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Milestone Report F – 1/15/08

**Pedestrian and Bicycle Project
Development, Design, and Operational
Considerations**

**Prepared as Background for the
Washington State Bicycle Facilities and
Pedestrian Walkways Plan**

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Chapter F.1 Introduction

Overview

This report examines bicycle and pedestrian facility design and operation relevant to Washington. It looks at current bicycle and pedestrian design and operation guidelines in the Washington State Department of Transportation's 2006 Design Manual, Washington's Local Agency Guidelines, and WSDOT's Traffic Operations Manual, as well as those from other state and local entities outside of Washington.

Recommendations taken from proven best practices in bicycle and pedestrian design and operations are included. As the Bicycle Facilities and Pedestrian Walkways Plan is developed, additional information sources may be added to this Milestone Report F.

Requirements of the State's Bicycle Facilities and Pedestrian Walkways Plan

Consistent with Washington State Law (RCW 47.06.100) and federal guidance, the scope of this project includes:

#1: Establishing a statewide strategy for addressing bicycle and pedestrian transportation.

For bicycle and pedestrian modes to be viable choices for citizens, they should be included in all aspects of the transportation system—planning, project development, funding, implementation, and maintenance. This report examines the level of this inclusion.

#2: Integrating bicycle and pedestrian travel with other transportation modes.

Bicycling and walking are ways people access buses, trains and ferries. For many people, non-motorized modes are the only way to access transit. Bus stops, park-and-ride lots, and inter-modal stations will be analyzed for bicycle and pedestrian accessibility, including bicycle parking.

#3: Coordinating WSDOT and local municipalities, regional planning entities and transit agencies.

To improve safety and mobility, planners and engineers at all levels of government should improve coordination. State, regional and local policies and operations are analyzed for coordination opportunities.

#4: Determining the role of bicycle and pedestrian transportation in reducing automobile congestion.

Reducing congestion and resulting green house gas emissions requires giving people viable transportation choices. Sidewalks and accessible pedestrian routes get people from home to their destinations and to transit stations and stops. Trails and bicycle lanes allow people to ride a bike instead of drive for many trips, and provide another way to access transit. Bike and pedestrian connections are analyzed for gaps and opportunities.

#5: Assessing statewide bicycle and pedestrian needs (needs related to state, city and county routes).

How much will it take to significantly improve the bike and pedestrian travel in Washington? Analyzing existing conditions will lead to an estimate of cost to build high-priority bike and pedestrian infrastructure.

Purpose and Organization of this Report

Chapter 2 of this Report F summarizes current federal, state and local design guidance that applies in Washington State.

In Chapter 3, we identify some design and operational considerations or focus areas for Washington based on an assessment of current design and operations guidance and practices in other states. This discussion is not intended to replace or supplement any of Washington's existing design or operations guidance, but rather to point out potential areas of focus that may need to be addressed through appropriate review processes in order to continue improving conditions for bicycling and walking.

In conjunction with each potential consideration or focus are, examples from other states are discussed or provided.

Chapter F.2 Existing Federal, State and Local Design Standards

Under federal law (23 CFR 652), the AASHTO Guide for Development of Bicycle Facilities or equivalent guides accepted by the division office of FHWA are established as construction and design guidance for projects making use of Federal Aid.

In 2004, AASHTO published the *Guide for the Planning, Design and Operation of Pedestrian Facilities*. At the time the federal law (23 CFR 652) was adopted this AASHTO pedestrian guide did not exist.

In Washington, FHWA's Division 10 Office has accepted WSDOT's Design Manual Chapters 1020 and 1025 as bicycle and pedestrian facility construction and design guidance for Federal Aid projects. The State Design Standards Committee has also accepted WSDOT's Design Manual as guidance for local agencies on all "new construction on major arterial and secondary arterial streets and to reconstruction of old such streets as far as practicable" per State Law [RCW 35.78].

This is important because at currently written, the WSDOT Design Guidance related to bicycle and pedestrian facilities is primarily written with a focus on state highways. Local streets and roads are often located in different settings (e.g., residential, community commercial, etc..) and have a different set of bicycle and pedestrian safety and operational issues than state highways.

The following sections outline the relevant federal, state and local design standards and guidance.

Federal Highway Administration (FHWA)'s Design Guidance

In the FHWA's subsequent Design Guidance issued in 2000 (entitled *Accommodating Bicycle and Pedestrian Travel: A Recommended Approach*), the following statement is made:

1. Bicycle and pedestrian ways shall be established in new construction and reconstruction projects in all urbanized areas unless one or more of three conditions are met:
 - Bicyclists and pedestrians are prohibited by law from using the roadway. In this instance, a greater effort may be necessary to accommodate bicyclists and pedestrians elsewhere within the right of way or within the same transportation corridor.
 - The cost of establishing bikeways or walkways would be excessively disproportionate to the need or probable use. Excessively disproportionate is

defined as exceeding twenty percent of the cost of the larger transportation project.

- Where scarcity of population or other factors indicate an absence of need. For example, the Portland Pedestrian Guide requires "all construction of new public streets" to include sidewalk improvements on both sides, unless the street is a cul-de-sac with four or fewer dwellings or the street has severe topographic or natural resource constraints.
2. In rural areas, paved shoulders should be included in all new construction and reconstruction projects on roadways used by more than 1,000 vehicles per day, as in States such as Wisconsin. Paved shoulders have safety and operational advantages for all road users in addition to providing a place for bicyclists and pedestrians to operate.

Federal Law - 23 CFR Sec. 652.13 Design and Construction Criteria.

(a) The American Association of State Highway and Transportation Officials' "**Guide for Development of New Bicycle Facilities, 1981**" (AASHTO Guide) or **equivalent guides** developed in cooperation with State or local officials and acceptable to the division office of the FHWA, shall be used as standards for the construction and design of bicycle routes. Copies of the AASHTO Guide may be obtained from the American Association of State Highway and Transportation Officials, 444 North Capitol Street, NW, Suite 225, Washington, DC 20001.

(b) Curb cuts and other provisions as may be appropriate for the handicapped are required on all Federal and Federal-aid projects involving the provision of curbs or sidewalks at all pedestrian crosswalks.

*Note: In 2004, AASHTO published the *Guide for the Planning, Design and Operation of Pedestrian Facilities*. At the time the federal law (23 CFR 652) was adopted this AASHTO pedestrian guide did not exist.

The purpose for both the AASHTO Guide for the Development of Bicycle Facilities and WSDOT's Bicycle Facilities Design Guidance is to provide uniform minimum standards and criteria for the design and construction of bicycle facilities.

Washington State Laws

Under Washington state law, a State Design Standards Committee is created with the authority to establish uniform design standards for new construction on major arterial and secondary arterial streets and to reconstruction of old such streets, including bicycle and pedestrian facility design standards. State law also gives guidance to the State Design

Standards Committee that these standards must meet or exceed the standards set in WSDOT's Design Manual.

Washington State Law RCW 35.78

State design standards — Committee — Membership.

There is created a state design standards committee of seven members, six of whom shall be appointed by the executive committee of the Association of Washington Cities to hold office at its pleasure and the seventh to be the state aid engineer. The members to be appointed by the executive committee of the Association of Washington Cities shall be restricted to the membership of the association or to those holding office and/or performing the function of chief engineer in any of the several municipalities in the state.

Committee to adopt uniform design standards.

The design standards committee shall from time to time adopt uniform design standards for major arterial and secondary arterial streets.

Design standards must be followed by municipalities — Approval of deviations.

The governing body of the several municipalities shall apply the uniform design standards adopted under RCW [35.78.030](#) to all new construction on major arterial and secondary arterial streets and to reconstruction of old such streets as far as practicable. No deviation from the design standards as to such streets may be made without approval of the state aid engineer.

Washington State Law - RCW 35.75.060

Use of street and road funds for bicycle paths, lanes, routes and improvements authorized — Standards

Any city or town may use any funds available for street or road construction, maintenance, or improvement for building, improving, and maintaining bicycle paths, lanes, roadways, and routes, and for improvements to make existing streets and roads more suitable and safe for bicycle traffic: PROVIDED, That any such paths, lanes, roadways, routes, or streets for which any such street or road funds are expended shall be suitable for bicycle transportation purposes and not solely for recreation purposes. Bicycle facilities constructed or modified after June 10, 1982, shall meet or exceed the standards of the state department of transportation.

Washington State Pedestrian Design Guidance

WSDOT Design Manual Chapter 1025.04

(1) General

Pedestrian facilities are required along and across sections of state routes and city streets, and are an integral part of the transportation system. FHWA policy (23 CFR 652.5) suggests that safe bicycle and pedestrian facilities be given full consideration on all federal aid highway improvement projects. Provide ADA-compliant pedestrian facilities on highway projects unless one or more of the three conditions below are met:

- Pedestrians are prohibited by law from using the facility.
- The cost of the improvements is excessive and disproportionate to the original need or probable use (as a guide, more than 20% of the project estimate). In these instances, evaluate options to modify the scope of the pedestrian improvements or investigate funding for a separate pedestrian project. Any improvement must comply with ADA accessibility requirements. Include documentation of the results of the investigation for funding a separate pedestrian project.
- Low population density or other factors (such as a lack of pedestrian generators within a quarter-mile radius of the project) indicate there is no need.

Washington State Bicycle Design Guidance

Design Manual Chapter 1020.04

(1) Facility Location

Provide bicycle facilities on routes that have been identified as a local, state, or regional significant bike route. Fill gaps in the existing network of bicycle facilities when the opportunity is available. For all other roadways, provide full design level shoulders for bicycle needs, unless:

- Bicyclists are prohibited by law from using the facility.
- The cost is excessively disproportionate to the need or probable use (generally defined as 20% of project cost..
- Other factors indicate there is no need.

Local Agency Guidelines

62.3 Design Standards

“The design standards for roadway and pedestrian projects shall be at a minimum the City and County Design Standards.

The design standards for bicycle or shared use facilities shall be the WSDOT Design Manual Chapter 10.”

It should be noted that while the Local Agency Guidelines make reference to City and County Design Standards, if those local standards do not address pedestrian and bicycle design, which currently many do not, the default is WSDOT Design Manual.

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Chapter F.3 Project Development Considerations

Context Sensitive Solutions

WSDOT has published an Executive Order related to implementation of context sensitive design [WSDOT Executive Order 1028.00]. It states:

“Context Sensitive Solutions is a model for transportation project development that has recently received much discussion and broad acceptance. Its essence is that a proposed transportation project must be planned not only for its physical aspects as a facility serving specific transportation objectives, but also for its effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting.

WSDOT endorses the Context Sensitive Solutions approach for all projects, large and small, from early planning through construction and eventual operation. This means that WSDOT employees working on projects and facilities should:

- Engage from the project’s inception with representatives of affected communities, including elected and appointed officials and a widely representative array of interested citizens.
- Assure that transportation objectives of projects are clearly described and discussed with local communities in a process that encourages reciprocal communication about local views and needs in the overall project setting.
- Pay attention to and address community and citizen concerns.
- Ensure the project is a safe facility for both the user and the community.

Context Sensitive Solutions is a process that places a high value on seeking and, if possible, achieving consensus. WSDOT’s belief is that consensus is highly advantageous to all parties and may help avoid delay and other costly obstacles to project implementation.

The offices of Highways and Local Programs and the State Design Engineer are charged with developing training, rules, and procedures for WSDOT employees to carry out this Executive Order.”

Context Sensitive Solutions presents an important opportunity to incorporate bicycle and pedestrian infrastructure in WSDOT projects and should continue to be a focus area. WSDOT should consider measurement mechanisms for Context Sensitive Solutions identified in Report E as well as expansion of the WSDOT publication, “Understanding Flexibility in Transportation Design”.

WSDOT Project Development Process

In order to move forward with Context Sensitive Solutions efforts at WSDOT, the agency should consider identifying opportunities in the project development process to more formally include consideration of bicycle and pedestrian facilities. For example, WSDOT should consider including opportunities to go beyond wide shoulders or sidewalks that parallel an urban mobility project on a state highway and consider crossing opportunities, connectivity, paths/trails and other locally identified needs in the vicinity of the project. See WSDOT Design Manual Chapter 150.00 for a discussion of project development.

WSDOT Design Matrices

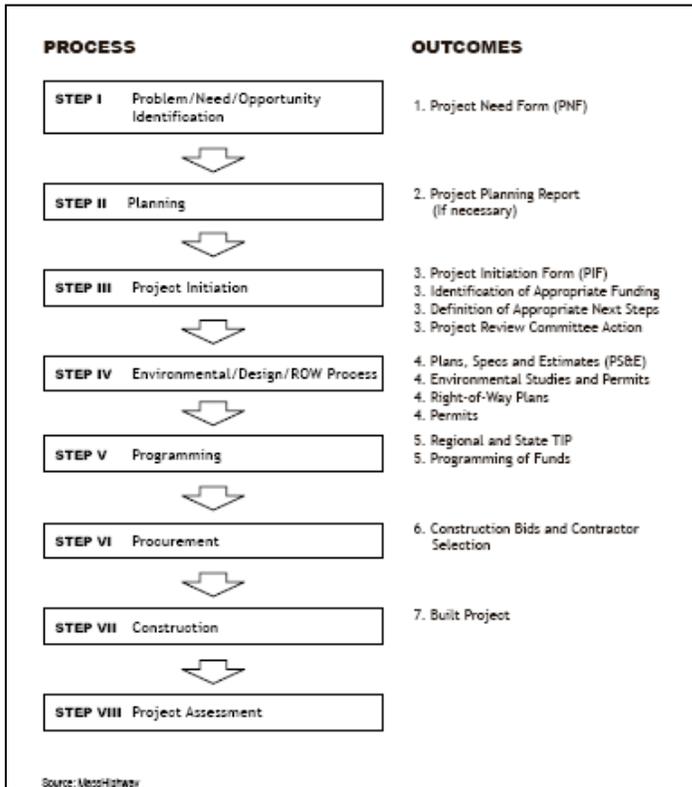
WSDOT like many other state agencies has established guidelines for all projects based on their location on the Interstate, the Non-Interstate Highway System or other location. The Design Matrices list all of the elements of the roadway that are to be considered or included in project design.

The challenge these design matrices present for designing bicycle and pedestrian infrastructure is that they may guide the designer toward specific types of features. For example in an urban mobility project on the Interstate or Non-Interstate Highway System, the matrix requires full design level for bicycles and pedestrians. Full design level is then discussed further in WSDOT Design Manual Chapter 440. However, the discussion in this section is focused on shoulders, curbs and medians and may guide the designer toward inclusion of these features.

Examples from Massachusetts

In 2006, Massachusetts Highway Department adopted their award winning “Project Development and Design Guide” which integrates a context sensitive approach in all of their processes. They clearly define the role of each division, office and staff person within their agency in developing context sensitive solutions. In the Guide, they outline an eight-step project development process to move a project from problem identification to completion. See **Figure 1** for an outline. They have also avoided prescriptive matrices that may limit a designer’s ability to creatively address transportation needs in certain settings or contexts.

Figure 1. MassHighway Project Development and Design Process



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Chapter F.3 Project Design and Operations

As cities and states throughout the U.S. have worked to improve conditions for multimodal transportation, many innovative traffic operation designs and policies have been tested, implemented and adopted. This chapter includes design and operational considerations that may help improve safety and mobility for bicyclists and pedestrians.

Safe Routes to School and School Zone Accommodation

Walking and biking are important transportation modes for children in the vicinity of schools. A child's ability to traverse traffic is different than the average adult and necessitates designing additional accommodations to provide for their safety. The challenge is to provide safe and efficient facilities that address the needs of children walking and biking to school as well as motorists. It is important to strike the right balance when designing improvements

Special Considerations for Children

Children have limitations that should be considered when planning for engineering improvements.

- They have narrower side vision
- They are less able to determine the direction of sound
- They have a limited capacity to anticipate vehicle speed
- Due to their smaller size, it is more difficult for them to see vehicles and to be seen by motorists
- They have limited reasoning and judgment abilities
- They are less focused than adults
- They have less experience navigating safely to their destinations.

Engineering improvements targeted to improve safety for children on their way to school help enable the motorist to recognize and accommodate the sometimes unexpected movements of children. The best designs that take into account both pedestrian and motor vehicle needs can help reduce conflicts and make it easier for the motorist to see children and stop in time to avoid them.

Walk/Bike Route Considerations

These guidelines should be used in making decisions about selecting walk/bike routes within a two-mile radius of a school. Where practical, planners should look for routes that:

- Have separated facilities such as sidewalks (separated from the road by a buffer), bike lanes, or shared use paths
- If the route is adjacent to roads, follow roads with lower speed limits, lowest traffic volumes and lowest truck volumes
- Do not require students to walk/bike more than a block or two out of the way
- Have fewer needs for crossing streets
- Provide crossing locations on roads with the lowest traffic speeds, lowest traffic volumes, few heavy truck volumes, and the best sight distance
- Provide crossings with adequate sight distance, existing stop signs, marked crosswalks, traffic signals, pedestrian signals, or safety patrols
- Utilize easements and parks
- Provide illumination, especially at crossing locations
- Separate the students from traffic on the school grounds

In selecting the walk/bike route there may be locations that do not meet these preferred conditions and may merit improvements.

Any route that is chosen should encourage children to walk or bike in groups.

School Zone Improvement Considerations

- Provide the Right Pedestrian Amenities
 - Separated facilities such as multi-use paths, trails, and bridges typically provide the highest pedestrian benefit but also come at a higher cost
 - Sidewalks improve safety, especially when they include a buffer with plantings, providing better separation from vehicle traffic along with a pleasant aesthetic quality
 - Bicycle facilities such as multi-use paths, bike lanes or wide shoulders.
- Reduced Speed Limit Zones
 - Mark roads adjacent to schools as 20 mph School Zones.
 - A 20 miles per hour school speed zone may be created on state highways, county roads, and city streets at a marked school crossing. The speed zone shall extend three hundred feet in either direction from the marked crosswalk.
 - Along state highways, school speed zones do not require a traffic regulation.
 - A county or incorporated city or town may create a school or playground speed zone on a roadway bordering a marked school or playground and extending up to 300 feet beyond the edge of the property in either direction. The speed zone may only include the area consistent with active school or playground use.

- No school or playground speed zone may extend less than 300 feet in either direction from a marked crosswalk or a marked school or playground.
 - A school or playground speed zone may extend more than 300 feet from the crosswalk, however a total distance greater than 600 feet requires a traffic regulation based on the traffic and engineering investigation prescribed by the Manual for Uniform Traffic Control Devices.¹ Such school or playground speed zones along state highways may be enacted by the Washington State Department of Transportation and requires a traffic regulation based on traffic and engineering investigation.
 - Making Speed Reductions Work Through Good Traffic Calming and Signage
 - Look for design opportunities to influence speed in the vicinity of schools and post reduced speed limits with the goal of speed limits on the school walk/bike routes that are 25mph or less.
 - Implement traffic calming measures such as curb extensions, roundabouts, curb radius reductions, vehicle speed feedback signs, speed humps, refuge islands, full medians or narrowing the road width.
 - Mark or Signalize Street Crossings
 - Allow one crossing for each block adjacent to the school property (300 to 600 ft. spacing) and as appropriate along the school walk/bike routes.
 - Crossing treatments may include curb extensions, medians, in street pedestrian crossing signs, high visibility markings, enhanced signing, speed tables (raised crossings), traffic signals, in-pavement pedestrian activated flashing lights, pedestrian countdown signals and angled crossings.
 - Maintain Visibility Between Motorists and Pedestrians
 - Vegetation, signage, parking and street furniture along the school walk/bike routes should be maintained or moved so that it does not limit the needed two-way visibility between motorists and smaller pedestrians.
 - Vegetation should be maintained to prevent encroachment. Plantings and shrubs should be no higher than three feet, or the height of the smallest pedestrian. Trees should be trimmed so that the lowest branches are at least seven feet above the sidewalk.
 - Restrict parking within the influence area of pedestrian crossings.
 - Provide Treatments to Address Issues Related to Multi-lane Roadways
 - Multi-lane roadways pose added difficulties to pedestrians and bicyclists and may require additional safety treatments. Examples include pavement marking, curb extensions, pedestrian lighting, signals, signage, and medians.
 - Always Provide Accommodations for People With Disabilities.
 - Accommodations for people with disabilities include curb ramps, audible traffic signals, truncated domes and accessible routes.
 - Provide Illumination Provide illumination along school walk/bike routes and especially at crossing locations.
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- Provide Facilities Separate from Children Drop-Off Areas
 - At the school, locate children drop-off facilities away from main entrances, bicycle parking facilities and other activity areas.

Mid-block Pedestrian Crossings

In high-density business or retail districts with signals at every intersection, pedestrians can easily and safely cross the roadway at reasonable intervals. In the suburbs, however, where multi-lane arterials dominate, the long distances between signalized intersections reduce crossing access for pedestrians. If such a corridor is a transit route, or includes retail and employment centers, there will likely be many pedestrians needing to cross the roadway. For example, transit users will likely have to cross the roadway to get to their stop on one leg of their trip. Most people will not walk an unreasonable distance out of their way to utilize a signalized crossing, and will instead attempt potentially hazardous mid-block crossings.

WSDOT's pedestrian design guidelines states: "The installation of a midblock pedestrian crossing on a state highway is a design deviation that requires approval and documentation". There are many common situations, however, where mid-block crossings must be addressed, including:

- The crossing is at an approved school crossing on a school walk route,
- The adjacent land use creates a high concentration of pedestrian crossings, (i.e., retail centers with nearby neighborhoods, colleges, parks, and recreational facilities.)
- A significant number of pedestrian crossings and substantial pedestrian/vehicle conflicts occur (i.e., at-grade trail intersections with roadways), and
- The proposed crossing can concentrate or channel multiple pedestrian crossings to a single location. (i.e., strip retail centers on opposite sides of a street)

Current guidelines for installing mid-block crossings rule out areas where pedestrian risk is highest (higher speed, higher volume, wider roads). WSDOT and local agencies should consider developing priority locations for mid-block crossing applications.

Crosswalk Spacing

The WSDOT Pedestrian Design Considerations chapter does not have guidelines for maximum intervals between pedestrian crossings. It does, however, state that midblock crossings on state highways are "not desirable" less than 300 ft from a signalized intersection or less than 600 ft from another pedestrian crossing. Current research shows that maximum crosswalk spacing in areas where walking is encouraged, should be between 300 and no more than 800 feet. WSDOT may consider identifying a maximum crosswalk spacing criteria for urban areas and centers or where pedestrian safety is a concern.

If the Average Daily Traffic of a roadway is greater than 30,000 vehicles and utilizes at least four lanes, WSDOT Design Considerations specify inclusion of a pedestrian signal at all pedestrian crossings. This guideline makes no reference to pedestrian warrants, so it is unclear if there must be a minimum of potential pedestrian crossing traffic in order to install a pedestrian signal. Also, it is not clear in the document that such a pedestrian signal would be permitted at a mid-block location.

The current WSDOT guidelines should be updated to address these issues. Examples from other states are given below.

Examples from other States

Georgia DOT – *Pedestrian and Streetscape Guide*

Georgia DOT references the ITE manual, *Design and Safety of Pedestrian Facilities*:

“In some urban areas where distances between intersections are long, mid-block crossing points provide pedestrians opportunities to cross safely. Mid-block crossings can also provide convenience and safety in less developed areas, where pedestrian activity is high (such as between an apartment site and a grocery store; a school and a park; or a transit stop and a residential neighborhood).

Locations being considered for a mid-block crossing need to be carefully studied. The following guidance for determining locations for mid-block crossing installation is provided by the ITE manual, *Design and Safety of Pedestrian Facilities*:

- Where significant pedestrian crossings and substantial pedestrian/vehicle conflicts exist;
- Where the crossing can serve to concentrate or channelize multiple pedestrian crossings to a single location;
- At approved school crossings or crossings on recommended safe school walk routes;
- Where land uses create high concentrations of pedestrians needing to cross (such as residential areas across from retail or recreation, and transit stops across from residential or employment);
- Where pedestrians could not otherwise recognize the proper place to cross or there is a need to delineate the optimal location to cross;
- Where there is adequate sight distance for the motorist and pedestrian. (Any obstacles that would interfere with visibility at the crossing location such as mailboxes, utility poles, street furniture, and landscaping should be removed or relocated. On-street parking should be set back from the crossing point for improved visibility; and
- Installed on the basis of an engineering study if located at other than an existing stop sign or traffic signal.

Oregon DOT

The Oregon DOT's 1995 bicycle and pedestrian plan acknowledges that midblock crossings are a fact that roadway designers need to consider, since people will take the shortest route to their destination. "Prohibiting such movements is counter-productive if pedestrians dash across the road with no protection. It is better to design roadways that enable pedestrians to cross safely."

Regarding signalizing mid-block crossings of high-volume, multi-lane roads, the Oregon plan states that a pedestrian-activated signal may be warranted where the expected number of people needing to cross a roadway at a particular location is significant. However, anticipated use must be high enough for motorists to get used to stopping frequently for a red light (a light that is rarely activated may be ignored when in use). Oregon DOT's plan refers to the MUTCD's pedestrian warrants in considering signalizing a pedestrian crossing.

FHWA Guidelines

The Federal Highway Administration's guidelines for pedestrian crossings acknowledges that placement of mid-block pedestrian signals is called for in some locations. The FHWA guidelines state the following:

"The warrants provided in the Manual on Uniform Traffic Control Devices (MUTCD) should be followed." These warrants specify which locations should have signals based on pedestrian volume and vehicle gaps based on vehicle speeds, volumes, and nearby signals which may create appropriate crossing gaps. It also includes the 300 foot spacing requirement from nearby signals reflected in the current WSDOT design guidelines.

However, since FHWA's document does not require that pedestrian warrants be followed, a pedestrian-activated signal could be installed at an important unsignalized or mid-block pedestrian location regardless of the volume of pedestrian traffic. FHWA's guidelines state that where a midblock crossing is needed on a high-volume arterial with six vehicle lanes, a pedestrian signal is essential.

At-Grade Pedestrian Crossing Treatments

Research is currently being conducted at both state and national levels to determine the mix of pedestrian crossing treatments that provides the most cost-effective safety improvements for various circumstances, especially for crossings on higher speed, higher volume roads.

Some of the research to date has identified several treatments that should be considered and potentially incorporated into WSDOT Design Guidance and Traffic Operations Guidance including:

- Zig Zag Approach Restrictions,
- Pavement Legends for Pedestrians,
- Overhead Warning Signs and Lights,
- Pedestrian Railings,
- Curb Extensions and Medians,
- Lane Reductions,
- Setback Crosswalks,
- Pedestrian Light Controlled or Pelican Crossing,
- Pedestrian User Friendly Intelligent or Puffin Crossing,
- Two Can Cross or Toucan Crossings,
- High-Intensity Activated or Hawk Crossing,
- Leading Pedestrian Interval,
- Advance Stop Lines or Bars, and
- Scramble Pattern at Signals.

Countdown Pedestrian Signals

Pedestrian signals that utilize a visible countdown clock have become more widespread in recent years. With this design, numerals indicating the number of seconds remaining to cross a roadway for a pedestrian already in the crosswalk are displayed next to the flashing upraised hand during the “pedestrian change” or warning phase. During other phases the countdown display is dark.

The countdown signals have been found to accomplish several key goals of a safe pedestrian environment:

- Safer crossings. When people know exactly how much time they have to cross the street, they are less likely to dash across at the last moment and risk a collision with a vehicle.
- Encouragement to walk. With the conventional style of pedestrian signal, a pedestrian could not tell how long they had to get across the street after the warning phase began. This often causes a person to skip the current pedestrian phase altogether, and wait for an entire vehicle signal phase to complete before attempting to cross again. Pedestrians left on the corner waiting for the next phase grow impatient, feel like their time is being wasted, and end up feeling like walking is not such a practical mode of transportation. Countdown signals make crossing more predictable, relaxed and comfortable. Overall, they can help make the pedestrian environment more attractive.
- Motorist behavior improves. A Maryland State Highway Administration study has shown that countdown pedestrian signals produced a reduction in the number of motorists entering the intersection at the end of the yellow phase. These motorists are watching the pedestrian countdowns signals to see how much time they have, resulting in the decrease in red light running at these intersections.

State and local jurisdictions all over the U.S. are transitioning their pedestrian signals to the countdown type. While there are certain conditions that are higher priorities for crossing safety improvements (of which countdown signals are one type), the benefits of countdown signals make them practical for all signalized pedestrian crossings.

Examples from other States

The **Florida Department of Transportation** has determined that countdown pedestrian signals are its preferred type of pedestrian signal. The agency began installing countdown signals on all new and rebuilt signal projects in 2006, and is planning to phase them in at all pedestrian signal locations in the next several years.

As budgets allow, Florida DOT is encouraging its districts to replace the conventional style with countdown signals, giving priority to locations with the following conditions:

- Pedestrian crash history
- High percentage of older pedestrians
- High percentage of tourist pedestrians
- High percentage of school-age children
- High speed roadway
- Multi-lane and/or wide intersections

The state of **Maryland** has conducted studies on countdown pedestrian signals, and is phasing them into its operations of the Maryland State Highway Administration. The department's study⁵ in Montgomery County found a significant reduction in pedestrian-motorist conflicts when pedestrian signal heads were changed to the countdown type.

Washington D.C. is the first large urban area in the U.S. to change all of its pedestrian signal heads to countdown signals beginning with upgrades at 1500 intersections.⁶

Toronto, Ontario, Canada is on track to have upgraded 2000 intersections with countdown pedestrian signals by the year 2009.⁷

Wayfinding/Signage

Signs should be posted at locations where a state bicycle or pedestrian route intersects a local bicycle or pedestrian route. Since most regional bicycle routes and many pedestrian routes are often a combination of city, county and state roads, bicyclists and pedestrians need to be directed to new segments along the



Trail Signage on State Route in Jefferson Co. WA

route just as motorists do as they travel between the various road systems.

Connecting nonmotorized routes on the state system to those in a local system is one of the key goals of a statewide bicycle and pedestrian plan, and a wayfinding protocol is necessary to ensure an efficient interface between the two systems. State and local agencies should coordinate to provide effective signage to the key bike and pedestrian routes. If a regional nonmotorized route is a trail located in state right-of-way, WSDOT should provide street signs where the trail intersects local bicycle and pedestrian routes, plus signage directing users to key bicycle and pedestrian attractors such as transit stops, commercial centers, recreation sites, etc.

It is especially important to direct bicyclists and pedestrians from state routes to a trail when the two systems intersect. The recently constructed Larry Scott Memorial Trail in Jefferson County is a good example of signage to direct bicyclists or pedestrians off the state road and onto the local or regional route that follows a trail.

Appendix B is an example of a wayfinding protocol in the proposed Seattle Bicycle Master Plan, which may serve as an example for input to a WSDOT protocol.

Designating Alternate Routes/Local Routes

Input received at public hearings points to an opportunity to improve coordination between WSDOT and local agencies in project development, especially regarding bicycle and pedestrian safety and mobility. Elected officials from several local agencies across the state made this key point during their remarks.

There is an opportunity for WSDOT to develop a more detailed project development processes for coordination with local governments. The state may realize an efficiency by including non-motorized safety and mobility features and other locally identified needs in new highway or roadway construction and re-construction projects, rather than as separate projects. Providing these facilities could also help in achieving the goals of Washington's Transportation Plan.

Bicycle Lane Markings

As stated in Chapter 1020 of WSDOT Design Manual, "bike lanes are established along streets in corridors where there is current or anticipated bicycle demand and where it would be unsafe for bicyclists to ride in the travel lane. Bike lanes delineate the rights of way assigned to bicyclists and motorists and provide for movements that are more predictable by each."

The minimum width for a bike lane is 4 feet; the most common widths are 5 – 6 feet, while roads with ample right of way can accommodate bike lanes up to 10 feet wide.

Bike lanes striped next to the curb should, or along curbside parking as long as there is enough room to provide “door-free” space between parked cars and bicycles. The total parking lane plus bicycle lane should be at least 15 feet wide when striping bicycle lanes along curbside parking.

There are many designs for accommodating bike lanes on a wide variety of both one- and two-way roadways, those with bus routes and bus stops, and different configurations of on-street parking. While WSDOT’s Chapter 1020 includes several bike lane configurations, there are additional guidelines from other jurisdictions for designating, signing and marking bike lanes on a wide range of roadway widths and types.

Several considerations for the short term include: frequency of bicycle lane markings and signage placement. **Appendix C** includes details of bicycle lane designs and markings from the City of Chicago’s Bike Lane Design Guide.

Bicycle Lanes Through Intersections

Of particular importance in designing safe bike lanes is how to mark them at and through intersections. The most common design is to dash the left-side bike lane stripe approximately 30 ft from the intersection stop bar. This marking indicates that the bicyclist may be moving into the car lane to position him or herself ahead of the queue to prevent cars from turning right in front of the bicyclist. The dash also indicates to right-turning motorists to be aware of crossing a bike lane to make the right turn. A variation on this design is to drop the left-side bike lane boundary line altogether at the intersection.

Bike lane striping at intersections can also remain solid in a variety of conditions, including when right-turn-only lanes are provided, or when intersecting a one-way street where neither cars nor bikes are turning right.



Portland’s Blue Bike Lanes

Colored bicycle lanes are becoming increasingly popular, particularly at intersections. The City of Portland has installed colored bike lanes at 10 locations throughout the City to improve bicycle safety at known conflict points, particularly yielding to cyclists by right turning vehicles.

Appendix C includes details of designs and marking of bike lanes at intersections, from the City of Chicago’s Bike Lane Design Guide.

The Bike Box or Advance Stop Line

A common safety issue for bicyclists is at intersections when motorists turn either right or left in front of a bicyclist traveling straight through the intersection. One explanation for this type of collision is that motorists are often poor at judging how fast a bicyclist travels, and the motorist thinks he/she has enough time to make the turn in front of the approaching bicyclist. The bike box is an innovative and effective treatment for reducing this type of collision.



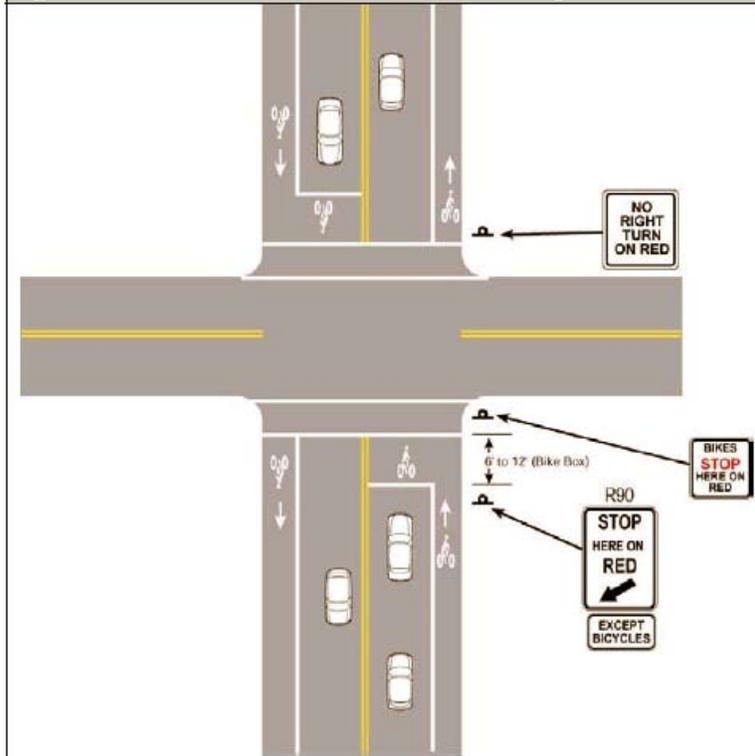
Bike Box or Advance Stop Lines – Cambridge, MA

“Bike box” is a term for this marking treatment originating in Europe but now being used in many U.S. cities. Also called “streaming bicycle lane” or “advanced stop bar”, the bike box is a right-angle extension to a bike lane placed at the head of an intersection. The box allows bicyclists to position themselves at the front of the traffic queue on a red traffic signal indication and then proceed first into the intersection on the green. Bicyclists entering the intersection ahead of cars, which they can easily accomplish due to their quick acceleration capability, significantly reduces the chances that a car will turn either right or left in front of the bicyclist who is preceding straight through.

Potential applications of the bike box include:

- At intersections with a high volume of bicycle and motor vehicles,
- Where there are frequent turning conflicts,
- At intersections with a high percentage of turning movements by both bicyclists and motorists,
- No right turn on red locations,
- Combined with a bicycle signal.

Figure 2 show an example of intersections using the bike box on a two-way street, with right turn on red prohibited.

Figure 2. Basic Bike Box or Advance Stop Line Markings

Appendix D includes a study of the bike box conducted in Eugene, Oregon, and details of the application used in San Francisco.

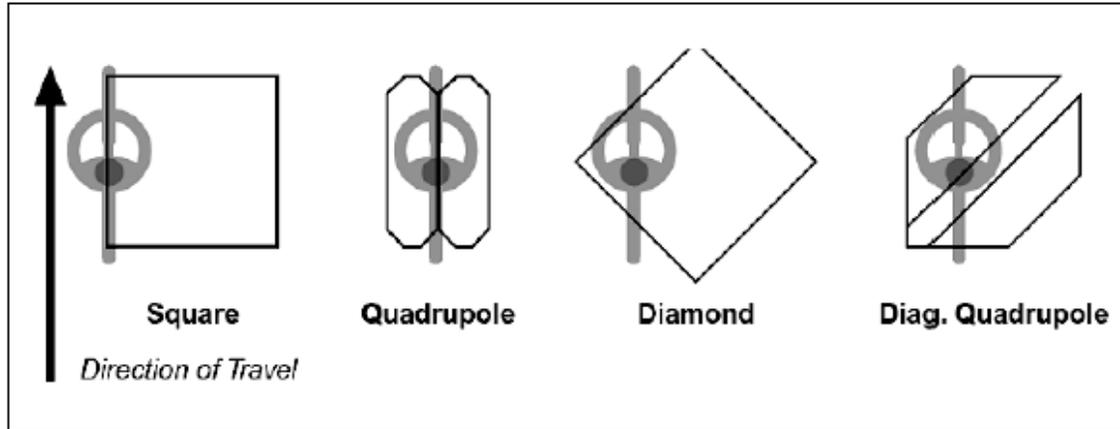
Bicycle Loop Detectors and Markings

Signal loop detectors which sense bicycles should be considered for all intersections where a state route serves as a local arterial or collector and is used by bicyclists. Detectors should be installed where bicyclists are likely to travel, typically the right side of through travel lanes, the center of bicycle lanes, and the right side of left turn lanes.

Traffic-actuated signals without the capability to detect bicycles can leave a bicyclist stranded at an intersection until a car comes along to activate the signal. At certain times of the day, a bicyclist could have to wait for several cycles of the signal before being permitted to proceed. This situation can encourage bicyclists to break traffic laws and “run” the red. While this would not necessarily be hazardous since light car traffic would be the cause for the bicyclist to get stuck, most bicyclists would prefer to obey traffic laws.

Quadrupole and diagonal-type loop detectors provide the best bicycle detection. **Figure 3** shows examples of various loop detector types.

Figure 3. Existing Loop Detectors for Bicycles



Quadrupole loops are often used in bike lanes and diagonal quadrupole loops on shared roadways. A proven design recommendation is a 5.5 x 5.5 ft, 45-degree skewed loop set within 4 inches of the surface.⁸ This configuration most accurately detects motor vehicles and bicycles. Standard rectangular, square and diamond loops tend to only detect bicycles along the loop edges.

It's essential to provide markings to tell bicyclists where the loop is located, and where the most sensitive part of the loop is. The accepted marking is a small stenciled bicycle figure positioned parallel to the direction of travel, over the most sensitive part of the loop. **Figure 3** above illustrates the best stencil placement for each type of loop detector. Please see **Appendix E** for an example of the loop detector bicycle stencil.

Bikeways at Roundabouts

Roundabouts have been proven effective at reducing collisions, decreasing traffic speed by 85%, improving overall safety for the motoring public. However, several studies have shown that bicyclists and some pedestrians, particularly the sight impaired, may not receive the same safety benefits as motor vehicles. A recent study conducted by Florida DOT finds that cyclists consider roundabouts more stressful to navigate than other intersection treatments, especially on higher volume roads. For both cyclists and pedestrians, multilane roundabouts are not as safe as single-lane roundabouts, since crossing distances are longer and motor vehicle speeds may be greater.²

WSDOT Design Manual Chapter 915 currently states, “end all marked bicycle lanes or shoulders before they enter a roundabout in order to direct bicycles to either enter traffic

and use the circulating roadway, or leave the roadway onto a separate shared-use path or shared-use sidewalk.”

Special provisions for bicyclists are not currently required at roundabouts in current WSDOT Design Guidance. Consideration should be given to inclusion of a separated bicycle facility in the case of higher speed (35 mph +), multi-lane roundabouts, if space permits.

Pedestrians and Roundabouts

Studies show that pedestrian collision rates are lower at roundabouts with slower vehicle speeds than at traditional intersections. Many of the roundabouts studied in this research also had splitter islands and other pedestrian treatments as well as lower vehicle operating speeds. It should be noted that some multi-lane roundabouts with angled entry points (>45 degrees) may accommodate vehicle operating speeds greater than 35 mile per hour.

WSDOT Design Manual Chapter 915 currently states, “when pedestrian activity is anticipated, include a pedestrian refuge in the splitter island and mark all pedestrian crosswalks.” However, a threshold for pedestrian activity is not provided in this discussion.

WSDOT Design Guidance currently recommends offsetting the pedestrian crossing by one car lengths from the yield line of the roundabout. Research suggests offsetting the pedestrian crossing one to three car lengths from the yield line of the roundabout. This allows motorists that are approaching the roundabout to yield to pedestrians crossing the approaches and causes motorists to look for a gap to merge with oncoming traffic.

Additional recommendations or considerations for pedestrians in roundabouts include:

- Identifying all conflict points to aid in design
- Design for the minimum number of entry, circulating and exit lanes needed,
- Audible, pedestrian actuated signals should be considered at crosswalks,
- A distinctive edge, particularly paving-to-grass, a raised curb, or detectable warning can provide orientation to the crossing direction,
- Consider including stop bars, LED in-roadway warning lights, signal pre-emption, and stop for pedestrians signage in the roundabout design.

Sidepaths or Cycle Tracks

Research conducted to date indicates that bicycling on sidewalks and similar facilities may pose more risks to cyclists than on-street bicycle lanes or riding with traffic due to the increased exposure to turning motor vehicles. However, sidepaths are proposed as a longer term consideration for design in this report as they are one of many tools that may be appropriate in certain settings or circumstances. As more information becomes available about sidepaths and best practices for sidepath design. It may be appropriate to include in WSDOT Design Guidance.



Sidepath – Cambridge, MA

Channelization Plans-- Bicycle and Pedestrian Markings

WSDOT's Channelization Plans are an important part of the agency's operations. These plans document all of the conditions on a given roadway, and are used by contractors and by WSDOT construction forces during construction to make sure all such conditions are maintained after the construction. An example of the documented conditions are: number and width of vehicle lanes, shoulder widths, sidewalks, curb ramps, signals, bike lanes, placement of signs, etc.

WSDOT should ensure a consistent protocol for channelization plans throughout all of its regions. An analysis of WSDOT's Northwest Region Channelization Plan Documentation from 2002 shows areas for improvement in planning for bicycle and pedestrian accommodations before and after design and construction of roadway projects.

For example, the Northwest Region's document contains two sets of guidelines for contractors to use: 1) Project Design Guidelines, and 2) Channelization Plan Checklist. While the Project Design Guidelines sheet includes all aspects of motor vehicle facilities design, the following elements of bicycle and pedestrian facilities are missing:

- Bike lanes and markings
- Sidewalks
- Placement of pedestrian signal activator buttons
- ADA issues such as running and cross slopes, curb ramps, accessible routes to transit

- Work zone accommodation

The Channelization Plan Checklist does include some bicycle and pedestrian elements in the following bullet point:

“Typical roadway sections showing all channelization features with dimensions (i.e., travel lanes, turn lanes, medians, shoulders, curb and gutter, bike lane, sidewalk, etc).”

While this is inclusive of the bicycle and pedestrian modes, it could be improved with more details such as making note of curb ramps, placement of signal activators, bicycle lane markings, placement of signs and other features.

WSDOT’s Northwest Region Channelization plan is a positive step toward bicycle and pedestrian accommodation. Using this plan as a basis, researching other regional channelization plans if they exist, and adding appropriate improvements, WSDOT may develop a recommended plan for all WSDOT regions.

Work Zone Accommodation for Bicycles and Pedestrians

Work zones may pose severe safety hazards and mobility challenges for bicycles and pedestrians. It’s essential to include bicycle and pedestrian accommodations in any roadway work zone traffic control plans, including safe detours, signage, removal of construction debris and route access.

Some of the issues pedestrians face in work zones are sidewalk closures, out of reach signal activator buttons, signage blocking the sidewalks, overhead hazards and circuitous detours. Mobility impaired people, especially wheelchair users, face particular challenges during construction. A wheelchair user accustomed to having safe access to a destination or transit stop may suddenly find him- or herself blocked from their daily travel route. If a closed sidewalk forces them into a narrow vehicle travel lane, personal safety as well as access is greatly compromised. Further, work zone conditions can render a pedestrian route out of compliance with the Americans with Disabilities (ADA) Act.

Bicyclists face similar dangers when construction displaces a bicycle lane or other accommodation, potentially forcing them into a travel lane with high traffic volumes and high speeds. Construction zone signage can also serve as a hazard to bicyclists if it’s placed in a bicyclist’s line of travel, forcing the rider to swerve into vehicle traffic to avoid it. Construction debris is another serious hazard for bicyclists, particularly when left in bike lanes or on trails and sidepaths frequented by large numbers of cyclists traveling at high speeds.

Traveler inconvenience is even more of a factor for bicyclists and pedestrians than for motorists during construction. Since bicycling and walking are human-powered modes of travel, the extra time and energy caused by construction detours are exponentially

more difficult for bicyclists and pedestrians to deal with. When these users depend on bicycling and walking as part of their daily work commute, accommodating these modes in construction zones, particularly those of lengthy durations, is key in a multimodal transportation system.

The Federal Highway Administration has established guidelines for accommodating bicyclists and pedestrians in work zones.

Universal Design Including Accessibility (ADA)

The intent of universal design is to simplify life for everyone by making products, communications, and the built environment more usable by as many people as possible at little or no extra cost. Universal design benefits people of all ages and abilities.

While Universal Design is broader than Americans with Disabilities Act (ADA) that many transportation professionals are becoming more accustomed to following, it may help WSDOT and local agencies to meet these requirements by encouraging designers to approach design of the built environment in a way that is more consistent with the agency's Context Sensitive Solutions policies.

The Center for Universal Design at North Carolina University identifies the following principles of Universal Design.

1. Equitable use
2. Flexibility in use
3. Simple and intuitive
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use

WSDOT should consider Universal Design training for transportation planners and designers. WSDOT should also consider the integrating the principles of Universal Design into all chapters of the agency's design guidance. This approach to design will become increasingly important as the population ages and more communities are designing to accommodate a changing population, for example, increasing numbers of older road users with a range of physical and mental challenges that may not be considered disabilities under federal law.

Additional Considerations

Maintaining Bicycle Facilities

- A cyclist riding along a roadway and suddenly encountering a hazard might require moving into traffic. These maintenance hazards include broken glass, loose gravel, excessive leaf litter, dropped fruit (such as blackberries), tree branches, buckled pavement, an abrupt pavement edge, or a dangerous sewer grate. Common bike routes should receive regular cleaning and inspection, particularly during the high-use months.
- Road maintenance signs should not be placed on the shoulder if they force cyclists into the roadway and be removed as soon as possible. Fallen or broken road signs create cycling hazards when left on the shoulder.

Considering the Cyclist

- A cyclist riding along a roadway and suddenly encountering a narrowed or disappearing shoulder might require moving into traffic.
- A speed bump that is not easily visible on the shoulder can surprise the rider and cause a fall.
- Unclear signage regarding bike routes can cause cyclists to miss the intended routes and end up on busy roadways.
- Poor sewer grate design or placement, and abrupt paving margins create hazards to bicyclists.
- Cars parked intermittently along the roadway create cycling hazards when they force cyclists into the roadway to move around them and when they increase the chance of a car door suddenly swing into the path of a cyclist.

Considering the Motorist

- Tinted windows on autos prevent cyclists from making eye contact with drivers and greatly increase the risk of a collision. Window tinting should be regulated for safety issues.
- Excessively wide vehicles with protruding rear-view mirrors create a hazard for cyclists.
- Excessively quiet engines give cyclists no warning that a vehicle is approaching. All engines should have minimum (and maximum) noise ratings.
- Excessively loud horns can startle cyclists and cause a fall. The DOT and cyclists could work with manufactures and regulators to set maximum noise limits.

APPENDIX A: Sources

Sources cited in text

1. RCW 46.61.440 and WAC 468-95-330
2. RCW 46.61.440(1)
3. “Evaluation of Pedestrian Countdown Signals in Montgomery County, Maryland”; Eccles, K.A and Mangum, B.C. Transportation Research Record #1818
4. As viewed on Washington D.C. DOT web site, page dated 2/26/04:
<http://newsroom.dc.gov/show.aspx/agency/ddot/section/2/release/9264/year/2004/month/2>
5. As viewed on “Spacing Toronto” web site, page dated 10/18/07:
<http://spacing.ca/wire/?p=2393>
6. Minnesota DOT bicycle design guidelines
7. Florida Department of Transportation “Bicycle and Pedestrian Considerations at Roundabouts, September 2000.

Primary Design Resources

Safe Routes to School Guide – Engineering (National Center for Safe Routes to School)

American Association of State Highway and Transportation Officials (ASHTO) “Guide for the Planning Design and Operation of Pedestrian Facilities”.

AASHTO “Guide for the Development of Bicycle Facilities”.

WSDOT Design Manual Chapter 1020, “Bicycle Facilities”

WSDOT Design Manual Chapter 1025, “Pedestrian Facilities”

FHWA’s Designing Sidewalks and Trails for Access – Part I and II

Manual on Uniform Traffic Control Devices (MUTCD)

MUTCD – Washington State Modifications (Chapter 468.95 RCW, Manual on uniform traffic control devices for streets and highways)

Guidelines for Bicycle Parking Design (Association of Pedestrian and Bicycle Professionals)

Alternative Treatments for At-Grade Pedestrian Crossings (Institute of Transportation Engineers)

APPENDIX B: Wayfinding Protocol, DRAFT Seattle Bicycle Master Plan 2007

Bicycle route signs will be posted on designated roadways and trails to direct bicyclists to major destinations throughout Seattle. Pavement markings will also be used to assist with wayfinding in some locations. The protocol for locating signs and markings is described below. Several routes will be signed during the first year after this Plan is adopted, and modifications will be made to this protocol based on this experience.

General

- Use standard City and regional sign designs developed as a part of this Plan (see below).
- Follow MUTCD standards for sign installation, such as minimum height of signs above ground and horizontal placement from edge of the roadway or trail.
- Post the regional route sign separate from the City route sign on all segments that are both regional and City routes (e.g., combined signs will not be used).
- City route signs should include a directional arrow, destination and distance.
- Destinations on signs should be named using Urban Villages and Urban Centers, major transit hubs and regional parks (see the major activity center names on Figure 1: Major Bicycle Destinations and Key Bicycle Corridors).
- Whenever any type of sign or marking is used on a bicycle route, there must always be a sign that shows the direction to follow to remain on the route.
- While a route may extend the length of the City, it should not show all destinations on a single sign; instead, it should show important intermediate destinations
- When directional subplate signs (e.g., “blades”) are used, the sign listing the closest destination should be on top, and the furthest destination should be on the bottom. A maximum of three directional subplate signs should be used on any single bicycle route sign.
- Reduced-size signs can be used as route confirmation signs on regional routes. These smaller signs may be placed lower to the ground or on different types of poles than the regular-size signs.
- Regional route signs can be installed on the same or separate posts as the City route signs. When regional route signs are added to a post with City route signs, they should be the small-sized version of the regional route sign, and they should go underneath the City route signs.

Bicycle Routes on Trails

- Post bicycle route signs at all major decision points along the trail (feeder trail intersections, forks in the trail, etc).
- Provide bicycle route confirmation signs
 - After all roadway crossings (local streets and arterials)
 - Every one-third to one-half mile, depending on the segment length, sight distance, and need for confirmation signs
- Provide directional signs indicating how to access nearby destinations from the trail
 - Feeder streets between nearby destinations and the route may have sign subplates to indicate direction and distance to the destination or to the route
- Street name signs should be placed at all locations where trails intersect streets (this type of sign should have a sign blade for both the street name and the trail name)

Bicycle Routes on Streets

- Post bicycle route signs at all turns or decision points along the route
- On non-arterial streets, use circular dot bicycle pavement markings with an arrow (or other markings) to indicate turns along an on-street route where signs may be difficult to see because of parked cars or vegetation (optional: use bike-in-arrow markings to indicate turns)
- Route confirmation signs
 - Provide bicycle route confirmation signs every one-third to one-half mile on straight segments of the route, depending on the locations of crossings with other bicycle routes, locations of primary arterial roadway crossings, sight distance, and overall frequency of street crossings
 - Locate bicycle route confirmation signs near crossings of other bicycle routes and primary arterial roadway crossings on straight segments of bicycle routes
 - Confirmation signs may also be complemented by pavement markings
- Provide directional signs indicating how to access nearby destinations from the signed bicycle route
 - Feeder streets between nearby destinations and the route may have sign subplates to indicate direction and distance to the destination or to the route
 - Pavement markings may be used on feeder streets to supplement signs
- Spot signage can be installed to show bicyclists how to access and cross bridges, travel through complicated areas, and connect through gaps between existing sections of bicycle facilities (this signage does not need to be part of a signed route)

Sign designs for bicycle wayfinding on city streets and on Urban Trails and Bikeways System routes were developed during the Bicycle Master Plan process. These designs are shown in Figure G.1: Bicycle Wayfinding Sign Designs. The Seattle Parks and Recreation Department is working with SDOT to develop brown signs for routes on Olmstead Boulevards.

Figure G.1. Bicycle Wayfinding Sign Designs

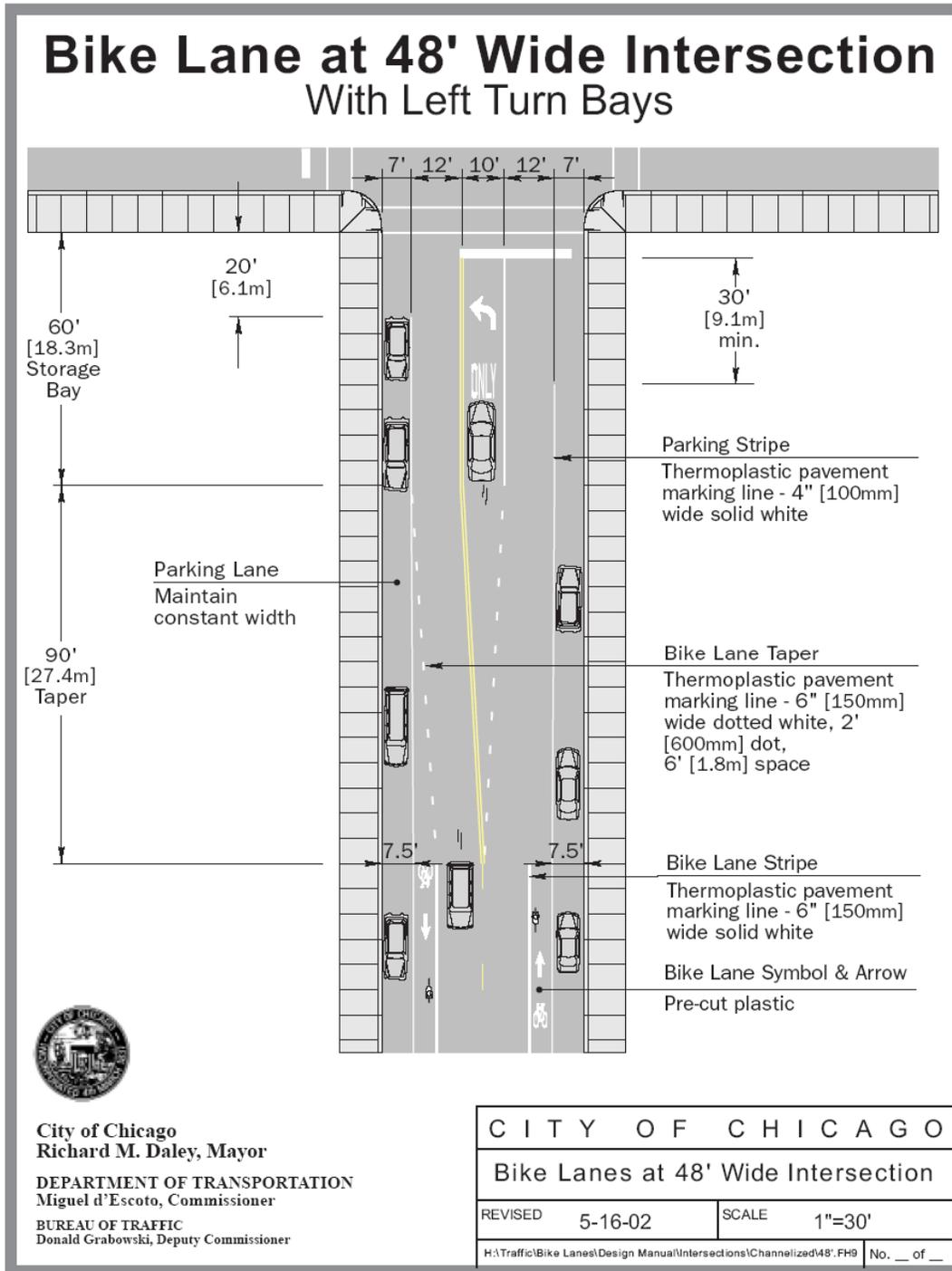


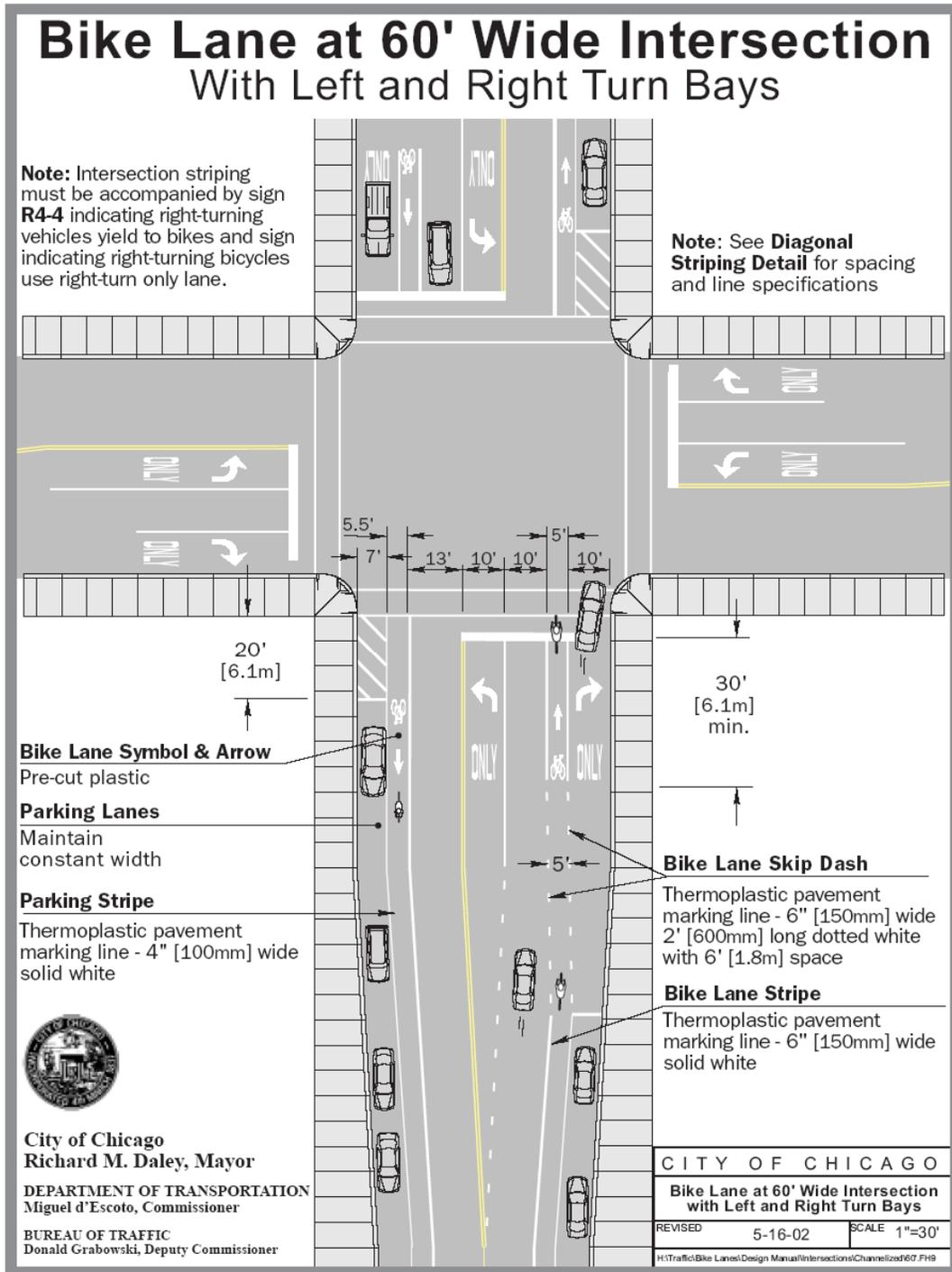
Example wayfinding signs for City routes

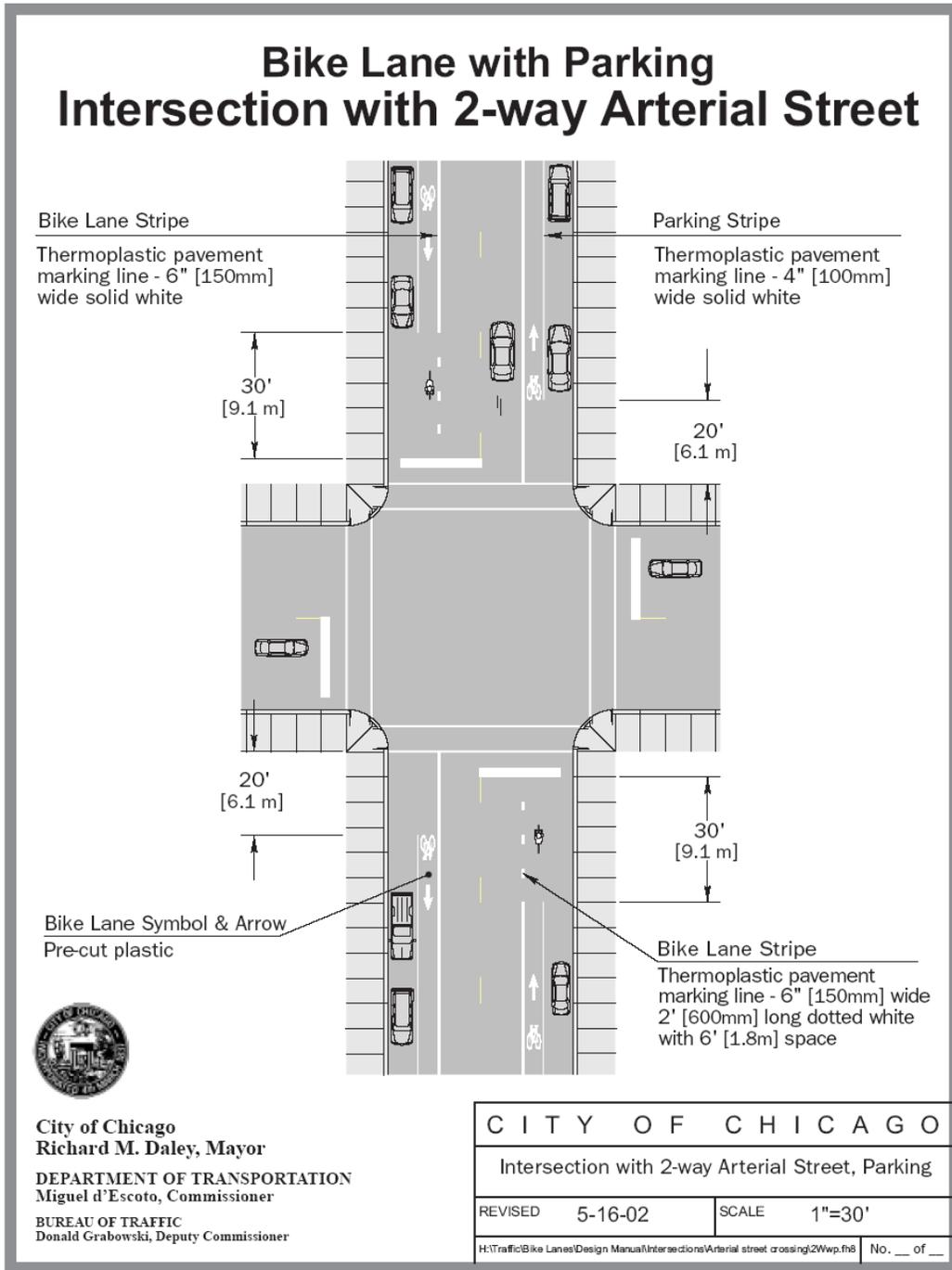


Example wayfinding sign for regional route

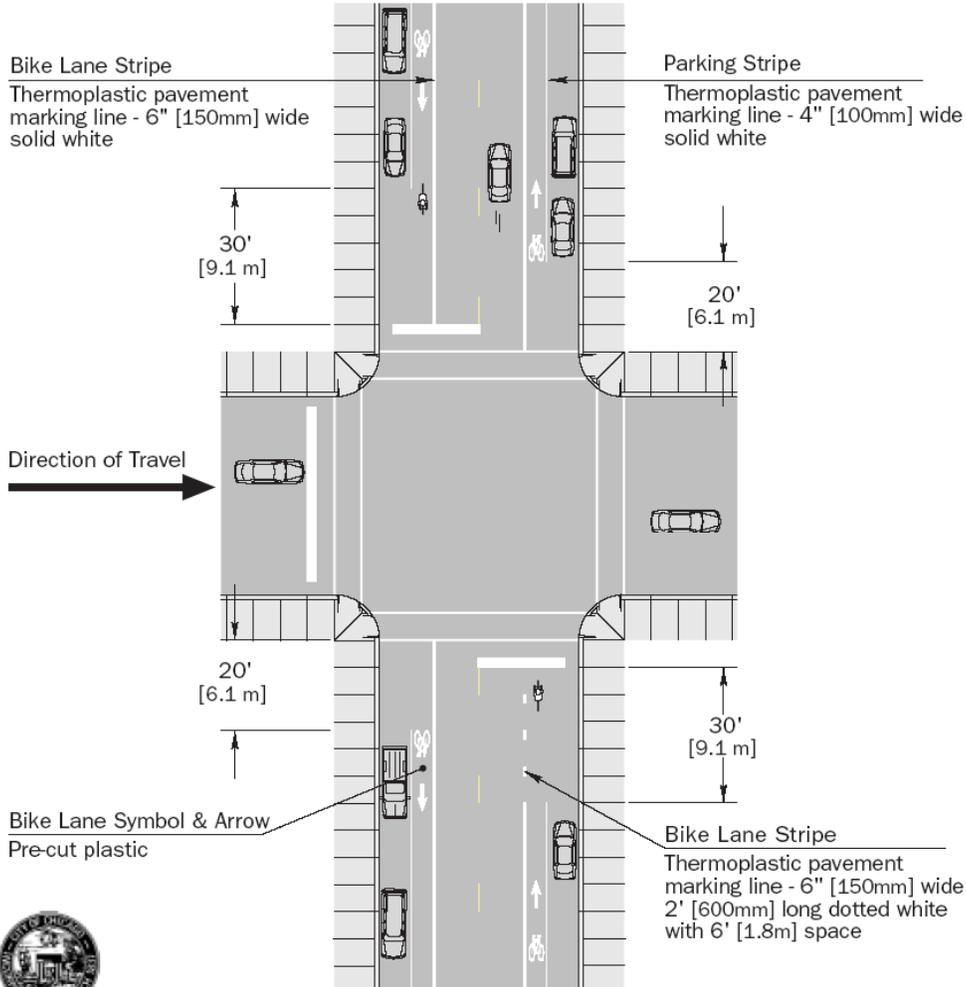
APPENDIX C: City of Chicago Bike Lane Design Guide







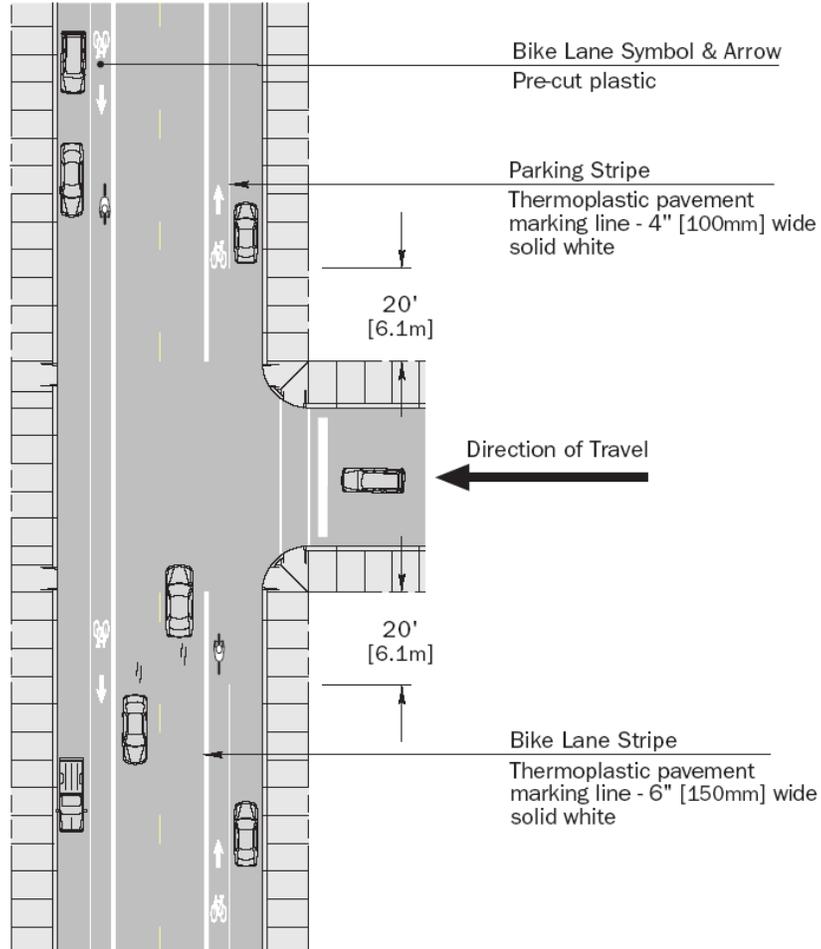
Bike Lane with Parking Intersection with 1-way Arterial Street



City of Chicago
Richard M. Daley, Mayor
DEPARTMENT OF TRANSPORTATION
Miguel d'Escoto, Commissioner
BUREAU OF TRAFFIC
Donald Grabowski, Deputy Commissioner

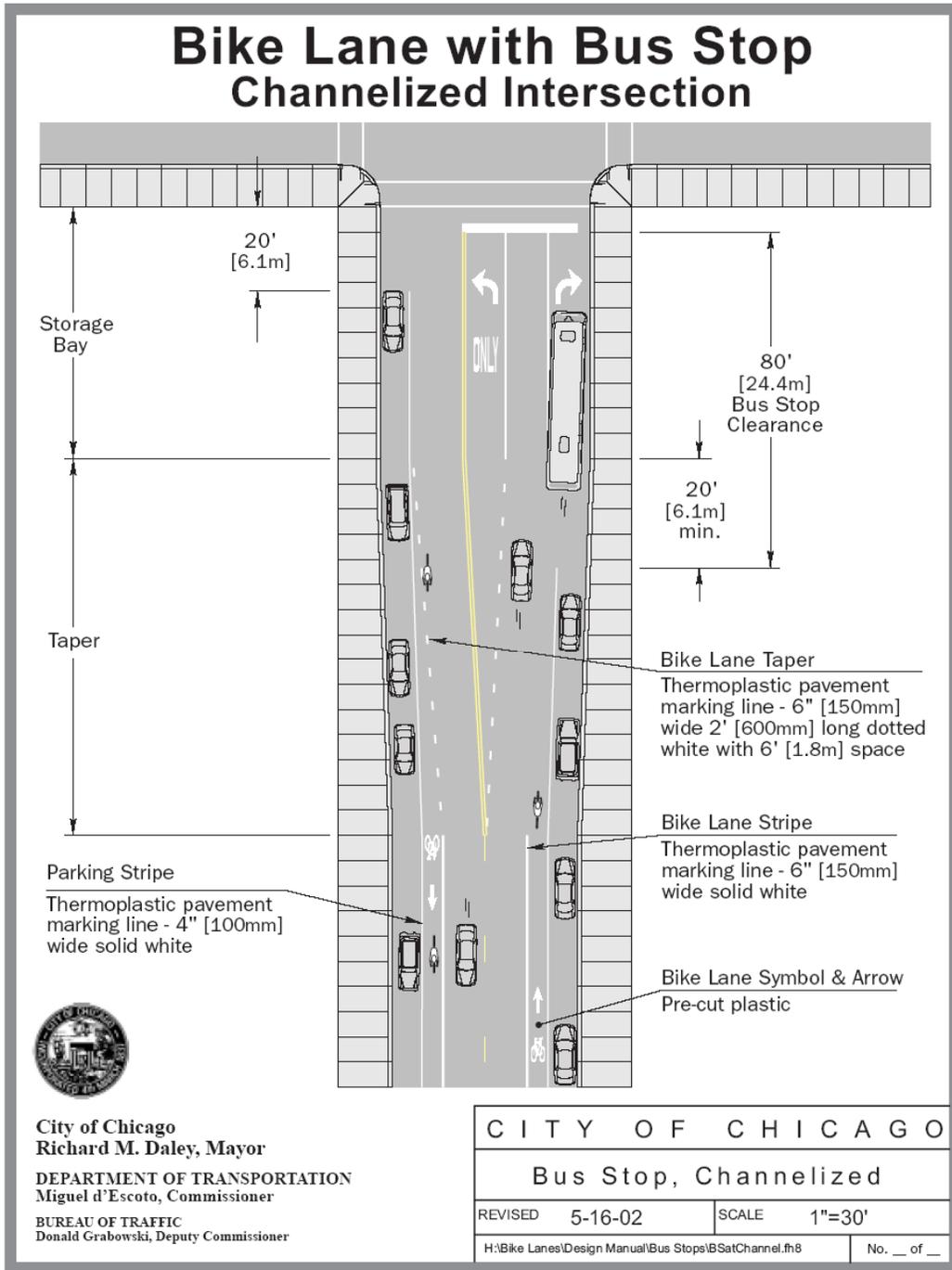
CITY OF CHICAGO			
Intersection with 1-way Arterial Street, Parking			
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Bike Lane with Parking Intersection with One-way Local T

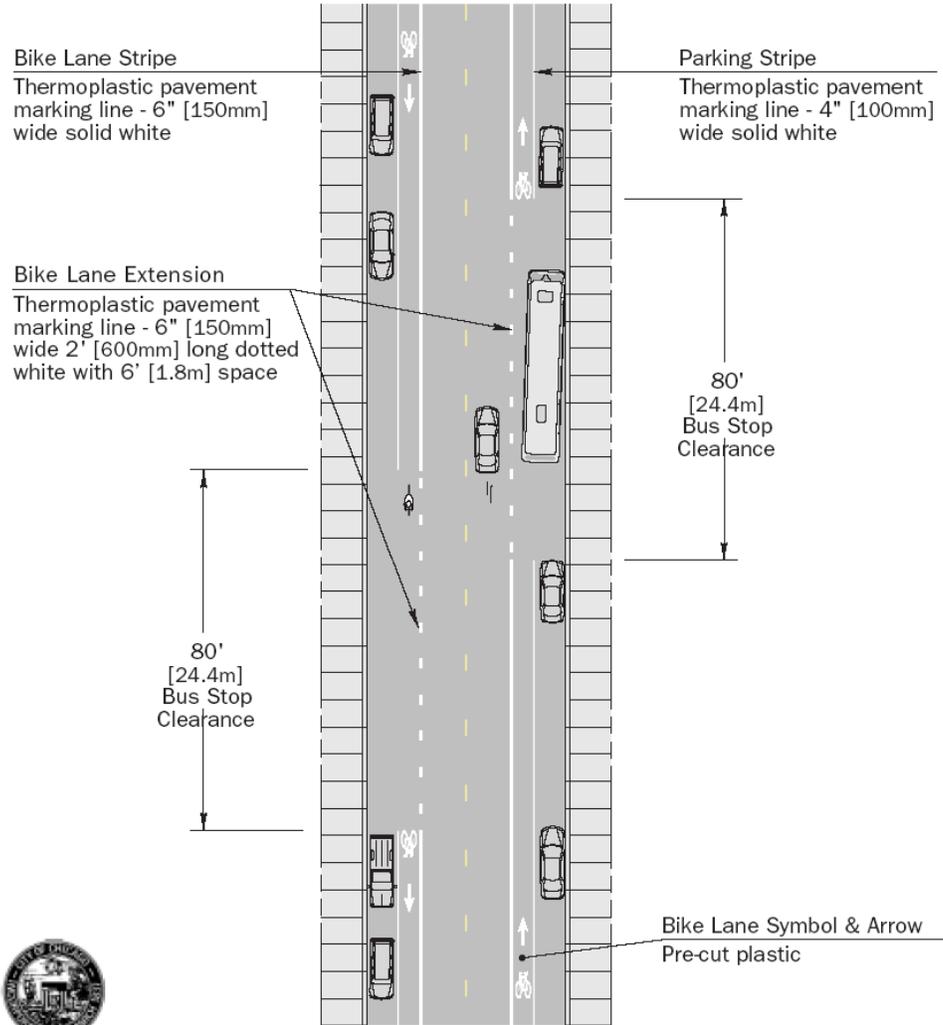


City of Chicago
 Richard M. Daley, Mayor
 DEPARTMENT OF TRANSPORTATION
 Miguel d'Escoto, Commissioner
 BUREAU OF TRAFFIC
 Donald Grabowski, Deputy Commissioner

CITY OF CHICAGO			
Intersection with One-way Local T, Parking			
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Bike Lane at Mid-Block Bus Stop



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 DEPARTMENT OF TRANSPORTATION
 Miguel d'Escoto, Commissioner
 BUREAU OF TRAFFIC
 Donald Grabowski, Deputy Commissioner

CITY OF CHICAGO			
Bus Stop, T-intersection			
REVISED	5-16-02	SCALE	1"=30'
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APPENDIX D: Eugene, Oregon Bike Box Study

#26 – Innovative Application of the Bike Box**EUGENE, OREGON**

William W. Hunter, Senior Research Scientist, UNC Highway Safety Research Center

Background

Bike box is a term that has gained popularity in the United States for a European treatment usually known as the advanced stop bar (figure 1). The box is a right angle extension to a bike lane at the head of the intersection. The box allows bicyclists to get to the head of the traffic queue on a red traffic signal indication and then proceed first when the traffic signal changes to green. Such a movement is beneficial to bicyclists and eliminates conflicts when, for example, there are many right-turning motor vehicles next to a right side bike lane. Being in the box, and thus at the front of the traffic queue, also tends to make bicyclists more visible to motorists.

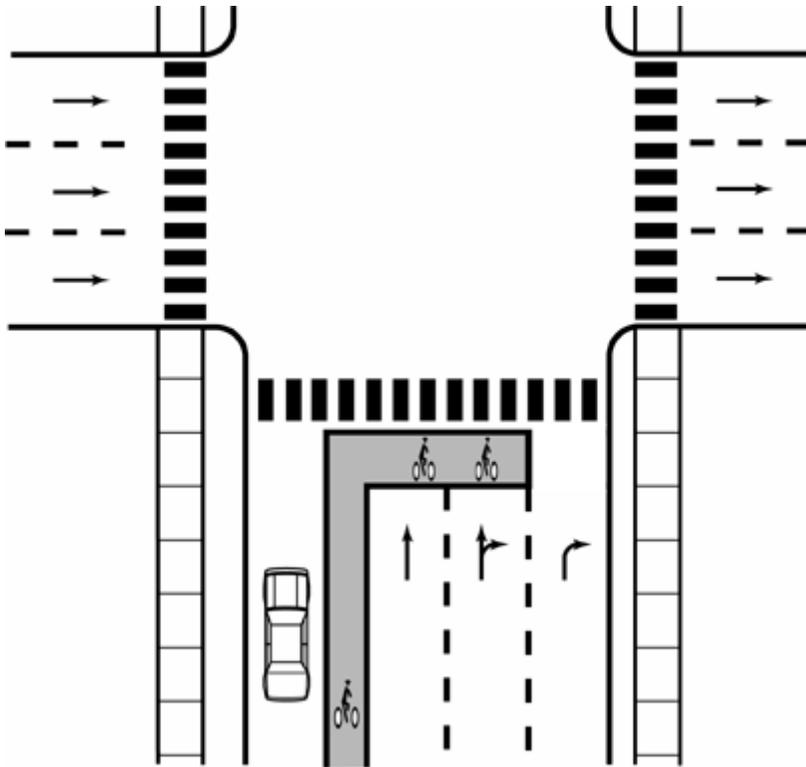


Figure 1. Diagram of a bike box used with left side bike lane.

Countermeasures

A bike box and accompanying traffic signs, but with no special traffic signals to hold motorists or direct bicyclists to the box, were installed on High Street at 7th Avenue in Eugene, OR, in the summer of 1998. The application of the bike box was innovative in the sense that the intent was to give bicyclists a safer way to change from one side of the street to the other at a busy downtown intersection featuring two one-way streets. Prior to the box, the vast majority of cyclists approached on High Street in the left-side bike lane adjacent to parked motor vehicles. The bike lane was left-side to match with another one-way couplet and to avoid having a right-side bike lane next to intersections with double right-turn lanes. Many of the cyclists approaching in the left-side bike lane preferred to switch to the right-side (through) bike lane on the far side of the intersection because at the next block cyclists in the left-side bike lane must turn left. Moving from left to right side after the intersection entails crossing three lanes of traffic. The average annual daily traffic on

High Street is about 8,500 vehicles per day, and the peak hour total is about 1,000 motor vehicles. When traffic was busy, bicyclists could have difficulty finding a gap large enough to allow an easy move from left to right. Some bicyclists were aggressive and used hand signals to indicate their movement from left to right. Many, however, simply stopped in the bike lane and waited for a suitable gap.

Besides the crossover from left to right after the intersection identified above, there were a variety of other ways used by bicyclists to negotiate this intersection. Some would shift from the bike lane to the motor vehicle traffic lanes prior to the intersection. Others rode or walked their bicycle through the crosswalks on both High Street and 7th Avenue as pedestrians would, a movement that delays right-turning motorists. Some bicyclists would intentionally disobey the traffic signal at the intersection proper while motorists waited for the signal to change, move into the intersection, and then shift from left to right.

With the bike box in place, bicyclists desiring to change from the left to the right side of High Street can proceed to the head of the traffic queue on a red traffic signal indication and then cross over to the front of the second lane of traffic (figure 2). The second lane is a combination through/right-turn lane. The right-most lane is right turn only. Right turn on red is not permitted; however, some motorists do not comply. The box is not meant to be used on a green traffic signal indication.

Bicyclists have the right of way when in the box. They generally are able to accelerate quickly through the intersection ahead of motor vehicles when the signal changes to green, then safely switch to the through bike lane on the right-hand side of High Street such that motorists are not inconvenienced.

Several other steps were taken to help bicyclists and motorists understand the use of this innovative treatment at this intersection. A press release was prepared and stories run in the local newspaper and the University of Oregon student newspaper. A special sign board with information about how to use the bike box was placed on a construction barricade near the intersection pedestrian crosswalk. The barricade with educational sign also had a flashing light attached. Traffic signs with orange diamond attachments added for conspicuity were placed at the intersection to indicate that traffic, except bikes, should stop prior to the box on a red signal indication (STOP HERE ON RED, with EXCEPT BICYCLES mounted below). A yellow diagrammatic sign with a BICYCLES MERGING message was already in place.



Figure 2. Three bicyclists using the box correctly.

Evaluation and Results

Cyclists traveling through the intersection were videotaped before and after placement of the box. The videotapes were coded to evaluate operational behaviors and conflicts with motorists, other bicyclists, and pedestrians. Other data concerning bicyclists' characteristics and experience, as well as their opinion of how the bike box functioned, were obtained through short oral surveys. These surveys were performed on days when videotaping was not occurring.

The use of a bike box to facilitate the movement of bicyclists from a left-side bike lane, through an intersection, and across several lanes of a one-way street to a right-side bike lane was an innovative approach. The data indicated that the use of the box was reasonably good. Usage can be examined several ways.

- For all bicyclists coming through this intersection, 11 percent used the box as intended (i.e., approaching from the left-side bike lane and then moving into the box on a red traffic signal indication).
- Including bicyclists who used the box through other maneuvers, such as crossing from left to right before the intersection and then moving into the box, 16 percent of all bicyclists used the box.
- Narrowing further, of the bicyclists who approached in the left-side bike lane and then crossed to the right side of the street (the bicyclists for whom the box was most intended), 22 percent used the box.
- Many more bicyclists in this target group could have used the box (i.e., they had a red signal indication and enough time to move into the box). Had these bicyclists done so, then some 52 percent would have used the box. This last percentage thus approximates the upper limit of bike box use for this pilot location and left-to-right maneuver during this time period.

A problem with motor vehicle encroachments into the box likely diminished the amount of use. Overall, encroachments occurred in 52 percent of the red traffic signal indications after the box had been in place for five months. While this is not uncommon, even in Europe where the design has been in place for some time, it is troubling, and remedies should be sought. Bicyclists surveyed about the pilot location tended to frequently complain about the encroachment problem.

The bike box had no effect on signal violations. Some 6 to 7 percent of bicyclists violated a red signal indication both before and after placement of the box.

The rate of conflicts between bicycles and motor vehicles changed little in the before and after periods. The rate was 1.3 conflicts per 100 entering bicyclists before the bike box and 1.5 conflicts per 100 entering bicyclists after. However, the pattern of the conflicts did change. Eight of the 10 conflicts in the before period involved a bicyclist moving from left to right across the travel lanes after the intersection. Two of the 10 conflicts in the after period were of this type. Six of the after conflicts took place within the intersection proper, but three of these involved bicyclists coming off the right sidewalk and conflicting with right turning motor vehicles. No conflicts took place while using the bike box in the normal sense.

Conclusions and Recommendations

Use of the bike box to help bicyclists negotiate a difficult maneuver at this intersection was considered to be a rigorous test. All things considered, the innovative treatment worked reasonably well. More evaluations should be conducted in other settings and for other maneuvers to further understand how well this design works in the United States and how it might be improved. For upcoming evaluations, a number of recommendations can be made.

- Education of both bicyclists and drivers as to the proper use of the box is important. This can be accomplished through newspaper stories, radio and television public service announcements, brochures in bike shops, etc. The special education sign posted at the Eugene intersection came about after it was learned in the oral survey of bicyclists that the box was not well understood. One of the bicyclists participating in the oral survey suggested use of a banner across the roadway. This would be an excellent way of drawing attention to the presence of the box and the expected movements, especially for motorists.
- Use of bold demarcation of the box is vital. This could involve wider striping than the norm or perhaps painting the box a bright color.
- Steps should be taken to limit motor vehicle encroachment. Setting stop bars back a short distance from the box might lessen encroachment. Offset (or staggered) stop bars also would be beneficial, not only for encroachment purposes but also to help motorists see bicyclists moving into the box. Some police presence may also be necessary to instruct, warn, or ticket motorists about improper encroachment.

In summary, the bike box is a promising tool to help bicyclists and motorists avoid conflicts in certain kinds of intersection movements. More boxes need to be installed and evaluated to further understand their effectiveness in different settings. Pilot testing the Danish treatment of recessed stop bars for motor vehicles is also recommended.

Costs and Funding

Costs included paint (regular, not thermoplastic) removal, new thermoplastic, two signs near intersection and informational sign for approximately \$2,500 parts and labor. If traffic loops have to be moved: \$1,000/lane extra.

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The modification (bike box) that is the subject of this case study is not compliant with the Manual on Uniform Traffic Control Devices, nor is it currently being considered for inclusion. Accordingly, it is imperative that any jurisdiction wishing to utilize the bike box (or any other non-approved traffic control device) should seek experimental approval from the Federal Highway Administration. For information on how to do so, please visit this Web site: <http://mutcd.fhwa.dot.gov/kno-amend.htm>

APPENDIX F: Loop Detector Bicycle Stencil

