FHWA Bicycle and Pedestrian Program Resources

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/

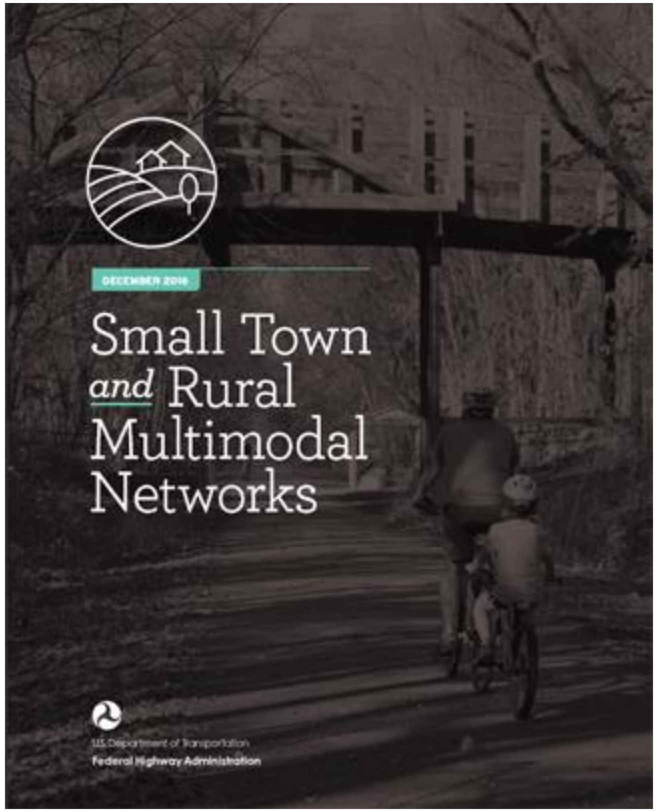
Planning and Design

- Small Town and Rural Multimodal Networks
- Achieving Multimodal Networks
- Guidebook for Developing Pedestrian and Bicycle Performance Measures
- Separated Bike Lane Planning and Design Guide
- Incorporating On-Road Bicycle Networks into Resurfacing Projects
- Pursuing Equity in Pedestrian and Bicycle Planning
- Bike Network Mapping Idea Book

Small Town and Rural Multimodal Networks

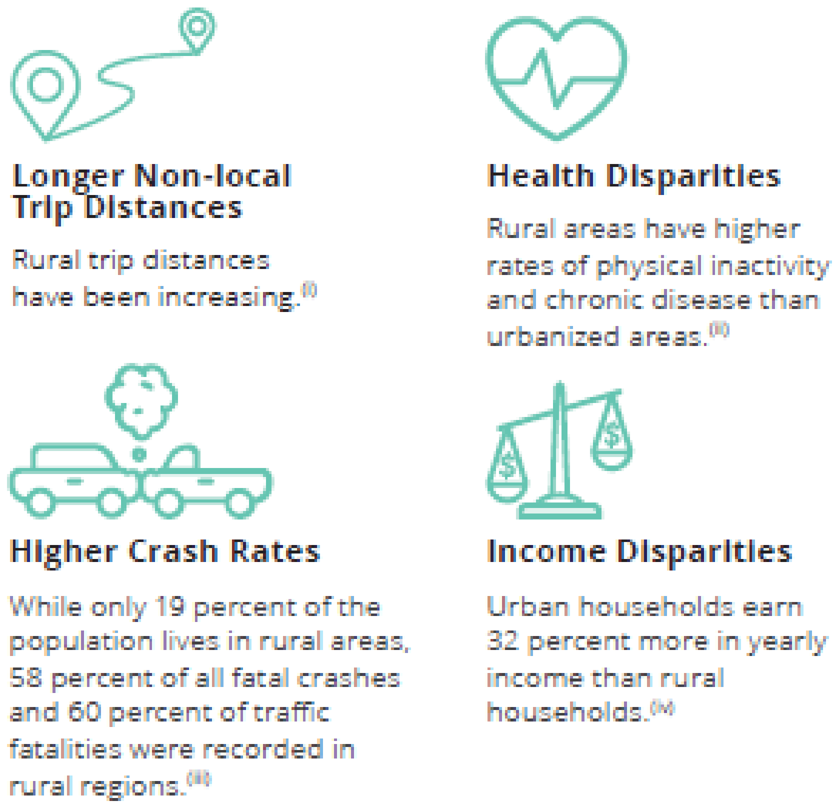
Why a Rural and Small Town Focused Guide?

- Different Types of Facilities
- Key Opportunities

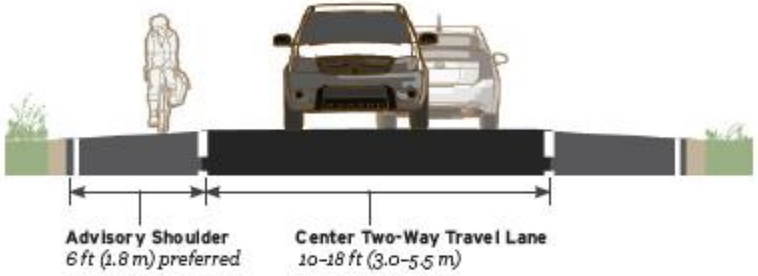


Why a Rural and Small Town Focused Guide?

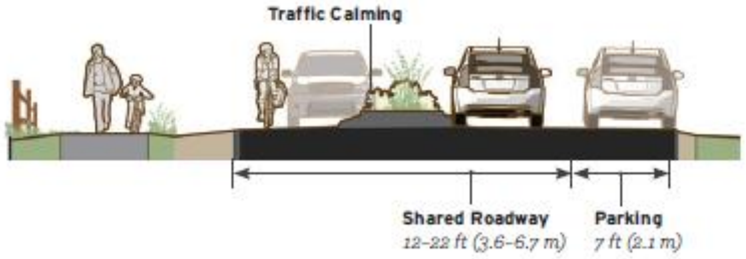
Though in many rural communities, residents live long distances from services, most small towns provide a compact center well-suited for walking and bicycling trips.



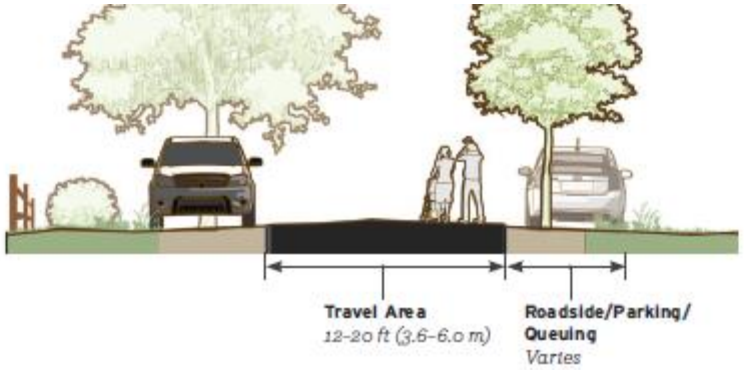
Mixed Traffic Facilities



Advisory Shoulder

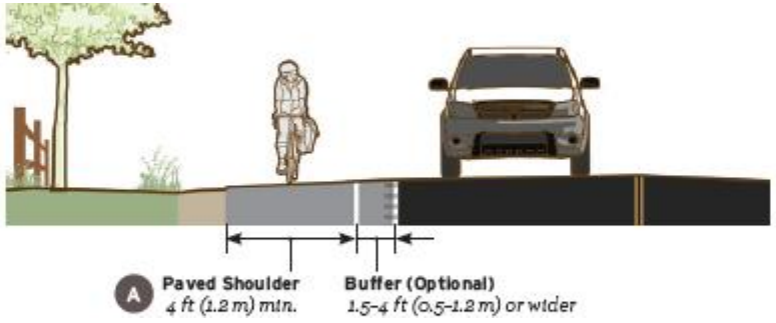


Bicycle Boulevard

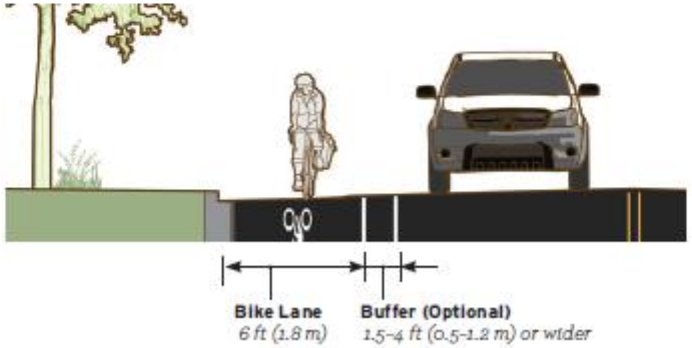


Yield Roadway

Visually Separated Facilities

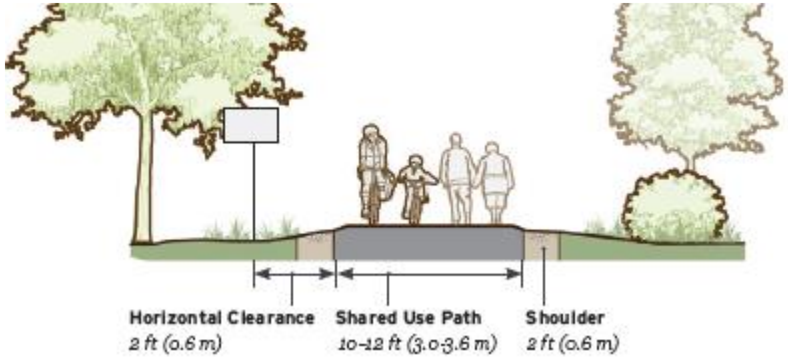


Paved Shoulder

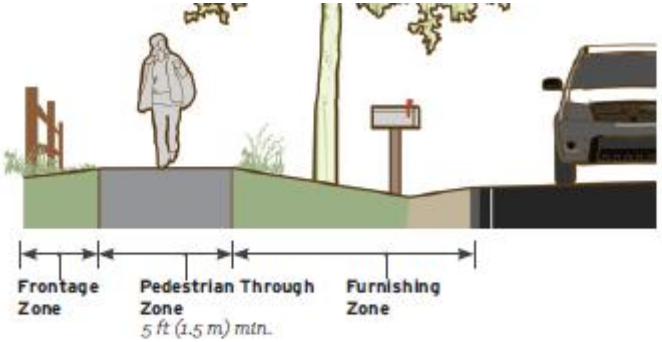


Bike Lane

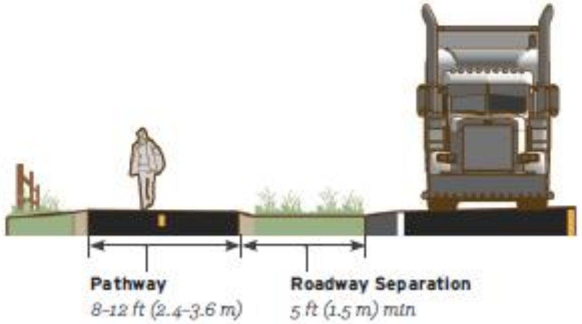
Physically Separated Facilities



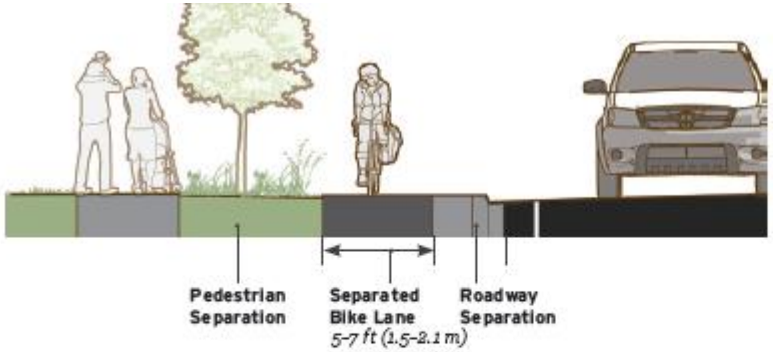
Shared Use Path



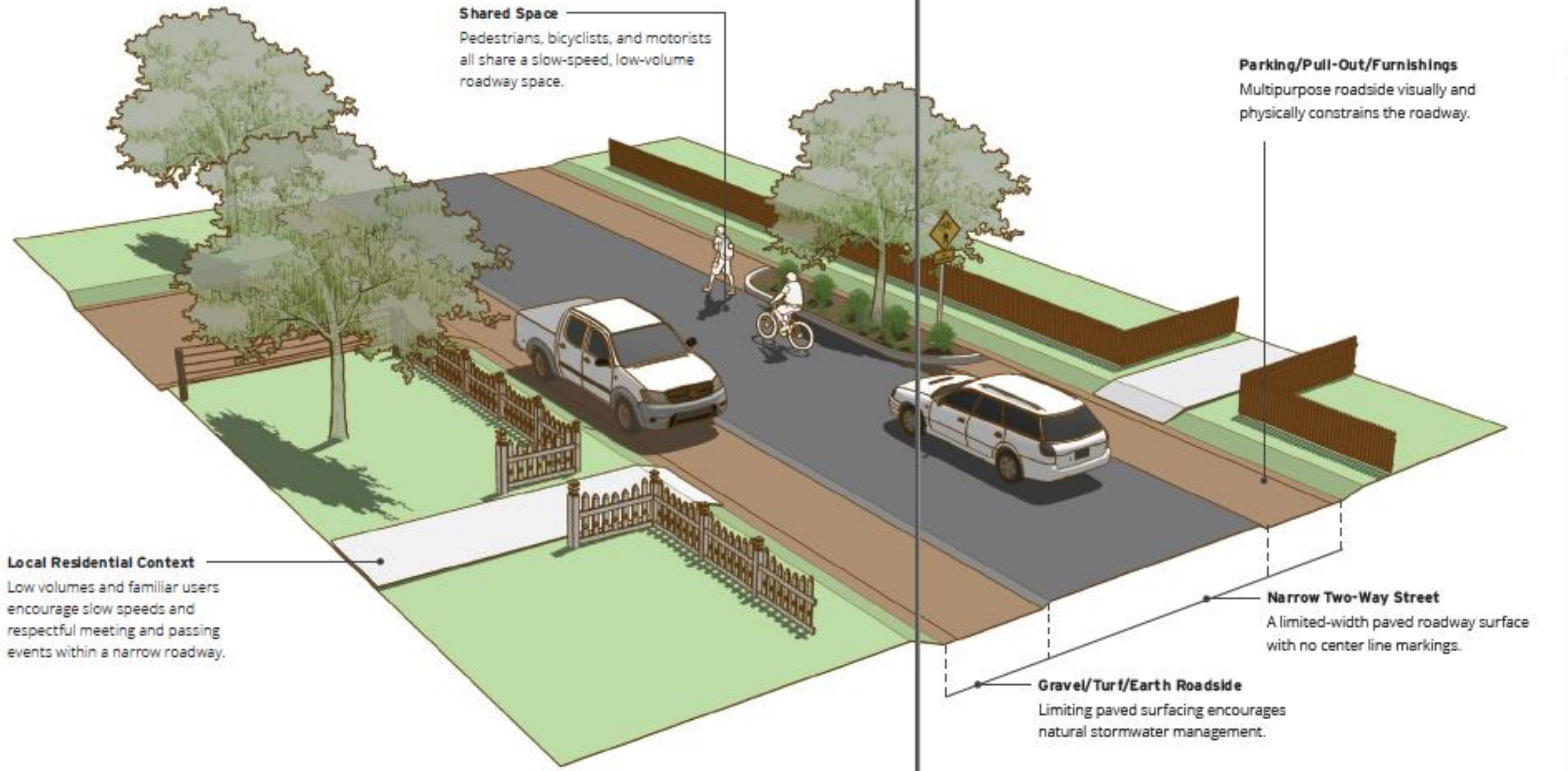
Sidewalk



Sidepath



Separated Bike Lane



Yield Roadway

A yield roadway is designed to serve pedestrians, bicyclists, and motor vehicle traffic in the same slow-speed travel area. Yield roadways serve bidirectional motor vehicle traffic without lane markings in the roadway travel area.

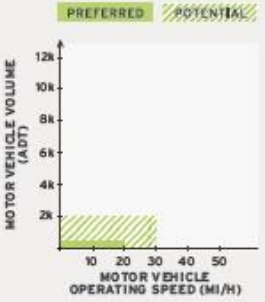
BENEFITS

- Less costly to build and/or maintain than fully paved cross sections.
- Connects local residential areas to destinations on the network.
- Limits impermeable surface area and minimizes stormwater runoff.
- Maintains aesthetic of narrow roads and uncurbed road edges.
- Encourages slow travel speed when narrower than 20 ft (6.0 m).
- Can support a larger tree canopy when located within wide unpaved roadside areas.
- Supports on-street or shoulder parking for property access.
- Low maintenance needs over time.

APPLICATION

Speed and Volume

Appropriate on roads with very low volumes[8] and low speed.



Network

Local residential roadways. Not for through motor vehicle travel.

Land Use

Within built-up areas, particularly near residential land uses where most traffic is familiar with prevailing road conditions.

Yield Roadway

Yield roadways can effectively serve local travel needs, maintain aesthetic preferences, and is a common form for low-volume local rural roads. When operating at very-low volumes and at low speeds, pedestrians and bicyclists are comfortable walking within the travel area of the roadway.[1] Yield roadways are designed with narrow roadway dimensions to prioritize local access and community livability.

For more information on related roadway types, refer to sections on Slow Streets and Shared Streets in *FHWA Achieving Multimodal Networks 2016.*

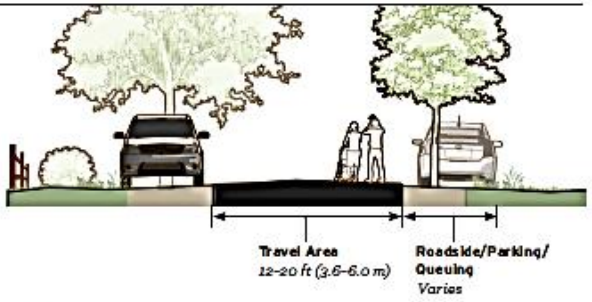


Figure 2-1. When vehicles travelling in opposite directions meet, the two vehicles may not have enough room to pass within the travel area. One vehicle may need to pull into a parking lane, pull-out, or driveway area to let the other pass.

GEOMETRIC DESIGN

TWO-WAY TRAVEL LANE

The paved two-way travel lane should be narrow to encourage slow travel speeds and require courtesy yielding when vehicles traveling in opposite directions meet.

- Total traveled way width may vary from 12 ft (3.6 m)–20 ft (6.0 m).
- Traveled way width below 15 ft (4.5 m) or below function as a two-way single-lane roadway and should follow the guidance of the AASHTO Low Volume Roads 2001.

A When width is 15 ft (4.5 m) or narrower, provide pull-out areas every 200–300 ft to allow for infrequent meeting and passing events between motor vehicles. Pull-out areas may be established in the parking lane or roadside area.

- Access for emergency vehicles should be provided. There is no single fire code standard for local roads; however, a range of clear widths for parking and deploying fire department apparatus is between 16–20 ft (5.0–6.0 m). Designers should provide an opening of this width every 200–300 ft (600–91 m).

ROADSIDE

If desired, parking may be located on the paved roadway surface or on gravel or soil shoulders outside of the paved roadway. The parking lane may also serve as a pull-out area while yielding.

- When possible, the parking lane should be constructed with a contrasting material to differentiate the lane from the travel area. Bituminous, crushed stone, gravel, and turf shoulders can be used as contrasting materials to the travel area (AASHTO Green Book 2011, p. 4-13).
- Trees may be planted within the roadside area at regular intervals to visually and physically narrow the corridor, add to the aesthetic environment, and encourage slow speeds.

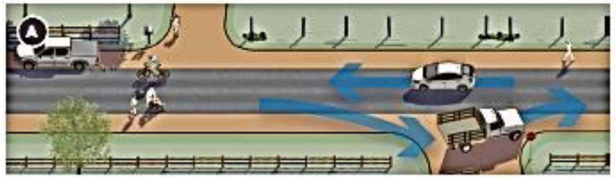


Figure 2-2. A travel area width of 16–18 ft (4.8–5.5 m) is appropriate for low volumes of two-way traffic and may require slowing when vehicles traveling in opposite directions meet. A travel area of 12–15 ft (3.6–4.5 m) is too narrow for two motor vehicles to pass, and one vehicle may need to pull into a parking lane, pull-out, or driveway area to let the other proceed.

Yield Roadway

MARKINGS

No markings are necessary to implement a yield roadway.

- Do not mark a center line within the travel area. The single two-way lane introduces helpful traffic friction and ambiguity, contributing to a slow-speed operating environment.

SIGNS

Use signs to warn road users of the special characteristics of the street. Potential signs include:

- A PEDESTRIAN (W11-2) warning sign with ON ROADWAY legend plaque. See Figure 2-3.
- Use a Two-Way Traffic warning sign (W6-3) to clarify two-way operation of the road if any confusion exists.

Figure 2-3. Pair a W11-1, W1-2, or W11-15 warning sign with a custom legend plaque to inform road users that shared use by pedestrians and/or bicyclists might occur.

INTERSECTIONS

At uncontrolled crossings of local streets, no special treatment is necessary. The additional space within the intersection area offers queuing opportunities when vehicles traveling in opposite directions meet.

- Consider parking prohibitions of 20–50 ft (6.0–15.0 m) in advance of intersections. This is particularly helpful to accommodate large vehicle turning movements.
- Provide adequate stopping sight distance around curves and at uncontrolled intersections. Values of stopping sight distance for two-way single-lane roads should be twice the stopping sight distance for a comparable two-lane road.

IMPLEMENTATION

In rural communities with a disconnected street network, local streets are the only viable connection to a scene of an emergency. Implementing agencies should work closely with emergency response stakeholders.

ACCESSIBILITY

Yield roadways allow motor vehicles, bicyclists, and pedestrians to share the same space. On very low-volume and low-speed streets, pedestrians and bicyclists may be comfortable using the roadway with the occasional vehicle. If this facility is intended for use by pedestrians, it must meet accessibility guidelines for walkways.

CASE STUDY | YIELD ROADWAY

Manzanita, Oregon

PROJECT DESCRIPTION

The residents of Manzanita cherish their small town and have outlined ways to maintain this character. One of the goals identified in the town's Comprehensive Plan is "to maintain and create residential living areas which are safe and convenient, which make a positive contribution to the quality of life, and which are harmonious with the coastal environment." Toward this end they have a network of local streets that create peaceful conditions for people walking, bicycling, and driving.

In addition, there is a recognition that even on collector streets bicycle and pedestrian travel should be safe. The plan states that "Sufficient pavement width should be included on all major streets or roads to accommodate bicycle traffic."

Where a visually or physically separated facility is not provided, speeds will be slowed to create bicycle-friendly conditions. The plan states, "Efforts to reduce speeding on Laneda Avenue should be carried out by the city. This should take the form of maintaining a low speed (20 Mi/h), requesting that the City police and Tillamook County Sheriff's Department maintain a high level of enforcement and installing appropriate warning signs." Efforts such as these enable Manzanita's local streets to be shared roadways where people driving, walking, and biking can all safely share the street.

DETAILS

COMMUNITY CONTEXT

Manzanita is a quiet, peaceful village surrounded by the natural beauty of the Pacific Ocean, Neah-Kah-Nie Mountain, and State and private forests. The Manzanita area is home to 725 full time residents. In the summer the population swells to 2,500 to 3,000.

KEY DESIGN ELEMENTS

The standard City residential street is 20 ft wide paved with asphalt and with a concrete gutter along one side.

ROLE IN THE NETWORK

Manzanita's local streets connect residences with the ocean, parks, and downtown. The ability to use these shared local streets allow people walking or on bikes to access all parts of the community.

FUNDING

The key aspect of this treatment is that it requires funding beyond what is currently used to maintain the local streets. The City maintains the streets that have been brought up to city standards. Graveled streets that have not been brought up to City standards are maintained by the adjacent property owners. There are some roads within the City that are County roads maintained by Tillamook County.

For more information refer to the City of Manzanita website: http://ci.manzanita.or.us/

Yield Roadway

Ennis, MT–Population 850

FOOTNOTES

i Very low-volume local roads are typically used by people who are familiar with the roads. These roads are used by such lowvolumes of traffic that crashes are rare, as vehicles hardly encounter other vehicles. AASHTO defines a very low-volume street as one that is functionally classified as a local road and has 400 cars per day or less (AASHTO Green Book 2011, p. 5-34).

On local streets with less than 400 vehicles per day, no separated pedestrian infrastructure may be necessary (AASHTO Pedestrian Guide 2004).

ii The AASHTO Green Book notes that, on narrow, unlaned roads, "random intermittent parking on both sides of the street usually results in areas where two-way movement can be accommodated" (2011, p. 4-74). Additionally, "The level of user inconvenience occasioned by the lack of two moving lanes is remarkably low in areas where single-family units prevail" (2011, p. 5-13).

iii When two vehicles do encounter one another on a narrow, unlaned street, "opposing conflicting traffic will yield and pause on the parking lane area until there is sufficient width to pass" (AASHTO Green Book 2011, p. 5-13).

iv On the subject of emergency response, the AASHTO Green Book states that a "curb face-to-curb face width of 8 m [26 ft] provides a 3.6-m [12-ft] center travel lane that provides for the passage of fire trucks and two 2.2-m [7-ft] parking lanes" (2011, p.5-13).

v The *Oregon DOT Neighborhood Street Design Guidelines* support local street configurations with a clear travel area of 14 ft (2000, p.20). Dan Burden's *Emergency Response Handbook* calls for an "operations area for emergency responders every 200–300 ft" (Burden 2000, p.32).

vi The FHWA MUTCD does not recommend center line markings on paved two-way streets that are narrower than 16 ft wide, or operating below 3,000 ADT (2009, p.349).

vi The FHWA MUTCD permits local highway agencies to "develop special word message signs in situations where roadway conditions make it necessary to provide road users with additional regulatory, warning, or guidance information..." These "new word message signs may be used without the need for experimentation." (2009, p.28).

WORKS CITED

American Association of State Highway and Transportation Officials. *Guide for the Planning, Design, and Operation of Pedestrian Facilities.* 2004.

American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets.* 2011.

American Association of State Highway and Transportation Officials. *Guidelines for Geometric Design of Very Low-Volume Local Roads.* 2001.

Burden, Dan, and Zykofsky, Paul. *Emergency Response: Traffic Calming and Traditional Neighborhood Streets.* 2000.

Federal Highway Administration. *Achieving Multimodal Networks.* 2016.

Federal Highway Administration. *Manual on Uniform Traffic Control Devices.* 2009.

Oregon Department of Transportation (ODOT). *Neighborhood Street Design Guidelines: An Oregon Guide for Reducing Street Widths.* 2000.

PHOTO CREDIT

Page 2-1. Western Transportation Institute

Page 2-6. Western Transportation Institute

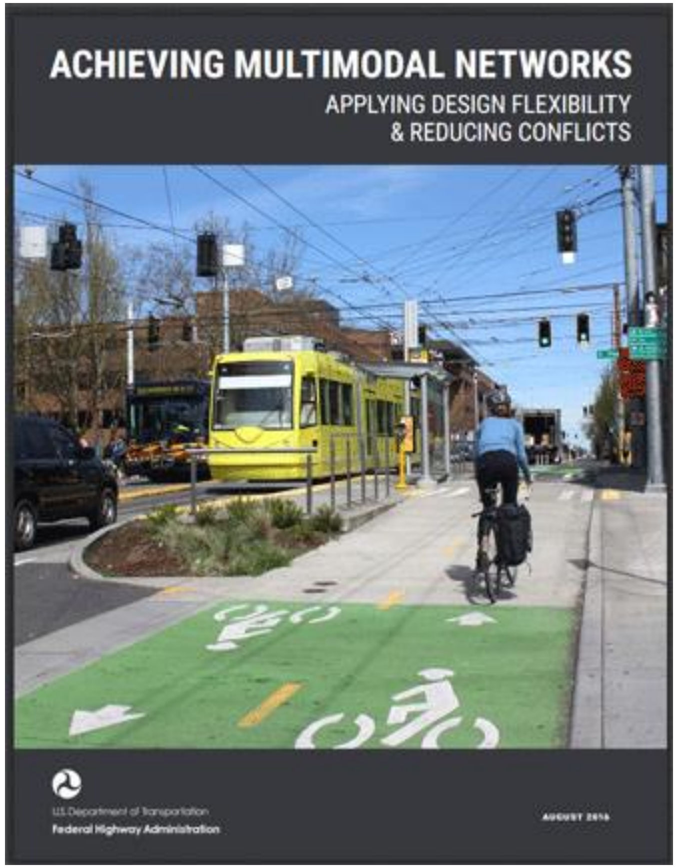
Page 2-7. Alta Planning + Design

Page 2-8. Western Transportation Institute

Achieving Multimodal Networks

A resource for practitioners seeking to build multimodal networks.

- 24 design topics
  - 12 focus on design flexibility
  - 12 focus on measures to reduce conflicts between modes



PART 1: APPLYING DESIGN FLEXIBILITY

- Design Criteria and Lane Width
- Intersection Geometry
- Traffic Calming and Design Speed Transitions to Main Streets
- Road Diets and Traffic Analysis
- Enhanced Crossing Treatments
- Signalized Intersections
- Paved Shoulders
- Separated Bike Lanes
- Bus Stops
- Bridge Design
- Slow Streets

PART 2: REDUCING CONFLICTS

- Network Connectivity
- School Access
- Multimodal Access to Existing Transit Stations
- Multimodal Access to New Transit Stations
- Transit Conflicts
- Freight Interaction
- Accessibility
- Turning Vehicles
- Separated Bike Lanes at Intersections
- Shared Use Paths
- Midblock Path Intersections
- Shared Streets

TRANSIT CONFLICTS


Source: Nathan Wilkes, City of Austin, Texas

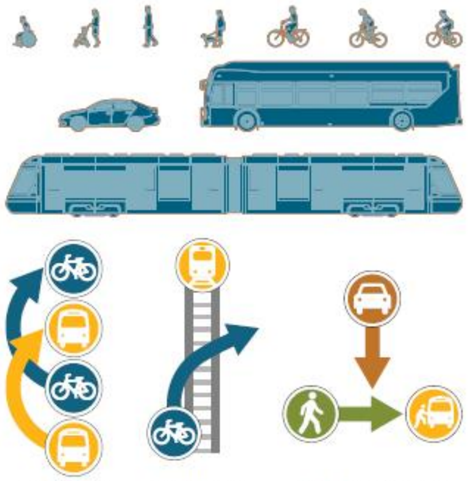
Transportation networks in all land use settings enable people to walk, bike, and/or take transit to and from their destinations. A single trip may consist of using multiple transportation modes, for example walking to a bus stop, riding the bus downtown, and bicycling the last half mile to the office on bike share. Each transportation mode should operate safely and efficiently without negatively impacting others.

Transit conflicts can be a broad topic. This design topic focuses on conflicts between transit vehicles, such as buses and streetcars, and vulnerable road users, such as pedestrians, bicyclists, and pedestrians accessing bus stops. These principles and strategies can be applied to other modes such as bus rapid transit, subways, or heavy railroad stations.

Conflicts between transit vehicles and vulnerable road users can consist of a bus accessing a stop by crossing a standard bike lane, a bicyclist traveling across or along rail tracks, or a pedestrian or bicyclists passing a bus stop with waiting passengers. Conflicts also occur between pedestrians and motor vehicles when accessing or departing from a bus stop.

Transit conflicts may be addressed through designs that clearly delineate the path for each mode and maximize predictability between users.

COMMON USERS IN CONFLICT AND TYPICAL CRASH TYPES



GUIDING PRINCIPLES TO REDUCE CONFLICTS

SAFETY
Roadways should allow safe operation of transit vehicles and vulnerable road users by minimizing potential crashes.

ACCOMMODATION AND COMFORT
The design should provide a sense of comfort to vulnerable road users and transit passengers while accommodating transit operations.

COHERENCE
The path of travel for each mode should be clearly delineated through design, pavement markings, and signs.

PREDICTABILITY
The design should create predictable behaviors that allow transit vehicles, motorists, bicyclists, and pedestrians to have clear right-of-way assignments.

CONTEXT SENSITIVITY
Designs should respond to typical users and conflict types in a manner that complements community character and supports community health, economic, and livability goals.

EXPERIMENTATION
Designers should consider innovative solutions to reducing bicycle hazards at streetcar tracks

DESIGN STRATEGIES

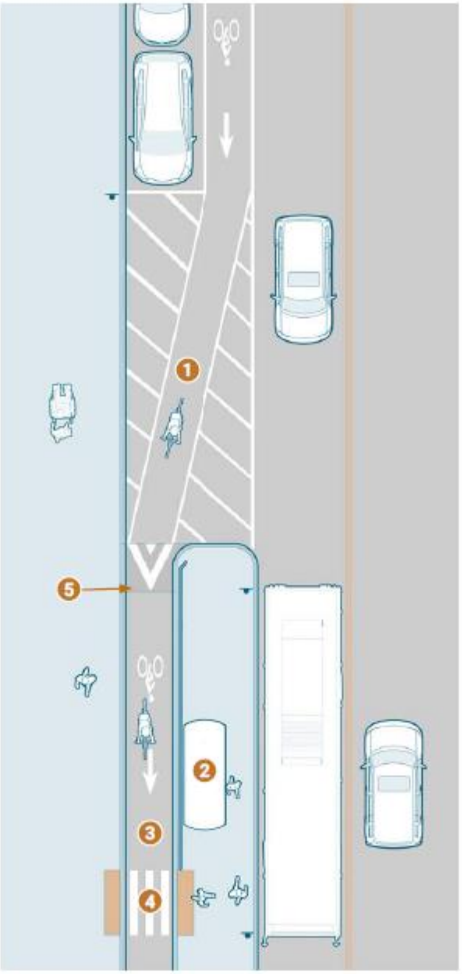
BUS AND BIKE CONFLICTS

A common conflict between buses and bicyclists is referred to as bus-bike leapfrogging. Bus-bike leapfrogging occurs when a bus and bike are traveling on a roadway in the same direction and pass each other at multiple places. The bicyclist is traveling at a constant speed with the bus passing, pulling into a stop, departing the stop, passing the bicyclist, and traveling to the next stop. This crossing of users can create multiple instances where conflicts can occur.

Bus-bike leap-frogging is uncomfortable for bicyclists as well as for bus drivers and passengers as it can impact bus schedules. On one-way streets it may be feasible to avoid transit conflicts entirely by locating bicycle facilities on the other side of the street. Otherwise, implementation of a floating bus stop can eliminate leap-frogging, improving bicyclist's comfort and bus operation.

CONSIDERATIONS

- Provide clear indication of the purpose and operations of the floating bus stop for pedestrians and bicyclists.
- Provide adequate tapers for bicyclists to transition from bicycle lane to behind the bus stop. 1
- Provide bus stop passengers amenities such as shelters, benches, and trash barrels outside of bicycle travel. 2
- Maintain accessible pedestrian access to stop amenities, sidewalk, and boarding areas.
- Provide continuous separated bicycle facility behind the boarding area. For more information, refer to the design topic on **Separated Bike Lanes** 3 **(FHWA Separated Bike Lane Guide 2015, pp. 92–96)**.
- Provide clearly marked crosswalks from the island to the adjacent sidewalk 4 **(FHWA Separated Bike Lane Guide 2015, pp. 92–96)**.
- Consider a raised crosswalk across the bicycle facility 5 **(FHWA Separated Bike Lane Guide 2015, pp. 92–96)**.
- Consider yield or stop lines and YIELD [or STOP] HERE FOR PEDESTRIANS (R1-5) signs to alert bicyclists of the passenger crosswalks **(MUTCD 2009, Sec. 2B.11)**.

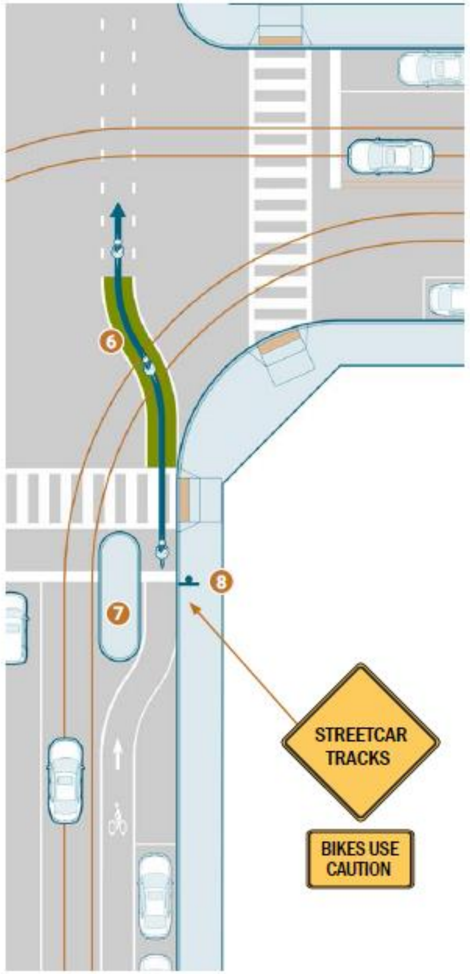


NETWORK

Connected networks for pedestrians and bicyclists allow convenient access to and from transit facilities including stations and bus stops. Factor in desire lines when installing new transit facilities. For more information, refer to the design topic on **Network Connectivity**.

EDUCATION

Educating transit vehicle drivers to be aware and cautious around vulnerable users can help reduce conflicts. Drivers should receive trainings, ideally through driving simulators, on how to operate when bicyclists and pedestrians are present. Bus drivers should be alert that the exiting passengers may cross in front of the bus. Educating bicyclists to be cautious and courteous at transit stops can help reduce conflicts. Consider installing educational signs at strategic locations such as on buses and shelters.



TRACK AND BIKE CONFLICTS

Cities are competing to provide multimodal transportation networks that focus on complete streets and public transportation options. Some have reintroduced light rail and streetcar vehicles to their transit systems. Light rail transit or streetcars, also known as trolley cars, are short public transit vehicles that run on rails on a regular schedule. Light rail transit typically operates within its own exclusive space and streetcars operate in a travel lane along a roadway. Boston, Portland, Seattle, and San Francisco are a few examples of cities that operate light rail and streetcars as part of their transportation systems.

Between the resurgence of light rail and streetcars and increases in bicycling, conflicts between bicyclists and tracks may become more common. Tracks typically contain a gap, called the flangeway, which can be a hazard for bicycle tires. In wet conditions, tracks may be slippery, causing bicyclists to lose control.

CONSIDERATIONS

- Consider using the best track surface material for safe bicycle travel especially when the surface may be regularly wet.
- Consider reducing the flangeway or using a flangeway filler product.
- Provide pavement markings such as bike lane lines, bike symbols, and green colored pavement surfaces to direct bicyclists to cross the tracks between 60 and 90 degrees to reduce the risk of getting bicycle tires caught in the tracks. 6 **(AASHTO Bike Guide 2012, p. 4-38)**
- Consider a median to force deflection of bicyclist to cross the tracks at the appropriate angle and prevent illegal parking by motorists. 7
- Provide advance track warning signs to alert bicyclists of the tracks ahead. 8

BUS STOP PLACEMENT

Bus stop placement is a key component of reducing conflicts between bus passengers, pedestrians, bicyclists, and motorists. Bus stops should be located at appropriate distances based on the context of the area. For example, bus stop spacing in central business districts is less than 400 feet. Bus stops should complement the sidewalk and bicycle facilities to connect passengers with the surrounding pedestrian and bicycle networks. At intersections, bus stops can be provided on the near- or far-side of the intersection. Far-side bus stops are preferred when feasible as near-side bus stops can block visibility between turning vehicles and pedestrians. At midblock bus stop locations, depending on the proximity of other crosswalks, a midblock crossing may be necessary and may require enhanced crossing treatments. For more information, refer to the **design topics on Enhanced Crossing Treatments, Bus Stops,** and **Midblock Path Intersections.**

(AASHTO Transit Guide 2014, p. 5-11–5-13)

CASE STUDIES

DIRECTING BIKES ACROSS STREETCAR TRACKS
BOSTON, MA

With the number of bicyclists increasing in Boston, the City has seen an increase in bicycle crashes resulting from the presence of in-street rail lines. The City decided to address the issue of bicyclist interaction with in-street rail through pavement markings and green colored pavement.

At intersections where track angles were creating challenges for bicyclists, dashed white lane lines with green colored pavement were added to help bicyclists position themselves to cross the tracks at near 90-degree angles.

Boston also has streetcars that run along the center of streets that are too narrow for exclusive bike lanes. To encourage bicyclists to stay in the right lane, the City installed shared lane markings and left-turn queue boxes to assist bicyclists in making left turns.

Source: Nicole Freedman

FLOATING BUS STOP
SEATTLE, WA

The City of Seattle has installed bus stop floating islands at a majority of bus stops along Dexter Avenue, a major bicycle commuting corridor that has peak bicycle volumes of over 300 bicyclists per hour. This 1.5-mile corridor carries buses at 10 minute headways during peak periods. The bus stop floating islands allow buses to stop in-lane, decreasing bus delay and allowing buses to easily re-enter traffic without waiting for a gap in passing motorists. The buffered bike lane is routed behind the bus stop, which prevents conflicts between bicyclists and stopped buses. The bus stop floating islands are accessible, with curb ramps and detectable warning surfaces. Some of the bus stops include railings across the back of the bus islands to encourage pedestrians to cross the bike lane at a designated point.

FOR MORE INFORMATION

American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities*. 2012.

American Association of State Highway and Transportation Officials. *Guide for Geometric Design of Transit Facilities on Highways and Streets*. 2014.

Federal Highway Administration. *Guidance Memorandum on Promoting the Implementation of Proven Safety Countermeasures*. 2012.

Federal Highway Administration. *Manual on Uniform Traffic Control Devices*. 2009.

Federal Highway Administration. *Separated Bike Lane Planning and Design Guide*. 2015.

National Association of City Transportation Officials. *Urban Street Design Guide*. 2013.

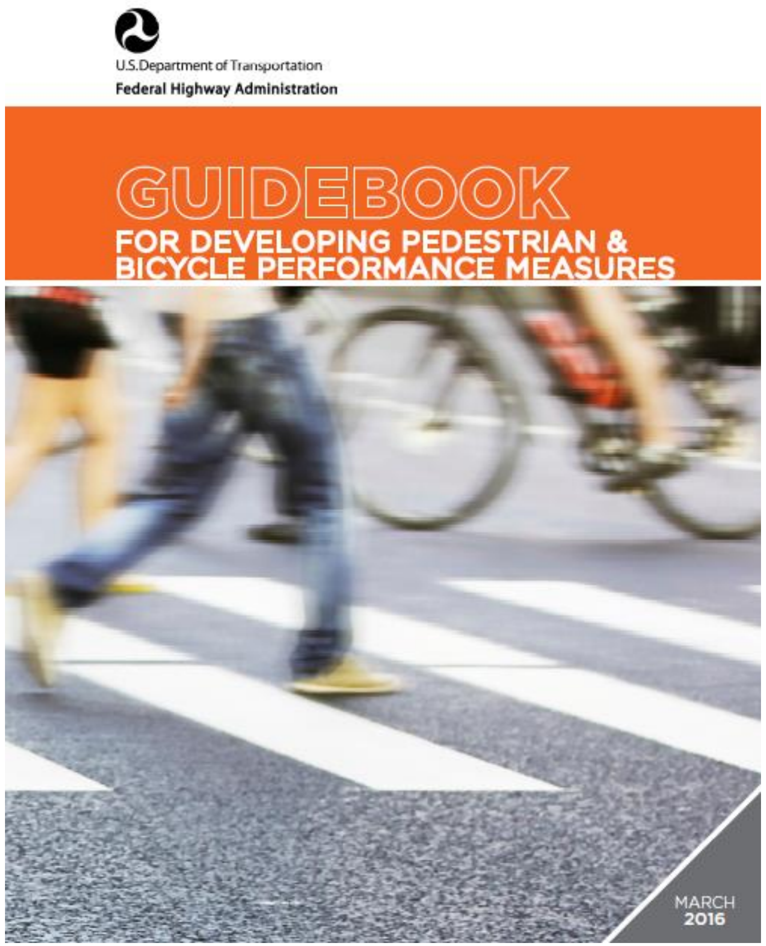
Guidebook for Developing Pedestrian and Bicycle Performance Measures

Documents ways that walking and bicycling investments, activity, and impacts can be measured.

• Highlights data requirements and examples of communities that are currently using the respective measures.

• Links transportation investments to community goals.

• A resource for communities as they develop a performance management strategy.



Performance Measures

- Access to Community Destinations
- Access to Jobs
- Adherence to accessibility laws
- Adherence to traffic laws
- Average travel time
- Average trip length
- Connectivity length
- Crashes
- Crossing Opportunities
- Delay
- Density of Destinations
- Facility Maintenance
- Job creation
- Land consumption
- Land value
- Level of service
- Miles of pedestrian/bicycle facilities
- Mode split
- Network completeness
- Pedestrian space
- Person throughput
- Physical activity and health
- Population served by walk/bike/transit
- Retail impacts
- Route directness
- Street trees
- Transportation disadvantaged population served
- User perceptions
- Vehicle miles traveled impacts
- Volume

VEHICLE MILES TRAVELED (VMT) IMPACTS

The measurement of miles traveled by vehicles in a specific location for a specific period of time. Total VMT has impacts on emissions levels and air quality, which impact public health.

GOALS

- CONNECTIVITY ◯
- ECONOMIC ◯
- ENVIRONMENT ⓧ
- EQUITY ◯
- HEALTH ⓧ
- LIVABILITY ⓧ
- SAFETY ⓧ

RELATED MEASURES

- Average Travel Time
- Average Trip Length
- Density of Destinations
- Mode Split
- Person Throughput
- Volume

CONTEXT

PERFORMANCE MEASURE APPLICATION

PROJECT PRIORITIZATION
Anticipated VMT changes can be calculated for projects and used to rank transportation investments.

ALTERNATIVES COMPARISON (POSSIBLE)
A project's impact on VMT may depend on resulting mode split and changes to the transportation network.

SCENARIO EVALUATION
Measuring VMT at a macro level under various planning scenarios helps describe impacts and benefits.

BENCHMARKING
Annual reporting of VMT will help a transportation agency understand changes in net new or net reduction of vehicle trips.

STANDARD
Using VMT impact to measure a project's impacts focuses on net new vehicle trips rather than delay or capacity.

GEOGRAPHY	PREFERRED	POSSIBLE
STATE	ⓧ	◯
REGION	ⓧ	◯
LOCAL	ⓧ	◯

LAND USE CONTEXT	PREFERRED	POSSIBLE
URBAN	ⓧ	◯
SUBURBAN	ⓧ	◯
RURAL	◯	ⓧ

HOW TO TRACK

VMT is emerging as a strong metric for evaluating transportation impacts. Unlike intersection level of service analysis, VMT impacts focus on additional vehicle trips on the network, irrespective of existing congestion. Whereas traditional methods may discourage infill development, a focus on VMT actually encourages investment in areas that can take advantage of existing walk, bike, and transit infrastructure. "Trips, another obvious and useful measure of the quantity of travel, differs from VMT in length, making VMT a more convenient measure by which to combine the travel consisting of multiple trips made by many people."[69] A reduction in VMT also means fewer greenhouse gases and pollutants that are harmful to the environment and public health. FHWA's Congestion Mitigation and Air Quality Improvement (CMAQ) Program supports multimodal projects and other efforts that contribute air quality improvements and provide congestion relief.[70]

VMT can be calculated per capita, an average daily basis, in total, and/or on an annual basis. There are two approaches for calculating VMT:

1. Geographic boundary: use traffic counts to estimate the amount of vehicle travel that occurs within a given geographic boundary. This is the method used to develop the FHWA VMT data.
2. Trip generation: use a travel demand model to estimate the vehicle travel of residents living within a given geographic area. An alternative data source is household surveys. Travel model data can include trips produced by and/or attracted to an area, for all trip purposes (e.g., work, school, shopping, etc.).

A rural community may need to rely on a statewide travel model to estimate VMT.

DATA NEEDS & SOURCES

- Roadway characteristics (e.g., segment length).
- Daily traffic volumes (through counts or from local jurisdiction).
- To estimate VMT for projects and land use scenarios, access sketch models or regional or State travel demand models.
- State DOT, MPO, and the FHWA Office of Highway Policy Information may have relevant data.

PEERS TRACKING THE MEASURE

- Memphis MPO – The Long Range Transportation Plan goal related to congestion has performance measures that track whether the number of vehicle miles traveled annually is decreasing per capita and whether the number of work commute trips made by bicycling, walking, or transit is increasing.
- State of California – New draft CEQA guidelines from the Governor's Office of Planning and Research require that environmental review of transportation impacts is measured by changes to VMT, not automobile level of service.
- Denver Regional Council of Governments – DRCOG's Metro Vision 2035 Plan identifies a 10 percent reduction in VMT per capita by 2035.
- Puget Sound Regional Council (Seattle, WA) – the Council's Transportation 2040 refers to the VMT goal and target reduction established in State legislation: RCW 47.01.440 establishes statewide annual per capita reduction benchmarks for vehicle miles traveled. The legislation established the forecast baseline of statewide vehicle miles traveled of 75 billion by the year 2020, exempting trucks over 10,000 pounds, with a targeted reduction of 18 percent by 2020, 30 percent by 2035, and 50 percent by 2050.

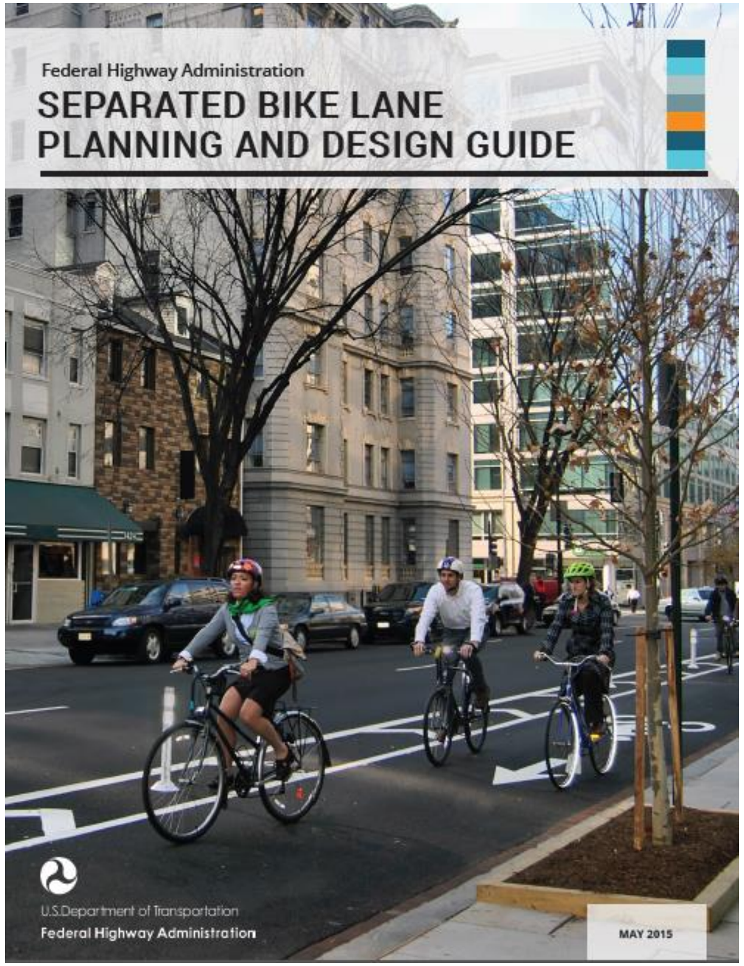
NOTES

The Environmental Protection Agency's Mixed-Use Trip Generation Model may be used to help estimate the trip-generation impacts of mixed-use developments.

Separated Bike Lane Planning and Design Guide

The what and why of separated bike lanes.

- Planning Separated Bike Lanes
  - ✓Location
  - ✓Funding, maintenance, outreach
  - ✓Evaluation



Separated bike lanes fill needs in creating low stress bicycle networks.

Planning: Choosing Locations

- Are cyclists already using corridor?
- Connect Origins and Destinations
- Improve connections for disadvantaged populations
- In context with on-street parking? Transit? Loading/unloading?
- Pilot projects with flex posts allow for adjustments after implementation.

With newer, complex facility types, design tweaks can be expected and are not indicative of a failed design.

Planning: Funding, Maintenance and Outreach

CASE STUDY

BID Support for Separated Bike Lanes

Philadelphia, PA and Miami, FL

The City of Philadelphia and the Center City District temporarily closed one lane (at left) on Market Street to demonstrate the impacts of adding a separated bike lane. (Source: Dylan Semler)

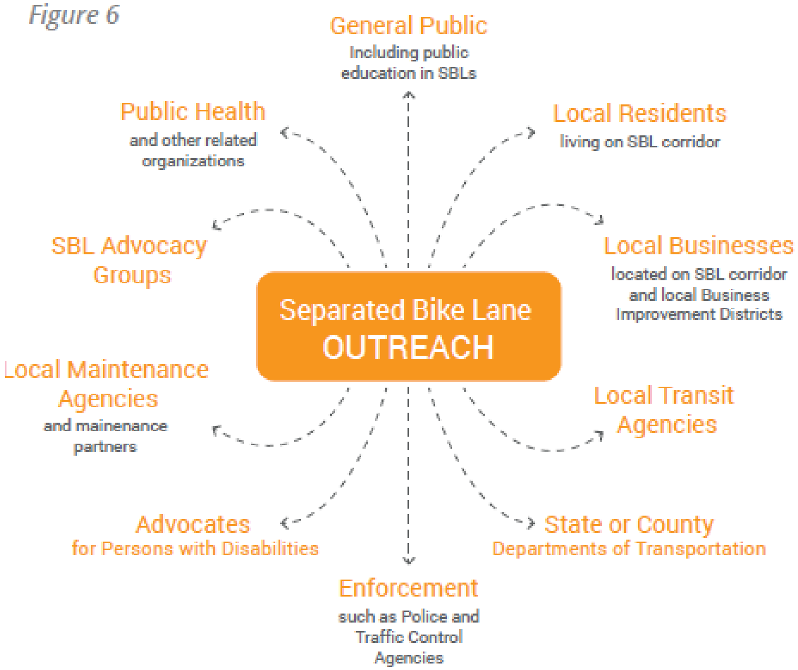
CASE STUDY

Sweeper Selection for Separated Bike Lane Maintenance

Nationwide

Narrow sweepers like this one can fit into most separated bike lanes (Source: PeopleForBikes)

Figure 6



Project Evaluation

- Holistic Evaluation of Separated Bike Lanes
- Best Practices on Data Collection

CASE STUDY

Separated Bike Lane Project Evaluation

New York City, NY

Retail sales grew along New York City's 9th Avenue separated bike lane corridor when compared with comparison corridors without separated bike lanes (Source: NYC DOT)

Design Recommendations

1. Establish directional and width criteria
   - 1 or 2-way, bicycle volume, parking placement
2. Select forms of separation (parked cars, bollards, medians, etc.)
   - Based on street widths, cost, maintenance, motorized traffic volume + speed
3. Identify midblock design challenges and solutions
   - Loading zones, driveways, transit stops
4. Develop intersection design
   - Safe, within sight, guide and prompt

Incorporating On-Road Bicycle Networks into Resurfacing Projects

Recommendations for how roadway agencies can integrate bicycle facilities into their resurfacing program.

- Why Include Bicycle Facilities When Resurfacing?

- Resurfacing Process and Timelines

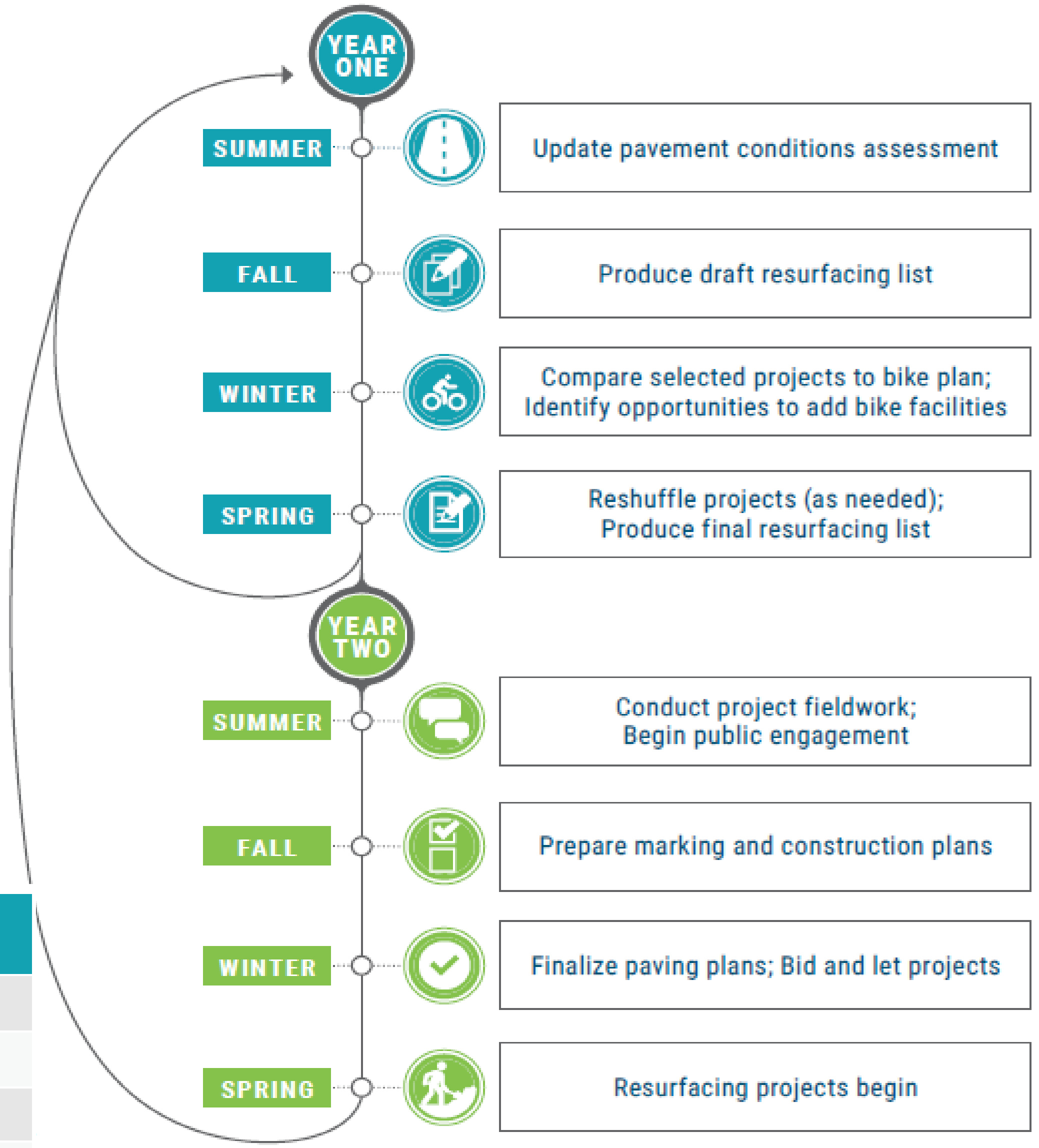
- Methods for Including Bikeways
  - Lane narrowing, roadway reconfiguration, parking removal

- Cost and Material Considerations

Material	Initial Relative Cost $=Low $$$$=High	Lifespan (months)	Retroreflectivity ●=Low ●●●=High
Paint	$	3 – 24	●
Epoxy Paint	$$	24 – 48	●●
Thermoplastic (sprayed)	$$$	48 – 72*	●●
Preformed Tape	$$$$	36 – 96*	●●●

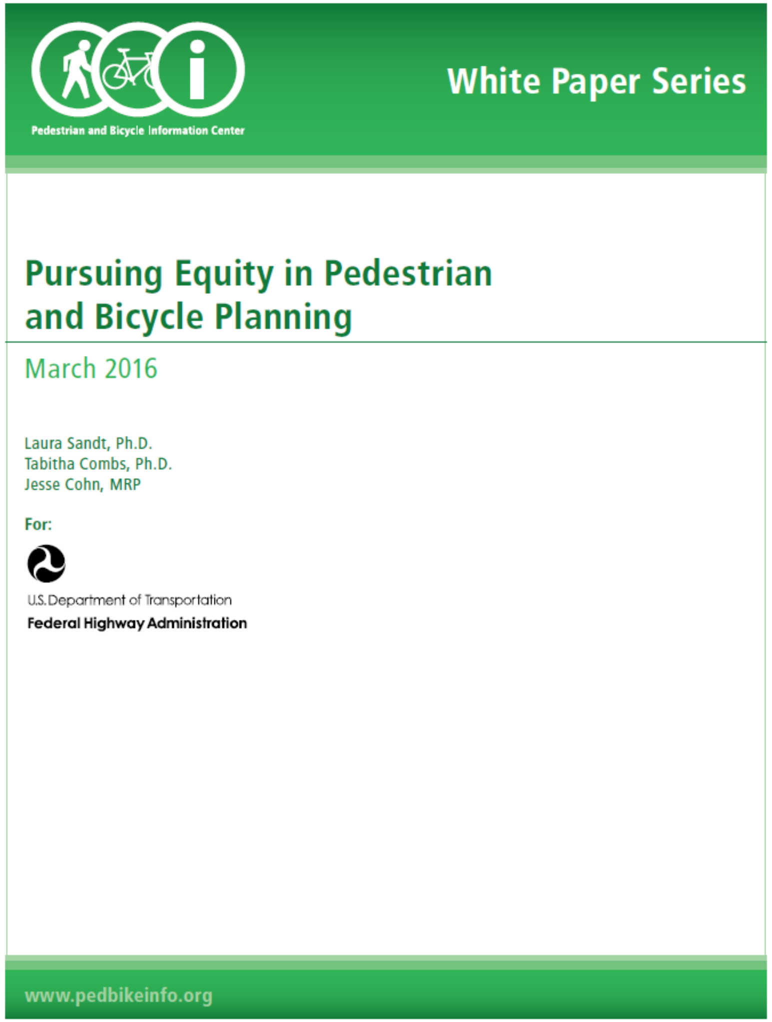
Note: Estimates based on 2014 comparative costs.[7,8]

** Thermoplastic and tape have shortened lifespans in snowy areas where they are often damaged by snowplows.*



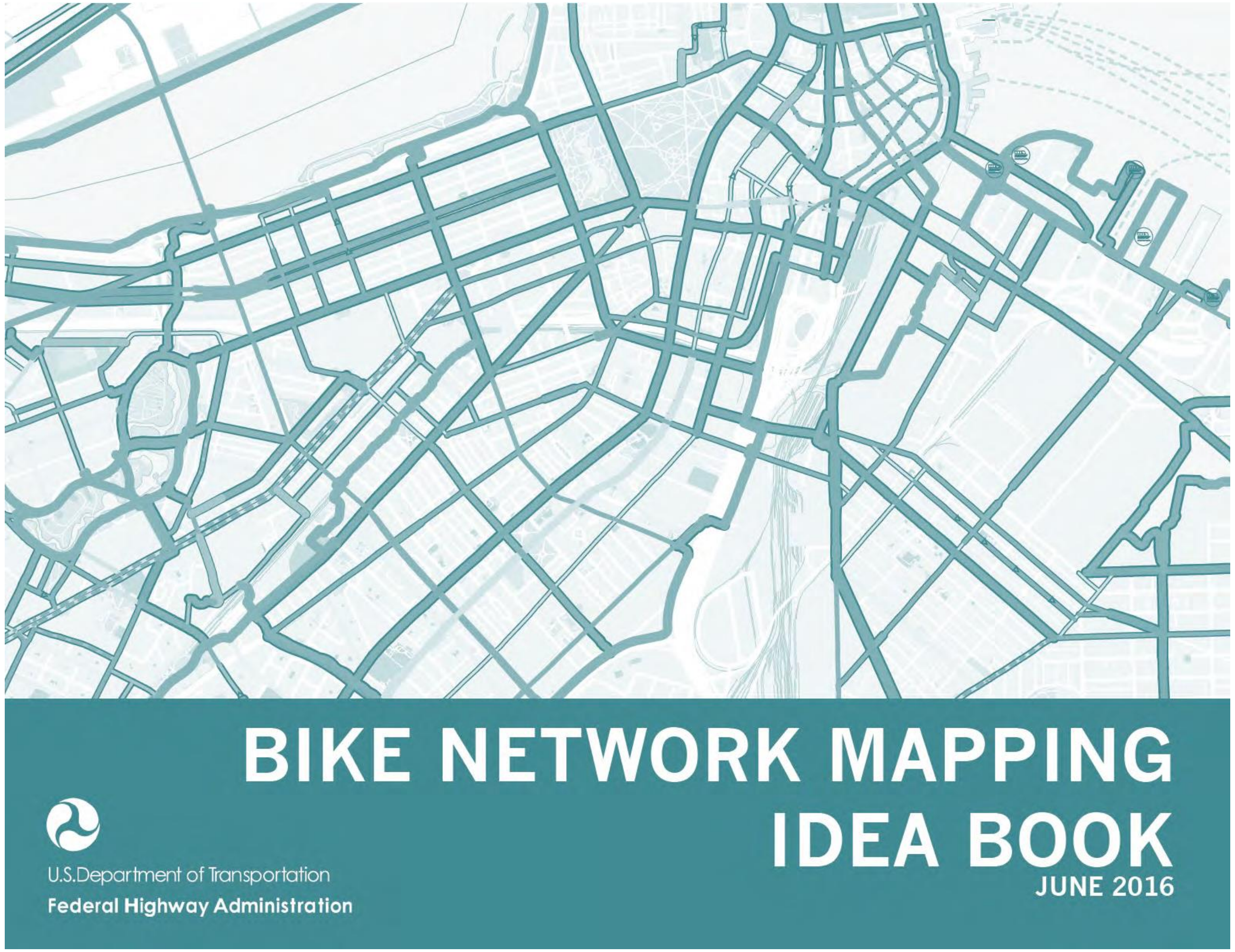
Pursuing Equity in Pedestrian and Bicycle Planning

1. Transportation equity-related terms in the context of pedestrian and bicycle planning.
2. Recent research findings related to the travel needs of traditionally underserved populations and the role of pedestrian and bicycle planning in addressing equity concerns.
3. Strategies, practices and resources to address bicycle & pedestrian planning inequities.

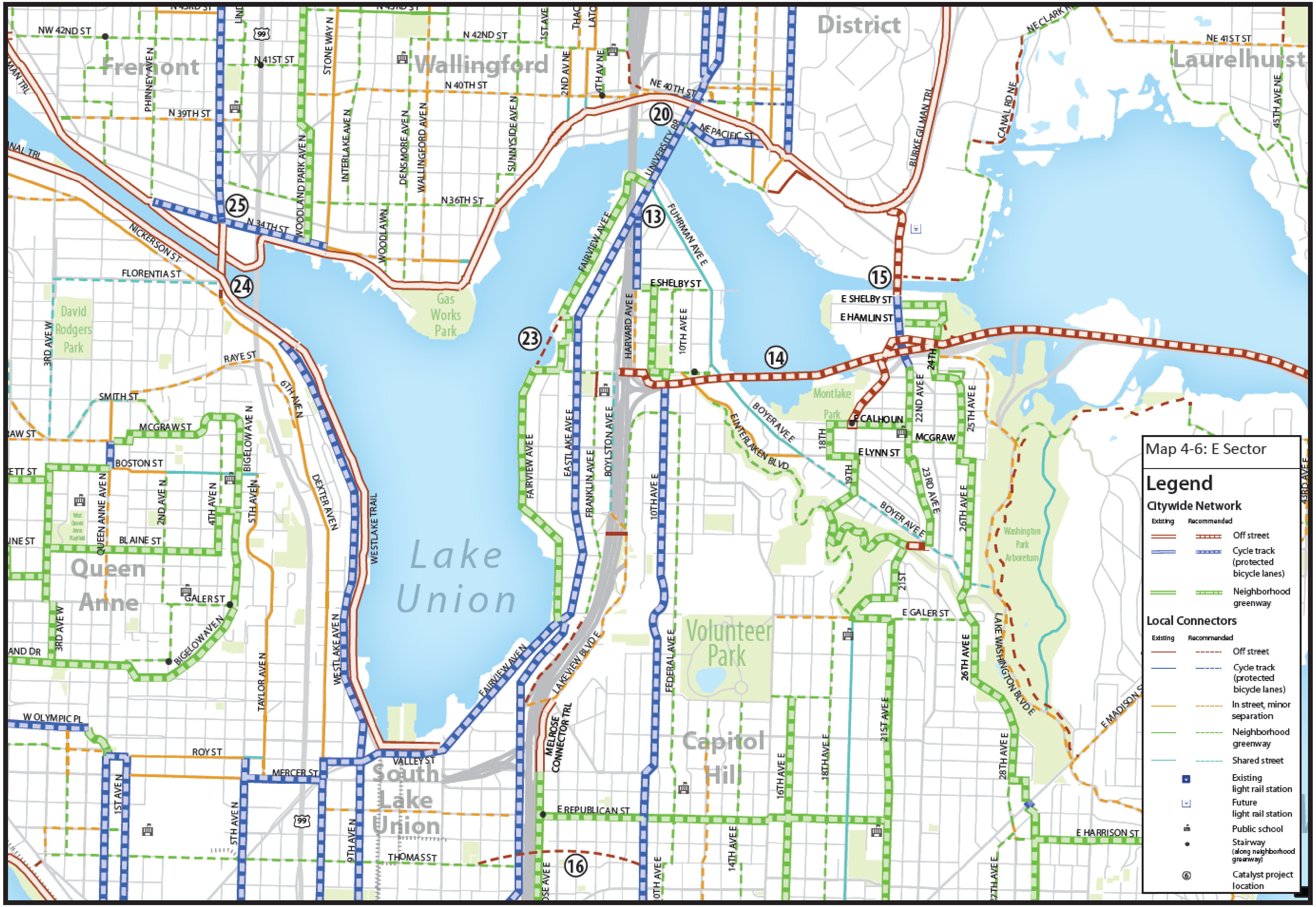


Bike Network Mapping Idea Book

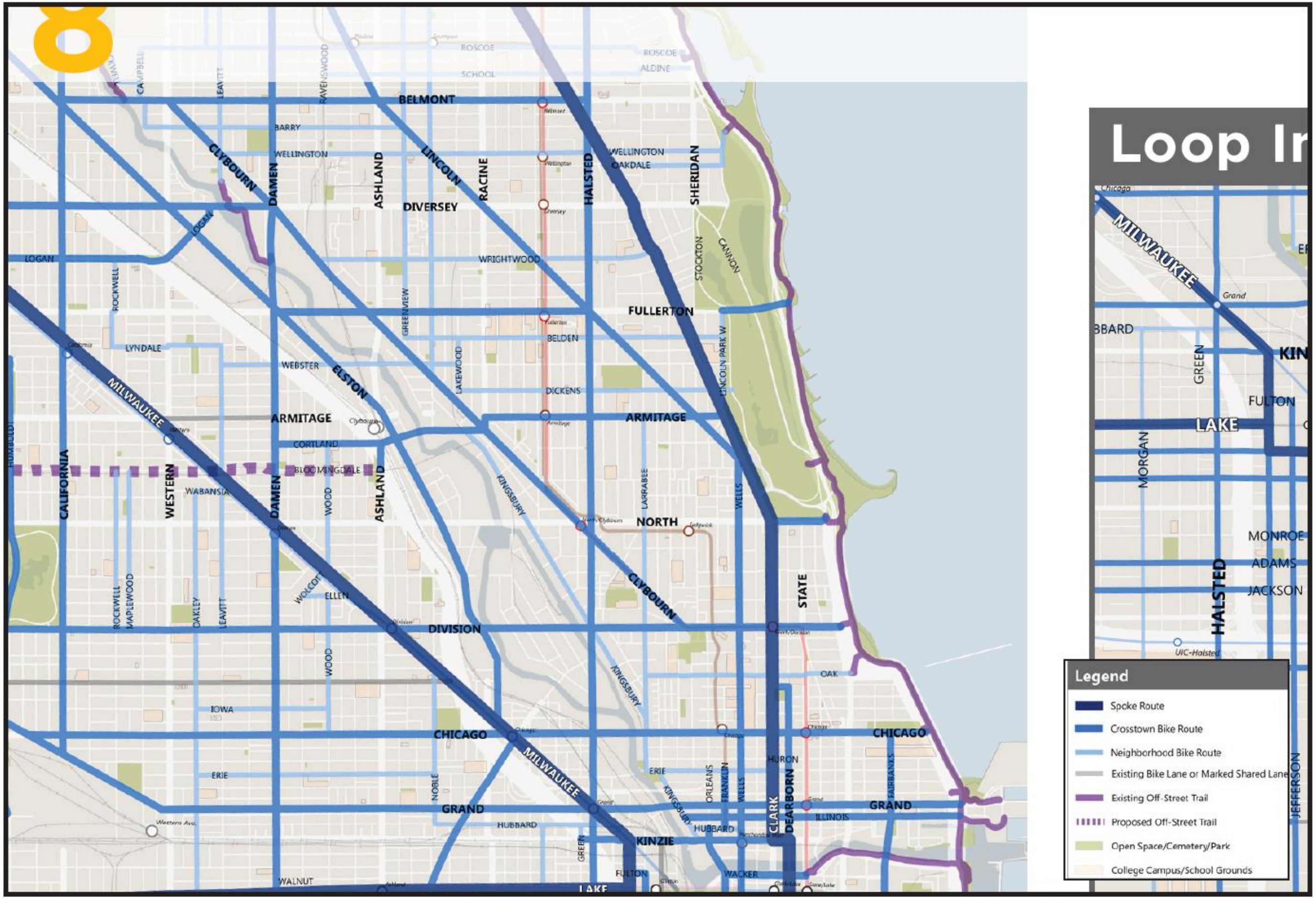
Highlights ways that different communities have mapped their existing and proposed bicycle networks.



Seattle, WA


Map 4-6: E Sector
Legend
Citywide Network
Existing
Recommended
Off street
Cycle track (protected bicycle lanes)
Neighborhood greenway
Local Connectors
Existing
Recommended
Off street
Cycle track (protected bicycle lanes)
In street, minor separation
Neighborhood greenway
Shared street
Existing light rail station
Future light rail station
Public school
Stairway (along neighborhood greenway)
Catalyst project location
Fremont
Wallingford
District
Laurelhurst
Queen Anne
Lake Union
South Lake Union
Capitol Hill
Volunteer Park
Gas Works Park
David Rodgers Park
Montlake Park
Washington Park Arboretum
25
24
23
20
13
15
14
16
NW 42ND ST
N 42ND ST
N 41ST ST
N 40TH ST
N 39TH ST
N 36TH ST
N 34TH ST
NE 40TH ST
NE PACIFIC ST
NE 41ST ST
NE CLARK RD
NICKERSON ST
FLORENTIA ST
RAYE ST
SMITH ST
MCGRAW ST
BOSTON ST
BLAINE ST
GALER ST
W OLYMPIC PL
ROY ST
MERCER ST
VALLEY ST
THOMAS ST
E REPUBLICAN ST
E SHELBY ST
E HAMLIN ST
E CALHOUN
MCGRAW
E LYNN ST
E GALER ST
E HARRISON ST
E MADISON ST
STONE WAY N
WOODLAND PARK AVE N
INTERLAKE AVE N
DENSMORE AVE N
WALLINGFORD AVE N
SUNNYSIDE AVE N
WOODLAWN
PHINNEY AVE N
UNIVERSITY BR
FUHRMAN AVE E
FAIRVIEW AVE E
EASTLAKE AVE E
FRANKLIN AVE E
BOYLSTON AVE E
HARVARD AVE E
10TH AVE E
BOYER AVE E
E INTERLAKEN BLVD
LAKE WASHINGTON BLVD E
BURKE GILMAN TRL
CANAL RD NE
45TH AVE NE
3RD AVE W
QUEEN ANNE AVE N
2ND AVE N
4TH AVE N
5TH AVE N
6TH AVE N
BIGELOW AVE N
DEXTER AVE N
WESTLAKE TRAIL
WESTLAKE AVE N
TAYLOR AVE N
1ST AVE N
9TH AVE N
FAIRVIEW AVE N
LAKEVIEW BLVD E
MELROSE CONNECTOR TRL
FEDERAL AVE E
14TH AVE E
16TH AVE E
18TH AVE E
21ST AVE E
22ND AVE E
23RD AVE E
25TH AVE E
26TH AVE E
28TH AVE E
43RD AVE E
99

Chicago, IL



BELMONT
BARRY
WELLINGTON
DIVERSEY
LOGAN
WRIGHTWOOD
FULLERTON
BELDEN
LYNDALE
WEBSTER
DICKENS
ARMITAGE
CORTLAND
BLOOMINGDALE
WABANSIA
NORTH
DIVISION
OAK
IOWA
CHICAGO
HURON
ERIE
GRAND
ILLINOIS
HUBBARD
KINZIE
FULTON
WACKER
WALNUT
LAKE
ROSCOE
SCHOOL
ALDINE
OAKDALE
CLYBOURN
LINCOLN
ELSTON
MILWAUKEE
KINGSBURY
CALIFORNIA
WESTERN
DAMEN
ASHLAND
RACINE
HALSTED
SHERIDAN
STOCKTON
CANNON
LINCOLN PARK W
WELLS
STATE
CLARK
DEARBORN
LARRABEE
ORLEANS
FRANKLIN
FAIRBANKS
NOBLE
WOOD
WOLCOTT
ELLEN
ROCKWELL
MAPLEWOOD
OAKLEY
LEAVITT
GREENVIEW
LAKEWOOD
CAMPBELL
RAVENSWOOD
GREEN
Loop In
MILWAUKEE
Grand
KIN
GREEN
FULTON
LAKE
MORGAN
MONROE
ADAMS
JACKSON
HALSTED
UIC-Halsted
JEFFERSON
Legend
Spoke Route
Crosstown Bike Route
Neighborhood Bike Route
Existing Bike Lane or Marked Shared Lane
Existing Off-Street Trail
Proposed Off-Street Trail
Open Space/Cemetery/Park
College Campus/School Grounds

FHWA Bicycle and Pedestrian Program Resources

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/