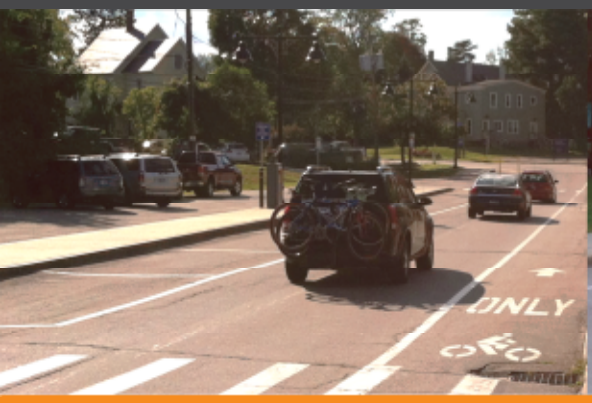
STUDY REPORT

BICYCLE AND PEDESTRIAN IMPROVEMENT PLAN - DURHAM, NH

10.3.2014



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CONTENTS

1.0 INTRODUCTION 1
2.0 GUIDING PRINCIPLES 3
3.0 EXISTING CONDITIONS ASSESSMENT 5
3.1 | Road Segment Assesment 5
3.2 | Inventory 7
4.0 OPPORTUNITIES, CONSTRAINTS, RECOMMENDATIONS 10
4.1 | Study Area General Recommendations 12
4.2 | Madbury Road Recommendations 13
4.3 | Mill Road Recommendations 16
4.4 | Main Street Recommendations 18
4.5 | Pettee Brook Lane Recommendations 21
4.6 | Coe Drive (Woodman/Dennison) Recommendations 23
4.7 | Bagdad Road Recommendations 25
4.8 | Garrison Avenue 25
4.9 | Edgewood Road (0.85 Miles) 25
5.0 DESIGN NEEDS – GUIDELINES FOR PEDESTRIAN AND BICYCLE FACILITIES 26

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FIGURE 2: TOWN OF DURHAM ROAD SEGMENTS 2
FIGURE 3: BICYCLE LANE, CROSSWALK, AND SIDEWALKS IN DURHAM 4
FIGURE 4: AVERAGE ANNUAL DAILY TRAFFIC (AADT) BY ROAD SEGMENT 7
FIGURE 5: MAIN STREET VEHICLE SPEEDS 8

FIGURE 6: NHDOT VEHICLE/PEDESTRIAN & BICYCLE CRASHES 2008 - 2013 9
FIGURE 7: OPPORTUNITIES & CHALLENGES 11
FIGURE 8: TYPICAL CROSS-SECTION WITH SHARED USE LANES (LEFT) AND BICYCLE LANES (RIGHT) 13
FIGURE 9: VEIW LOOKING NORTH ON MADBURY ROAD TOWARDS PETTEE BROOK LANE 14
FIGURE 10: MADBURY-PETTEE BROOK IMPROVEMENT 14
FIGURE 11: MADBURY ROAD NORTH OF GARRISON AVENUE 15
FIGURE 12: RECOMMENDED BICYCLE LANE INTERSECTION CROSSING MARKINGS 15
FIGURE 13: MILL STREET/MAIN STREET INTERSECTION RECOMMENDATIONS 16
FIGURE 14: RECOMMENDED SIDEWALK LOCATION ON MILL ROAD 17
FIGURE 15: MAIN STREET IMPROVEMENT PLAN 18
FIGURE 16: TWO LANE - SHARED LANE OPTION 19
FIGURE 17: MAIN - MADBURY BIKE LANE CROSSOVER 20
FIGURE 18: MAIN - MADBURY SHARED LANE CROSSOVER 20
FIGURE 19: PETTEE BROOK LANE – MAIN STREET IMPROVEMENT PLAN 21
FIGURE 20: MAIN/PETTEE BROOK/QUAD ROUNDABOUT CONCEPT 22
FIGURE 21: WOODMAN-DENNISON IMPROVEMENT PLAN 24

APPENDICIES

APPENDIX A. DRAWINGS

APPENDIX B. CRASH DATA

APPENDIX C NATIONAL DESIGN MANUALS

1.0 INTRODUCTION

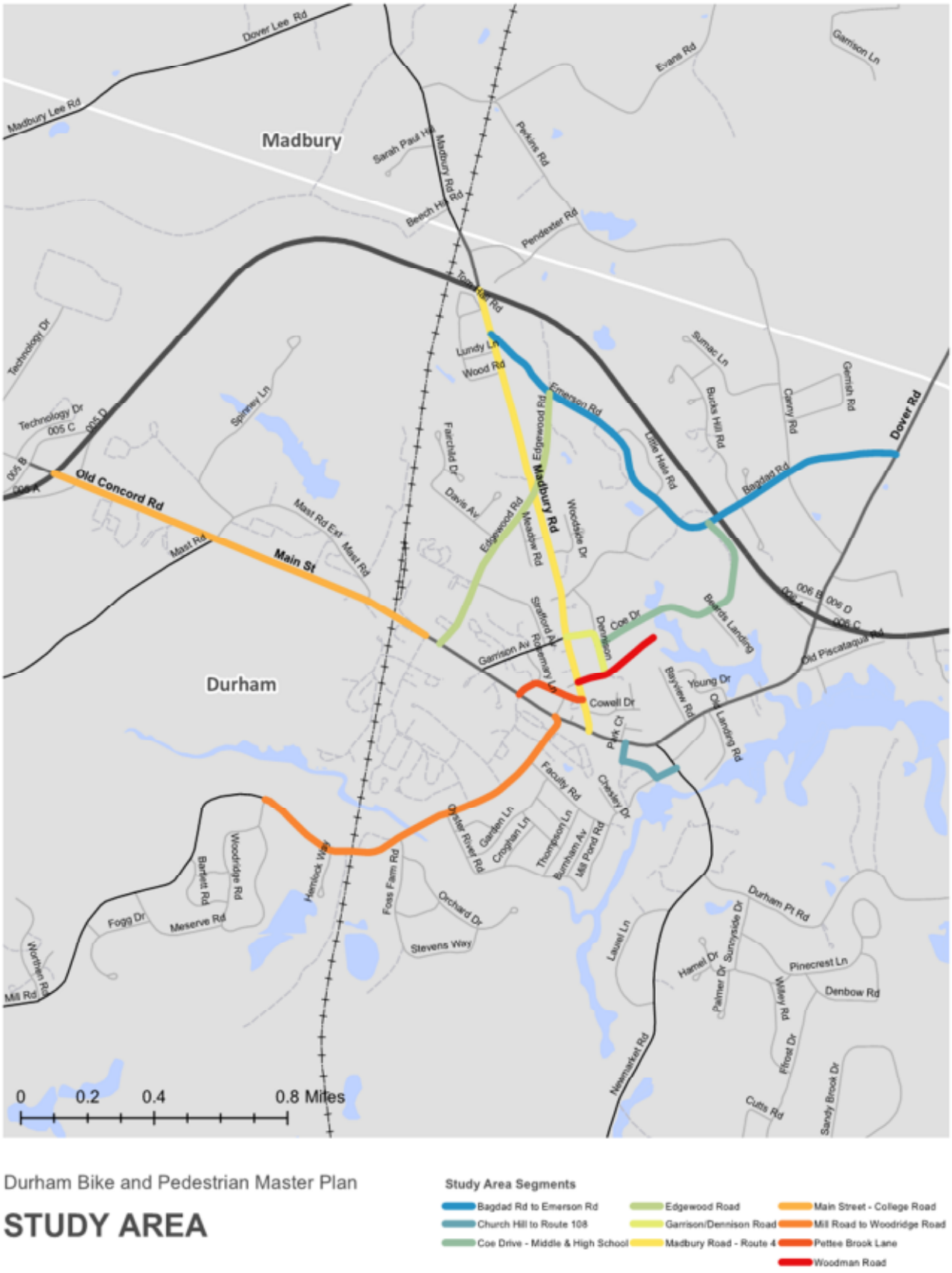
Nationally and across New Hampshire, there is an increasing interest in promoting cycling and walking as legitimate forms of alternative transportation as well as recreation. Some of this interest is heath related. As people exercise more, they become stronger, healthier individuals. Some of this interest is tied to strengthening the social fabric of the community. As people walk and bicycle more, they are more likely to interact with and get to know their neighbors. Some of this interest is traffic related. If safe locations can be created for cyclists and walkers within the transportation system, a certain volume of traffic will be removed from the local road network, reducing fuel usage, congestion, and improving air quality conditions.

The goal of this report is to develop a targeted plan of guidelines and recommendations for improving bicycle and pedestrian facilities throughout the Town

The walking and bicycling conditions in the Town of Durham's downtown core have been improving incrementally over the years. The Town is looking comprehensively at the network of bicycling and walking facilities to create a unified set of recommendations for the future implementation of improvements to enhance mobility options and safety for cyclists and pedestrians throughout Durham. In recognizing the need to improve bicycle and pedestrian safety and connectivity, the Town began a planning and implementation process to provide more visible, convenient, and safe connections between neighborhoods, the downtown, the middle and high schools, and the library. A part of that process is to evaluate a targeted selection of streets and create a set of recommendations that will make it more comfortable for a wider range of users to walk and bike throughout town.

FIGURE 1: CYCLIST ON MAIN STREET

FIGURE 2: TOWN OF DURHAM ROAD SEGMENTS



Durham Bike and Pedestrian Master Plan

STUDY AREA

Study Area Segments

- Bagdad Rd to Emerson Rd
- Church Hill to Route 108
- Coe Drive - Middle & High School
- Edgewood Road
- Garrison/Dennison Road
- Madbury Road - Route 4
- Main Street - College Road
- Mill Road to Woodridge Road
- Pettee Brook Lane
- Woodman Road

2.0 GUIDING PRINCIPLES

Below are guiding principles for bicycle and pedestrian designs that are used in the recommendations section of this study. (Technical treatments that pull together best practices by facility type from public agencies and municipalities nationwide are included in Section 5.0.)

- **The walking and bicycling environment will be safe.** All bicycling and walking routes will be physically safe and perceived as safe by all users. Safe means minimal conflicts with external factors, such as noise, vehicular traffic and protruding architectural elements. Safe also means routes are clear and well-marked with appropriate pavement markings and directional signage.
- **The pedestrian and bicycle network will be accessible.** Sidewalks, shared-use paths, bike routes and crosswalks should permit the mobility of residents of all ages and abilities. The pedestrian and bicycle network will employ principles of universal design which refers to facilities and environments that are inherently accessible to older people, people without disabilities and people with disabilities. Bicyclists have a range of skill levels, and facilities will be designed with a goal of providing for inexperienced/recreational bicyclists (especially children and seniors) to the greatest extent possible.

- **Pedestrian and bicycle network improvements can be economical.** Pedestrian and bicycle improvements can achieve the maximum benefit for their cost, including initial cost and maintenance cost, as well as a reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way will stimulate, reinforce and connect with adjacent private improvements.
- **The pedestrian and bicycle network will connect to places people want to go.** The pedestrian and bicycle network should provide continuous direct routes and convenient connections between destinations such as homes, schools, shopping areas, public services, recreational opportunities and transit. A complete network of on-street bicycling facilities shall connect seamlessly to existing and proposed multi-use trails to complete recreational and commuting routes.
- **The walking and bicycling environment will be clear and easy to use.** Sidewalks, shared-use paths and crossings must allow all people to easily find a direct route to a destination with minimal delays, regardless of whether these persons have mobility, sensory, or cognitive disability impairments. All roads are legal for the use of pedestrians and bicyclists (except freeways, from which each is prohibited unless a separate facility on that right of way is provided). This means that most streets are bicycle facilities and must be designed, marked and maintained accordingly.

- **The walking and bicycling environment can be attractive to enhance community livability.** Good design can integrate with and support the development of complementary uses and should encourage preservation and construction of art, landscaping and other items that add value to communities. These components can include open spaces such as plazas, courtyards and squares, and amenities like street furniture, banners, art, plantings and special paving. These along with historical elements and cultural references, will promote a sense of place. Public activities should be encouraged and the municipal code should permit commercial activities such as dining, vending and advertising when they do not interfere with safety and accessibility, and permit accessible entrance improvements to businesses in the right of way where possible.
- **Design guidelines are flexible and will be applied using professional judgment.** This document references specific national guidelines for bicycle and pedestrian facility design, as well as a number of design treatments not specifically covered under current guidelines. Statutory and regulatory guidance may change. For this reason, the guidance and recommendations in this document function to complement other resources considered during a design process, and in all cases sound engineering judgment must be used.

FIGURE 3: BICYCLE LANE, CROSSWALK, AND SIDEWALKS ON PETTEE BROOK LANE

3.0 EXISTING CONDITIONS ASSESSMENT

3.1 | ROAD SEGMENT ASSESMENT

The Durham Bicycle and Pedestrian Improvement Plan targets specific roadway segments to evaluate. To inventory the conditions throughout the project area, existing conditions were reviewed and are organized into the following eight segments:

MADBURY ROAD (1.37 MILES)

The Madbury Road segment runs from Main Street downtown to US 4. It is a primary connector into and out of the downtown area. There is a wide mix of uses along the segment including civic (post office & library), retail stores, UNH housing, and single family residential homes.

The segment starts at Main Street where it carries one-way travel between Main Street and Pettee Brook Lane. A single, one-directional bicycle lane exists on the east side of the road until the Pettee Brook Lane intersection where the road becomes two-way and bicycle lanes are on both sides of the road. The bike lane widths vary between four and five feet along curbed sections. There is an asphalt sidewalk and parallel parking with a five foot bike lane on the west side of the road and a 5 to 8-foot shoulder on the east side that bicycles and pedestrians share. Heading north past the Garrison Avenue intersection, the roadway width begins to narrow with a 5' wide asphalt sidewalk adjacent to the roadway on the east side, with no marked bicycle lanes. After the intersection with Bagdad Road, a landscape buffer on the east side is present between the roadway and sidewalk. This cross-section continues until just before Edgewood Road when the sidewalk crosses over to the west side and is adjacent to the roadway. This cross-section continues out to US 4.

MILL ROAD (1.1 MILES)

The Mill Road segment runs from Main Street downtown, southwest along the edge of the UNH campus and connects to Packers Falls Road. The land uses along this segment are primarily residential except as it approaches Main Street where there are a variety of retail stores and restaurants. Mill Road also serves as a collector road from campus parking and road network. Mill Road has a sidewalk on the south side of the road for most of its length until it approaches near the campus where sidewalks are present on both sides of the street.

The study segment starts at Main Street and runs westerly to Woodbridge Road. The intersection improvements at Main Street are included in the Main Street Complete Streets Pilot Project. Past this area, the roadway width is approximately 30 feet from curb to curb/edge of pavement between Mill Plaza/UNH Lot C to just north of Foss Farm Road. There is 5 foot wide asphalt sidewalk on the north and south side of the street for the first portion to the UNH Parking Lot C/Mill Plaza driveway, then a 5 foot asphalt sidewalk on the south side of Mill Road for the remainder of the segment. Beyond Foss Farm Road, the road narrows to approximately 24 feet and is variable in width.

MAIN STREET (0.8 MILES)

Main Street runs from US 4 on the western end to NH 108 on the east. It bisects the UNH campus and is a connector route to regional destinations outside of Durham. It travels through the downtown and acts as a local collector for students and residents accessing the downtown. The western portion of Main Street, through campus, has on-road bike lanes that vary between four and five feet wide with curbing and sidewalks on both sides. The bike lanes terminate at Pettee Brook Lane where Main Streets changes to two lanes in one direction (eastbound). During the summer of 2014, a pilot project was implemented that included a lane reduction, reconfigured parking, and a five foot wide painted bike lane between Pettee Brook Lane and Madbury Road. The pilot project was discontinued in September 2014. Bike lanes and sidewalk continue east beyond Madbury Road to NH 108 where a future NHDOT project is planned to provide bike lanes on NH 108.

PETTEE BROOK LANE (0.2 MILES)

Pettee Brook Lane is a short downtown street segment that is part of the one-way downtown loop including Main Street and Madbury Lane. This segment was previously converted from two-lane, one-way to a single lane with parking and five foot wide bike lanes. Like Main Street, this also started as a pilot project with pavement marking changes and then permanently implemented. Due to the one-way direction, there are issues at the intersections with bike lane connections.

COE DRIVE (0.75 MILES)

The Coe Drive segment includes short minor roadways – Denison Road, Woodman Road, and Garrison Avenue, as well as Coe Drive. The Oyster River High School anchors the northern end of this segment with the Oyster River Middle School located midway along the segment. There are varying levels of bicycle and pedestrian facilities along the Coe Drive segment. Bike lanes that vary in width from three to five feet exist on Woodman Road to Dennison Road, Dennison Road to Coe Drive and along Coe Drive to just before the High School. Garrison Avenue is a two-lane, one-way road that exits the Middle School to Madbury Road and prohibits any eastbound access from Dennison Road to Coe Drive. This portion of Garrison Avenue has a sidewalk but no bicycle facilities.

BAGDAD ROAD (0.4 MILES)

The Bagdad Road segment runs from Madbury Road to Emerson Road that accesses the Oyster River High School. The land use in this area is primarily residential. There are sidewalks but no bicycle facilities. The northern portion of Emerson/Bagdad Road as it crosses over US 4 has bike lanes on both sides and is a popular bicycle and walk/run route that ends at the High School.

GARRISON AVENUE (0.1 MILES)

The Garrison Avenue segment consists of two vehicle lanes in a one-way direction (westbound) with a sidewalk on the north side of the street. Starting at the Oyster River Middle School the road intersects with Madbury Road and is the only vehicle exit for the Middle School. Dennison Road is one lane, one way approaching the school from the north and south. No bicycle facilities exist.

EDGEWOOD ROAD (0.85 MILES)

The Edgewood Road segment begins at the intersection of Main Street in the center of the UNH campus and runs northeasterly to Madbury Road. The road continues northeasterly through residential areas to Emerson Road. The southern portion of Edgewood Road has a five-foot sidewalk on the west side of the road and no bicycle facilities. Vehicles often use Edgewood Road to bypass the downtown area. The northern section of Edgewood Road has a wider sidewalk on the east side and is separated from the road by a vegetated grass strip for the majority of its length.

3.2 | INVENTORY

In order to create a pedestrian and bicycle network that functions well for the Durham community and is compatible with its current roads and infrastructure, several factors must be taken into consideration. These factors are summarized below.

ROAD CLASSIFICATION AND OWNERSHIP

With the exception of US 4 and NH 108, which are state-owned and maintained, the majority of roads in the study area are local roads maintained by the Town. Most of the local roads have 11 foot travel lanes and narrow shoulders, much of which is drained via open swale system, although some roads such as Main Street and Pettee Brook Lane have closed drainage.

TRAFFIC VOLUMES

Main Street is the primary east-west connection across the UNH Campus and downtown Durham and receives the highest amount of daily traffic within the study area. Recent traffic volume data from the New Hampshire Department of Transportation, (NHDOT) is summarized in Figure 4 and shows that traffic volumes are heaviest along the Main Street and Madbury Road corridors. The traffic on Mill Road reduces significantly, as it heads south away from downtown.

FIGURE 4: AVERAGE ANNUAL DAILY TRAFFIC (AADT) BY ROAD SEGMENT

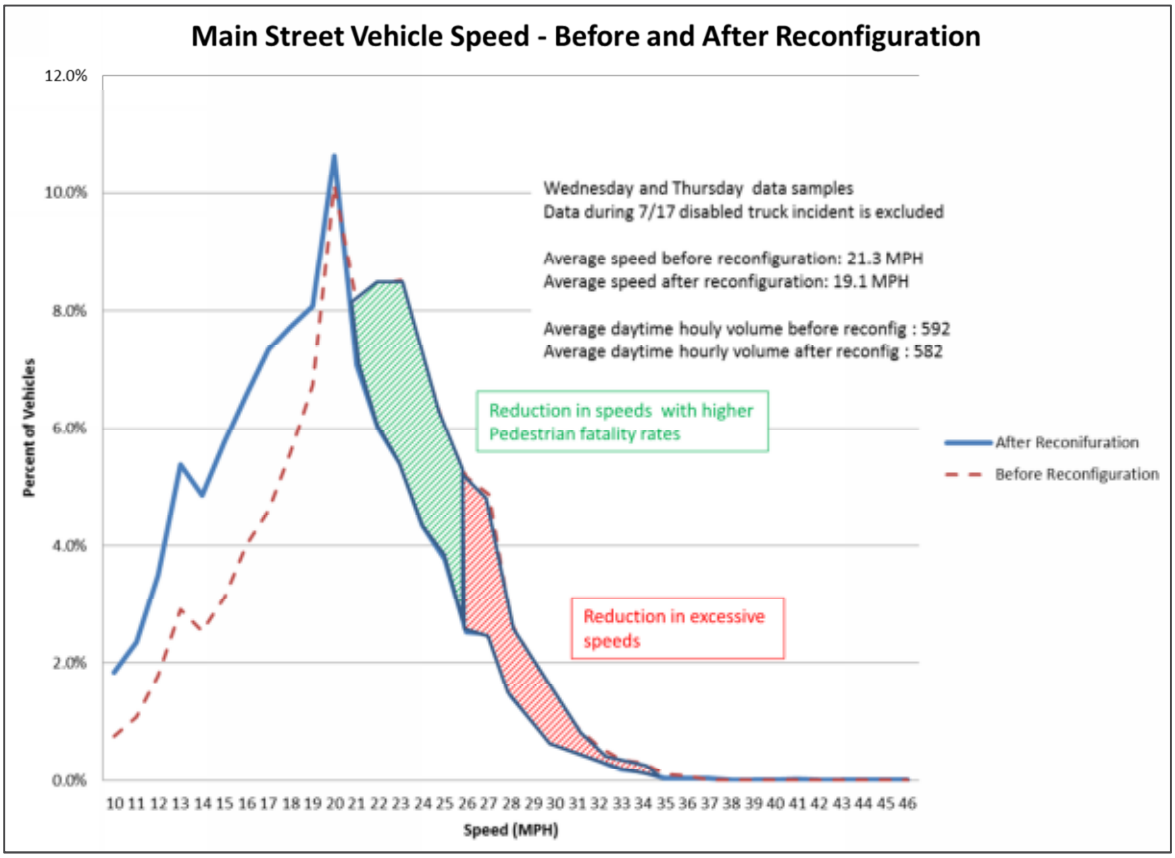
SEGMENT	LOCATION	AVERAGE ANNUAL DAILY TRAFFIC (AADT)	COUNT YEAR
Madbury Road	South of US 4	5,300	2012
Madbury Road	South of Garrison	6,300	2011
Madbury Road	North of Main Street	11,000	2011
Mill Road	South of Main Street	7,600	2010
Mill Road	At RR Bridge	2,300	2012
Main Street	West of NH 108	14,000	2012
Main Street	East of Loop Road (Mast Ext)	9,900	2013
Main Street	West of Garrison	8,600	2012
Main Street	West of Madbury	11,000	2011
Bagdad Road	At Route 4 overpass	1,800	2012
Bagdad Road	East of Dennison	690	2011

TRAFFIC SPEED

The majority of Durham's roads within the study area are posted at 25 miles per hour (mph). Bicycle lanes and shared lanes are appropriate for roads where cars travel at 35 mph or less.

Figure 5 below indicates the vehicle speeds along Main Street east of Pettee Brook Lane before and after the implementation of the summer 2014 lane reconfiguration pilot project. This data shows that the average speed reduced by over two mph (from 21 mph to 19 mph) with the implementation of the reconfiguration.

FIGURE 5: MAIN STREET VEHICLE SPEEDS[1]



[1] Town of Durham Police Department data from the portable radar speed feedback sign

CRASH DATA

The Durham Police Department provided data on bicycle accidents from 2002 to 2014 and is provided in Appendix B of this report. The crash data show the following:

- 41 bicycle accidents were reported in the 11 years between 2002 and July 2014
- An average of 3.73 bicycle-related accidents per year with none occurring in 2003 and seven occurring in 2008
- 15 bicyclists were transported to the hospital with injuries (37% of accidents)
- 21 accidents were attributed to fault of vehicle drivers (51%), 18 to fault of the bicyclists (44%), and two were mutual fault (5%)
- 88% of bicycle-related accidents occurred in daylight
- 85% of bicycle-related accidents occurred in clear weather

Crash history data was obtained for the study area segments from the NHDOT. Figure 6 shows the number of crashes involving vehicles and bicycles/pedestrians over the period from 2008 to 2013. The total number of crashes reported is 24. This is less than the Town's data and it assumed that local crash reports may not have been forwarded or filed with NHDOT.

FIGURE 6: NHDOT VEHICLE/PEDESTRIAN & BICYCLE CRASHES 2008 - 2013

AT INTERSECTION	# CRASHES	ALONG ROADWAY	# CRASHES
Madbury/Pettee Brook	1	Dennison Road	1
Main/Garrison	1	Edgewood Road	1
Main/Edgewood	1	Garrison Avenue	1
Mill Academic	1	Madbury Road	5
		Main Street	8
		Mill Road	3
		Pettee Brook Lane	1

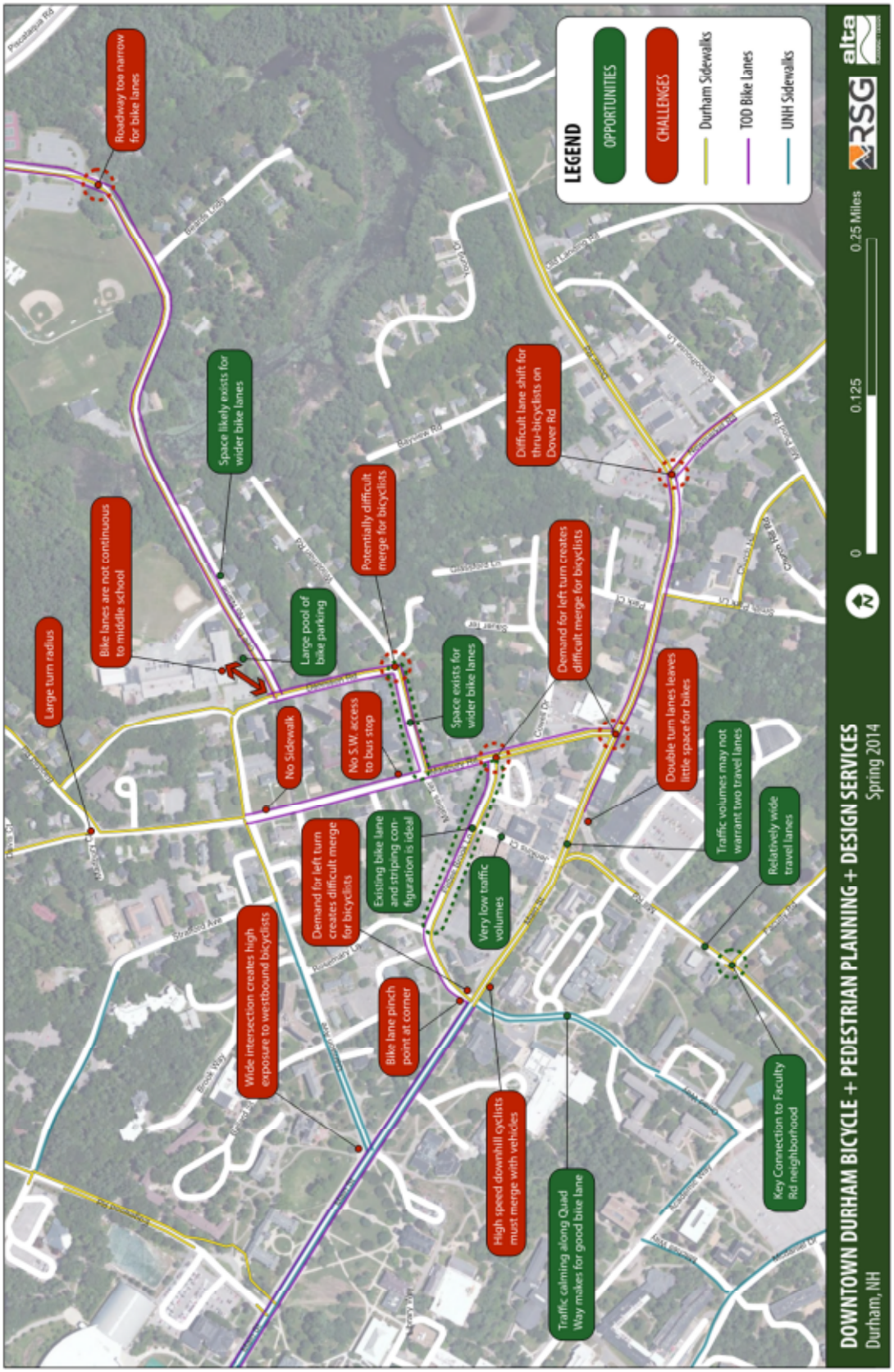
4.0 OPPORTUNITIES, CONSTRAINTS, RECOMMENDATIONS

The growing desire for greater safer walking and bicycling facilities has been an area of focus in Durham's downtown core for a number of years. This area has been transforming in recent years using "complete streets" elements – moving away from vehicle centric roadways, to a street that is safe and accessible for all users and modes of transportation. The Town and UNH have made significant improvements in the downtown core to improve the balance between parking, travel lanes, sidewalks, and bicycle facilities. These improvements include additional bike lanes on Main Street, shared-use lanes on College Road, lane reduction and bike lanes on Pettee Brook Road, and most recently the pilot program for bicycle lanes and lane reductions on Main Street downtown.

Through this study, the Town of Durham is looking to understand and develop recommendations for targeted segments of the network and a comprehensive view of bicycling and walking facilities to create a unified set of recommendations for future improvements in other parts of the Town. The upgrades will make conditions safer and more accessible for a range of users and travel modes.

This section provides a detailed description of specific bicycle and pedestrian facility recommended improvements throughout the study area. These recommendations are based on National Design Manuals that are referenced in Appendix C. The overarching opportunities and challenges of improving the pedestrian and bicycle facilities within the study area is presented in Figure 7and as a larger fold-out map in Appendix A.

FIGURE 7: OPPORTUNITIES & CHALLENGES



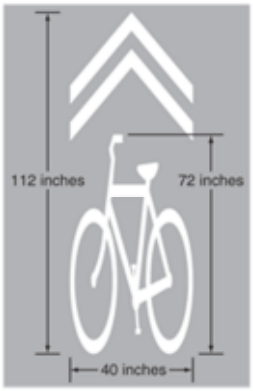
4.1 | STUDY AREA GENERAL RECOMMENDATIONS

PEDESTRIAN FACILITIES

In many locations, the reveal between the edge of roadway and the top of curb at the sidewalk is less than 4 inches. It is recommended to increase the curb reveals to 6 inches by either milling the roadway surface or raising the curbing. This can be done as roadways are reconstructed or re-surfaced.

All new crosswalk locations require the installation of ADA compliant sidewalk ramps

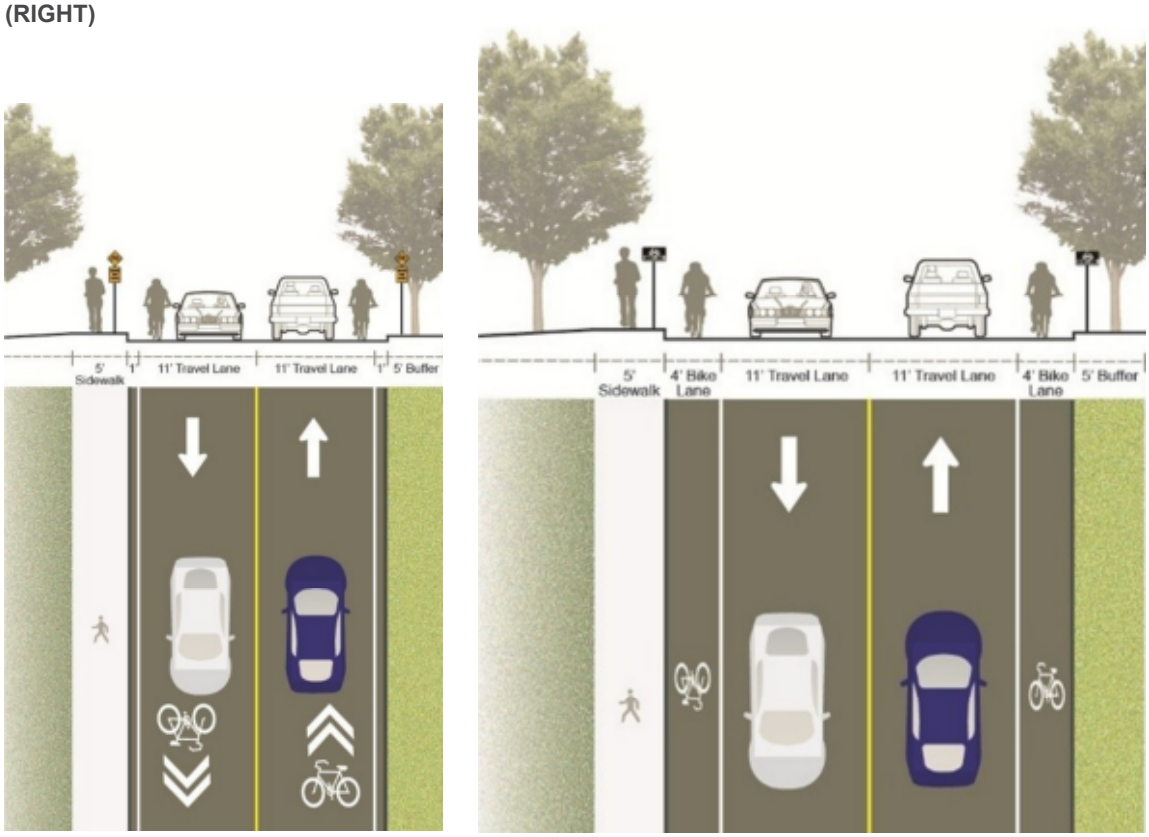
BICYCLE FACILITIES



- **Shared Lanes**: Shared lane marking (SLM) are used to encourage bicycle travel and proper positioning within the travel lane. Like signage, pavement markings can be used to confirm that bicyclist are on a preferred route and alert motorists to the position bicyclists will occupy in the roadway. The proper placement of the SLM marking centerline is 11 feet from the edge of curb where on street parking is present, and 4 feet from the curb with no parking. Placing SLM's between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of treatment. Shared lane markings should be placed immediately after intersections and spaced at most 250 feet apart thereafter. A "Bicycles May Use Full Lane" sign may be used in addition to or instead of the Shared Lane Marking to inform road users that bicyclists might occupy the travel lane.[2]
- **Bike Lanes:** Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is typically located on the right side of the street, between the adjacent travel lane and curb, and is used in the same direction as motor vehicle traffic. Bike lane width shall be a minimum of 5 feet wide when adjacent to a curb. In constrained conditions, 4 foot is permitted adjacent to curb or when no curb is present. Figure 8 below shows a typical roadway section with shared-use lanes and with bicycle lanes and no on-street parking.

[2] Manual on Uniform Traffic Control Devices (MUTCD), Section 9C.07

FIGURE 8: TYPICAL CROSS-SECTION WITH SHARED USE LANES (LEFT) AND BICYCLE LANES (RIGHT)



4.2 | MADBURY ROAD RECOMMENDATIONS

Improve Bicycle Lane Crossing at Pettee Brook Lane: Currently, bicyclists traveling north on Madbury Road from Main Street are forced to cross over two lanes of traffic to connect with the bicycle lane on Pettee Brook Lane (see Figure 9). To enhance cyclist safety transitioning from Madbury Road to Pettee Brook Lane, the recommended configuration would include green-colored bicycle lane segments and a short shared-use lane segment at Pettee Brook Lane (see Figure 10).

FIGURE 9: VIEW LOOKING NORTH ON MADBURY ROAD TOWARDS PETTEE BROOK LANE

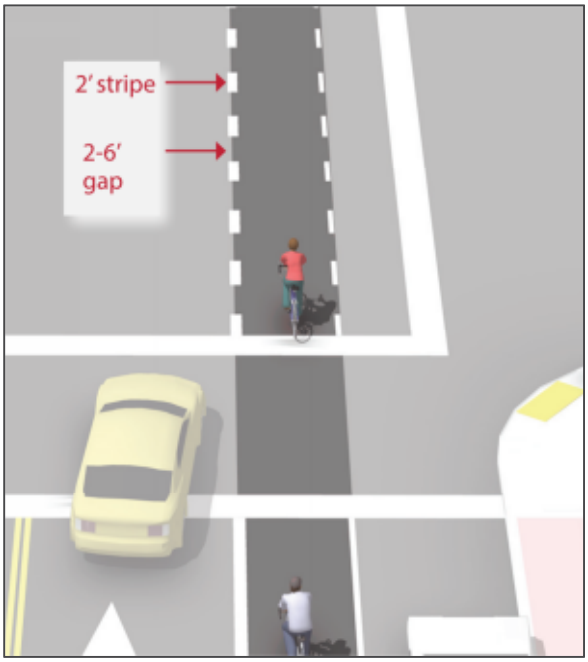
FIGURE 10: MADBURY-PETTEE BROOK IMPROVEMENT

Add bicycle lanes or shared lanes north of Garrison Avenue: North of Garrison Avenue, the Madbury Road shoulder is less than four feet wide in most locations and not wide enough for a full bike lane (Figure 11). The bicycle lane symbols should be removed unless the shoulders are widened to a minimum of four feet in locations with a curb and three feet where there is no curb. Alternatively, Shared Lane Markings can be added to Madbury Road north of Garrison Avenue to identify the travel lane as intended for both bicycles and vehicles.

FIGURE 11: MADBURY ROAD NORTH OF GARRISON AVENUE

Install bicycle pavement markings through intersections: The Madbury Road intersections that have bicycle lanes on both sides (currently Woodman and Garrison) should have pavement markings through the intersections as shown in Figure 12. If bike lanes are extended north of Garrison in the future, pavement markings should be included at the other intersections (i.e. Bagdad, Davis, Woodside, Edgewood, and Emerson).

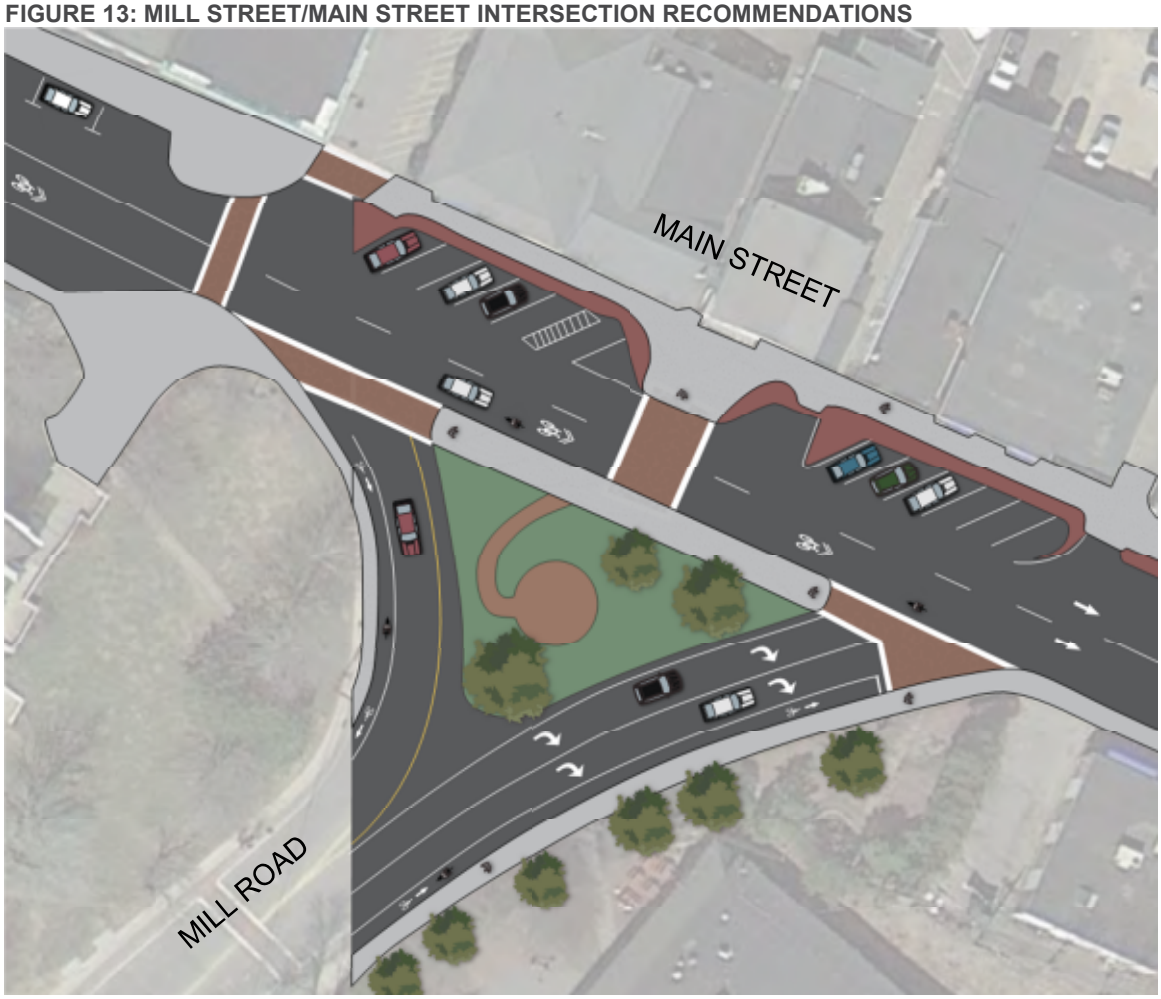
FIGURE 12: RECOMMENDED BICYCLE LANE INTERSECTION CROSSING MARKINGS



4.3 | MILL ROAD RECOMMENDATIONS

Add Bicycle Lanes to Mill Road/Main Street Intersection: In conjunction with the Main Street Complete Street Project, Figure 13 shows recommended bicycle lanes to the right-turn lane onto Mill Road and right-turn onto Main Street from Mill Road As a part of the pilot program installed in summer 2014, the northbound lane approaching Main Street was widened by resetting the granite curbing on the west side. this allowed the room for two right-turn lanes and a bicycle lane.

FIGURE 13: MILL STREET/MAIN STREET INTERSECTION RECOMMENDATIONS

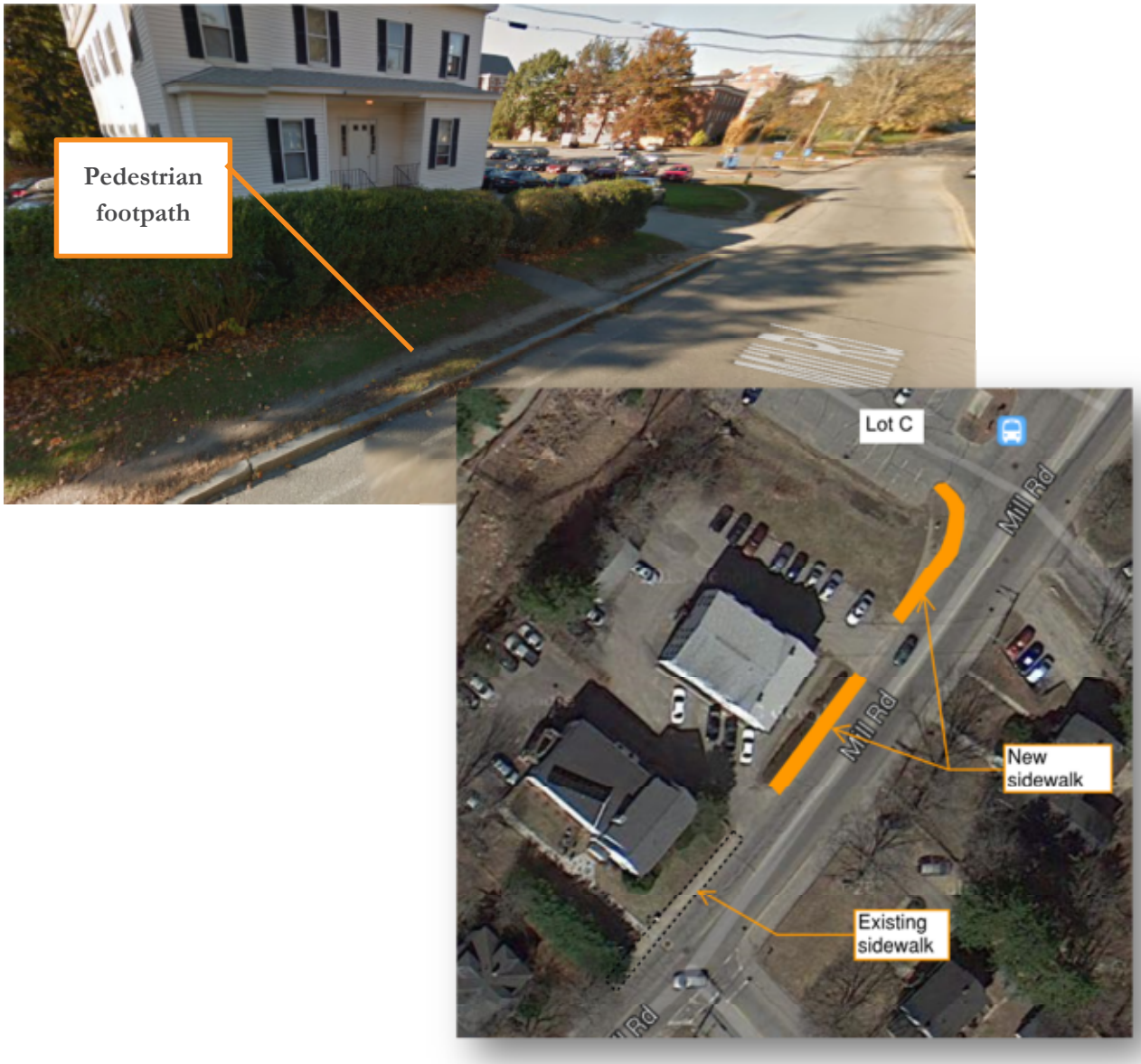


Install bike lanes between Main Street & Foss Farm Road: As shown on the Physical Bicycle & Pedestrian Improvement Summary Map, the 30-foot wide roadway can accommodate a 4 foot bicycle lane and 11 foot vehicle travel lanes. Improvements should include restriping pavement, bicycle pavement markings, and related signage (see typical section in Figure 8).

Install shared-use lanes between Foss Farm Road & Woodbridge Road: The portion of roadway from Foss Farm Road east to Woodbridge Road is approximately 24 feet wide and can accommodate shared-use lanes. Improvements should include shared lane markings (SLMs) and rated signage (see typical section in Figure 8).

Install new sidewalk connection between dead end and Lot B: On the north side of Mill Road opposite Faculty Drive, there is an existing asphalt sidewalk along the frontage of a single lot and is not connected to the broader sidewalk system. Based on the pedestrian wear line, it is recommended that a new sidewalk be installed from the end of the existing sidewalk to UNH Parking Lot C as shown in Figure 14. A pedestrian crosswalk should be installed across Mill Road at the Faculty Drive intersection.

FIGURE 14: RECOMMENDED SIDEWALK LOCATION ON MILL ROAD



4.4 | MAIN STREET RECOMMENDATIONS

Install a bicycle facility from Pettee Brook Lane to Madbury Road: This segment was a gap between the existing bike lanes on both the east and west ends where no bicycle facility was previously provided. One of the components of the recent Main Street Complete Street Design Pilot plan (see Figure 15) was to install a single bike lane on the south side of Main Street from Pettee Brook Lane to Madbury Road. This concept also included other bicycle facility improvements at the intersections along the study segment. A pilot program implemented some of these improvements in the summer of 2014 to determine the effectiveness of the improvements. The single vehicle lane with a bike lane is the primary recommendation. Bike lanes are recommended over shared lanes when adequate roadway width can be provided.

Alternatively, if the two through lanes were to remain on Main Street, shared lanes marked with sharrows can be installed from Pettee Brook Lane to Madbury Road (see the maps of the One Lane and Two Lane options in Appendix A).

FIGURE 15: MAIN STREET IMPROVEMENT PLAN – ONE LANE OPTION

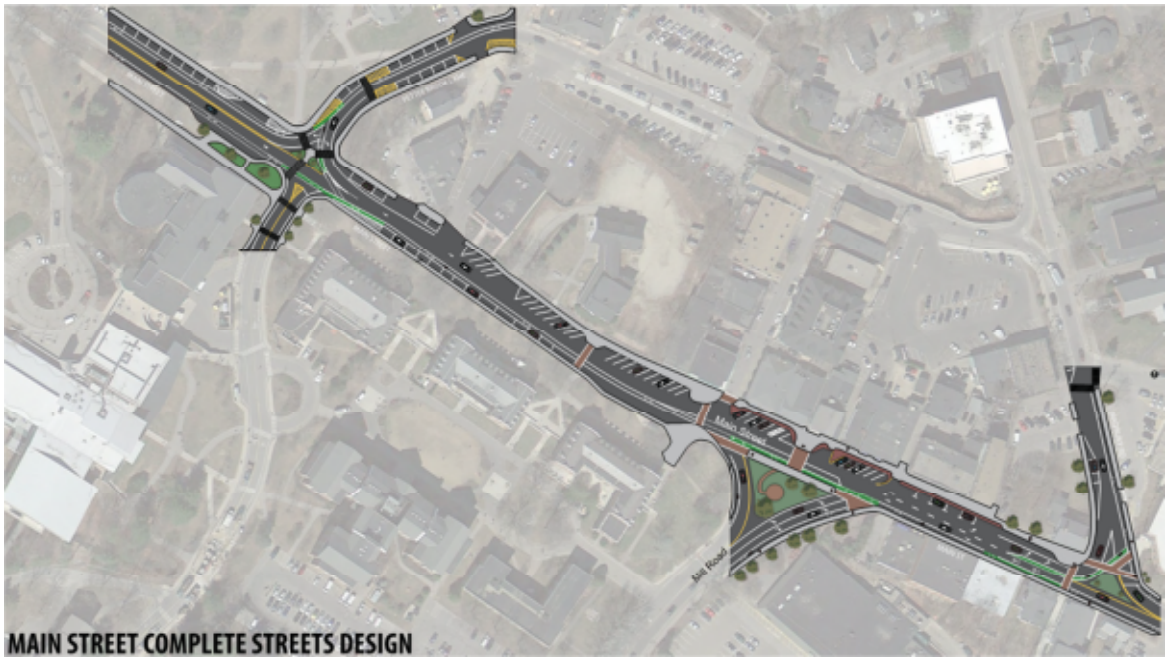
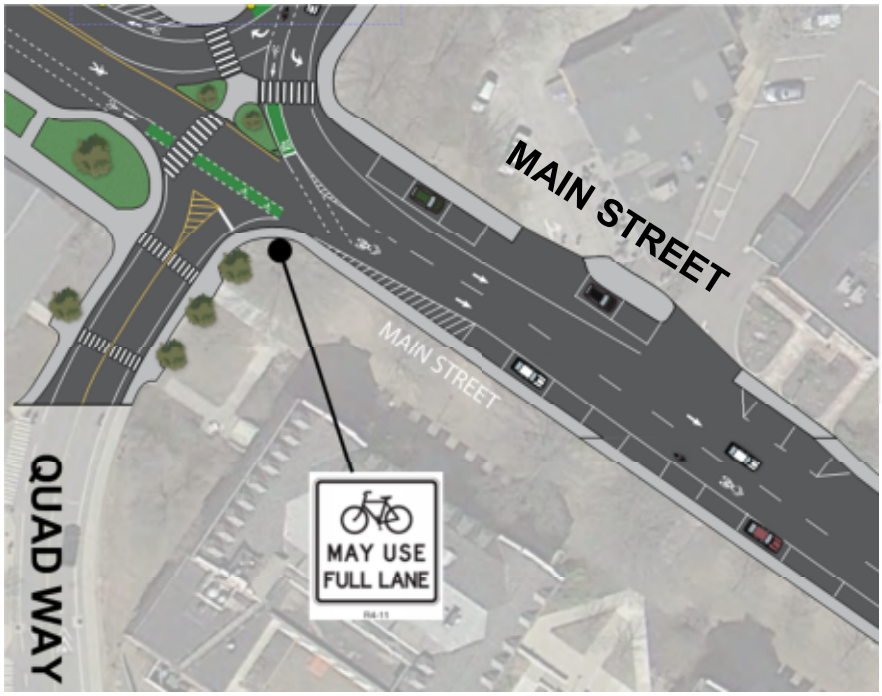


FIGURE 16: TWO LANE - SHARED LANE OPTION



Improve Bicycle Lane Crossing at Madbury Road: Currently, bicyclists traveling east on Main Street that want to travel north on Madbury Road either need to use the pedestrian crosswalk or cross over the Main Street through lane and take the left-turn lane onto Madbury Road. Vehicles turning left have free movement while the incoming westbound right-turns have a stop control. Figure 17 and Figure 18 shows two optional configurations to improve this bicycle-crossing maneuver. One alternative provides a green dashed bicycle cross-over lane and the second option provides a shared lane transition to cross over Main Street.

FIGURE 17: MAIN - MADBURY BIKE LANE CROSSOVER

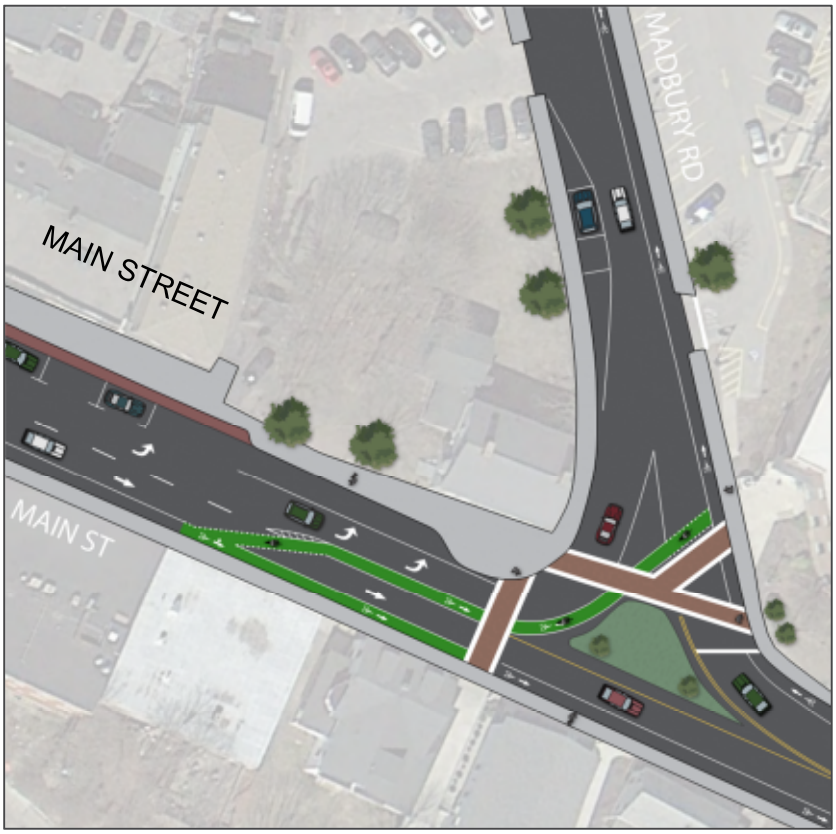


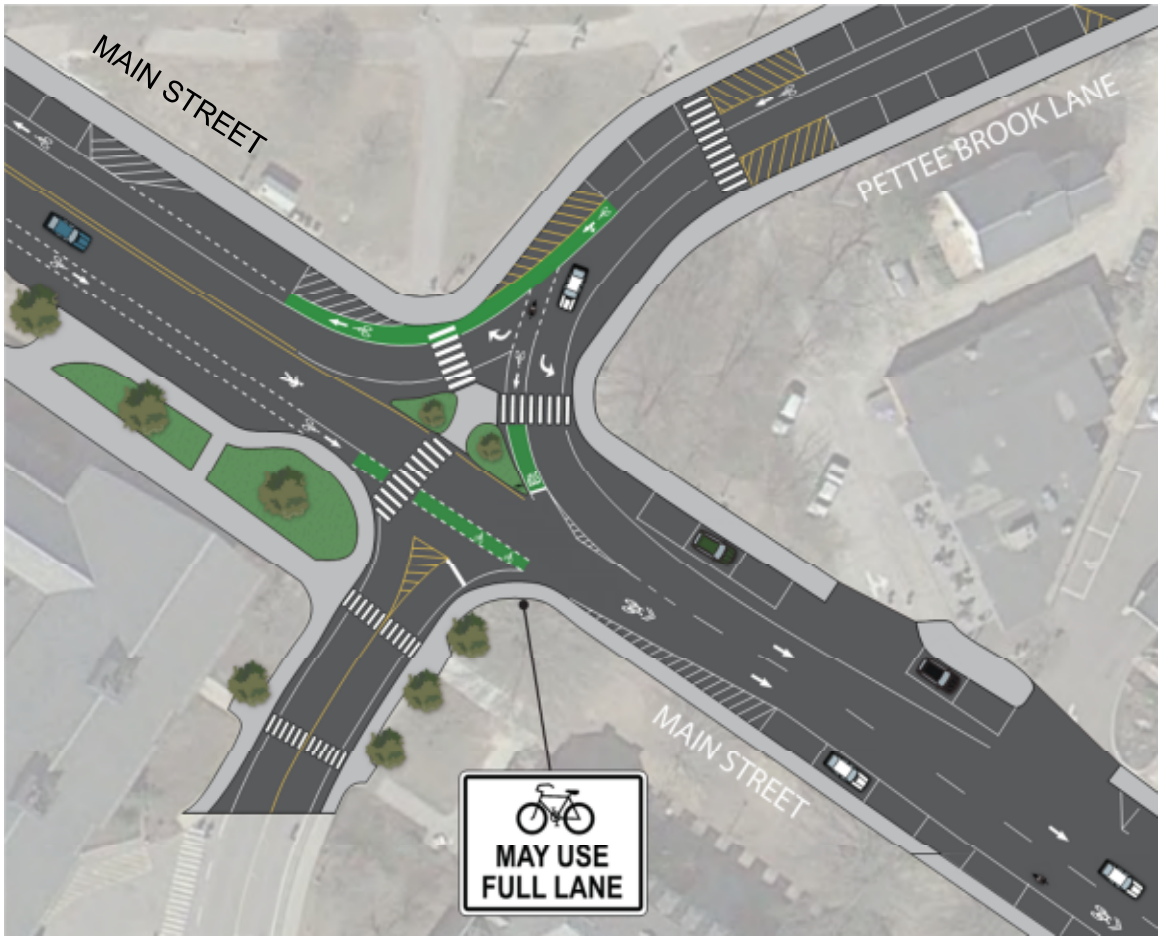
FIGURE 18: MAIN - MADBURY SHARED LANE CROSSOVER

4.5 | PETTEE BROOK LANE RECOMMENDATIONS

Improve Bicycle Lane Crossing at Main Street: To travel from Pettee Brook Lane to Main Street eastbound, cyclists need either to use the pedestrian crosswalks or cross over one lane on Pettee Brook Lane and then merge into the shard use lane on Main Street.

A short-term improvement for this intersection involves maintaining the current, intersection geometry and adding a dedicated left turn bicycle lane (Figure 19).

FIGURE 19: PETTEE BROOK LANE – MAIN STREET IMPROVEMENT PLAN



The mid-term recommendation for the Pettee Brook Lane/Main Street intersection is to construct a single-lane roundabout (Figure 20). The roundabout option was evaluated and presented in a Technical Memorandum[4] which showed the benefits of the roundabout, including reduced vehicle miles traveled, reduced vehicle emissions, and increased pedestrian safety.

The proposed roundabout is expected to improve pedestrian safety at the Main Street/Pettee Brook Lane/Quad Way intersection and on surroundings roadways. Currently only vehicles approaching this intersection from Quad Way have to yield to conflicting traffic. Vehicles travelling down Pettee Brook Lane and turning onto Main Street currently have no conflicting movements and thus are not required to slow down while travelling through the intersection. While vehicles are required to yield to pedestrians in crosswalks, the lack of an obligatory vehicular stop or yield increases the potential for conflicts with pedestrians crossing Pettee Brook Lane. With a roundabout in place, all entering vehicles will have to contend with a conflicting vehicle flow and thus will need to slow down and yield to both vehicles and pedestrians. Additionally, a roundabout at this location will cause all traffic to slow somewhat to navigate the intersection, calming traffic entering the commercial section of Main Street to the east. The roundabout also opens access to Quad Way southbound – a movement that is currently prohibited.

WHY ROUNDABOUTS ARE SAFE FOR PEDESTRIANS

- *Slower speeds for all motorists*
- *Shorter crossing distances – reduced exposure*
- *Reduced conflict points*
- *Only crossing one direction of travel at a time*
- *Refuge (splitter) island*

FIGURE 20: MAIN/PETTEE BROOK/QUAD ROUNDABOUT CONCEPT

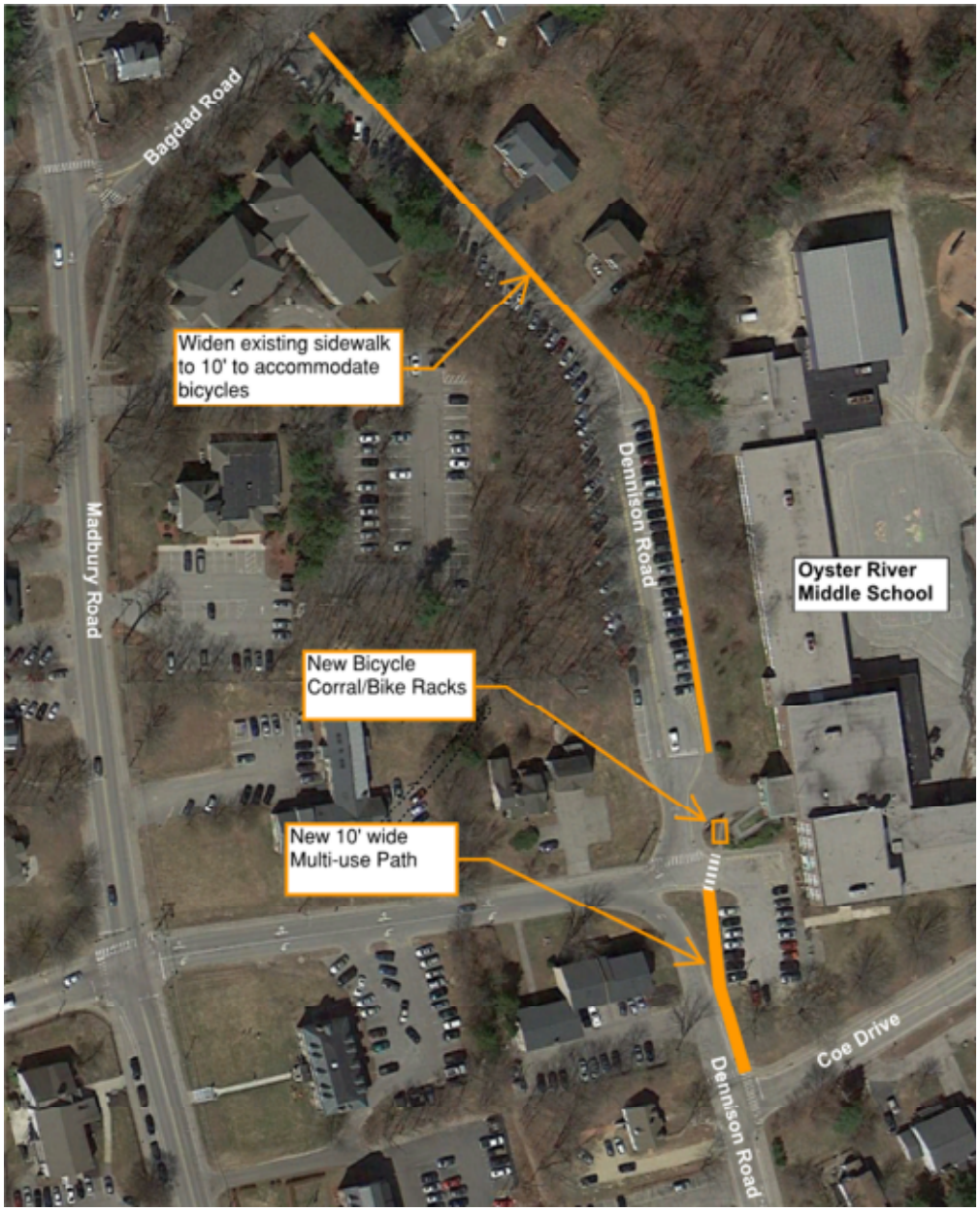
[4] Technical Memorandum – Main Street/Pettee Brook Lane/Quad Way Intersection, prepared by RSG November 4, 2013.

FIGURE 21: PHOTO OF A ROUNDABOUT EXAMPLE

4.6 | COE DRIVE (WOODMAN/DENNISON) RECOMMENDATIONS

Install a Multi-use Path at the Middle School: The Coe Drive segment includes short minor roadways – Denison Road, Woodman Road, and Garrison Avenue, as well as Coe Drive. The Oyster River High School anchors the northern end of this segment with the Oyster River Middle School located midway along the corridor. It is recommended that a new 10 foot wide multiuse path be installed from the intersection of Dennison Road and Coe Drive that will accommodate bicycles accessing the front of the school. Installation of a bike corral near the front of the school will help safely store bikes and promote more children to bike to school. It is also recommended to widen the existing 5 foot sidewalk to a 10 foot multiuse path from Bagdad/Dennison intersection to allow pedestrians and bicycle a safe route to the school. (See Figure 22)

FIGURE 22: WOODMAN-DENNISON IMPROVEMENT PLAN



Widen roadway/reduce lane widths near High School: There are existing bike lanes on Coe Drive from Dennison Road to just before the High School. The northern shoulder from Beards Landing narrows to less than four feet and continues through the High School parking lots. There are a few options to consider in this area:

1. Provide a bike path separated from the roadway on the eastern side. Since there is on-street parking, both parallel and perpendicular, the bike path should be located on the back side (east) of the parking.
2. Provide a multiuse path on the west side of the road, widening the existing sidewalk. The school is on the west side of the road and will reduce the pedestrian and bicycle road crossings.

3. Widen roadway or adjust the pavement markings for the lane widths and shoulders to accommodate a four-foot bike lane on the west side and a bike lane adjacent to parking on the east.

4.7 | BAGDAD ROAD RECOMMENDATIONS

Install shared-lane markings: Bagdad Road is too narrow to accommodate bicycle lanes (unless the roadways were to be widened the entire length). To improve bicycle safety in the near term, shared-lane markings and signage is recommended in each direction from Madbury Road to Emerson Road.

4.8 | GARRISON AVENUE

Install multi-use path: A 10' wide multi-use path on the north side of Garrison Avenue would allow bicycle travel in both directions along this one-way road. Since this is the primary exit for the middle school and most users would be between ages of 12 and 15, keeping the bicycle facilities separated from the roadway will provide a safer route for cyclists. This multi-use path can then link to the shared-use lanes on Garrison Avenue east of Madbury Road. Alternatively, bicyclists could use Dennison Road to access Madbury Road (see Dennison Road recommendations).

4.9 | EDGEWOOD ROAD (0.85 MILES)

Install shared-lane markings: A short-term recommendation is to provide shared-use lane markings and signs along Edgewood Road in both directions. This would link the bicycle lanes on Main Street to future bicycle facilities on Madbury Road.

Install separated multi-use path: A long short-term recommendation is to provide a 10-foot multi-use path along the eastern edge of Edgewood Road. This could be extended on the northern portion of Edgewood Road by widening the existing sidewalk to provide a 10-foot multi-use facility. This would provide a safe way to get to and from the town's outdoor public pool and the UNH Whitmore Center. The wider path would also better accommodate higher pedestrian volumes during events.

5.0 DESIGN NEEDS – GUIDELINES FOR PEDESTRIAN AND BICYCLE FACILITIES

Design Needs of Pedestrians

Sidewalks

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel that is separated from vehicle traffic. Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped planting strip area. Sidewalks are a common application in both urban and suburban environments.

Attributes of well-designed sidewalks include the following:

Accessibility: A network of sidewalks should be accessible to all users.

Adequate width: Two people should be able to walk side-by-side and pass a third comfortably. Different walking speeds should be possible. In areas of intense pedestrian use, sidewalks should accommodate the high volume of walkers.

Safety: Design features of the sidewalk should allow pedestrians to have a sense of security and predictability. Sidewalk users should not feel they are at risk due to the presence of adjacent traffic.

Continuity: Walking routes should be obvious and should not require pedestrians to travel out of their way unnecessarily.

Landscaping: Plantings and street trees should contribute to the overall psychological and visual comfort of sidewalk users, and be designed in a manner that contributes to the safety of people.

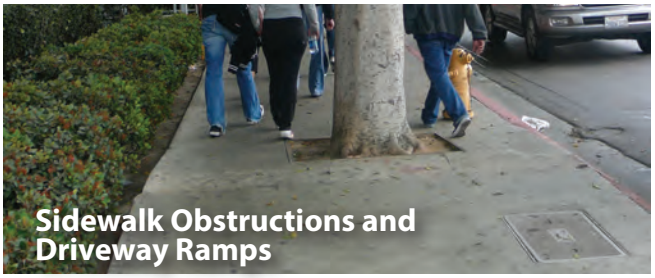
Drainage: Sidewalks should be well graded to minimize standing water.

Social space: There should be places for standing, visiting, and sitting. The sidewalk area should be a place where adults and children can safely participate in public life.

Quality of place: Sidewalks should contribute to the character of neighborhoods and business districts.


Zones in the Sidewalk Corridor


Sidewalk Widths


Sidewalk Obstructions and Driveway Ramps


Pedestrian Access in Construction Areas


Social Space

Marked Crosswalks

Description

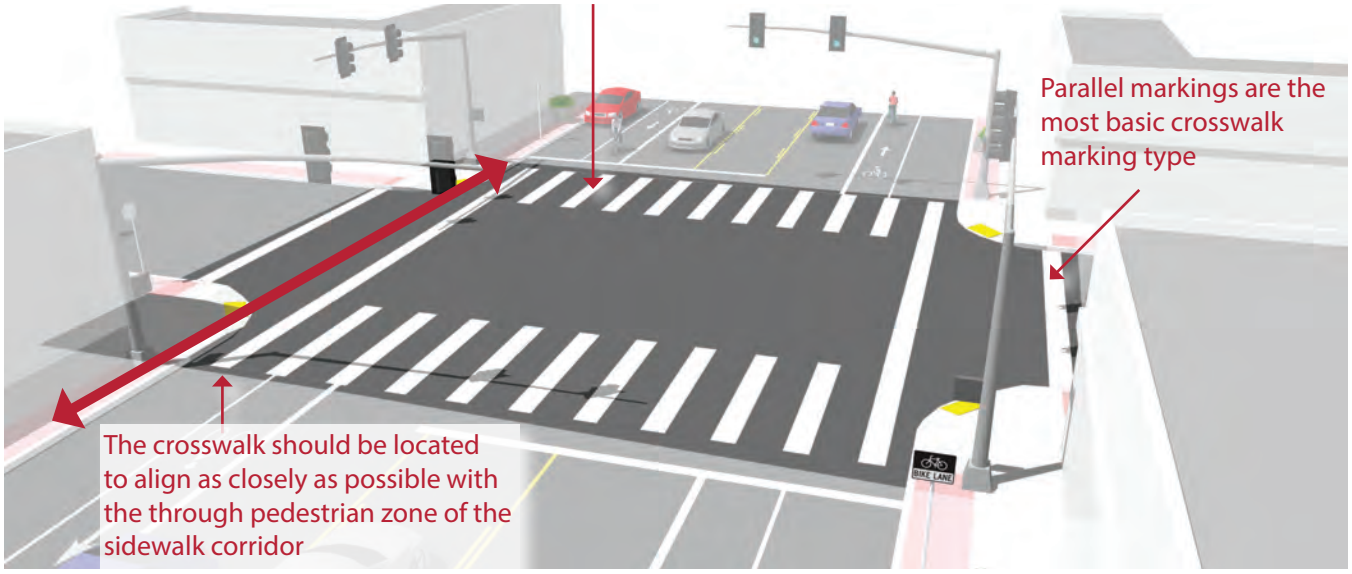
A marked crosswalk signals to motorists that they must stop for pedestrians and encourages pedestrians to cross at designated locations. Installing crosswalks alone will not necessarily make crossings safer especially on multi-lane roadways.

At mid-block locations, crosswalks can be marked where there is a demand for crossing and there are no nearby marked crosswalks.

Guidance

At signalized intersections, all crosswalks should be marked. At un-signalized intersections where posted speeds are less than 45mph, crosswalks may be marked under the following conditions:

- At a complex intersection, to orient pedestrians in finding their way across.
- At an offset intersection, to show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts.
- Flashing beacons or RRFBs should be considered, especially along three- or four-lane roadways.
- At an intersection within a school zone on a walking route.



Discussion

Continental or zebra style markings should be used at crossings with high pedestrian use or where vulnerable pedestrians are expected, including: school crossings, across arterial streets for pedestrian-only signals, at mid-block crosswalks, and at intersections where there is expected high pedestrian use and the crossing is not controlled by signals or stop signs.

See **Intersection Signalization** for a discussion of enhancing pedestrian crossings.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices. (3B.18)
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
FHWA. (2005). Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.
FHWA. (2010). Crosswalk Marking Field Visibility Study.

Materials and Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority. Thermoplastic markings offer higher durability than conventional paint. Contrasting materials can also be used to replicate the look of paint or thermoplastics markings.

Median Refuge Islands

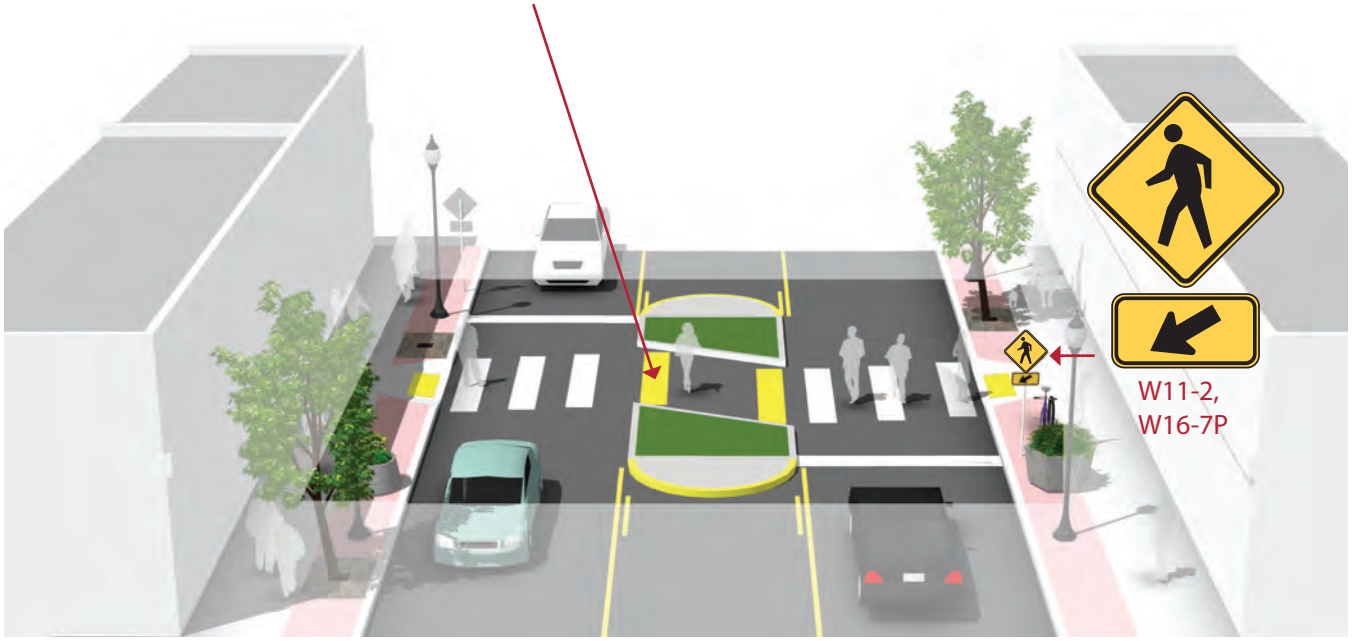
Description

Median refuge islands are located at the mid-point of a marked crossing and help improve pedestrian safety by allowing pedestrians to cross one direction of traffic at a time. Refuge islands minimize pedestrian exposure by shortening crossing distance and increasing the number of available gaps for crossing.

Guidance

- Can be applied on any roadway with a left turn center lane or median that is at least 6' wide.
- Appropriate at signalized or unsignalized crosswalks
- The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- The island should be at least 6' wide between travel lanes (to accommodate bikes with trailers and wheelchair users) and at least 20' long.
- On streets with speeds higher than 25 mph there should also be double centerline marking, reflectors, and "KEEP RIGHT" signage.

Cut through median islands are preferred over curb ramps, to better accommodate bicyclists.



Discussion

If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Shrubs and ground plantings should be no higher than 1 ft 6 in.

On multi-lane roadways, consider configuration with **active warning beacons** for improved yielding compliance.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Refuge islands may collect road debris and may require somewhat frequent maintenance. Refuge islands should be visible to snow plow crews and should be kept free of snow berms that block access.

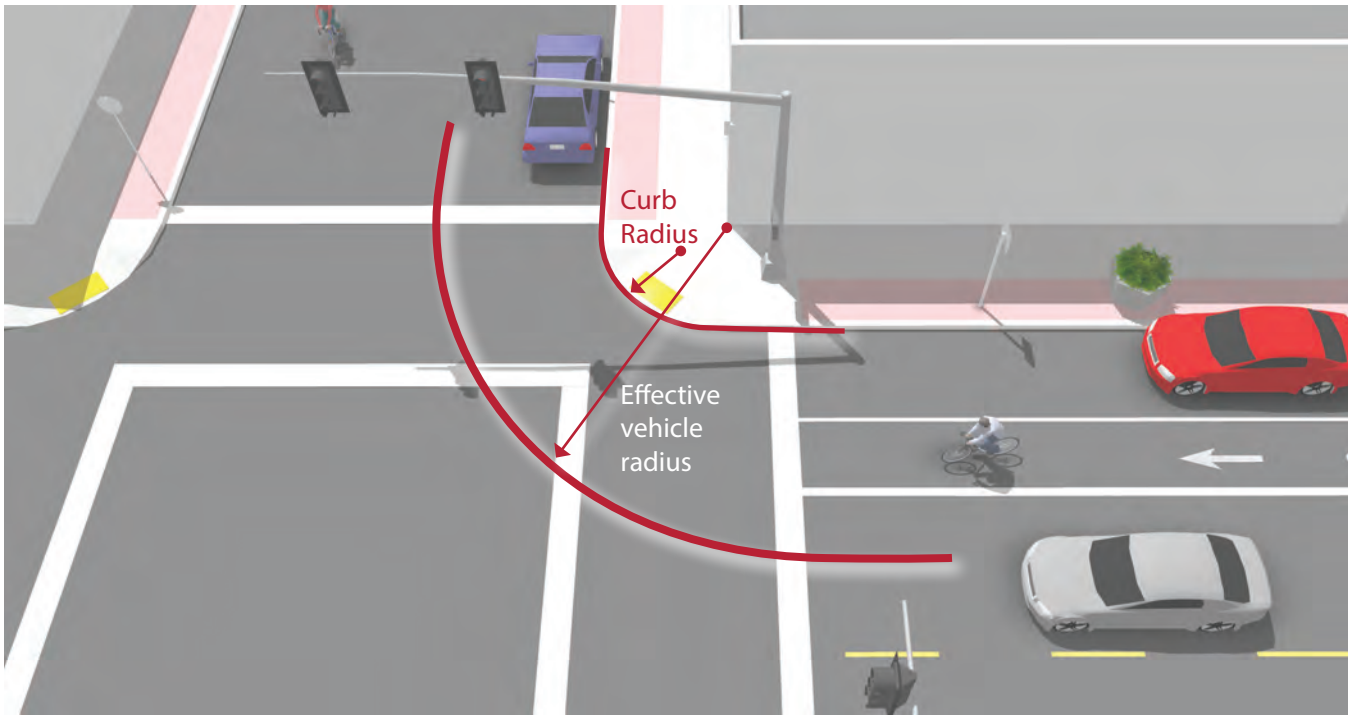
Minimizing Curb Radii

Description

The size of a curb's radius can have a significant impact on pedestrian comfort and safety. A smaller curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crossing distance and requires vehicles to slow more on the intersection approach. During the design phase, the chosen radius should be the smallest possible for the circumstances.

Guidance

The radius may be as small as 3 ft where there are no turning movements, or 5 ft where there are turning movements, adequate street width, and a larger effective curb radius created by parking or bike lanes.



Discussion

Several factors govern the choice of curb radius in any given location. These include the desired pedestrian area of the corner, traffic turning movements, street classifications, design vehicle turning radius, intersection geomerty, and whether there is parking or a bike lane (or both) between the travel lane and the curb.

Additional References and Guidelines

AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
AASHTO. (2004). A Policy on Geometric Design of Highways and Streets.

Materials and Maintenance

Improperly designed curb radii at corners may be subject to damage by large trucks. Regardless of curb radii, snow clearance at any curb cut is critical to maintain pedestrian access.

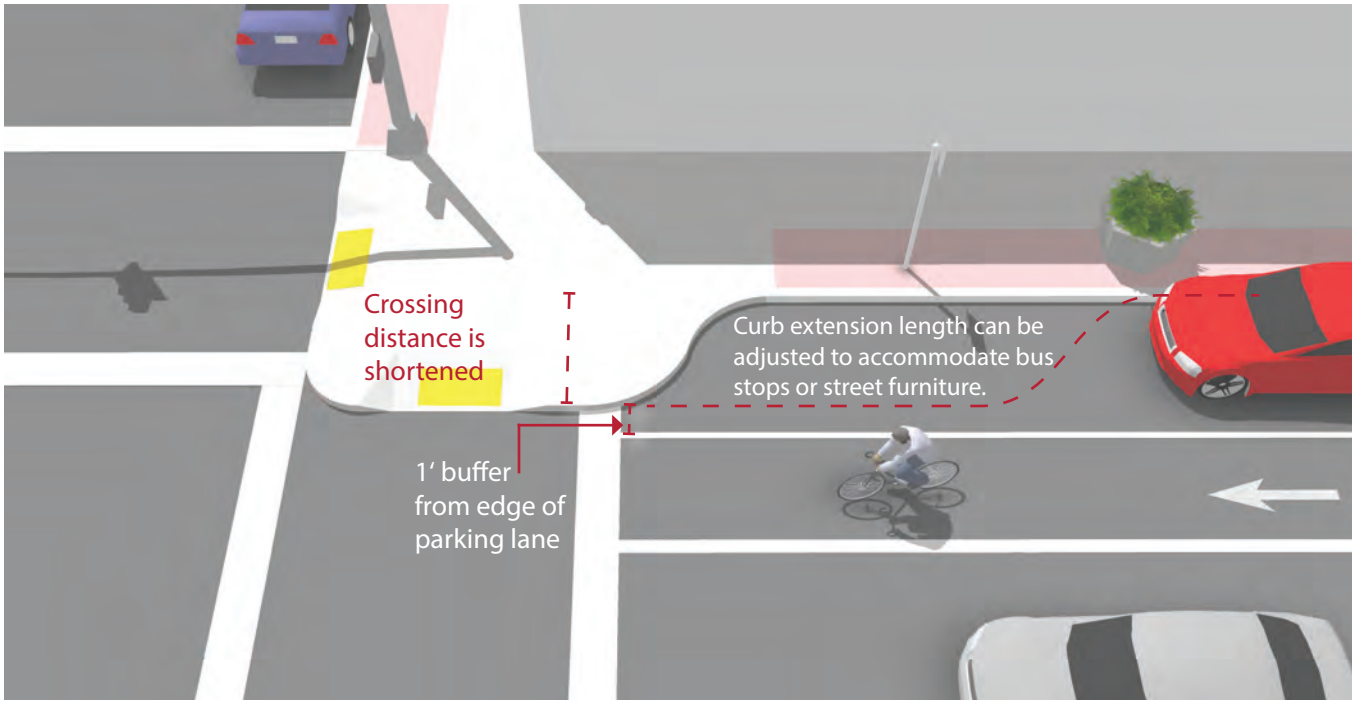
Curb Extensions

Description

Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and giving pedestrians a better chance to see and be seen before committing to crossing. They may also provide additional space for street furniture and bike parking. They are appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb. In certain contexts without curb-side parking, small curb extensions are still desirable but need to be carefully designed so as not to negatively impact vehicle operations, especially bicyclists.

Guidance

- In most cases, the curb extensions should be designed to transition between the extended curb and the running curb in the shortest practicable distance.
- For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft and the two radii should be balanced to be nearly equal.
- Curb extensions should terminate one foot short of the parking lane to maximize bicyclist safety.



Discussion

If there is no parking lane, adding curb extensions may be a problem for bicycle travel and truck or bus turning movements. The designer must carefully weigh the benefits of pedestrian safety improvements with the potential negative impact to bicycle accessibility and safety.

Additional References and Guidelines

AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
AASHTO. (2004). A Policy on Geometric Design of Highways and Streets.

Materials and Maintenance

Planted curb extensions may be designed as a bioswale, a vegetated system for stormwater management.

Design Needs of Bicyclists

Design Needs of Bicyclists

The purpose of this section is to provide the facility designer with an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction and maintenance practices than motor vehicle drivers. Bicyclists lack the protection from the elements and roadway hazards provided by an automobile's structure and safety features. By understanding the unique characteristics and needs of bicyclists, a facility designer can provide quality facilities and minimize user risk.

Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The figure below illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable.

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. The figure and table below summarize the typical dimensions for bicycle types.

Design Speed Expectations

The expected speed that different types of bicyclists can maintain under various conditions also influences the design of facilities such as shared use paths. The table to the right provides typical bicyclist speeds for a variety of conditions.

Types of Bicyclists

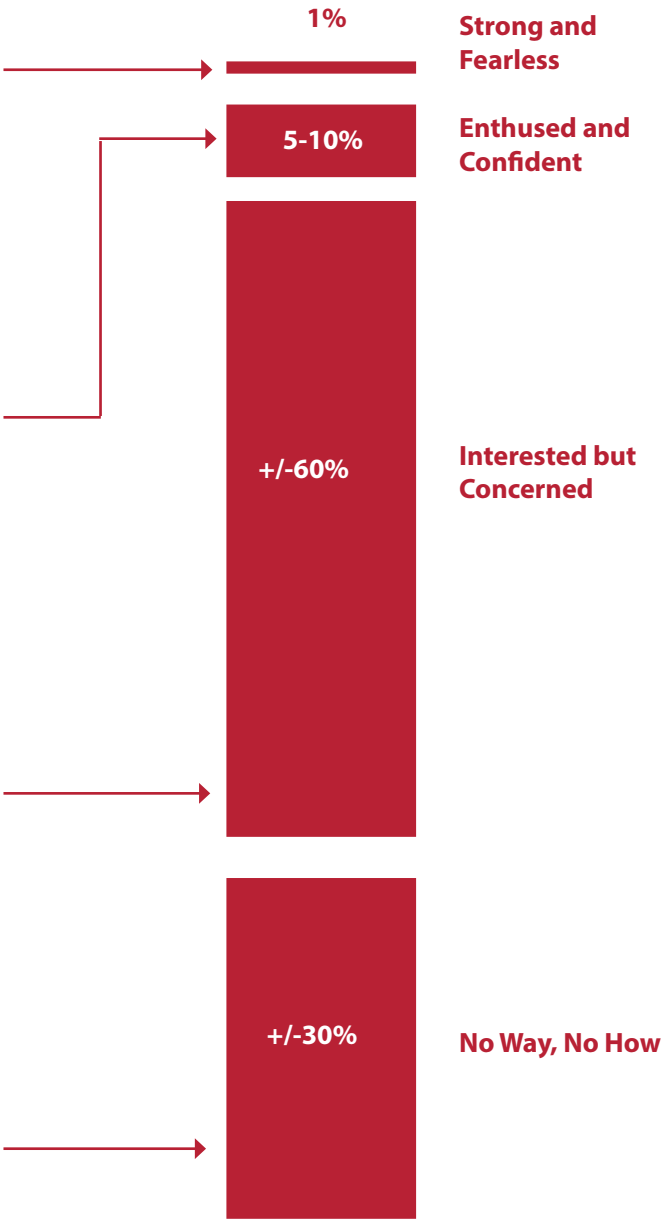
It is important to consider bicyclists of all skill levels when creating a non-motorized plan or project. Bicyclist skill level greatly influences expected speeds and behavior, both in separated bikeways and on shared lanes. Bicycle infrastructure should accommodate as many user types as possible, with decisions for separate or parallel facilities based on providing a comfortable experience for the greatest number of people.

The bicycle planning and engineering professions currently use several systems to classify the population, which can assist in understanding the characteristics and infrastructure preferences of different bicyclists. The most conventional framework classifies the "design cyclist" as *Advanced*, *Basic*, or *Child*[1]. A more detailed understanding of the US population as a whole is illustrated in the figure below. Developed by planners in Portland, OR[2] and supported by data collected nationally since 2005, this classification provides the following alternative categories to address varying attitudes towards bicycling in the US:v

1 *Selecting Roadway Design Treatments to Accommodate Bicycles. (1994). Publication No. FHWA-RD-92-073*

2 *Four Types of Cyclists. (2009). Roger Geller, City of Portland Bureau of Transportation. http://www.portlandonline.com/transportation/index.cfm?&a=237507*

- **Strong and Fearless** (approximately 1% of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as shared use paths.
- **Enthused and Confident** (5-10% of population) - This user group encompasses bicyclists who are fairly comfortable riding on all types of bikeways but usually choose low traffic and/or low speed streets or shared use paths when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists such as commuters, recreationalists, racers and utilitarian bicyclists.
- **Interested but Concerned** (approximately 60% of population) – This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or multi-use trails under favorable weather conditions. These bicyclists perceive significant barriers to their increased use of cycling, specifically traffic and other safety issues. These people may become "Enthused & Confident" with encouragement, education, experience and safe, well-designed facilities.
- **No Way, No How** (approximately 30% of population) – Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually become more regular cyclists with time and education. A significant portion of these people will not ride a bicycle under any circumstances. This group also includes people who are physically unable to ride a bicycle.



Typical Distribution of Bicyclist Types

Vertical Traffic Calming

Description

Motor vehicle speeds affect the frequency at which vehicles pass bicyclists as well as the severity of crashes that can occur. Maintaining motor vehicle speeds closer to those of bicyclists' greatly improves bicyclists' comfort. Slower vehicular speeds also improve motorists' ability to see and react to bicyclists and minimize conflicts at driveways and turning locations.

Vertical speed control measures are composed of slight rises in the pavement, on which motorists and bicyclists must reduce speed to cross.

Speed Hump

Offset Speed Hump

Temporary Speed Cushion

Raised Crosswalk

Guidance

- Neighborhood byways should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Speed humps are raised areas usually placed in a series across both travel lanes. A 14' long hump reduces impacts to emergency vehicles. Gaps in the center or by the curb accommodate bicyclists and improve drainage. Speed humps can also be offset to accommodate emergency vehicles. Counter slopes of 1:20 (5%) are needed to prevent wheelchairs from getting caught in the gutter area.
- Speed lumps or cushions have gaps to accommodate the wheel tracks of emergency vehicles.
- Speed tables are longer than speed humps and flat-topped. Raised crosswalks are speed tables that are marked and signed for a pedestrian crossing.
- For all vertical traffic calming, slopes should not exceed 1:10 or be less steep than 1:25. Tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance. The vertical lip should be no more than a 1/4" high.

Discussion

Emergency vehicle response times should be considered where vertical deflection is used. Because emergency vehicles have a wider wheel base than passenger cars, speed lumps/cushions allow them to pass unimpeded while slowing most other traffic. Alternatively, speed tables are recommended because they cannot be straddled by a truck, decreasing the risk of bottoming out. Traffic calming can also deter motorists from driving on a street. Monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.

Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.

BikeSafe. (No Date). Bicycle countermeasure selection system.

Ewing, Reid. (1999). Traffic Calming: State of the Practice.

Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.

Materials and Maintenance

Traffic calming should be designed to minimize impacts to snowplows. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

Horizontal Traffic Calming

Description

Horizontal traffic calming devices cause drivers to slow down by constricting the roadway space or by requiring careful maneuvering.

Such measures may reduce the design speed of a street, and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.

Guidance

- Maintain a minimum clear width of 20 feet (or 28 feet with parking on both sides), with a constricted length of at least 20 feet in the direction of travel.
- Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays on alternating sides of a street forming an "S"-shaped curb, which reduce vehicle speeds by requiring motorists to shift laterally through narrowed travel lanes.
- Pinchponts are curb extensions placed on both sides of the street, narrowing the travel lane and encouraging all road users to slow down. When placed at intersections, pinchpoints are known as chokers or neckdowns. They reduce curb radii and further lower motor vehicle speeds.
- Traffic circles are raised or delineated islands placed at intersections that reduce vehicle speeds by narrowing turning radii and the travel lane. Traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

Temporary Curb Extension

Chicane

Choker or Neckdown

Pinchpoint with Bicycle Access

Discussion

Horizontal speed control measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element so bicyclists can avoid having to merge into traffic at a narrow pinch point. This technique can also improve drainage flow and reduce construction and maintenance costs. Traffic calming can also deter motorists from driving on a street. Monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.

Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.

BikeSafe. (No Date). Bicycle countermeasure selection system.

Ewing, Reid. (1999). Traffic Calming: State of the Practice.

Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.

Materials and Maintenance

Traffic calming should be designed to minimize impacts to snowplows. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

Minor Intersection Treatments

Description

Treatments at minor roadway intersections are designed to improve the visibility of a neighborhood greenway, raise awareness of motorists on the cross-street that they are likely to encounter bicyclists, and enhance safety for all road users.

Guidance

- On the neighborhood greenway, the majority of intersections with minor roadways should stop-control cross traffic to minimize bicyclist delay. This will maximize bicycling efficiency.
- Traffic circles are a type of **Horizontal Traffic Calming** that can be used at minor street intersections. Traffic circles reduce conflict potential and severity while providing traffic calming to the corridor.
- If a stop sign is present on the neighborhood greenway, a second stop bar for bicyclists can be placed closer to the centerline of the cross street than the motorists' stop bar to increase the visibility of bicyclists waiting to cross the street.
- Curb extensions can be used to move bicyclists closer to the centerline to improve visibility and encourage motorists to let them cross.

Stop Signs on Cross-Street


Traffic Circles


Curb Extension

Discussion

Stop signs increase bicycling time and energy expenditure, frequently leading to non-compliance by bicyclists and motorists, and/or use of other less desirable routes. Neighborhood byways should have fewer stops or delays than other local streets. A typical bicycle trip of 30 minutes can increase to 40 minutes if there is a STOP sign at every block (*Berkeley Bicycle Boulevard Design Tools and Guidelines*). If several stop signs are turned along a corridor, speeds should be monitored and traffic-calming treatments used to reduce excessive vehicle speeds on the neighborhood greenway.

Additional References and Guidelines

City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines.
City of London Transport for London. Advanced stop lines (ASLS) background and research studies.
Transportation Research Board. (2006). Improving Pedestrian Safety at Unsignalized Crossings. NCHRP Report # 562.

Materials and Maintenance

Vegetation in traffic circles and curb extensions should be regularly trimmed to maintain visibility and attractiveness. Repaint bicycle stop bars as needed.

Lane Narrowing

Description

Lane narrowing utilizes roadway space that exceeds minimum standards to provide the needed space for bike lanes. Many roadways have existing travel lanes that are wider than those prescribed in local and national roadway design standards, or which are not marked. Most standards allow for the use of 11 foot and sometimes 10 foot wide travel lanes to create space for bike lanes.

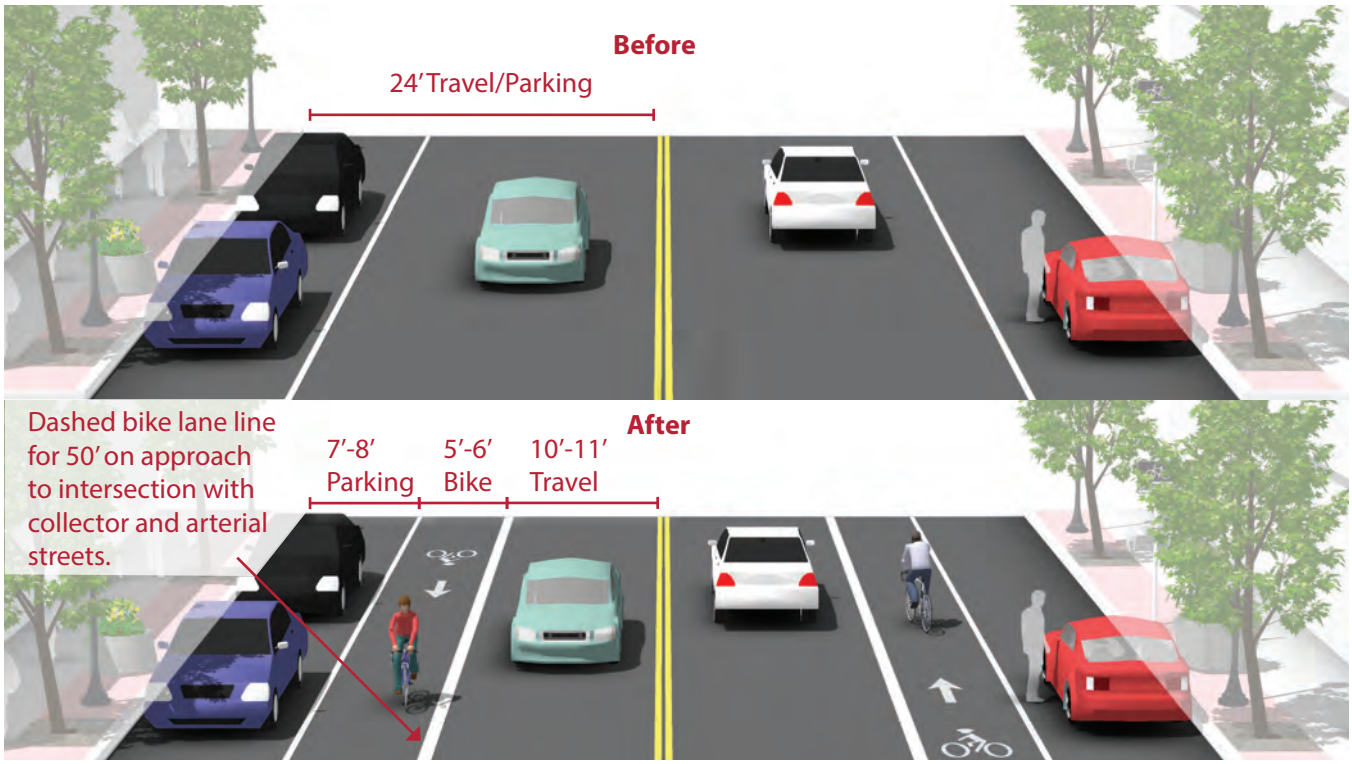
Guidance

Vehicle lane width:

- Before: 10-15 feet
- After: 10-11 feet

Bicycle lane width:

- Guidance on **Bicycle Lanes** applies to this treatment (See page 23-24).



Discussion

Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bike lanes.

AASHTO supports reduced width lanes in *A Policy on Geometric Design of Highways and Streets: "On interrupted-flow operation conditions at low speeds (45 mph or less), narrow lane widths are normally adequate and have some advantages."*

All lane-line dimensions are from face of curb to the center line of the stripe (or in the center of the pair of yellow lines).

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
AASHTO. (2004). A Policy on Geometric Design of Highways and Streets.

Materials and Maintenance

Repair rough or uneven pavement surface. Use bicycle compatible drainage grates. Raise or lower existing grates and utility covers so they are flush with the pavement.

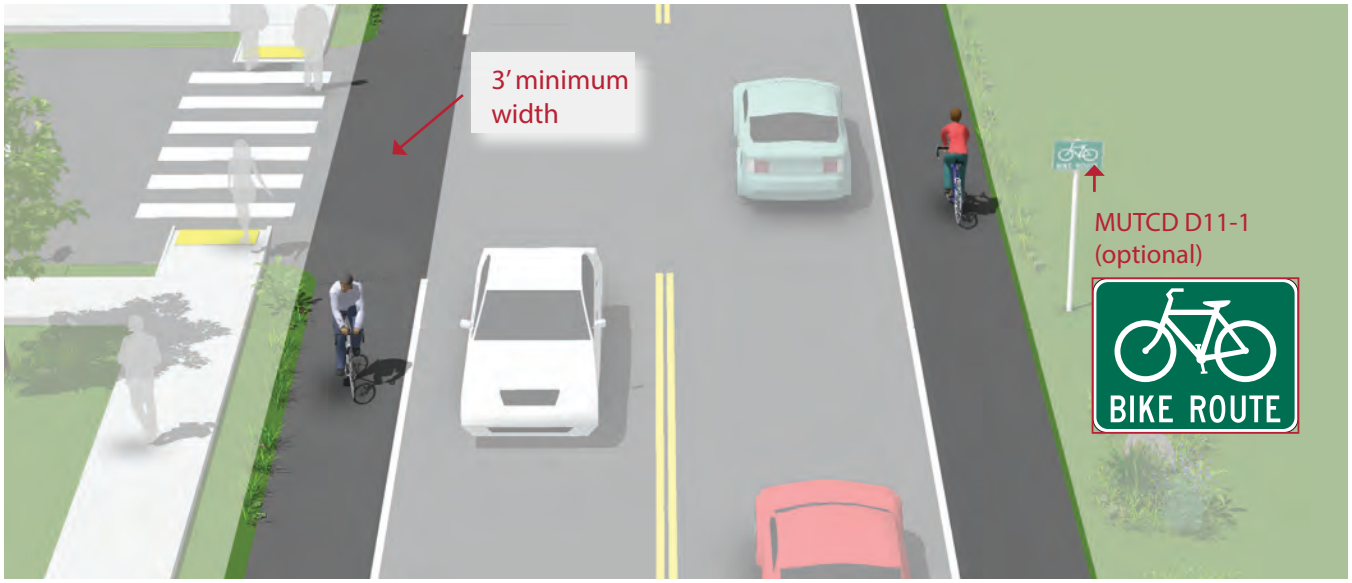
Bicycle Access to Shoulders

Description

Paved roadways with striped shoulders ≥ 3' wide provide a measure of bicycle accommodation in places where dedicated facilities are not needed or impractical, e.g. low-density neighborhoods or rural highways. Designers should attempt to create the widest possible shoulder wherever possible. Roadways with such shoulder conditions may get designated as bicycle routes (bikeways), in which case signage should be considered to alert motorists to expect bicycles along the route and possibly to provide way-finding guidance.

Guidance

- If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3' of usable space is recommended.
- Shoulders less than 3' wide do not meet any design standard for a bicycle facility. Shoulders less than 4' wide should never be stenciled as bike lanes.
- Reduce travel lane width to 10' if necessary to provide a minimum 3' shoulder.
- In locations where a 3' minimum shoulder is not possible to provide, reducing the travel lane to create the widest possible shoulder should be considered.



Discussion

A wide outside lane may be sufficient accommodation for bicyclists on streets with insufficient width for bike lanes. While a wide outside lane with **shared lane markings** is sufficient accomodation for bicyclists on streets with insufficient width for bike lanes, a Bikeway should be considered an option.

Where feasible, **roadway widening** should be performed with pavement resurfacing jobs, but not exceeding desirable bike lane widths.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities. FHWA. (2009). Manual on Uniform Traffic Control Devices.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bikeways should be cleared of snow through routine snow removal operations.

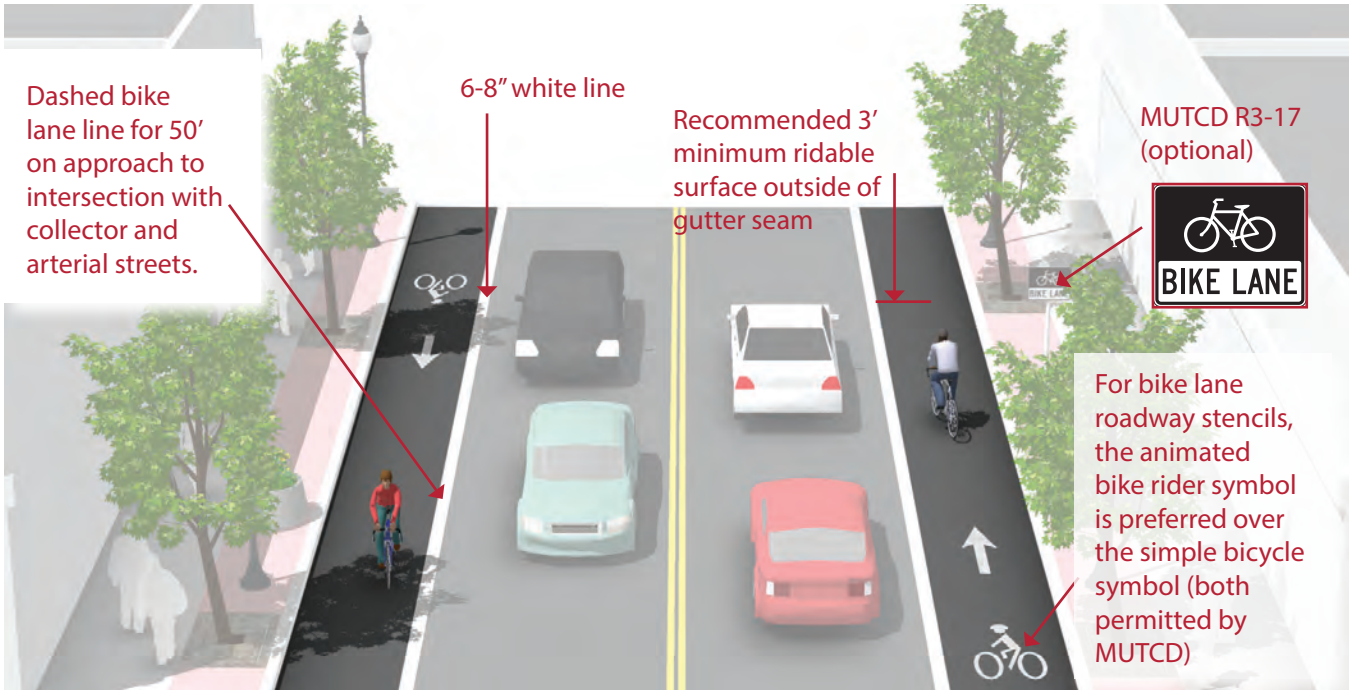
Bike Lane without On-Street Parking

Description

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is typically located on the right side of the street, between the adjacent travel lane and curb, and is used in the same direction as motor vehicle traffic.

Guidance

- 5 foot minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- In constrained conditions, 4 feet is permitted adjacent to a curb, or when curb-and-gutter are not present.
- 6 foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane. See **buffered bicycle lanes** when a wider facility is desired.
- The bike lane should be dashed for the last 50′ on the approach to an intersection to visually warn bicyclists that motorists may cross into the bike lane to make a right turn.
- If space allows for more than a 6′ bike lane, a secondary fog line between the bike lane and curb or edge of pavement should be considered to visually maintain the 6′ dimension.



Discussion

Wider bicycle lanes are desirable in certain situations such as on higher speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Consider **Buffered Bicycle Lanes** when space allows.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities. FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

Bike Lane Adjacent to On-Street Parallel Parking

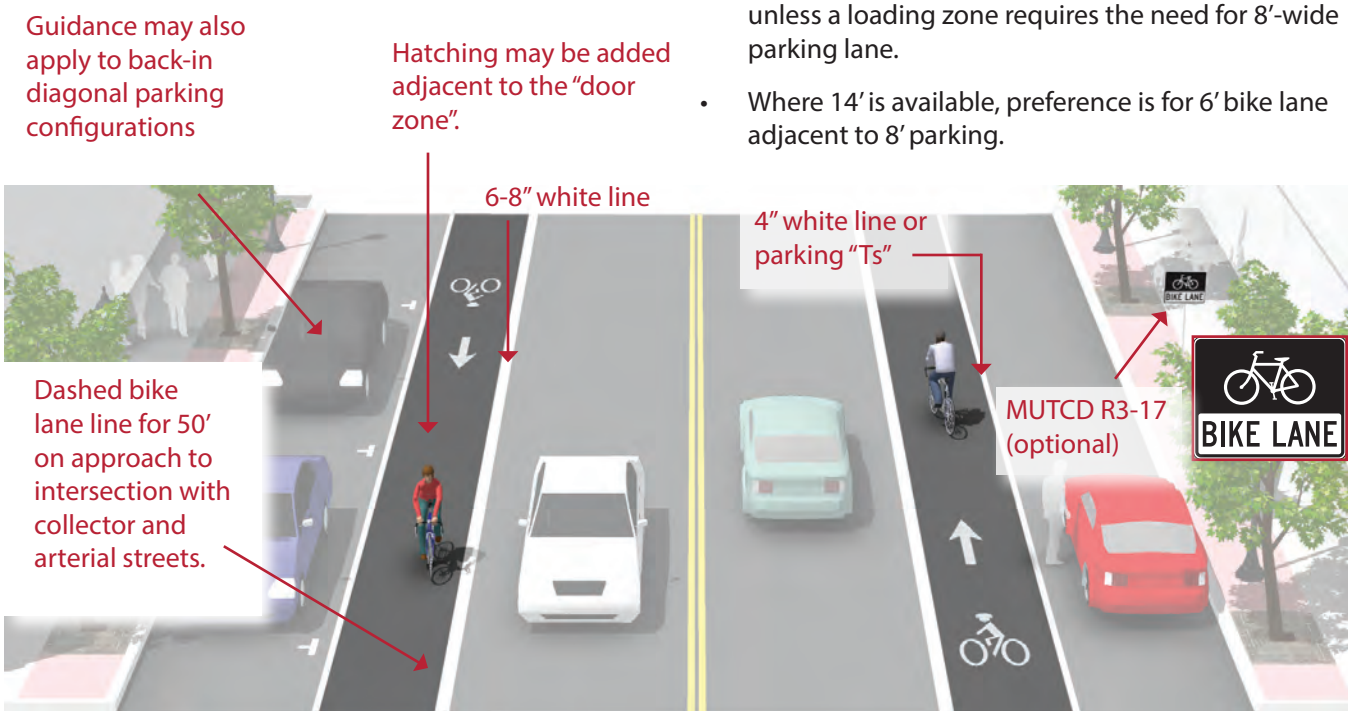
Description

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

Guidance (All dimensions are to the centerline of travel or center of bike lane stripe)

- 12′ minimum from curb face to edge of bike lane.
- 13′-14′ preferred from curb face to edge of bike lane.
- 7′ maximum for marked width of bike lane. Greater widths may encourage vehicle loading in bike lane.
- To provide buffer zone adjacent to the "door zone", 1′-6"′ wide diagonal hatch markings are recommended when parking is 8′ or less"
- Where 13′ is available between curb and travel lane, preference is for a 6′bike lane adjacent to 7′ parking unless a loading zone requires the need for 8′-wide parking lane.
- Where 14′ is available, preference is for 6′ bike lane adjacent to 8′ parking.



Discussion

Bike lanes adjacent to on-street parallel parking require special treatment in order to avoid crashes caused by an open vehicle door. The bike lane should have sufficient width to allow bicyclists to stay out of the door zone while not encroaching into the adjacent vehicular lane. White hatch lines occupying the right half of the lane create a parking side buffer that encourages bicyclists to ride farther away from the door zone.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

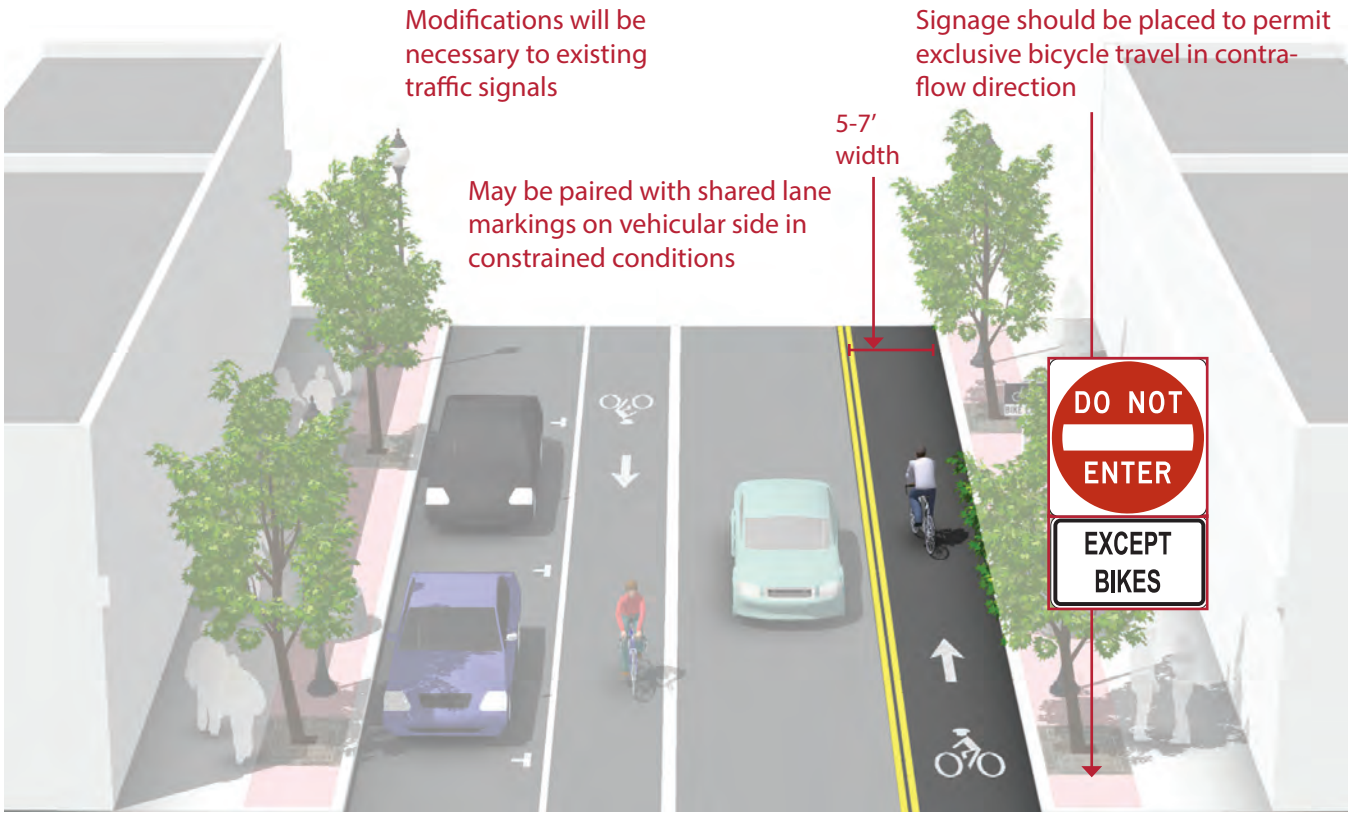
Contra-flow Bike Lane on One-way Street

Description

Contra-flow bike lanes provide bidirectional bicycle access on a roadway that is one-way for motor vehicle traffic. This treatment can provide direct access and connectivity for bicyclists and reducing travel distances. Contra-flow bike lanes can also be used to convert two-way motor vehicle traffic to one-way to reduce traffic volumes where desired.

Guidance

- The contra-flow bike lane should be 5-7 feet wide and marked with a solid double yellow line and appropriate signage. Bike lane markings should be clearly visible to ensure that the contra-flow lane is exclusively for bicycles. Coloration may be considered in the bike lane.
- Signage specifically allowing bicycles at the entrance of the contra flow lane should be used.



Discussion

Because of the opposing direction of travel, contra-flow bike lanes increase the speed differential between bicyclists and motor vehicles in the adjacent travel lane. If space permits consider a **buffered bike lane** or **cycle track** configuration to provide additional separation.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

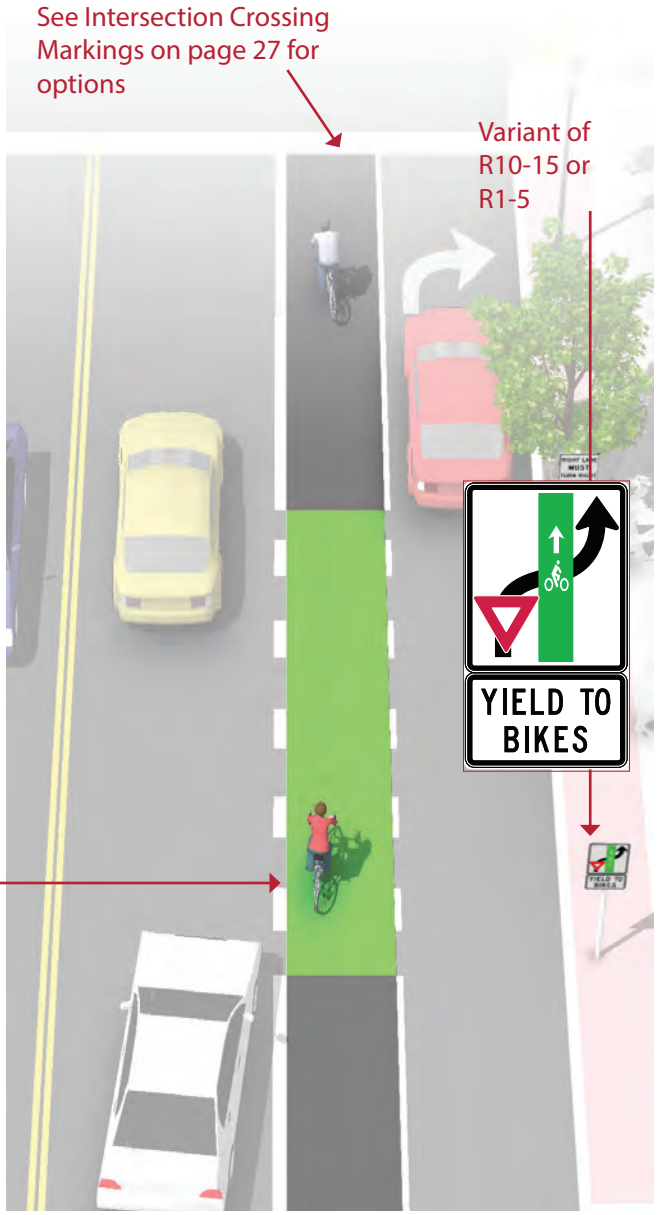
Colored Bike Lanes in Conflict Areas

Description

Colored pavement within a bicycle lane increases the visibility of the facility and reinforces priority of bicyclists in conflict areas.

Guidance

- Green colored pavement was given interim approval by the Federal Highways Administration in March 2011. See interim approval for specific color standards.
- The colored surface should be skid resistant and retro-reflective.
- A "Yield to Bikes" sign may be used at intersections or driveway crossings to reinforce that bicyclists have the right-of-way in colored bike lane areas.



Discussion

Evaluations performed in Portland, OR, St. Petersburg, FL and Austin, TX found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement when compared with an uncolored treatment.

Additional References and Guidelines

FHWA. (2011). Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10 as applicable at the time when considering use.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

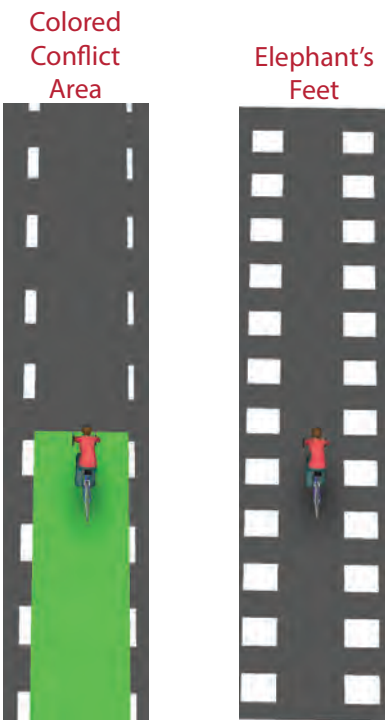
Intersection Crossing Markings

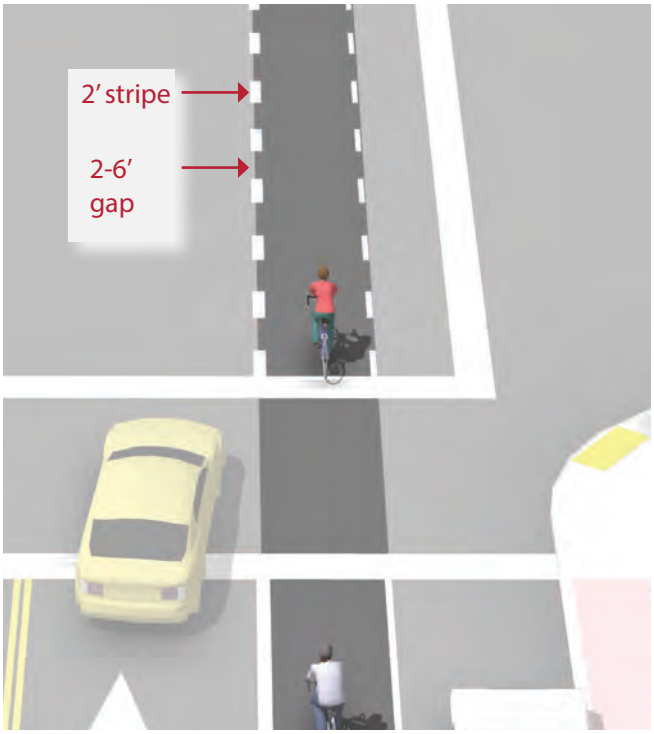
Description

Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane.

Guidance

- See MUTCD Section 3B.08: "dotted line extensions"
- Crossing striping shall be at least six inches wide when adjacent to motor vehicle travel lanes. Dotted lines should be two-foot lines spaced two to six feet apart.
- **Colored bike lanes in conflict areas** may be used to increase visibility within conflict areas or across entire intersections. Elephant's Feet markings are common in Europe and Canada.





Discussion

Additional markings such as chevrons, shared lane markings, or **colored bike lanes in conflict areas** are strategies currently in use in the United States and Canada. Cities considering the implementation of markings through intersections should standardize future designs to avoid confusion.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices. (3A.06)
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

Advisory Bike Lane

Description

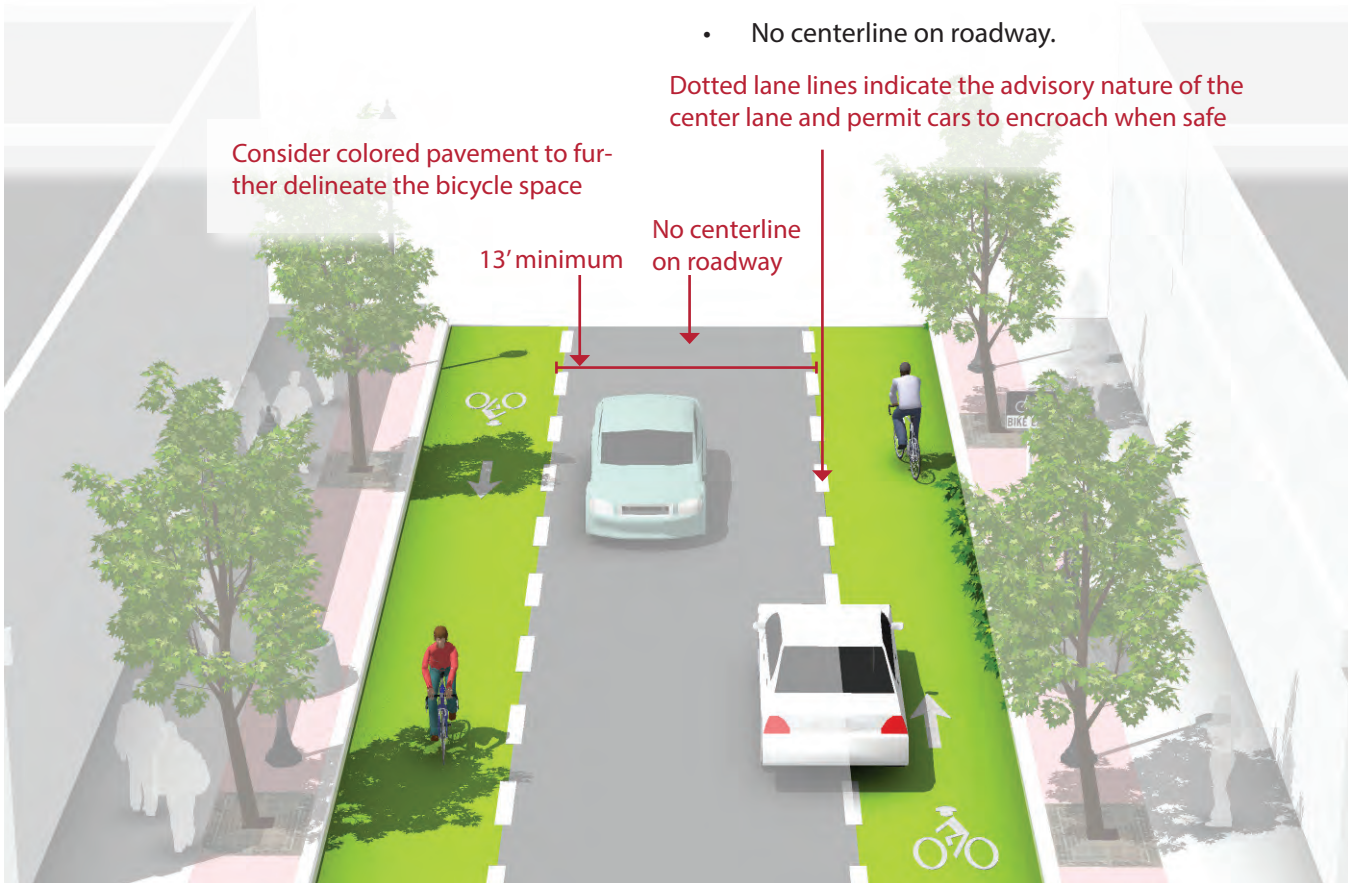
Advisory bike lanes are bicycle priority areas delineated by dotted white lines. The automobile zone should be configured narrowly enough so that two cars cannot pass each other in both directions without crossing the advisory lane line.

Motorists may enter the bicycle zone when no bicycles are present. Motorists must overtake with caution due to potential oncoming traffic.

Guidance

Advisory bike lanes can be used on roadways where the following conditions exist:

- Motor vehicle traffic is <3000 vehicles per day and speeds are 25 mph or less.
- Advisory bike lane width of 5 to 6 ft.
- Minimum 2-way motor vehicle travel lane width of 13 feet.
- No centerline on roadway.



Discussion

Most appropriate when roadways are straight with few bends, inclines or sightline obstructions. Consider the use of colored pavement within the bicycle priority area to discourage unnecessary encroachment by motorists or parked vehicles.

Additional References and Guidelines

This treatment is not currently present in any state or federal design standards though it is being implemented in the US and is common in many European countries.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations with particular attention paid at curb ramps so as not to block access to sidewalks.

Bike Box

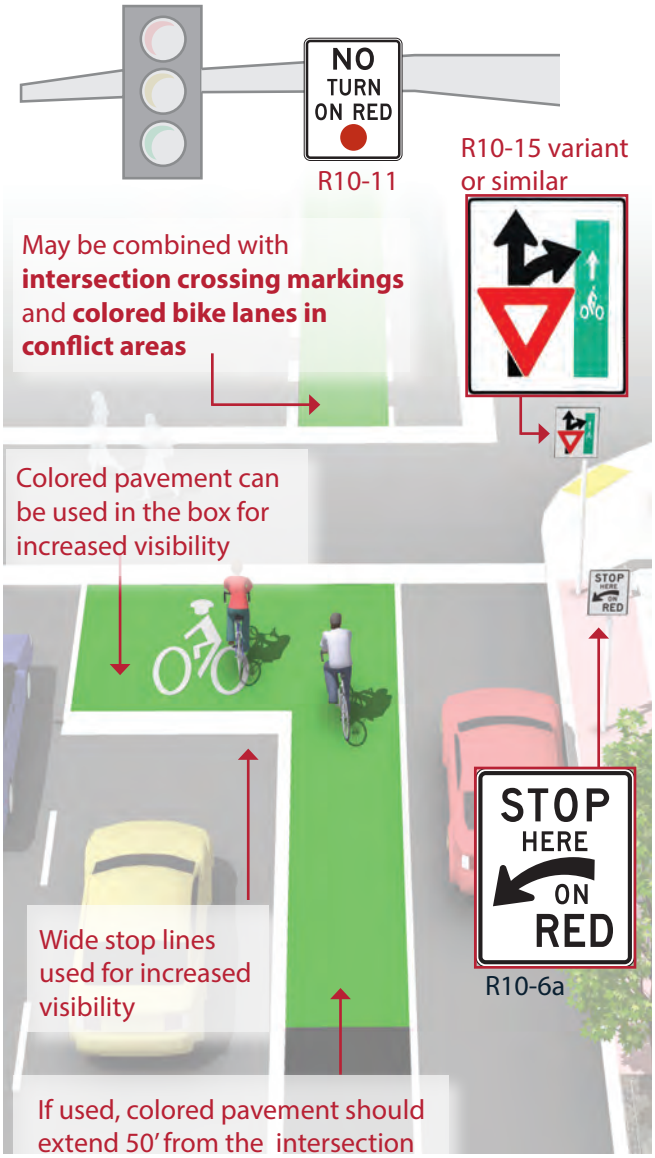
Description

A bike box is a designated area located at the head of a traffic lane at a signalized intersection that provides bicyclists with a visible space to get in front of queuing motorized traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box.

In certain contexts, a bike box can also help facilitate left turns for cyclists but only when there is a single lane of motor vehicle through traffic adjacent to the bike lane, and when cyclists are likely to arrive at the signal during the red phase.

Guidance

- 14' minimum depth
- A "No Turn on Red" (MUTCD R10-11) sign shall be installed overhead to prevent vehicles from entering the Bike Box.
- A "Stop Here on Red" sign should be post-mounted at the stop line to reinforce observance of the stop line.
- A "Yield to Bikes" sign should be post-mounted in advance of and in conjunction with an egress lane to reinforce that bicyclists have the right-of-way going through the intersection.
- An ingress bike lane should be used to provide access to the box.
- A supplemental "Wait Here" legend can be provided in advance of the stop bar to increase clarity to motorists.
- Bike boxes are not recommended to span more than one motor vehicle through lane.



Discussion

Bike boxes should be placed only at signalized intersections, and right turns on red shall be prohibited for motor vehicles. Bike boxes should be used in locations that have a large volume of bicyclists and are best utilized in central areas where traffic is usually moving more slowly. Bike boxes should not be used to accommodate left turns on busy, multi-lane streets (see **Two-Stage Turn Boxes** for preferred treatment). Bike boxes are an evolving treatment that more cities are incorporating at intersections. Designers should verify best engineering practices and the current state of any FHWA or AASHTO approvals prior to final design.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
FHWA. (2011). Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10

Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

Bicycle Racks

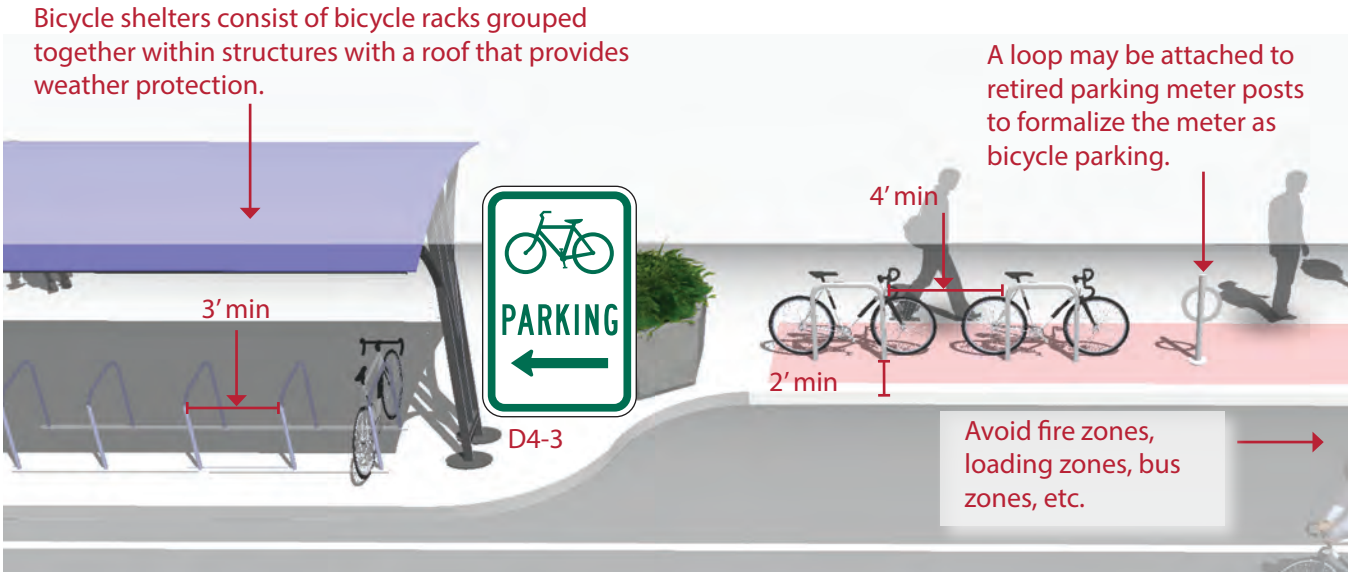
Description

Short-term bicycle parking is meant to accommodate visitors, customers, and others expected to depart within two hours. It should have an approved standard rack, appropriate location and placement, and weather protection. The Association for Pedestrian and Bicycle Professionals (APBP) recommends selecting a bicycle track that:

- Supports the bicycle in at least two places, preventing it from falling over.
- Allows locking of the frame and one or both wheels with a U-lock.
- Is securely anchored to ground.
- Resists cutting, rusting and bending or deformation.

Guidance

- 2' minimum from the curb face to avoid 'dooring.'
- Close to destinations; 50' maximum distance from main building entrance.
- Minimum clear distance of 6' should be provided between the bicycle rack and the property line.
- Should be highly visible from adjacent bicycle routes and pedestrian traffic.
- Locate racks in areas that cyclists are most likely to travel.



Discussion

Where the placement of racks on sidewalks is not possible (due to narrow sidewalk width, sidewalk obstructions, street trees, etc.), bicycle parking can be provided in the street where on-street vehicle parking is allowed in the form of **on-street bicycle corrals**.

Some types of bicycle racks may meet design criteria, but are discouraged except in limited situations. This includes undulating "wave" racks, schoolyard "wheel bender" racks, and spiral racks.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
APBP. (2010). Bicycle Parking Guide 2nd Edition.

Materials and Maintenance

Use of proper anchors will prevent vandalism and theft. Racks and anchors should be regularly inspected for damage. Educate snow removal crews to avoid burying racks during winter months.

On-Street Bicycle Corral

Description

Bicycle corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking. Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking. Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.

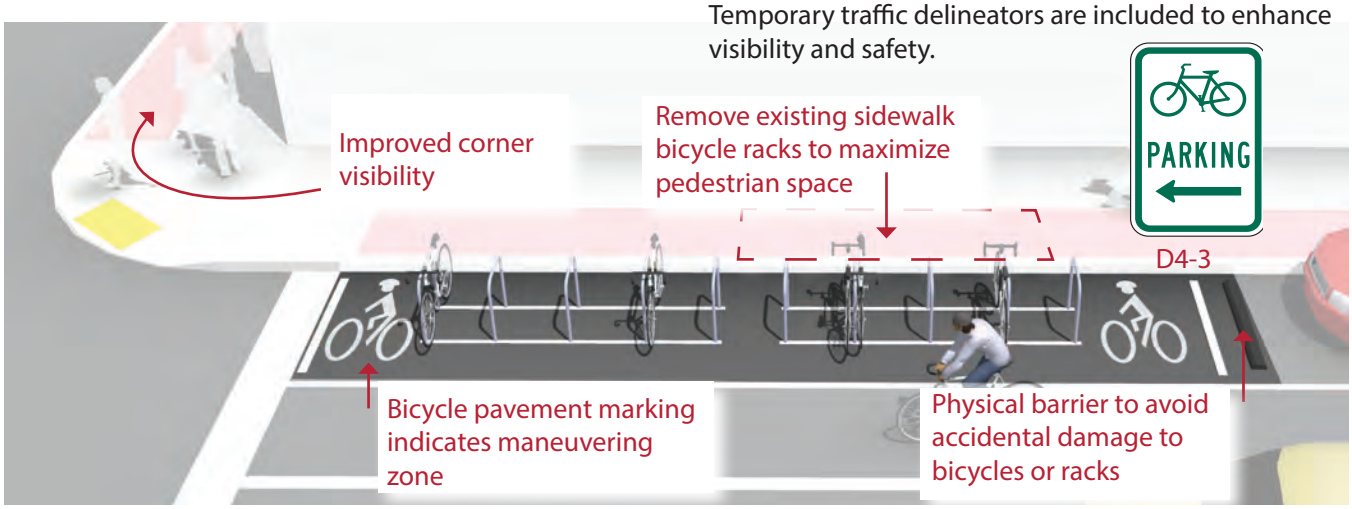
Bicycle corrals move bicycles off the sidewalks, leaving more space for pedestrians, sidewalk café tables, etc. Because bicycle parking does not block sightlines (as large motor vehicles would do), it may be possible to locate bicycle parking in 'no-parking' zones near intersections and crosswalks.

Guidance

See guidelines for sidewalk **Bicycle Rack** placement and clear zones.

- Bicyclists should have an entrance width from the roadway of 5' – 6'.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.

Bike corrals in Cambridge MA and elsewhere are considered temporary and removed each winter. Temporary traffic delineators are included to enhance visibility and safety.



Discussion

Bicycle corrals can be especially effective in areas with high bicycle parking demand or along street frontages with narrow sidewalks where parked bicycles would be detrimental to the pedestrian environment. Reallocation of automobile parking to bicycle parking can draw opposition from some businesses. Care must be taken to ensure buy-in from business owners and to give them an idea of potential additional revenue that frequently accompanies the bike corrals. The transformation may need to be considered a temporary pilot in the short-term to ease anxiety about the perceived loss of accessibility.

Additional References and Guidelines

APBP. (2010). Bicycle Parking Guide 2nd Edition.

Materials and Maintenance

Physical barriers may obstruct drainage and collect debris. Establish a maintenance agreement with neighboring businesses. In snowy climates the bicycle corral may need to be removed during the winter months.

APPENDIX A. DRAWINGS

Large turn radius

Bike lanes are not continuous to middle school

Roadway too narrow for bike lanes

Space likely exists for wider bike lanes

Wide intersection creates high exposure to westbound bicyclists

No Sidewalk

Large pool of bike parking

Demand for left turn creates difficult merge for bicyclists

No S.W. access to bus stop

Potentially difficult merge for bicyclists

Bike lane pinch point at corner

Existing bike lane and striping con-figuration is ideal

Space exists for wider bike lanes

High speed downhill cyclists must merge with vehicles

Very low traffic volumes

Difficult lane shift for thru-bicyclists on Dover Rd

Traffic calming along Quad Way makes for good bike lane

Demand for left turn creates difficult merge for bicyclists

Double turn lanes leaves little space for bikes

Traffic volumes may not warrant two travel lanes

Key Connection to Faculty Rd neighborhood

Relatively wide travel lanes

Davis Ct
Baqdad Rd
Madbury Ct
Edgewood Rd
Brook Way
Ballard St
Stratford Ave
Main St
Garrison Ave
Rosemary Ln
Library Way
Coe Dr
No Name
Beards Lndg
Piscataqua Rd
Dennison Rd
Woodman Rd
Bayview Rd
Young Dr
Mathes Ter
Madbury Rd
Peltee Brook Ln
Sauer Ter
Glassford Ln
Jenkins Ct
Cowell Dr
Park Ct
Old Landing Rd
Dover Rd
Newmarket Rd
Schoolhouse Ln
Smith Park Ln
Church Hill
Church Hill Rd
Mill Pond Rd
Mill Rd
Mitchell Way
Academic Way
Quad Way
McDaniel Dr
Faculty Rd

LEGEND

OPPORTUNITIES

CHALLENGES

Durham Sidewalks

TOD Bike Lanes

UNH Sidewalks

DOWNTOWN DURHAM BICYCLE + PEDESTRIAN PLANNING + DESIGN SERVICES

Durham, NH

Spring 2014

0 0.125 0.25 Miles

RSG

alta PLANNING + DESIGN

MAIN STREET

PETTEE BROOK LANE

MADBURY ROAD

JENKINS COURT

MAIN STREET

QUAD WAY

MILL ROAD

MAIN STREET COMPLETE STREETS DESIGN

DURHAM, NEW HAMPSHIRE

SPRING 2014

alta PLANNING + DESIGN

RSG

MAIN STREET

MAIN STREET

PETTEE BROOK LANE

PETTEE BROOK LANE

MAIN STREET

MAY USE FULL LANE

JENKINS COURT

MADBURY ROAD

QUAD WAY

MAIN STREET

MADBURY RD.

MAIN ST

MILL ROAD

BIKE LANE

MAIN STREET COMPLETE STREETS DESIGN - 2 LANES

DURHAM, NEW HAMPSHIRE

2014

APPENDIX B. CRASH DATA

Durham Police Department
86 Dover Road
Durham, New Hampshire 03824

MEMORANDUM

August 22, 2014

TO: Todd Selig, Town Administrator

FROM: Dave Kurz, Chief of Police

RE: Bicycle Accidents in Durham

Date	Location	Apparent contributing factor	Gist of event	Time of day	Weather conditions	Injuries
5/1/2002	Main Street-Route 4 on-ramp	Vehicle operator inattention	Vehicle turned into bicyclist	7:00PM Daylight	Clear	Transported Broken ankle
6/1/2002	Route 108	Vehicle did not provide minimum space	Vehicle mirror struck bicyclist	5:00PM Daylight	Clear	Transported Massive head injuries
9/24/2002	Main Street-College Road	Bicyclist failed to yield right of way	Vehicle struck bicyclist	6:00PM Daylight	Clear	Not Transported Scrapes and abrasions
10/22/2002	Old Concord Road	Bicyclist failed to yield right of way	Bike turned in front of vehicle	4:05PM Daylight	Clear	Transported Cuts
10/30/2002	Main Street-Edgewood Road	Bicyclist failed to yield right of way	Vehicle turned onto Main-bicyclist wrong way struck vehicle	5:05PM Dark	Clear	Not Transported Soreness
No	**Bicycle**	**Accidents**	**In**	**Durham**	**During**	**2003**
3/7/2004	Route 108-Simons Lane	Vehicle operator DWI-arrested	Vehicle struck bicyclist in rear as both heading north	6:05PM Dusk	Clear	Transported Leg injury
5/10/2004	Mill Road-Faculty Road	Vehicle enters intersection and strikes bicyclist	Vehicle struck bicyclist	1:30PM Daylight	Clear	Not Transported Soreness

9/10/2004	Route 108 – Main Street	Bicyclist did not stop for red light	Bicyclist did not stop at red light	5:45PM Daylight	Clear	Not Transported Soreness
03/04/2005	Main Street	Vehicle exiting drive struck bicyclist eastbound in westbound lane	Vehicle did not see bicycle in wrong lane	1:50PM Daylight	Cloudy	Transported Cuts
8/7/2005	Bennett Road	Vehicle turning into driveway	Vehicle did not yield to bicyclist	11:00AM Daylight	Clear	Not Transported Scrapes
9/2/2005	Main Street	Bicyclist hit rear of stopped vehicle	Vehicle stopped for pedestrian, bicycle hit vehicle	11:00AM Daylight	Clear	Transported Cuts
9/22/2006	Madbury Road-Edgewood Road	Vehicle enters intersection and strikes bicyclist	Bicyclist fails to stop at stop sign	1:00PM Daylight	Clear	Transported Head injury
4/21/2007	Rt. 4 – Madbury Road	Both entering intersection from opposite directions	Vehicle did not see bicyclist	2:00PM Daylight	Clear	Transported Cuts-broken bones
5/09/2007	Dover Road-Irving Gas Station	Failure to yield right of way	Vehicle did not see bicyclist in bike lane coming from behind	7:00AM Daylight	Clear	Transported Cuts
8/28/2007	Mill Road – McDaniel Drive	Failure to yield right of way	Vehicle did not see bicyclist	1:25PM Daylight	Clear	Not Transported Soreness
11/14/07	Rt. 108 - Stagecoach	Failure to yield right of way	Vehicle mirror struck bicyclist	2:15PM Daylight	Clear	Not Transported Cuts-bruises
3/26/2008	Main Street	Failure to yield right of way	Bicyclist struck vehicle exiting driveway	4:15PM Dusk	Clear	Not Transported Abrasions
04/18/2008	Main Street-Mast Road	Vision Obscured	Glare of sun blocked vehicles vision and did not see bicycle	7:07PM Daylight	Clear	Not Transported Scrapes

04/24/2008	Dover Road-Newmarket Road	Failure to Yield Right of Way	Vehicle struck bicycle while exiting gas station	3:32PM Daylight	Clear	Not Transported Shoulder pain
09/09/2008	Main Street-Quad Way	Improper Pass	Vehicle turned right striking bicycle in bike lane	5:18PM Daylight	Cloudy	Not Transported Cut to arm
09/10/2008	Main Street-Depot Road	Driver Inattention	Vehicle turned into bicycle	11:16AM Daylight	Clear	Not Transported Abrasions
09/30/2008	Main Street-Depot Road	Driver Inattention	Vehicle turned left into bicycle	9:05AM Daylight	Cloudy	No injuries
10/09/2008	Garrison Ave-Strafford Ave	Bicycle on sidewalk	Bicycle entered intersection from sidewalk with car turning at same time	9:05PM Dark – bicycle had no lights	Clear	No injuries
07/14/2009	Newmarket Road-Schoolhouse Lane	Driver Inattention	Vehicle turned into bicycle path	4:36PM Daylight	Clear	Not Transported Cuts
10/22/2009	Edgewood Road	Improper Turn	Vehicle turned into bicycle path	3:45PM Daylight	Clear	No injuries
10/29/2009	Dover Road	Failure to Yield Right of Way	Vehicle turned into bicycle path	7:48AM Daylight	Clear	Not Transported Scratch
08/03/2010	Dennison Road-Coe Drive	Unsafe Speed	Bicycle was going wrong way on a one way street	4:07PM Daylight	Clear	Not Transported Dislocated Kneecap
09/13/2010	Edgewood Road-Main Street	Driver Inattention	Vehicle turned into bicycle path	11:54AM	Cloudy	No injuries
09/30/2010	Madbury Road-Main Street	Bicycle on sidewalk, going against traffic	Bicycle was on sidewalk and hit car turning into street	10:44AM Daylight	Cloudy	No injuries

10/21/2010	Dover Road-Bayview Road	Bicycle going against traffic	Vehicle entering intersection hit bicycle	4:58PM Daylight	Cloudy	No injuries
05/13/2011	Mill Road-Main Street	Inattention by both drivers	Vehicle struck bicycle while turning	5:17PM Daylight	Clear	Transported Back & Leg injuries
07/25/2011	Madbury Road-Main Street	Bicycle going against traffic	Vehicle turning and struck bicycle	1:26PM Daylight	Clear	Not Transported Abrasions
09/19/2011	Newmarket Road-Laurel Lane	Improper Passing	Vehicle's trailer struck bicyclist as it passed	10:31AM Daylight	Clear	Transported Broken Clavicle
09/26/2011	Madbury Road-Main Street	Bicyclist going against traffic	Vehicle turning and struck bicycle	9:28AM Daylight	Clear	Transported Back pain
06/24/2012	Wiswall Road-Packers Falls Road	Failure to Yield Right of Way	Vehicle entered path of bicycle	6:48PM Daylight	Clear	No injuries
09/11/2012	Pettee Brook Lane-Rosemary Lane	Improper Lane Use	Bicycle traveling wrong way and vehicle hit the bicycle	5:13PM Daylight	Clear	Not Transported Abrasions
09/18/2012	Main Street-Edgewood Road	Failure to Yield Right of Way	Vehicle stopped for pedestrian. Bicyclist entered the crosswalk without stopping as the vehicle started to move	9:37AM Daylight	Clear	Not Transported Leg Pain
09/20/2012	Mill Road-Academic Way	Failure to Yield Right of Way	Bicycle traveling wrong way, crossed the road and vehicle struck bicycle	1:00PM Daylight	Clear	No injuries
05/02/2013	Dover Road-Newmarket Road	Failure to Yield Right of Way	Bicycle pulled out in front of vehicle	3:32PM	Clear	No injuries

11/05/2013	Mill Road	Bicycle without headlamp	Vehicle turned into lot and struck bicycle	6:27PM Dark – Lights on	Clear	Transported Cut
11/14/2013	Mill Road-Foss Farm Road	Failure to Yield Right of Way	Vehicle turned into the path of bicyclist	1:27PM Daylight	Clear	Transport Significant lower body and shoulder injury

- There were 41 accidents in the 11 years since 2002 and July of 2014

- There were an average of 3.73 accidents per year with 2003 having none and 2008 with 7

- Fifteen bicyclists were transported to the hospital with injuries. This is 37% of all accidents

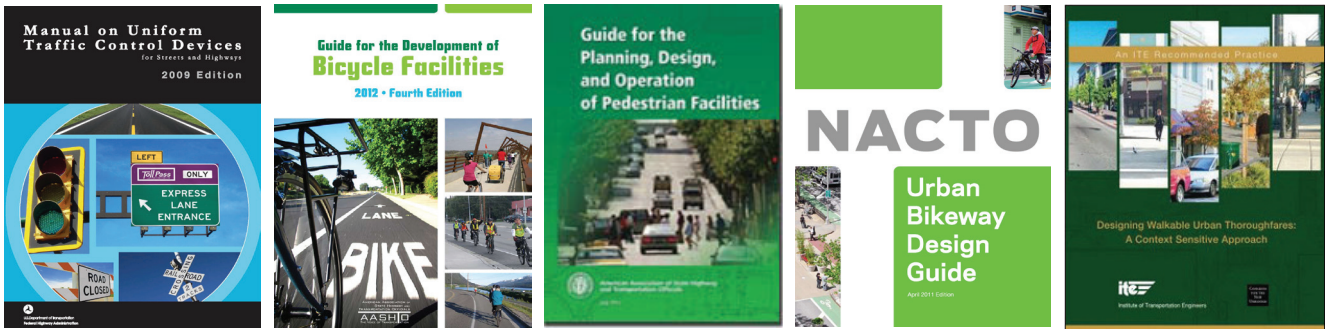
- Of the attributable causes for the accidents, vehicles were faulted 21 times (51%) with 18 (44%) attributed to the bicyclist. Two of the accidents were mutual errors (5%).

- Eighty-eight (88%) percent of the accidents occurred in daylight

- Eighty-five (85%) percent of the accidents occurred in clear weather

APPENDIX C. NATIONAL DESIGN MANUALS

National Design Manuals



The Federal Highway Administration's **Manual on Uniform Traffic Control Devices** (MUTCD) defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic. The MUTCD is the primary source for guidance on lane striping requirements, signal warrants, and recommended signage and pavement markings.

To further clarify the MUTCD, the FHWA created a table of contemporary bicycle facilities that lists various bicycle-related signs, markings, signals, and other treatments and identifies their official status (e.g., can be implemented, currently experimental). See **Bicycle Facilities and the Manual on Uniform Traffic Control Devices.**[1]

Bikeway treatments not explicitly covered by the MUTCD are often subject to experiments, interpretations and official rulings by the FHWA. The **MUTCD Official Rulings** is a resource that allows website visitors to obtain information about these supplementary materials. Copies of various documents (such as incoming request letters, response letters from the FHWA, progress reports, and final reports) are available on this website.[2]

American Association of State Highway and Transportation Officials (AASHTO) **Guide for the Development of Bicycle Facilities**, updated in June 2012 provides guidance on dimensions, use, and layout of specific bicycle facilities. The guidelines presented by AASHTO provide basic information, such as minimum sidewalk widths, bicycle lane dimensions, detailed striping requirements and recommended signage and pavement markings.

The National Association of City Transportation Officials' (NACTO) 2012 **Urban Bikeway Design Guide**[3] is the newest publication of nationally recognized bikeway design standards, and offers guidance on the current state of the practice designs. The NACTO Urban Bikeway Design Guide is based on current practices in the best cycling cities in the world. The intent of the guide is to offer substantive guidance for cities seeking to improve bicycle transportation in places where competing demands for the use of the right of way present unique challenges. All of the NACTO Urban Bikeway Design Guide treatments are in use internationally and in many cities around the US.

Offering similar guidance for pedestrian design, the 2004 AASHTO **Guide for the Planning, Design and Operation of Pedestrian Facilities** provides comprehensive guidance on planning and designing for people on foot.

Meeting the requirements of the Americans with Disabilities Act (ADA) is an important part of any bicycle and pedestrian facility project. The United States Access Board's proposed **Public Rights-of-Way Accessibility Guidelines**[4] (PROWAG) and the **2010 ADA Standards for Accessible Design**[5] (2010 Standards) contain standards and guidance for the construction of accessible facilities. This includes requirements for sidewalk curb ramps, slope requirements, and pedestrian railings along stairs.

Some of these treatments are not directly referenced in the current versions of the AASHTO Guide or the MUTCD, although many of the elements of these treatments are found within these documents. In all cases, engineering judgment is recommended to ensure that the application makes sense for the context of each treatment, given the

1 *Bicycle Facilities and the Manual on Uniform Traffic Control Devices. (2011). FHWA. http://www.fhwa.dot.gov/environment/bikeped/mutcd_bike.htm*

2 *MUTCD Official Rulings. FHWA. http://mutcd.fhwa.dot.gov/orsearch.asp*

3 *http://nacto.org/cities-for-cycling/design-guide/*

4 *http://www.access-board.gov/prowac/*

5 *http://www.ada.gov/2010ADAstandards_index.htm*

many complexities of urban streets.

The Institute of Transportation Engineers (ITE) **Designing Walkable Urban Thoroughfares: A Context Sensitive Approach** offers guidance for the planning and design of urban streets that enhance the pedestrian environment. This collaborative approach emphasizes the physical context of the roadway and adjacent spaces in transportation plans and projects, and focuses on the Context Sensitive Solutions (CSS) design philosophy which provides a framework for balancing transportation and community goals. The **ITE Traffic Control Devices Handbook** (2nd Edition) supplements the MUTCD with guidance on traffic control device applications and includes chapters specific to pedestrians, bicyclists, and schools.

Additional References

In addition to the previously described national standards, the basic bicycle and pedestrian design principals outlined in this chapter are derived from the documents listed below. Many of these documents are available online and provide a wealth of public information and resources.

Additional US Guidelines

- American Association of State Highway and Transportation Officials (2011). *AASHTO Policy on Geometric Design of Streets and Highways*. Washington, DC. www.transportation.org
- United States Access Board (2007). *Public Rights-of-Way Accessibility Guidelines (PROWAG)*. Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm
- United States Department of Justice (2010). *2010 ADA Standards for Accessible Design*. http://www.ada.gov/2010ADAstandards_index.htm

Best Practice Documents

- Alta Planning + Design and the Initiative for Bicycle & Pedestrian Innovation (IBPI) (2009). *Fundamentals of Bicycle Boulevard Planning & Design*. http://www.ibpi.usp.pdx.edu/media/BicycleBoulevardGuidebook.pdf
- Alta Planning + Design (2009). *Cycle Tracks: Lessons Learned.* http://www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf
- Association of Pedestrian and Bicycle Professionals (APBP) (2010). *Bicycle Parking Design Guidelines, 2nd Edition.*
- City of Portland Bureau of Transportation (2010). *Portland Bicycle Master Plan for 2030.* http://www.portlandonline.com/transportation/index.cfm?c=44597
- Federal Highway Administration (2005). *BIKESAFE: Bicycle Countermeasure Selection System.* http://www.bicycling-info.org/bikesafe/index.cfm
- Federal Highway Administration (2005). *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System.* http://www.walkinginfo.org/pedsafe/
- Federal Highway Administration (2005). *Report HRT-04-100, Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.* http://www.fhwa.dot.gov/publications/research/safety/04100/
- Federal Highway Administration (2001). *Designing Sidewalks and Trails for Access.* http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- King, Michael, for the Pedestrian and Bicycle Information Center (2002). *Bicycle Facility Selection: A Comparison of Approaches.* Highway Safety Research Center, University of North Carolina – Chapel Hill. http://www.hsrc.unc.edu/pdf/2002/BicycleFacilitySelectionMKingetal2002.pdf
- Oregon Department of Transportation (2012). *Oregon Bicycle and Pedestrian Design Guide.* http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- Rosales, Jennifer (2006). *Road Diet Handbook: Setting Trends for Livable Streets.*