	City of Fort Collins
	Authorized shared mobility devices may operate in the roadway if the maximum speed limit of the roadway does not exceed 30 mph. They may operate where speed limits exceed 30 mph if a bike lane is present.	City of Aurora, CO
Riding on sidewalks and trails	Riding on sidewalks is permitted outside of Dismount Zones. Riding on Natural Area or Parks trails is not permitted.	City of Fort Collins
Data reporting	Operators are required to report detailed data with the City on a quarterly basis related to usage, theft, crashes, origins, destinations, complaints, downloads, payment method, discount program utilization, and more.	City of Aurora, CO

Other Micromobility Devices

Most other micromobility devices are still classified by the state as toy vehicles and cannot be operated on public roadways, restricting their use to sidewalks, trails and shared-use paths, depending on local regulations. This "catch-all" category of micromobility devices is rapidly changing, with categories blending into one another. Communities should evaluate many of the equity, mobility, and safety considerations laid out for e-bikes and e-scooter in this chapter.

Figure 1Above: Individuals practicing riding motorized -e-boards. Image credit: Park City SUP

These devices may be commonly referred to as Electric Personal Assistance Mobility Devices (EPAMD), Personal Mobility Devices, or Portable Mobility Devices. These terms often refer to a self-balancing, two- to four-wheeled device, that is not greater than 25 inches wide, designed to transport only one person, with an electric propulsion system averaging less than 750 watts (1 horsepower), the maximum speed of which, when powered solely by a propulsion system on a paved level surface, is no more than 12.5 miles per hour.

Best Practices

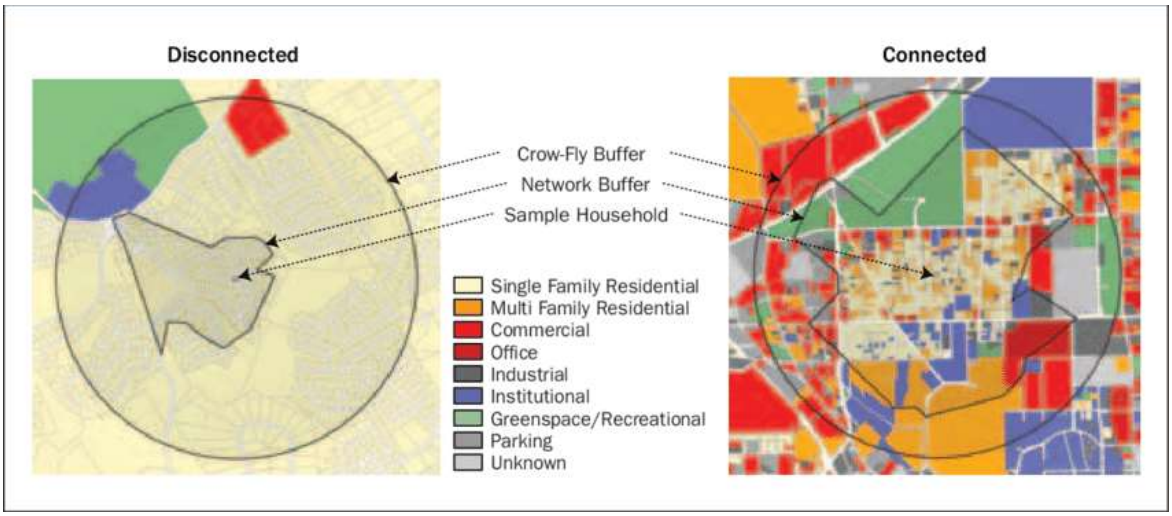
The best practices highlighted in **Table 3-5** may refer to either or both personal or shared ownership models. These practices may be helpful for local agencies when considering their individual approach to micromobility and may serve as a basis for achieving consistency across the region.

Table 3-5: Best Practices for Other Micromobility Devices		
Consideration	**Practice**	**Source**
Riding on roadways	Treat e-skateboards as e-scooters and e-bikes. Riders shall be granted all the rights and shall be subject to all the duties and responsibilities applicable to the driver of a motor vehicle under the laws of the state and the traffic ordinances of the city.	City of Norfolk, VA
Riding on sidewalks or trails	Any person riding a skateboard, toy vehicle, or similar device shall yield right-of-way to pedestrians.	City of Denver
Facility design	Where possible, a minimum sidewalk/path width of 60" allow to wheelchairs space to pass one another.	2010 ADA Standards for Accessible Design (ADAG)
Dismount zones	Riding skateboards is prohibited on sidewalks in designated dismount zones in the Old Town area using thermoplastic pavement signage.	City of Fort Collins

Land Use and Urban Form

Land use and transportation are inseparably intertwined. The number and types of destinations within a walkable or bikeable distance are a major factor in choosing to walk or bike. **Figure 3-8** illustrates how districts with homogenous zoning or land uses can increase the average trip length, while districts with a mix of land uses can decrease trip lengths by putting more destinations within a walkable or bikeable distance of more people. While a certain area may have comfortable walking or biking facilities, there may be no destinations within walking or biking distance. NFRMPO Staff plan to develop a white paper describing and analyzing the land use/transportation nexus and how it impacts Northern Colorado.

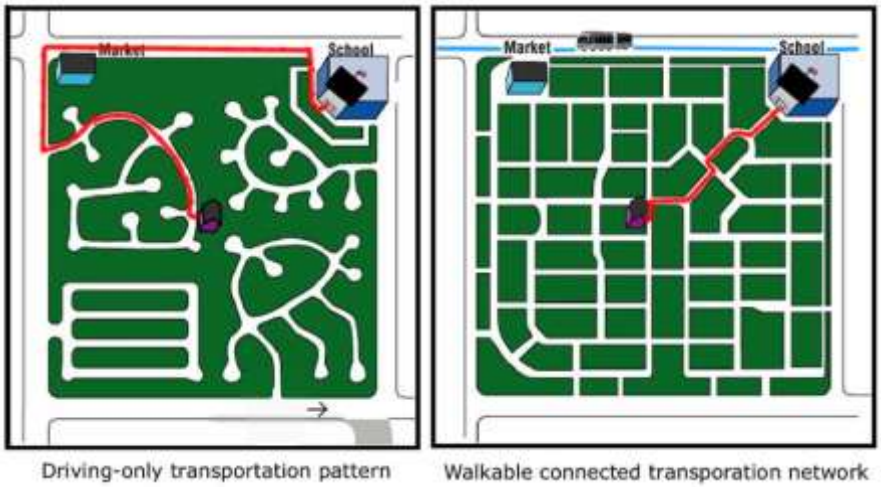
Figure 3-8: Land Use and Network Connectivity Comparison



Above: With a combination of mixed land uses and connected transportation networks, more destinations become accessible via a short walk or bike ride. Image credit: Patrick M Condon.

Land use patterns also influence the pattern and form of the transportation network. For instance, many older districts were developed with connectivity and walkability front of mind. These are often characterized by a grid-like street layout, with many access points and redundancy in the route a driver, bicyclist, or pedestrian can take to access a destination. In contrast, many newer residential districts are more car oriented; often characterized by winding, "loop and lollipop," or cul-de-sac patterns that may inhibit direct access to destinations. **Figure 3-9** below illustrates how these different street layouts impact travel distance.

Figure 3-9: Street Network Layout Comparison



Above: The red lines demonstrate the shortest walking or biking distance from a home to a school given different street layouts. Image credit: Center for New Urbanism (CNU).

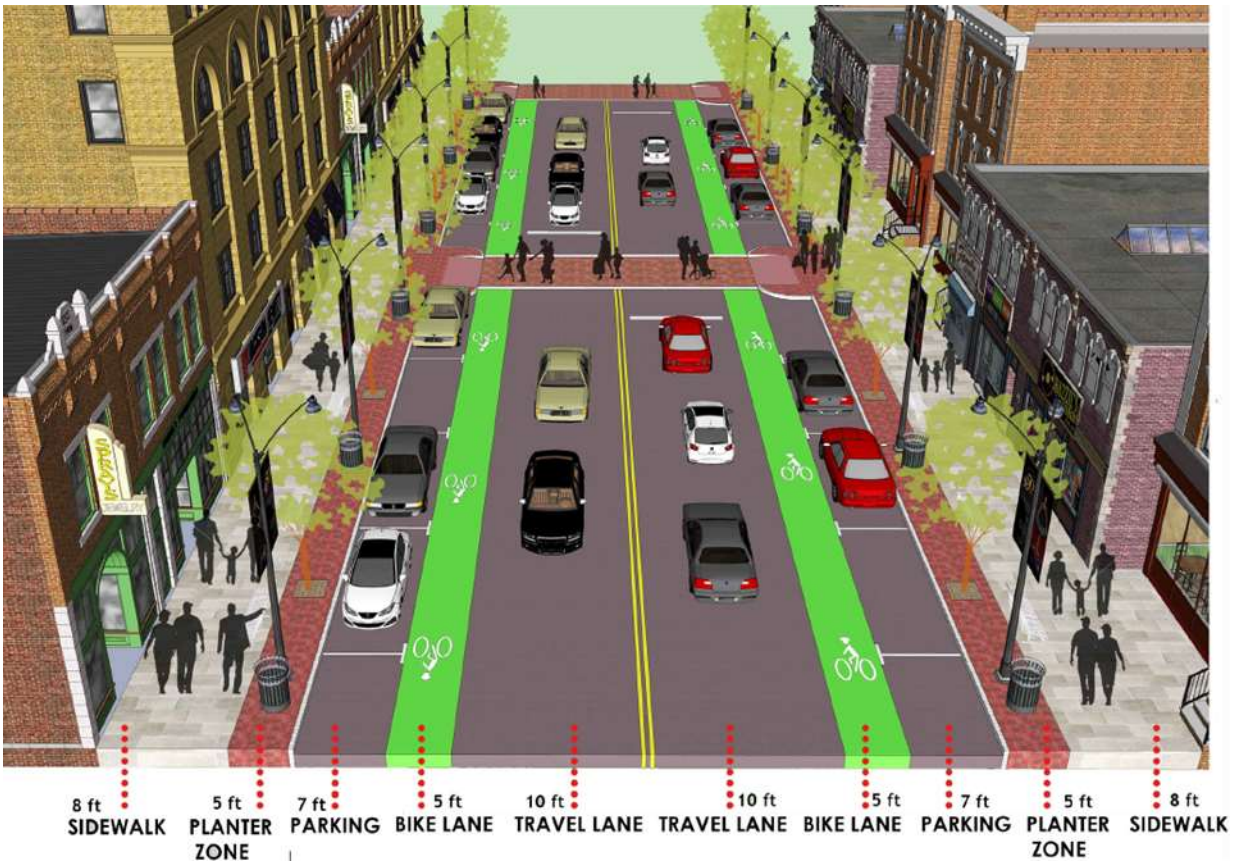
Figure 3-10 demonstrates how improvements can be made within an existing winding street pattern to improve bikeability and walkability. Short connector trails can dramatically reduce walking distances and can often be accommodated in narrow and/or otherwise undevelopable tracts of land.

Figure 3-10: Active Mode Connections within a Disconnected Roadway Network

Above: Dashed red lines demonstrate active transportation connections to improve connectivity and access in an otherwise disconnected transportation network. Image credit: CNU.

Complete Streets

Complete Streets are streets designed to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. The adoption of a Complete Streets policy by communities encourages the routine design and operation of the entire right of way to enable safe access for all users. **Appendix A: Resource Library** includes various resources for local agencies to learn more when considering complete street policies, development standards, or individual project design.



Above: Complete Streets Cross Section [35] demonstrates how space can be allocated in high-use areas where various travel modes interact on a regular basis.

Within the North Front Range region, Berthoud, Fort Collins, Greeley, Loveland, and CDOT have adopted Complete Streets policies. Other communities have referenced the concept of Complete Streets in a local plan and may have a variation or components of Complete Streets policies in local standards. NFRMPO staff are available to discuss how Complete Streets policies or principles can be incorporated in local processes.

Health in All Policies (HiAP)

Health in All Policies is a collaborative approach to improving the health of all people by incorporating health considerations into decision-making across sectors and policy areas. Due to the complex nature of the current health challenges in the US, five key elements are included: promoting health and equity, supporting intersectoral collaboration, creating co-benefits for multiple partners, engaging stakeholders, and creating structural or process change. Active transportation offers individuals an opportunity to use physical activity as a mode for reaching their destination. The Weld County Department of Public Health and Environment (WCDPHE), Larimer County Department of Health and Environment (LCDHE), and Colorado Department of

[35] The City of Elizabeth Releases a Complete Streets Concept Plan for Morris Avenue. Alan M. Voorhees Transportation Center. Rutgers Edward J. Bloustein School of Planning and Public Policy. http://vtc.rutgers.edu/

Public Health and Environment (CDPHE) have incorporated *HiAP* into their planning and outreach.[36] These agencies should be consulted for a better understanding of how health and the built environment are related.

Vehicle Automation

There are various levels of vehicle automation, or autonomy, as summarized in **Figure 3-11**. Many vehicles on the road today already include driver assistance technologies and partially automated features, such as lane keeping, forward collision warning, adaptive cruise control, automatic emergency braking, and rudimentary pedestrian detection features.[37] Although promising new safety technology is becoming available, pedestrian deaths continue to rise at alarming rates nationwide. According to Angie Schmitt, Owner/Principal of 3MPH Planning and Consulting, "In 2019, AAA tested the pedestrian detection systems in four midsized sedans with dummy pedestrians. The systems performed respectably at 20 miles per hour in daylight conditions, stopping about 40 percent of the time. But at 30 miles per hour, they were practically useless. AAA called them 'completely ineffective at night,' when 'none of the systems detected or reacted to the adult pedestrian.'"[38]

Thus far, complete automation, the autonomous vehicle (AV), has proven inadequate at detecting pedestrians, especially outside of marked crosswalks. The failsafe human drivers in the vehicles to stop or correct the vehicle have been unreliable. The National Transportation Safety Board (NTSB) has coined the term "automation complacency" as the typical inability of the human brain to remain vigilant and alert for an extended amount of time in the back-up driver role.[39]

[36] Health in All Policies: A Guide for State and Local Governments. American Public Health Association. 2013. http://www.phi.org/resources/?resource=hiapguide

[37] Schmitt, Angie. (2020). *Right of Way: Race, Class, and the Silent Epidemic of Pedestrian Deaths in America* (p. 120). Island Press.

[38] Schmitt, Angie. (2020). *Right of Way: Race, Class, and the Silent Epidemic of Pedestrian Deaths in America* (p. 121). Island Press.

[39] Schmitt, Angie. (2020). *Right of Way: Race, Class, and the Silent Epidemic of Pedestrian Deaths in America* (p. 116-118). Island Press.

Figure 3-11: Levels of Vehicle Automation / Autonomy

Image credit: NHTSA

Local, regional, and state agencies should consider their role in determining how autonomous vehicles will interact with their right-of-way and surrounding land uses. These agencies should proactively plan for full automation in a way that prioritizes quality of life, requiring new transportation technologies to adapt to community desires for safer, more efficient, and better places to live and work The National Association of City Transportation Officials (NACTO) has urged stakeholders at all levels to adopt the following five recommendations to AV manufacturers:

1. Plan for fully automated vehicles, not half-measures;
2. Rethink our streets and expressways;
3. Ensure safe operation on city streets, including limiting automated vehicles to a maximum speed of 25 miles per hour;
4. Create data-sharing requirements for automated vehicles; and,
5. Change planning models to incorporate the expected disruptive impact of this technology.

If safely implemented on a large scale, AVs could create benefits to active modes through optimized traffic signalization and more efficient use of limited public right-of-way.