

Low-stress Bicycle Facility Design Elements

Terminology and Definitions

Research and analysis of what features drive safety benefits and ridership has led to new bike facility styles in the United States, particularly since the early 2000's. This document provides definitions and examples of low-stress bike facility designs that are already in place in Bend, Oregon. This briefing uses common terminology to increase familiarity with these terms and allow easier communication.



Parking-protected bike lane



CITY OF BEND

Level of Traffic Stress

In 2018, ODOT adopted Level of Traffic Stress in their Analysis Procedures Manual¹. This methodology quantifies a roadway's perceived stress using speed of adjacent traffic, presence or absence of on-street parking, separation from traffic, intersection approach, and the intersection control type itself. Intersection approach characteristics that are included in the analysis include posted speed of the road; presence or absence of left- and right-turn lanes; and required rider position and interaction with traffic.

Intersection approaches that require interaction with traffic such as lane changing, "taking-the-lane," or the need to cross conflicting-streams of traffic, often in a negotiation for who has the right-of-way, increase the stress level of the intersection approach and decrease safety. Intersection control types covered in the analysis include signal, roundabout, and stop control.

For two-way stop control, the type of help provided to get across the street and what kind of street is crossed are included. Presence of a safety island, number of lanes to cross, and speed of the road crossed are assessed and quantified. The more help there is to cross the street (safety island, etc.) and the easier the street is to cross (fewer lanes, slower speed), the lower the LTS assigned will be. The assigned LTS is the worse of the road leading up to the intersection, the approach or crossing's LTS.

The higher the LTS, the fewer people can use the facility.

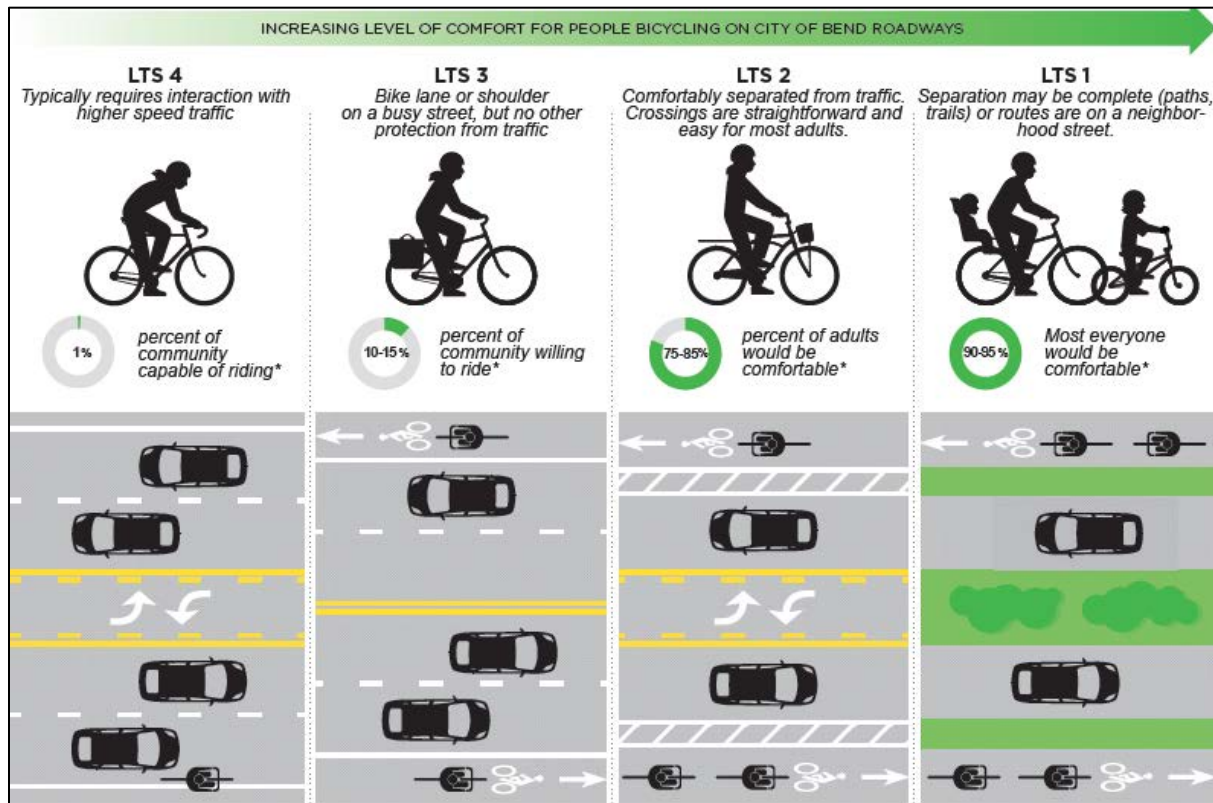


Figure 1 Level of Traffic Stress (LTS) and its impact on riding

¹ Oregon Department of Transportation, Analysis Procedures Manual, Version 2, Chapter 14, Multimodal Analysis, <https://www.oregon.gov/ODOT/Planning/Pages/APM.aspx>;

Peter Furth, Northeastern University, "Network Connectivity and Low-stress Bicycling," Transportation Research Board 2013 Annual Meeting.

Bicycle Rider Types

Based on research², bicycle facility designers now categorize community members who will use a bicycle as a means of transportation (rather than for recreation) into four categories:

Strong and Fearless rider types are very comfortable on almost any urban street, regardless of bike facility type. In any community, there are typically very few riders who fall into this category – in many communities this number is less than 1% of the population.

Enthusied and Confident rider types are comfortable with bike lanes on most streets (speed will influence their comfort). In any community, less than 10% fall into this category.

Interested but Concerned rider types are not very comfortable with bike lanes and are particularly sensitive to speed of traffic and the need to interact with traffic. These riders will bike on separated facilities, such as trails or paths, or on their own neighborhood streets. This is the largest segment of transportation riders and comprises up to 60% of the community.

No Way, No How rider types are people who cannot ride because of a physical condition, or are simply not interested in riding a bicycle. It could be they do not have exposure to riding, drive for a living such as a delivery driver, or may not own a bicycle. This category is between 25 and 37% of a community.

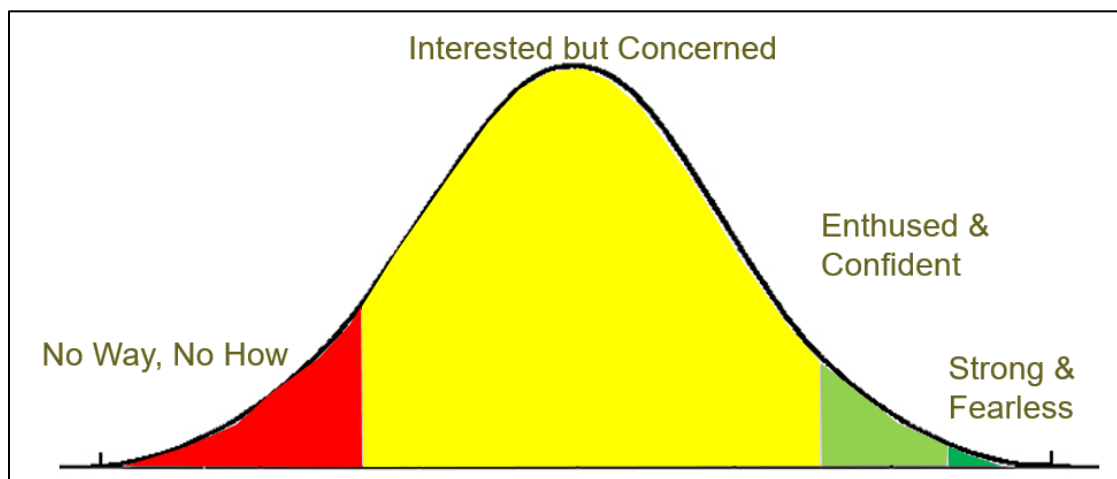


Figure 2 Rider types and their proportion within a community

Categorization into one particular rider type is fluid. As time allows people to practice riding and gain experience, people can move from *Interested but Concerned* to *Enthusied and Confident* and from *Enthusied and Confident* to *Strong and Fearless*. Portland, Oregon surveys, for example, estimate up to 6% of their commuting bike riders are now *Strong and Fearless*, principally moving up from the *Enthusied and Confident* rider type. Just as experience and practice can move a person up a category, however, the opposite is also true. Family dynamics such as having children can alter one's perception of riding facility acceptability. In addition, near collisions and fatal or serious injury crashes within a community can move a person down a category and suppress their willingness to ride for transportation.

² Roger Geller, "Four Types of Cyclists," <https://www.portlandoregon.gov/transportation/article/237507>;
Jennifer Dill, Nathan McNeil, "Four Types of Cyclists? Examination of Typology for Better Understanding of Bicycling Behavior and Potential," *Transportation Research Record: Journal of the Transportation Research Board*, 2387:129-138, 2013.

Neighborhood Greenways

These are select neighborhood streets that have slow speeds and few cars. They are typically located parallel to busier arterial and collector roadways. Cities may choose to route bike riders onto them to create low-stress routes throughout the community. Just like any other local street, neighborhood greenways typically have on-street parking. However, unlike most residential streets, their proximity to busier arterial and collector roadways, and their continuity, may also be enticing drivers to use these particular neighborhood streets as a short-cut through the neighborhood to avoid delay. Using streets with cut-through drivers as neighborhood greenway routes will require speed and traffic volume management with traffic calming devices such as speed humps and traffic circles. Traffic calming can increase livability by removing traffic intrusion and allowing speeds compatible with the residential nature of the street.



Example of signs
Credit: BikePortland

Figure 3 20 mph posted speeds are allowed on neighborhood greenways in Oregon

Neighborhood greenways are one way to provide longer routes of low-stress travel in a cost-effective manner to connect schools, parks, business districts and trailheads. The route provides help crossing busy streets in the form of crosswalks, signs and may need additional help such as flashing beacons.

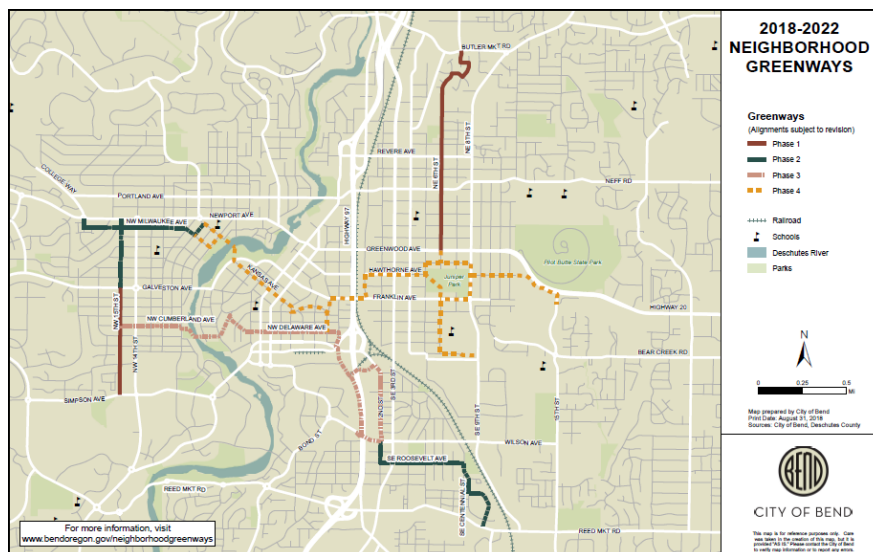


Figure 4 An initial network of neighborhood greenways in the city's capital program



Figure 5 NE Daggett Lane in Bend, Oregon has traffic calming and connects people to a school and a park

Basic Bicycle Lanes

Basic bike lanes (defined by an 8" white stripe and bike lane markings) are currently the standard bike lane type for on all arterial and collector roadways, no matter the posted speed of the road. The standard bike lane width in Bend, Oregon is 6' wide, but are often narrower, depending on the overall roadway width and the number of lanes. They are typically high-stress because the rider operates in close proximity to traffic.

They can be low-stress on low-speed roads and when wide enough.

Basic bike lanes on a two- or three-lane road have the following Levels of Traffic Stress³:

Posted Speed	Bike Lane Width less than or equal to 5.5'	Bike Lane Width 5.5' to 7'
20, 25, 30 mph	LTS 2	LTS 1
35 mph	LTS 3	LTS 3
40 mph, 45 mph	LTS 4	LTS 4

Any basic bike lane on a four- or five-lane road are high stress as noted below⁴:

Posted Speed	Bike Lane Width less than 7'
20, 25, 30 mph	LTS 3
35 mph	LTS 3
40 mph, 45 mph	LTS 4



Figure 6 The basic bike lane on NE 8th Street is high-stress because it is on a 35 mph roadway and is narrow

³ Oregon Department of Transportation, Analysis Procedures Manual, Version 2, Chapter 14, Multimodal Analysis, <https://www.oregon.gov/ODOT/Planning/Pages/APM.aspx>;

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Separated Bike Facilities

A category of bike lane that increases separation between cars and bike riders. Separated bike lanes provide less stressful riding conditions. They provide separation by paint, or by using on-street parking. Some communities have created the separation by using a vertical element such as a curb. They are typically one-way but can be two-way through special design techniques.

Interested but Concerned rider types desire a greater degree of separation between themselves and adjacent traffic. Separated bikeways appeal to the largest segment of current and potential bike riders for transportation purposes.

Buffered Bike Lanes

Buffered bike lanes are basic bike lanes paired with a painted buffer space to provide more separation between riders and adjacent motor vehicle traffic and/or parking lane. Riding further from traffic, and outside of the car door-opening zone creates a safer, more comfortable experience. Buffered bike lanes are the simplest form of a separated bike facility and are the least expensive to construct and maintain. In Bend, Oregon, buffered bike lanes facilitate street sweeping and snow plowing with equipment typically available to the public works crews.

At low speeds (20, 25 and 30 mph) buffered bike lanes at least 7' in width provide an LTS 1 experience.

Every intersection and driveway is a point where traffic must cross each other's travel paths. Buffered bike lanes are a good compromise to a more separated facility when there are frequent driveways.



Figure 7 In 2018, the City reconstructed NW 14th Street in Bend to provide separated bikeways. The new design incorporated buffered bike lanes and wide sidewalks

Parking Protected Bike Lane

Parking protected bike lanes are a form of a separated bicycle facility. Where on-street parking exists, and roadways have adequate width, the bike lane and on-street parking lane can switch positions.

The on-street parking provides a physical barrier between people riding bikes and vehicle traffic. There is a buffer between the parking lane and the bike lane, which serves as the car-door zone and facilitates ingress or egress from the passenger side of the vehicle. This buffer prevents open vehicle doors from obstructing the bike lane. The bike lane may be one-way or two-way. Two-way parking protected bikeways are helpful to connect trails or paths. They are most often used on one-way streets. They can also be used to connect neighborhood greenways that jog for a short-distance along the arterial or collector road.

At speeds of 20 and 25 mph there is not typically a need for an additional buffer space between the parked car and the moving traffic lane. At 35 mph, this additional buffer can make getting into and out of the vehicle on the driver's side more comfortable. At intersections, to ensure visibility of the bike rider and to provide good visibility for the crosswalk, the on-street parking ends. At the intersection, the bike lane could shift towards the road centerline with the use of a curb extension to further increase the visibility of crosswalks.

In Bend, Oregon, parking protected bike lanes facilitate street sweeping and snow plowing with equipment typically available to the public works crews.

Parking protected bike lanes provide an LTS 1 facility.



Figure 8 NW Wall Street in Bend, Oregon is close to downtown and provides a parking protected bike lane

Side Path Bike Facility / Shared Use Sidewalk

Side Paths or Shared Use Sidewalks are a type of separated bicycle facility. They allow people to travel in both directions. They typically look like wide sidewalks that anyone walking or bicycling can use. Their surface can be asphalt or concrete.

Side paths are LTS 1 facilities. They work best on corridors with fewer driveways or intersections to reduce conflicts. When people are riding on the side path in the direction that is against traffic, it is important to ensure sight lines are clear.



Figure 9 Side path along SW Colorado Avenue, in Bend, Oregon

Trails or Paths

Trails or paths are the highest form of separated bicycle facilities. They are off-road, typically located in their own right-of-way, and allow people to travel in both directions. Although, separated from traffic, they can still have roads to cross, but under-crossings or over-crossings are preferred in order to maintain the experience separate from traffic. Their surface can be paved or unpaved. When paved, they are typically asphalt. All trails and paths allow walking, and most in Bend allow bicycling. Some also allow other activities such as Nordic skiing, horseback riding, or snowmobiling. Their surface can be asphalt or concrete.

Trails are LTS 1 facilities. Best practice is to provide grade-separated crossings of any roadways (particularly the busiest roads to be crossed). At a minimum, any at-grade roadway crossing must also be LTS 1 to match that of the trail or path.



Figure 10 The West Bend Trail connects families to schools, and creates a low-stress way to travel



Figure 11 The Larkspur Trail is nearly 4 miles long and is an example of an urban recreational trail that serves commuters