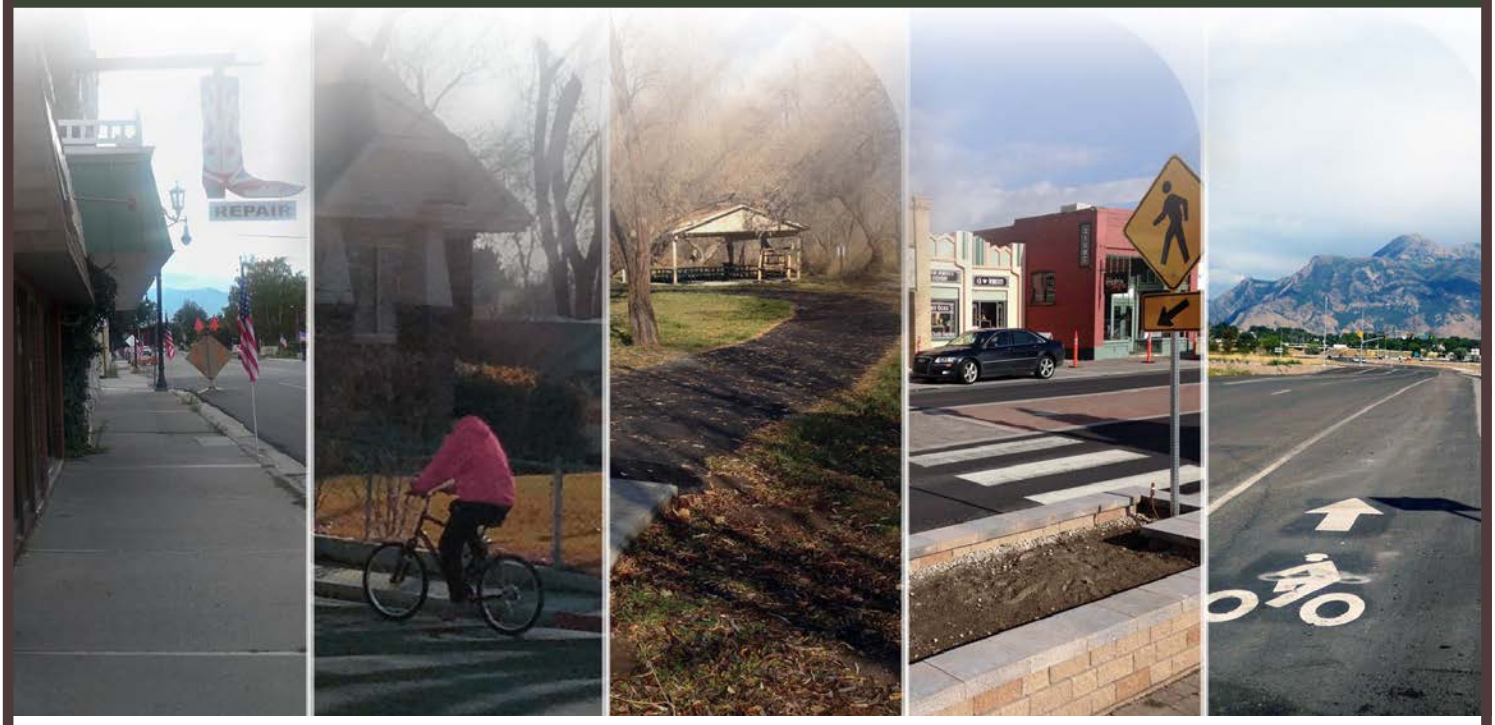
LEHI *Bicycle & Pedestrian Master Plan*



Prepared for:

LEHI

MOUNTAINLAND ASSOCIATION OF GOVERNMENTS

Prepared by:

InterPlan Transportation Planning

alta PLANNING + DESIGN

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1 Project Vision, Goals, & Objectives

The Vision, Goals, and Objectives of the Lehi Bicycle and Pedestrian Master Plan will guide the development and implementation of bicycle and pedestrian facilities in Lehi for years to come. Goals and objectives direct the way public improvements are made, where resources are allocated, how programs are operated, and how city priorities are determined. This chapter presents goals and objectives for increasing bicycling and walking in Lehi.

1.1 Vision Statement

A vision statement outlines what a city wants to be. It concentrates on the future and is a source of inspiration. Goals help guide the city towards fulfilling that vision, and relate to both existing and newly launched efforts by Lehi. Objectives are more specific statements that define how each goal will be achieved. They are measurable and allow tracking of progress toward achieving the goals and overall vision.

1.1.1 Project Vision

The steering committee that guided this master plan effort crafted the following vision statement:

"Lehi City will continue to foster the creation of an attractive network of bicycle and pedestrian facilities that supports and promotes safety and accessibility for all users and connects all areas and neighborhoods in Lehi as well as fosters connections to adjacent communities."

1.2 Goals & Objectives

The goals and objectives for the Bicycle and Pedestrian Master Plan are broken down into the following categories, and are described in further detail on the following pages.

1. Complete Streets
2. Bicycle and Pedestrian Network
3. Transit Integration
4. Maintenance
5. Safety
6. Education and Encouragement
7. Evaluation
8. Implementation

Connecting people who walk and bicycle to UTA's FrontRunner and bus services is part of Goal #3

Complete Streets is a strategy that embodies the principle of considering all users of the road when modifying existing roads and constructing new roadways.

Goal 1: Complete Streets	
Accommodate all roadway users within the public right-of-way.	
Objectives	
1A.	Consider every road in Lehi as a road that pedestrians and bicyclists will use.
1B.	Provide a continuous network of sidewalks, crosswalks, and other pedestrian facilities throughout Lehi.
1C.	Require all Capital Improvement Projects to include relevant recommended facilities as contained in the master plan.
1D.	Provide a non-motorized network that is safe and attractive to all users.
1E.	Evaluate streets for recommended on-street bike/pedestrian facilities when performing street resurfacing or re-striping projects.
1F.	Require private development projects to finance (as allowable) and install bicycle facilities, sidewalks, and shared-use paths, as appropriate and where recommended in the master plan as part of on-site improvements and off-site mitigation measures.

Complete streets welcome all types of users

A complete bicycle and pedestrian network provides a variety of facility types, accommodating users of varying skills and abilities, and connects them with destinations throughout the city.

Goal 2: Bicycle & Pedestrian Network	
Provide a complete bicycle/pedestrian network throughout the city of Lehi.	
Objectives	
2A.	Implement a continuous network of pedestrian facilities and bikeways that serve all user groups and types.
2B.	Identify gaps between intersecting or adjacent facilities to make the overall system function more safely and efficiently.
2C.	Bridge network gaps between adjacent communities.
2D.	Add designated bicycle lanes on public streets as identified and planned.
2E.	Work with the Utah Department of Transportation (UDOT) to coordinate desired bikeways on state roadways.
2F.	Prioritize future bikeway projects that connect to existing bicycle facilities.
2G.	Prioritize bikeway and pedestrian projects with connectivity to trails, schools, shopping centers, parks/recreation sites, transit stations, and other major trip generators.
2H.	Adopt and adhere to existing and future design guidelines and standards established by the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide, American Association of State Highway Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities, and the Manual of Uniform Traffic Control Devices (MUTCD).
2I.	Provide amenities such as benches, garbage containers (where collection is convenient), and drinking water along trails.

Enhancing connectivity between pedestrians, bicycles, and transit helps to reduce traffic congestion and promote both bicycle and transit use.

Goal 3: Transit Integration	
Improve multi-modal transportation by coordinating projects with existing and future transit plans.	
Objectives	
3A.	Provide access and bicycle support facilities to transit by connecting bikeways/ sidewalks to transit stops and intermodal centers.
3B.	Support Utah Transit Authority (UTA) in continuing to accommodate bicycles on all transit vehicles including FrontRunner commuter rail, buses, and future light rail cars.
3C.	Provide secure end-of-trip facilities (e.g. bike parking) at intermodal centers.
3D.	Partner with UTA when developing educational and outreach programs.
3E.	Integrate bicycle parking, curb ramps, and sidewalks into new bus shelters.

Bike racks on transit vehicles are a key way to integrate bicycling with transit

Bike facilities, such as this buffered bike lane in Salt Lake City, must be kept clean of debris, weeds, and snow

Well-maintained bikeways and sidewalks promote active use and enhance user safety and overall experience.

Goal 4: Maintenance	
Keep non-motorized facilities clean, safe, and accessible.	
Objectives	
4A.	Maintain existing and future bicycle and pedestrian facilities to a high standard in accordance with guidelines established in this plan.
4B.	Incorporate bicycle and pedestrian network repair and maintenance needs into the regular roadway maintenance regimen as appropriate, paying particular attention to sweeping and pothole repair on roadways with priority bicycle facilities.
4C.	Establish weed management program to target spread of Puncturevine (primarily adjacent to shared-use paths) and all other vegetation encroachment for the purpose of reducing tire punctures.
4D.	Address bicyclist and pedestrian safety during construction and maintenance activities.
4E.	Provide a simple way for citizens to report maintenance issues that impact bicyclist and pedestrian safety pedestrian safety and for the City to respond appropriately.
4F.	Implement an on-going citywide bicycle and pedestrian facility maintenance strategy.
4G.	Develop and update actual maintenance costs for existing and proposed bicycle and pedestrian facilities to help budget for the future network.
4H.	Coordinate with Utah County on their Adopt-a-Trail program for shared use paths.

Bicycle and pedestrian facilities should be constructed with user safety as a high priority.

Goal 5: Safety	
Make Lehi a safe and enjoyable place to walk and ride a bicycle.	
Objectives	
5A.	Reduce the number of crashes involving bicyclists/pedestrians and motor vehicles while increasing overall levels of bicycling and walking.
5B.	Design facilities that encourage bicyclists to travel at safe speeds when the facility is shared with other user types or intersects with pedestrians and other users.
5C.	Transition bicycle facilities through intersections in a safe manner.
5D.	Provide well-marked, visible roadway crossings for shared-use path facilities and clarify expected behavior for motorists, bicyclists, and pedestrians.
5E.	Control and enforce traffic speeds to create a calmer environment for people walking and bicycling.

Goal #5 focuses on the safety of people who walk and bicycle

Education courses encourage more people to bicycle and to do so in a safe manner

Many cities are finding that investments in road user education and encouragement are just as effective at increasing walking and biking as the development of new facilities.

Goal 6: Education & Encouragement	
Implement comprehensive education and encouragement programs targeted at all populations in the city.	
Objectives	
6A.	Educate the general public on bicycle safety issues and encourage non-motorized transportation with programs that target pedestrians, bicyclists, and motorists.
6B.	Install signage along local and regional bikeways/trails to assist with wayfinding and to increase awareness of bicycling and walking.
6C.	Install signage along roadways to make automobile drivers more aware of pedestrians and bicyclists.
6D.	Support Safe Routes to School and other efforts, including educational and incentive programs to encourage more students to bicycle or walk to school, through a partnership with the school districts and other interested parties.
6E.	Promote bicycling through events sponsored by Lehi City.
6F.	Encourage large employers, schools, UTA intermodal stations, and other activity centers to provide secure bicycle storage facilities and promote their efforts.
6G.	Encourage new commercial building projects to provide bicycle parking, showers, changing facilities, and lockers for employee use.
6H.	Partner with UTA when developing educational and outreach programs.
6I.	Develop and provide trail maps that show interconnecting trails/routes, distances to various destinations, and the location of amenities on the routes such as benches, water, and garbage cans.

Tracking the progress of the master plan recommendations allows the city to be accountable to its stakeholders and document success throughout the implementation of the plan.

Goal 7: Evaluation	
Monitor the implementation of the Lehi Bicycle and Pedestrian Master Plan and conditions relating to bicycling and walking in Lehi.	
Objectives	
7A.	Track the success of the master plan as a percent completed of the total recommended non-motorized system.
7B.	Track trends in bicycling and walking through the use of annual bicycle/pedestrian counts and commuter surveys in cooperation with Mountainland Association of Governments (MAG).
7C.	Monitor bicycle and pedestrian collision data to seek continuous reduction in bicycle collision rates.
7D.	Complete Bicycle Friendly Community application and apply for Gold-level status by 2020.*
7E.	Complete Walk Friendly Community application and apply for Gold-level status by 2020.*

*For more information on these programs, visit www.bikeleague.org/programs and www.walkfriendly.org/.

Cities across the nation are realizing the economic, health, and other benefits of becoming a Bicycle Friendly Community

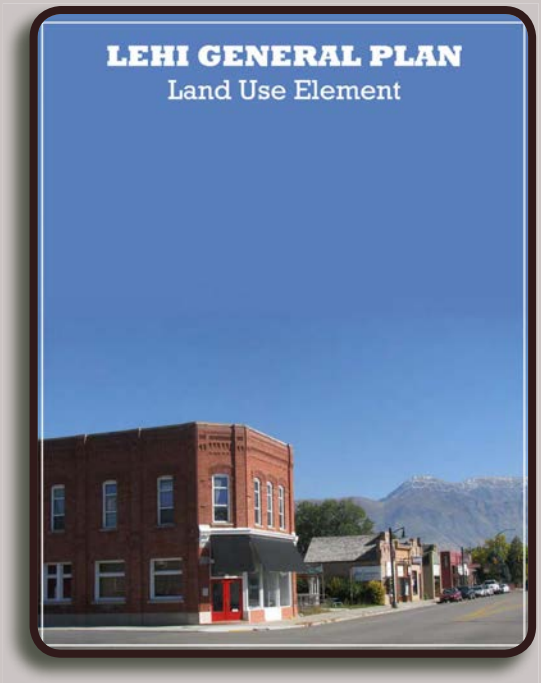
Implementing the recommendations outlined in the master plan will help Lehi address the needs of its residents.

Goal 8: Implementation	
Equip city staff/stakeholders with the necessary tools to implement the master plan.	
Objectives	
8A.	Thoroughly examine the recommendations in the master plan with the Project Steering Committee, and other applicable advisory bodies so that the plan can be implemented as efficiently as possible.
8B.	Utilize the master plan Steering Committee throughout project implementation to ensure citywide support and harmony with other department plans, policies, and goals.
8C.	Maintain open dialogue with Lehi residents, advocacy groups, and other public groups at every stage of the master plan implementation.
8D.	Analyze previously-planned bikeways for feasibility and value in the overall network.
8E.	Prioritize proposed projects for construction and funding.
8F.	Engage with elected officials at major milestones of master plan implementation to remind them of the importance of bicycling and walking in Lehi's transportation network.
8G.	Coordinate bikeway projects with UDOT, UTA, and MAG to help with planning and funding of bikeways.
8H.	Establish a process by which gaps in infrastructure under the jurisdiction of different agencies are identified and the agencies work together to bridge these gaps.
8I.	Identify and apply for funding to construct and maintain bicycle and pedestrian facilities.
8J.	Establish a process by which the city's police department collects collects bicycle and pedestrian crash data.

2 Summary of Existing Plans

This section summarizes the major planning documents that shape the physical and policy environment for Lehi City, as it relates to pedestrians and bicyclists. The following documents are reviewed in this section:

- Lehi General Plan: Land Use Element
- Lehi General Plan: Parks, Open Space, and Recreational Facilities Element
- Lehi Master Transportation Plan
- Downtown Revitalization Plan
- MAG Bicycle, Pedestrian, and Other Non-Motorized Modes
- UDOT Pedestrian and Bicycle Guide
- UDOT Bicycle Corridor Priority Routes Project
- UDOT Guidelines for Bicycle and Pedestrian Accommodations
- UDOT Roadway Design Manual of Instruction Section 9
- Utah Traffic Control for School Zones



The Land Use Element of Lehi's General Plan

2.1 Lehi City Plans

2.1.1 Lehi General Plan: Land Use Element

Lehi's General Plan was adopted in 2011 and helps to ensure that long-term decision making addresses and accommodates the needs of a growing and increasingly diverse population. Current projections show a population of over 100,000 people by 2040 compared with 47,000 at the 2010 Census. Lehi is comprised of six "districts" and neighborhoods. These districts are defined by their land uses or physical characteristics and are also somewhat delimited by major transportation corridors, physical features, or historic uses.

Land use within the city is dominated by residential uses with more than 54% of the city area devoted to housing. The city has several strong commercial areas including Lehi Main Street, Thanksgiving Point, and Cabela's.

The city's vision statement, as stated in the General Plan is:

"Lehi City, the center of Utah's future, is a vibrant community of rich history, and family-oriented neighborhoods, with an emerging technical and business center. With its continuing preservation of a small town feel and sense of community, Lehi City welcomes new residents and businesses."

Several goals are also specified in the General Plan. Those that relate to bicycle and pedestrian facilities include:

Parks & Recreation Facilities

- Provide a diverse network of parks, trails, and recreational facilities that afford all residents a wide range of recreational opportunities.
- Preserve and protect the Jordan River corridor as a natural feature and community asset for recreation, trails, wildlife habitat, and natural beauty in Lehi City.

Development

- Maximize opportunities to create an overall pattern of planned and orderly development with a system of land uses, adequately and efficiently served by a balanced and energy-efficient system of transportation, and community services that are sensitive to the natural physical qualities of the area.

Transportation

- Provide a comprehensive system of circulation linking areas of the City with pedestrian paths, bikeways, equestrian trails, roads and expressways, light rail, and high-speed train modes.

Each of these goals has specific "Best Practices" outlined and implementation steps identified. Best Practices that are particularly relevant to the Lehi Bicycle/Pedestrian Master Plan include:

Best Practice 10.3

- Develop an east-west bike and pedestrian path along Dry Creek from Utah Lake to the City of Highland's border.

Best Practice 10.4

- Develop existing, and identify new trails, in the City to enhance pedestrian and bike mobility and connectivity.

Lehi's General Plan includes an implementation plan for a list of projects identified for current or future execution. Each implementation plan includes information related to location, objective, stakeholders, action steps, potential funding sources, coordination with other projects in the plan, and timeline. No projects on the current work plan relate specifically to bike or pedestrian facilities although four projects in the future work plan do. The objectives, action steps, and timeline for each of these projects are summarized here. More detail on each project can be found in the Lehi City General Plan.

Important regional trails like the Jordan River Parkway pass through Lehi

Project #7: City-wide Sidewalk Improvements

Objective: To provide consistent, safe, and enjoyable routes for pedestrians and to enhance walkability around the entire City.

Action Steps:

- Conduct an inventory of existing sidewalk conditions to determine where sidewalk improvements are needed.
- Coordinate with Transportation and Parks and Open Space Elements of the General Plan to map out City-wide pedestrian systems and routes, including trails and shared-use paths.
- Identify desired design standards and draft City design guidelines for sidewalk improvements.

TImeline: Short-term (0-5 years)

Project #8: Downtown Complete Streets Program

Objective: To promote the inclusion of Complete Streets concepts (planning for cars, transit, bicycles, and pedestrians, equally) in Lehi's street design.

Action Steps:

- Coordinate with the 2007 Downtown Revitalization Plan, Master Transportation Plan, and other City long-range plans to determine the feasibility of implementing a Complete Streets Program in the downtown.
- As major transportation system redesign projects arise, work with project designers to ensure that plans balance safety and efficiency while promoting multi-modal use of downtown streets.
- Develop a program for the redesign of key roadways over time to include considerations for vehicles, future transit, pedestrians, bicycles, and horses.

Timeline: Mid-term (5-15 years)

Main Street provides destinations for pedestrians and bicyclists

Project #11: Comprehensive Streetscape Theme for Downtown and City

Objective: Create streetscapes with similar design themes and street elements (lighting, signage, street furniture, trees, etc.) along major routes in the City.

Action Steps:

- Work with the Transportation Element of the General Plan and the 2007 Downtown Revitalization Plan to determine which arterials and major roadways to include in the comprehensive streetscape theme.
- Consider a change to street cross sections to allow for a more thorough use of complete streets.
- Research and conduct studies to identify elements that will be included in the streetscapes (paving, art, banners, signage, lighting, landscape, street furnishing, street trees, etc.).
- Select a standard theme to be used on major roadways.

Timeline: Short-term (0-5 years)

Project #15: Lakefront Recreational Facilities

Objective: To provide recreational access to Utah Lake.

Action Steps:

- Conduct a study and survey to identify and determine desired lakefront recreational facilities and activities.
- Utilize the Parks and Open Space element of the General Plan to help identify locations along the Lake that can be used for recreational activity, as well as the possibility for trail development along the Lake.
- Update zoning and land use maps to allow for the inclusion of these facilities along the shores of the Lake.
- Install facilities and improvements including: dock for fishing and bird watching, dock for boats, etc.

Timeline: Mid-term (5 -15 years)

2.1.2 Lehi General Plan: Parks, Open Space, & Recreational Facilities Element

Lehi adopted this element of the plan in 2009. A map depicting the plan is shown in **Figure 2-1**. The purpose of this plan is five-fold:

1. Provide the framework for orderly and consistent planning development.
2. Provide detailed research and facts concerning community and the roles of parks and recreation.
3. Establish priorities and statements of direction based on researched and documented facts and a community based needs analysis.
4. Provide direction in the area of acquisition and development of park land to meet future needs.
5. Conform to the preparation suggestions and/or guidelines for local Park, Open Space, Trails, and Recreational facilities as prepared by the National Recreation and Parks Association.

The process involved looking at demographic trends and projections within the city and how these might impact providing a balanced recreational system over the next 20 years. Action plans for 5, 10, and 20-year increments were identified and in 2010, the city provided an updated summary of things that had been accomplished in the previous year.

The 5-Year Action Plan includes (not an exhaustive list):

- Land acquisition and construction for new rodeo grounds park
- Dry Creek Park
- North Lake Park (Phase 1)
- Peck Family Park (Phase 1)
- Veterans Ball Park (Phase 1)
- Wines Park

The 10-Year Action Plan includes (not an exhaustive list):

- New Community Park (Phase 1)
- Jordan Willows Park
- Lehi City Sports Park (Phase 1)
- North Lake Park (Phase 2)
- Peck Family Park (Phase 2)
- Rodeo Grounds Neighborhood Park (Phase 1)
- Rodeo Grounds Community Park (Phase 1)

The 20-Year Action Plan includes (not an exhaustive list):

- Lehi City Sports Park (Phase 2)
- New Community Park (Phase 2)
- Peck Family Park (Phase 3)
- Rodeo Grounds Neighborhood Park (Phase 2)
- Rodeo Grounds Community Park (Phase 2)

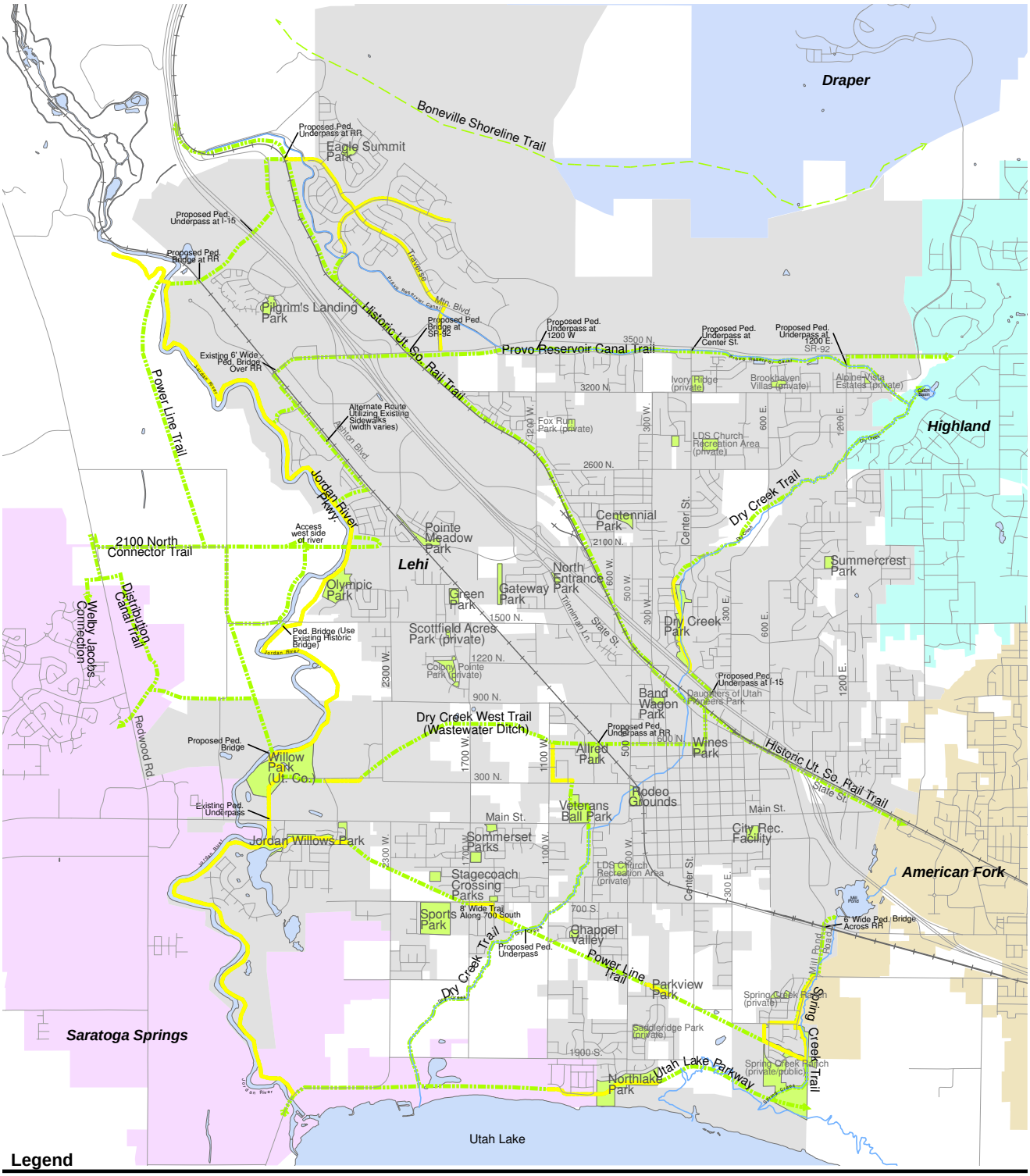


Figure 2-1: Lehi Parks & Trails Map

Lehi Trail Design Standards

The City has created trail design standards which apply to all trail corridors in the Lehi City General Plan. The standards read:

A. Required trails shall be grade separated, paved, multiple-use pathways (except the Bonneville Shoreline Trail, which is not paved), and users shall be non-motorized and may include but are not limited to: bicyclists, roller skaters, wheelchair users, pedestrians, and in some areas equestrian riders.

B. Trails are to be constructed of bituminous pavement no less than 2.5" thick and a base course of no less than 6" thick or concrete no less than 4" thick.

C. Minimum trail width shall be 10', with a 2' shoulder/clear zone on each side unless otherwise approved by the City Engineer due to physical constraints within the designated trail area. Sharp grade transitions, trees, signs, and other fixed objects within the shoulder/clear zone shall not be permitted.

D. If the trail is designated for equestrian use in addition to other users, an additional 6' equestrian area shall be provided using existing stabilized dirt, gravel, or other approved surface and an appropriate sub-surface that will allow for drainage as necessary.

E. A minimum vertical clearance of 10' shall be maintained from the equestrian trail surface.

F. Trails shall be located within a permanent right-of-way (or as approved otherwise by the City Engineer) that allows for the construction, operation, maintenance, repair, and/or replacement of the pathway. Minimum width shall be 20' unless otherwise approved by the City Engineer due to physical or other constraints within the designated trail area.

Dry Creek Trail

G. Trails are to be located with a minimum offset from any road surface of 12'. Lesser distances may be allowed when approaching intersections of streets to provide a safe alignment for crossing at the intersection or where the trail must be routed along a roadway.

H. Trails will generally follow the longitudinal slope of the existing ground, with adjustments in grade provided for intersecting streets or drives.

I. A minimum vertical clearance of 8' shall be maintained from the trail surface.

J. Limits of disturbance shall be implemented to minimize construction impacts. Construction limits shall be as small as practical to construct the trail. Significant vegetation and its root zone shall be considered when locating the trail and establishing construction limits.

K. Methods shall be employed to protect areas adjacent to the trail from impacts both during and after construction, including the construction of any necessary swales or culverts to prevent erosion. Swales or culverts shall be installed at all locations where the normal cross slope will not allow for adequate drainage.

L. Retaining walls shall be installed where necessary for safety, to prevent erosion of cut or fill slopes, to reduce cut and fill slopes, or to minimize disturbance on environmentally or aesthetically sensitive sites. Depending on height of retaining walls, a physical barrier, such as dense shrubbery, railing, or an approved safety fence may need to be provided to protect trail users.

M. Existing significant vegetation should be preserved wherever possible and indigenous materials used for retaining walls, bridges, and barriers.

N. Removable bollards and barriers shall be installed at trailheads to control access of motor vehicle traffic and to direct and/or protect trail users from steep or hazardous areas along the trail.

O. The placement of any necessary bridges will be required as needed.

P. Signs shall be installed at all trail entrances/trailheads and at all intersections with roadways according to the standards for bicycle and shared-use paths contained in the latest edition of the MUTCD or as otherwise required by the Planning Commission and City Council.

2.1.3 Lehi Master Transportation Plan

Currently, Lehi's Master Transportation Plan consists of a map of city streets by functional classification along with standard cross-sections for each category. This was adopted by the city council in September 2010. The map is shown in **Figure 2-2**.

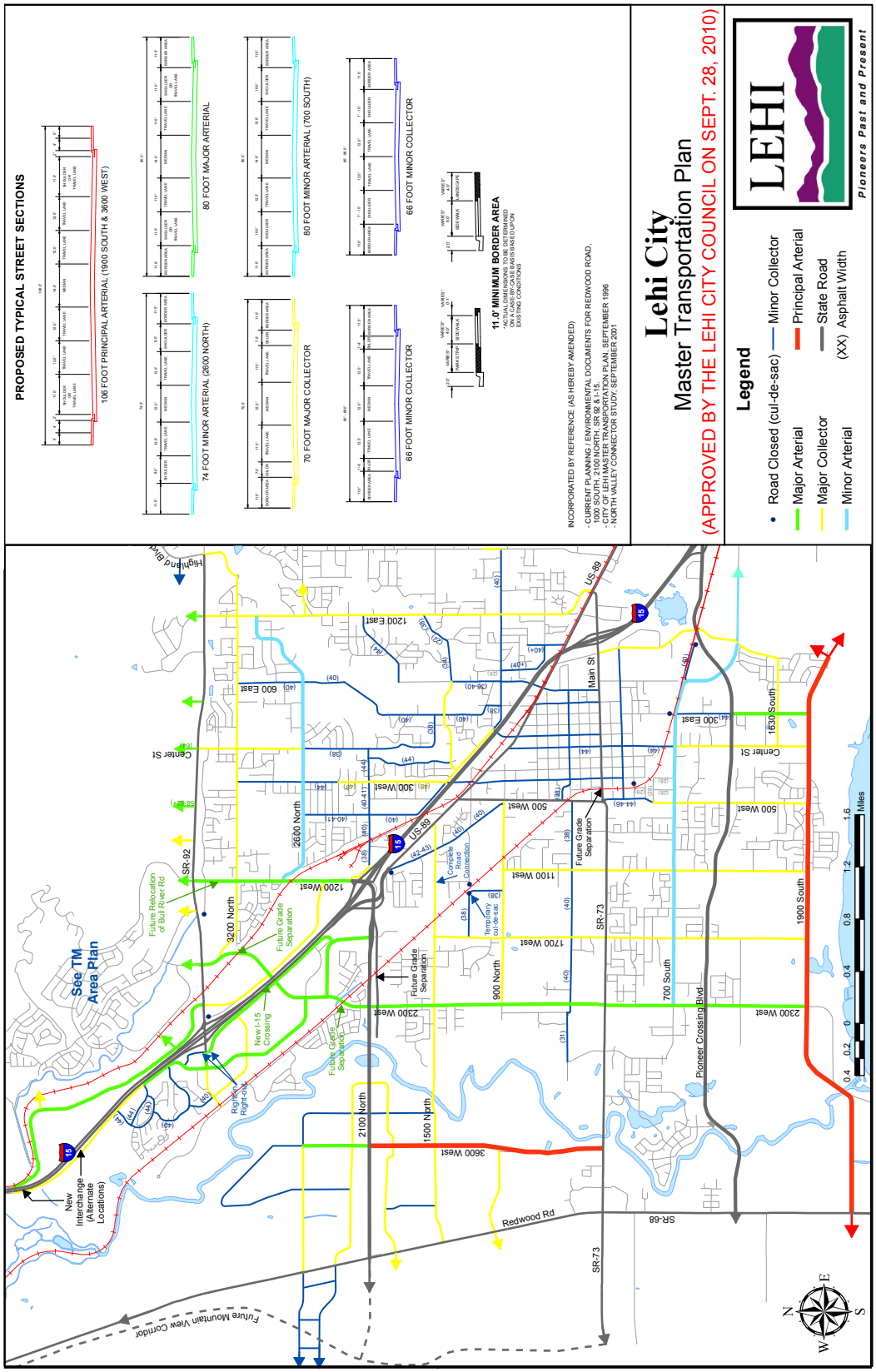


Figure 2-2: Lehi City Master Transportation Map

Sidewalk on Main Street

2.1.4 Downtown Revitalization Plan

In 2007, Lehi undertook a study of their downtown area to guide future development and growth in the area. The "planning concepts" identified during the process include:

- State Street is a part of downtown
- Preserve, enhance, and create places that make downtown special
- Preserve neighborhood character and maintain the downtown Lehi "sense of place"
- Attract and encourage a supportive business environment
- Improve pedestrian qualities and walkability
- Clean up downtown and focus on quality
- Improve opportunities to meet and play in downtown
- The need for good design and improved appearance

The plan specifically identifies the importance of pedestrian facilities, stating that pedestrian movement should be safe, comfortable, and seamless throughout downtown. All downtown sidewalks, paths, and crosswalks should be designed to ensure full compliance with the Americans with Disabilities Act (ADA), including necessary ramps and curb cuts. The width of sidewalks and pathways is critical. Sidewalks should be at least five feet wide, wherever possible.

The plan goes on to discuss trails, greenways, and other non-motorized connections and their importance to a vibrant downtown atmosphere. These connections consist of an array of facilities such as irrigation canals, greenways, and shortcuts that can be developed into a first class trail system. Eventually, this system could be linked to other trail systems, providing connections that extend beyond the boundaries of downtown. While many of these facilities are located on private property and securing them in the near future may be unlikely, key properties should be identified and easements negotiated with landowners. If this proves unworkable, private properties with identified trail resources may be purchased by Lehi City as they become available on the market in order to achieve these goals. Once secured, the open space feature can be separated from the property through subdivision or easement, and the property re-sold or utilized for an appropriate public use.

2.2 Regional Plans

2.2.1 MAG Bicycle, Pedestrian, & Other Non-Motorized Modes

MAG is responsible for preparing and approving a Transportation Improvement Program (TIP) for the area annually. The TIP is a compilation of projects sponsored by municipalities, the county, UDOT, UTA, and others utilizing various federal, state, and local funding sources. Funded projects from the current TIP that focus on bicycle or pedestrian accommodations include:

- Murdock Canal Trail, which is currently under construction
- Jordan River/Murdock Connector Trail
- Lehi Historic Utah Southern Rail Trail – Phases 2 & 3

In May 2011, the MAG 2040 Metropolitan Transportation Plan (2040 MTP) was adopted, which includes a discussion on bicycle and pedestrian improvements regionally, including Lehi. Generally, the 2040 MTP provides guidance on maintaining and enhancing the regional transportation system for urbanized Utah County. The 2040 MTP includes a section on Bicycle and Pedestrian Improvements that indicates that funding is a major barrier to fully constructing a trail network that provides for connectivity between cities and destinations in the urbanized area of Utah County. A stated goal of the regional bicycle and pedestrian network is its ability to reduce vehicle trips and mitigate traffic congestion. The 2040 MTP identifies a network that connects population and employment centers to each other based upon projected densities through planning year 2040. A map is provided within the 2040 MTP that shows where the paved trails, bike routes (which includes bike lanes, wide shoulders, and signed routes), crushed stone trails, and priority planned trails are planned at the regional level, including existing trails to show connectivity. This map is shown in **Figure 2-3**.

The 2040 MTP further states that design considerations should cover connectivity, safe roadway crossings, traffic calming techniques, street, street furniture, and other pedestrian-scaled

Murdock Canal Trail

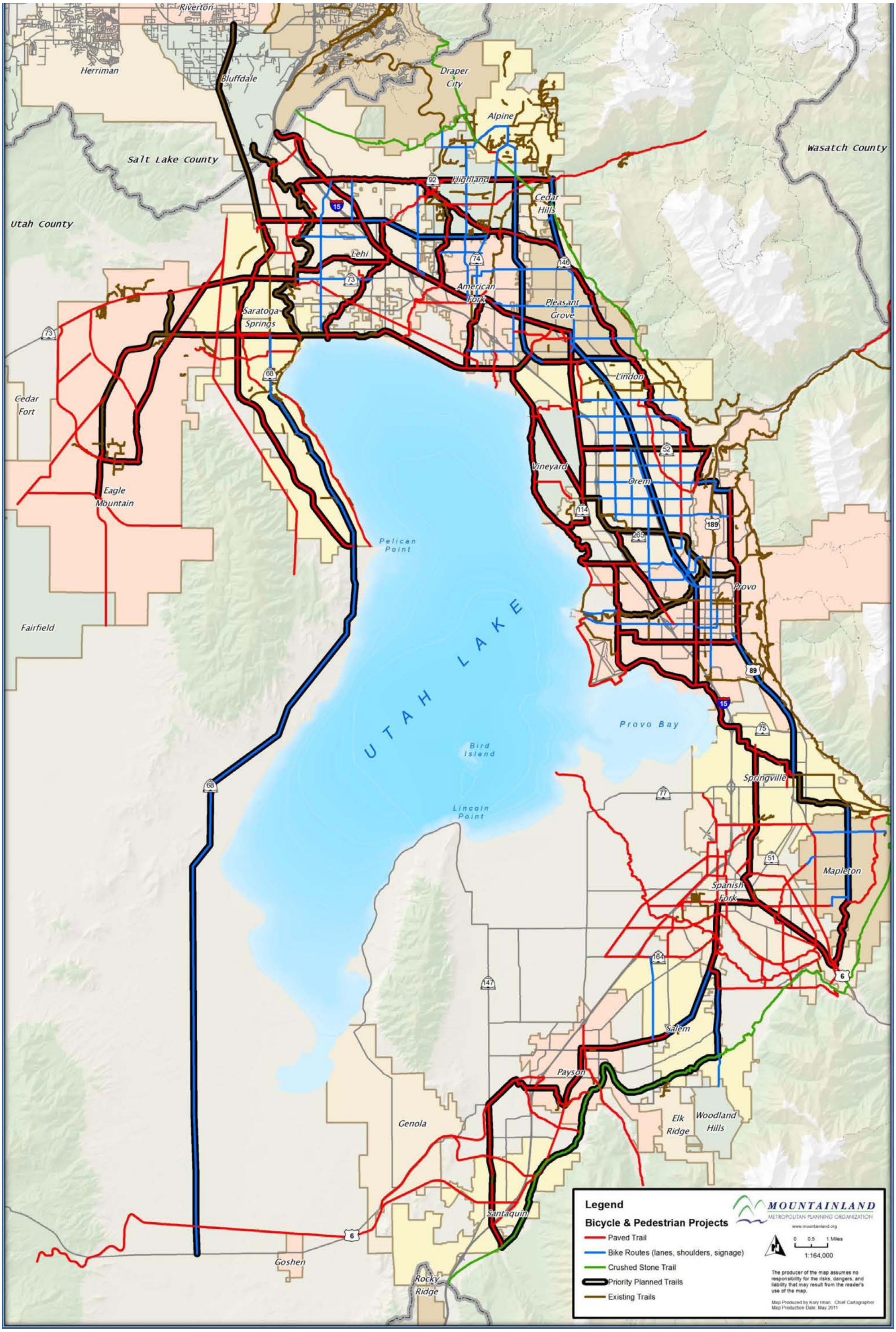


Figure 2-3: Bicycle & Pedestrian Projects - 2040 MAG Transportation Plan

amenities. MAG's staff utilizes the Bicycle Compatibility Index (BCI) model to analyze all roadway projects within the 2040 MTP. The output of the model indicates a Level-of-Service (LOS) ranging from "A" to "F". A LOS of "C" indicates that a roadway is comfortable for the average adult bicyclist. Based on an LOS of "C", MAG has identified that bike lanes or wide shoulders should be included in planned projects unless law or engineering judgment precludes such inclusion.

Regionally, approximately $16M is needed annually to fund a bicycle and pedestrian network. While this level is not currently available at MAG, efforts are being made to combine bicycle and pedestrian efforts with roadway projects that will eventually create a network over time. Most of the bicycle and pedestrian projects at the regional level are made up of local city projects with the Utah Valley Trails Committee helping to identify gaps and determine which regional facilities will help provide the most connectivity.

MAG has already funded and constructed the following bicycle and pedestrian projects in Lehi:

- Lehi Main Street Trail Undercrossing near Jordan River
- Historic Utah Southern Rail Trail
- Murdock Canal Trail

2.3 Statewide Plans

2.3.1 UDOT Pedestrian & Bicycle Guide

The purpose of the Guide is to provide useful, user-friendly information to both citizens and UDOT staff about improving walking and cycling conditions. The Guide provides information about design, funding, and education of motorists and cyclists about the rules of the road. Additionally, it discusses the UDOT project development processes for the purpose of helping pedestrian and bicycle interest groups better participate in UDOT projects.

Jordan River Parkway Access from Pioneer Crossing

UDOT's Pedestrain & Bicycle Guide

2.3.2 UDOT Bicycle Corridor Priority Routes Project

UDOT completed this project to determine the existing conditions for bicyclists along major roads throughout Utah, as well as to determine priorities where improvements could be made to fill in gaps and make connections. The priority route connections were grouped into either Level 1 or 2, with Level 1 projects being more important. Designations of these priorities, however, does not imply that funding has been allocated for completing the projects.

Level 1 Routes in Lehi

- Point of the Mountain Rail Trail (Draper/Lehi): 10' wide shared-use path from northernmost gravel pit entrance to American Fork
- I-15 East Frontage Road: Widen/improve either (or both) of the I-15 Frontage Roads across Point of the Mountain in conjunction with future I-15 widening
- SR-73: Bike lanes would be desirable, but wide shoulders would also be a significant improvement
- Utah Lake Trail: New 10' wide shared-use path from Lindon Boat Harbor to 300 West in Lehi

Level 2 Routes in Lehi

- US-89/State Street: Add shoulder to US 89/State Street from 1200 West to 500 West
- US-89/State Street: Add shoulder to US-89/State Street from 900 West in American Fork to 950 East in Lehi

Public open houses were conducted as part of the Bicycle Priority Routes Project so that individuals could make comments using an interactive map to indicate various roadway deficiencies or suggest potential locations for bike accommodations. Most of the comments in the Lehi City area relate to the area around the Point of the Mountain.

UDOT's Guidelines for Bicycle and Pedestrian Accommodations

2.3.3 UDOT Guidelines for Bicycle & Pedestrian Accommodations

UDOT has outlined bicycle and pedestrian accommodations guidelines to ensure safety and mobility of bicyclists and pedestrians in all roadway projects. The guidelines are as follows:

Urban & Rural Freeways & Limited Access Highways

Bicyclists and pedestrians are not allowed on urban freeways where alternative routes are available, hence accommodations are not required. Where they are permitted on rural freeways, special attention should be given to rumble strip application and shoulders. UDOT publishes a Bike Suitability Map that shows shoulder widths on State highways. They also publish a Bicycle Restrictions Map that shows the segments of State highway where bicyclists are not permitted to ride. Both of these maps may be downloaded from UDOT's website at: www.udot.utah.gov/walkingandbiking.

Urban & Rural Arterials

Pedestrian use of highway right-of-way is common within cities and towns. Utah Code defines bicycles as vehicles. Every effort should be made to include bicycle and pedestrian accommodations in all new construction and reconstruction projects on the state system. The specific level of accommodation will vary by project and should be determined by the Project Team, including the UDOT Bicycle and Pedestrian Coordinator. The guidelines were created in response to UDOT Policy 07-117: Routine Accommodations for Bicyclists and Pedestrians, adopted May 2006.

An accommodation is defined as any facility, design feature, operational change, or maintenance activity that improves the environment in which bicyclists and pedestrians travel. Examples of such accommodations include the provision of bike lanes, sidewalks, signs, and the addition of paved shoulders. Bicycling and walking are successfully accommodated when travel by these modes is efficient and safe for the public. The level of accommodation should be considered on a project-by-project basis.

A checklist is included as part of the guideline document to facilitate a discussion between the project team members and to determine the level of accommodation for bicyclists and pedestrians in a roadway project.

2.3.4 UDOT Roadway Design Manual of Instruction Section 9

UDOT encourages multi-modal transportation options on roadway facilities. Bicycle and pedestrian planning and design guidelines outlined in Section 9 are based on AASHTO standards. Checklists are provided for bicycle and pedestrian facilities in general, as well as for the Concept/ Environmental Phase and the Scoping Phase of a project.

Bicycle Facilities

UDOT encourages the use of the Bicycle Compatibility Index (BCI) to evaluate roadways for bicycle compatibility. UDOT specifies that state highways in an urban area should have an 8' minimum shoulder.

Pedestrian Facilities

Local transportation plans, in addition to site conditions, are used as the basis to determine the types of pedestrian facilities installed. At-grade crossings are permitted anywhere along a roadway unless specifically prohibited by posted signs.

2.3.5 Utah Traffic Controls for School Zones

UDOT provides this manual to ensure consistency and set specific standards for all Utah school crossing zones. All jurisdictions in Utah are required by code to use the manual.

UDOT provides a school zone traffic control manual

3 Summary of Existing Conditions

The highlights of the bicycle network in Lehi are its three extensive shared-use pathway systems. The Jordan River Parkway, Historic Utah Southern Rail Trail, and Murdock Canal Trail combine for approximately 15 miles within Lehi. Historically, Lehi was centered on its Main Street, which has a legacy of pedestrian oriented design. Sidewalks are generally available within the more developed central areas, with some minor gaps. The relatively new outer portions of Lehi have some significant gaps in the sidewalk network, particularly along major roadways and adjacent to unincorporated county land. This chapter summarizes Lehi's current pedestrian and bicycle infrastructure. It is divided into the following sections:

- Setting
- Existing Bicycle and Pedestrian Facilities
- Transit Connections
- Opportunities
- Constraints

It is important to provide walking and bicycling connections to civic and cultural destinations, such as the Veterans Memorial Building pictured here

3.1 Setting

According to the 2010 Census, the population in Lehi was 47,407 and grew by 149% in the previous decade. The municipalities surrounding Lehi are also experiencing high rates of growth. Lehi shares borders with four other municipalities. It has two eastern neighbors in Highland, with a population of 15,523, and American Fork with 26,263. Saratoga Springs is to its west and has 18,299 residents. Lehi is bounded on the north by the cities of Bluffdale and Draper, which have populations of 7,743 and 43,019, respectively.

The average high temperature for Utah County in January is 40°F and the average low is 22°F. In July, the summertime averages are 94°F for the high, and 60°F for the low. The annual average precipitation is about 20".

The existing topography and built environment in Lehi generally support walking and bicycling. Roads are relatively flat and streets are predominantly wide. These existing conditions provide a very good foundation from which to improve bicycle and pedestrian networks.

The older portions of Lehi have streets built upon a grid system, much like other Utah communities. The grid configuration provides various parallel routes for pedestrians, bicyclists, and motorists, which improves connectivity and provides multiple routing options. Some newly-developed areas of Lehi have deviated from the traditional grid form, and have taken on more disconnected cul-de-sac patterns.

Land use in Lehi is predominantly residential with the exception of a few distinct commercial and business corridors. One such commercial corridor is Main Street, which runs east-west through the city and has an interchange with I-15. Main Street terminates east of I-15 at State Street (US-89). The Main Street commercial strip primarily caters to local businesses, with the exception of the area between 500 East and State Street, which houses more national chain franchises and larger stores. Banks, boutiques, restaurants, specialty shops, a grocery store, and a Post Office are all located along Main Street. Businesses here are complemented by social and civic hubs like

the Lehi Legacy Center, Lehi High School, and the Lehi Swimming Pool, which are all located in close proximity to Main Street. Another commercial corridor is State Street, which houses several larger-sized developments with national stores oriented to better serve a regional clientele.

The Provo-Orem metro area has become a high-tech hub and companies such as Adobe Micron Technology, Microsoft, and Xactware have recently located in Lehi. Healthcare is also a staple in Utah's economy. Intermountain Healthcare (IHC) is the State of Utah's largest private employer and provides nearly 4,000 jobs in Utah County alone.

A popular regional attraction in Lehi is Thanksgiving Point, with nearly a million and a half visitors every year. Some of the many draws of Thanksgiving Point are a museum of ancient life, an art gallery, extravagant flower gardens, shopping and dining, conference and reception areas, and the largest golf course in Utah. The Lehi Station of UTA's FrontRunner Commuter Rail Line is adjacent to Thanksgiving Point. The Cabela's outdoor retail store located north of Timpanogos Highway (SR-92) and east of I-15 is also a regional trip attractor. People are known to come from surrounding states to shop there. An outlet mall is also located east of I-15 and north of Timpanogos Highway near Cabela's.

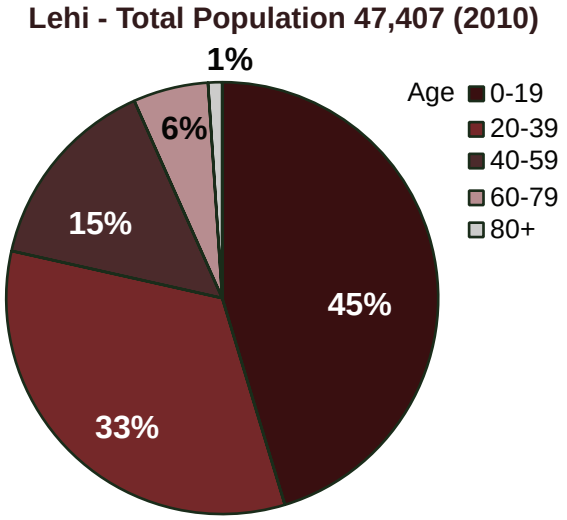


Figure 3-1: Population By Age

Utah County has a population topping 516,000 people, and is ranked as the 34th fastest growing county in the United States. Utah County also currently ranks as the 9th youngest county in the nation with a median age of 24.4 years. In Lehi, 45% of the population is under the age of 20, and 78% is younger than 40. **Figure 3-1** shows Lehi's population by age.

Lehi sits at the north end of the Provo-Orem metro area that has approximately 187,000 jobs. A significant number of area residents commute north for access to the 623,000 jobs found in Salt Lake County.

Utah Lake and Wasatch Mountain canyons provide the region's residents with instant outdoor recreation opportunities. This is an important aspect of Utah life and the state's economy. From fishing to skiing and boating to biking, many Utahns engage in outdoor recreation activities.

Lehi and Utah County residents currently rely on cars as their chief mode of transportation. 75% of workers in Utah County drive to work alone, while 14% carpool and 2% take public transportation. 7% of the county population works from home and the remaining 3% use other means. For Lehi residents who commute, it takes an average of 23.5 minutes to get to their places of work.

3.2 Existing Bicycle & Pedestrian Facilities

Lehi's existing bicycle network contains shared-use pathways of two distinct types. The first type is a shared-use path within an independent right-of-way (IROW) such as a stream, canal, railroad, or utility corridor. The other pathway type is a shared-use path built alongside a roadway, which is referred to as a "sidepath". On-street bike lanes and signed shared roadways round out the network. **Table 3-1** summarizes Lehi's existing bikeway mileage based on these facility types. **Tables 3-2** through **3-5** identify the existing bicycle facilities within each bikeway type.

Table 3-1: Existing Facilities

Facility Type	Mileage
Shared-Use Path (IROW)	19.96
Shared-Use Path (Sidepath)	7.34
Bike Lane	4.72
Signed Shared Roadway	4.51

Figures 3-2 to **3-5** graphically depict the bikeway types found in Lehi. **Figure 3-6** shows the existing city bikeway network described in the following tables.

Bicyclist on 1500 North in Lehi

Table 3-2: Shared-Use Paths (IROW)

Facility	Limit 1	Limit 2	Length (miles)
1420 S	350 W	150 W	0.15
Dry Creek Trail	1800 N	N Frontage Rd	0.72
Dry Creek Trail West	2900 W	2375 W	0.47
Historic Utah Southern Rail Trail North	HUS Rail Trail North	Timpanogos Hwy	0.62
Historic Utah Southern Rail Trail South	Timpanogos Hwy	300 W	2.60
Jordan River Connector 1	Jordan River Prkwy	Jordan Way	0.58
Jordan River Connector 2	Jordan Way	Jordan River Connector	0.13
Jordan River Connector 3	Jordan River Prkwy	Water Way Rd	0.33
Jordan River Parkway	Bluffdale Boundary	300 N	5.81
Jordan River Parkway	200 N	Saratoga Springs Boundary	2.52
JRP to 2100 N Connection	Jordan River Prkwy	2100 N	0.20
Murdock Canal Trail	HUS Rail Trail	3200 N	3.22
Power Line Trail	300 E	1300 S	0.08
Power Line Trail	1580 W	1370 W	0.10
Power Line Trail	Weeping Willow Trail	Spring Creek Trail	0.33
Power Line Trail Connector	Jordan River Prkwy	2600 W	0.78
Spring Creek Trail	Spring Creek Ranch	Power Line Trail	0.34
Utah Lake ShorelineTrail	1100 W	280 W	0.75
Weeping Willow Trail	1900 S	1630 S	0.25
		TOTAL	**19.96**

Table 3-3: Shared-Use Paths (Sidepaths)

Facility	Limit 1	Limit 2	Length (miles)
2100 N	Redwood Rd	Thanksgiving Way	2.41
300 N Dry Creek Trail South Fork	1100 W	960 W	0.14
3200 N to Murdock Canal Trail	150 W	400 E	0.58
Chapel Ridge Sidepath	Shady Hollow Loop	Toscana Hill Dr	1.01
Clubhouse Sidepath	Maple Loop	Thanksgiving Way	0.11
Dry Creek Trail South Fork	550 N	300 N	0.24
Power Line Trail	1700 W	1650 W	0.23
Spring Creek Sidepath	Weeping Willow Way	1300 S	0.45
Timpanogos Sidepath	Murdock Canal Trail	Highland Boundary	0.54
Traverse Mtn Sidepath	Jordan River	Triumph Blvd	1.36
Traverse Mtn Sidepath	Traverse Mtn Blvd	Timpanogos Hwy	0.27
		TOTAL	**7.34**

Table 3-4: Bike Lanes

Facility	Limit 1	Limit 2	Length (miles)
2100 N	Redwood Rd	Trinnaman Ln	2.73
Redwood Road	Bluffdale Boundary	1750 N	1.99
		TOTAL	**4.72**

Table 3-5: Signed Shared Roadway

Facility	Limit 1	Limit 2	Length (miles)
Pioneer Crossing	Jordan River Prkwy	American Fork Boundary	4.51
		TOTAL	**4.51**

Figure 3-2: Bike Lane

Figure 3-3: Signed Shared Roadway

Figure 3-4: Shared-Use Path (IROW)

Figure 3-5: Shared-Use Path (Sidepath)

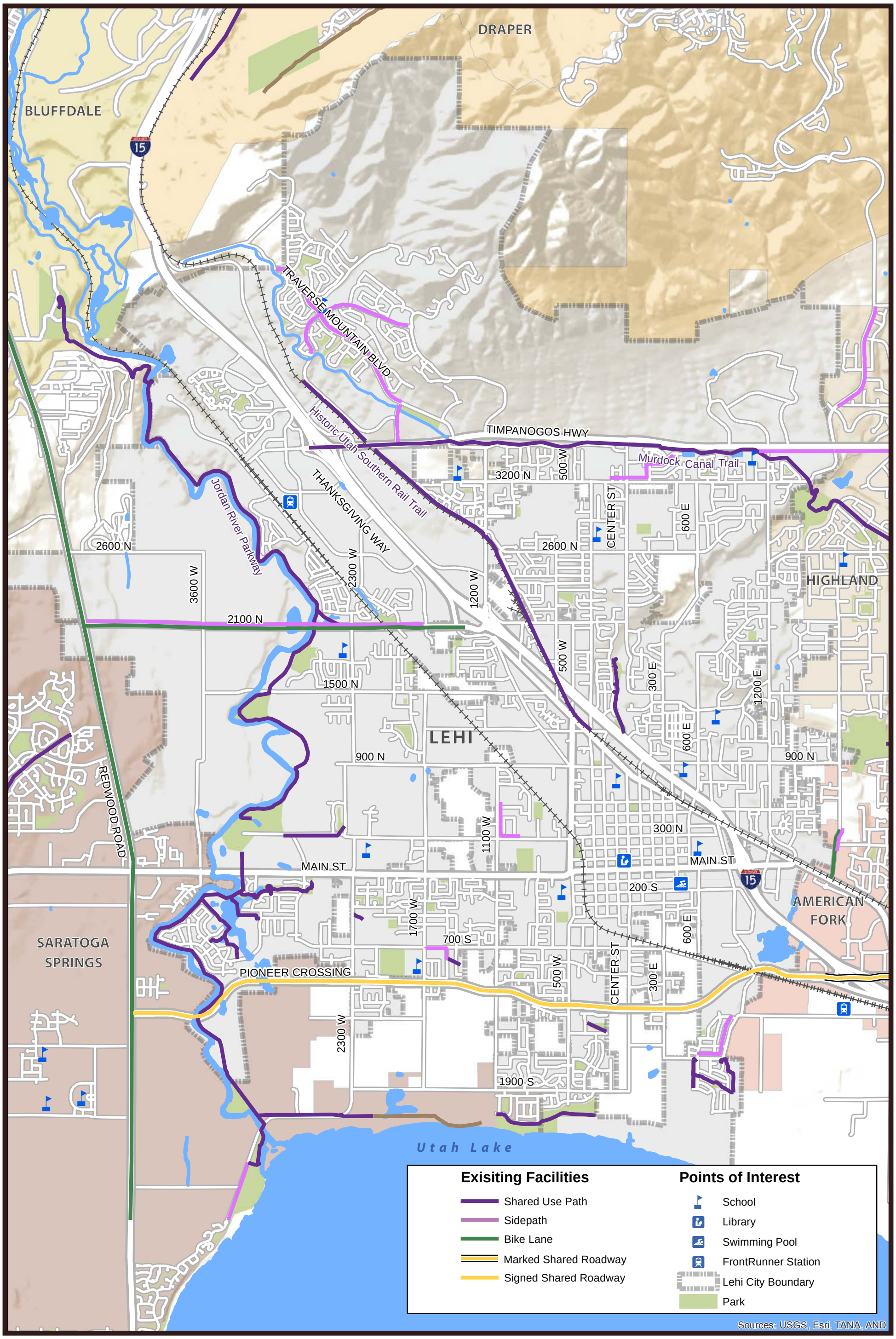


Figure 3-6: Existing Bikeways

3.2.1 Shared-Use Paths

Brief descriptions of all major shared-use paths in Lehi are provided below.

Jordan River Parkway

Nine miles of the Jordan River Parkway system is within Utah County, and most of that is in Lehi. The trail parallels nearly the entire Jordan River from Utah Lake to the Great Salt Lake. Several Utah County and Lehi City parks are located along the Jordan River Parkway.

Historic Utah Southern Rail Trail

When fully built out, this shared-use path is envisioned to stretch for the entire length of Lehi, connecting the Point of the Mountain Trail with American Fork. Existing phases follow the rail corridor from 300 West northwest past Cabela's Boulevard, with a major gap in the system at Timpanogos Highway. It features a bicycle and pedestrian bridge over Cabela's Boulevard. The corridor is owned by UTA.

Murdock Canal Trail

The Murdock Canal Trail system will ultimately run from the Provo River Parkway at the mouth of Provo Canyon to the Jordan River Parkway in Lehi. Several miles in Lehi are already constructed and efforts are underway to fill the remaining gaps between I-15 and the Jordan River Parkway.

Dry Creek Trail

This trail is located along Dry Creek within an established residential area north of I-15. It runs through Dry Creek Park, giving it a recreational character.

Waste Ditch Trail

This trail runs parallel to the canaled Waste Ditch and 300 North, ending a short distance from the Jordan River Parkway.

Lehi has several shared-use paths, such as the Jordan River Parkway and the Historic Southern Utah Rail Trail, both pictured above

Coordination with UDOT is important for establishing bikeways and walkways on arterials such as this one on 2100 North

Pioneer Crossing is a high speed roadway with wide shoulder accommodations for cyclists and sidewalks for pedestrians

Power Line Trail #1

This trail consists of a short shared-use path segment within a power line corridor, which then transitions to a sidepath that skirts the edge of the block. It serves a small residential area.

Power Line Trail #2

This trail is located within the same power line corridor as Power Line Trail #1. It serves as a park for nearby residents.

Utah Lake Parkway Trail

A small portion of the Utah Lake Parkway Trail is located in Lehi. It serves residents living near the Utah Lake shoreline. The trail skirts Northlake Park in Lehi and enters into Saratoga Springs. The trail eventually connects to the Jordan River Parkway 1 ½ miles to the west through what is currently undeveloped lands and open space.

3.2.2 Bike Lanes

Brief descriptions of all existing on-street bike lanes are given below.

2100 North (SR-85)

This bike lane was provided by UDOT as part of their construction of 2100 North. It currently runs between Redwood Road and State Street. Future plans indicate an expansion of this route to the west as part of the 2100 North/Mountain View Corridor route.

Redwood Road (SR-87)

The Redwood Road bike lanes connect Lehi north to Salt Lake County and south to Saratoga Springs. These bike lanes will tie into the Mountain View Corridor in western Salt Lake County, further extending the reach of bicycling.

3.2.3 Bike Routes

Brief descriptions of all existing bike routes are given below.

Pioneer Crossing

Pioneer Crossing is a higher speed roadway with sidewalks for pedestrians as well as bike route signs and wide shoulders for bicyclists.

3.2.4 Pedestrian Facilities

Sidewalk Design

Generally, sidewalks line the major roadways of the most developed part of Lehi. Sidewalks range in width from 3 feet to 10 feet. Some of them are placed immediately next to the roadway, while others are buffered from vehicle traffic by a planter strip.

Sidewalk Connectivity

A sidewalk inventory was conducted on all arterial and collector roadways to determine the locations of missing sidewalk segments within the city. Sidewalk connectivity is fairly complete within the central core. However, many roadways in the less developed outer portions of Lehi lack sidewalks. **Figure 3-7** shows the locations of missing sidewalks on collector and arterial streets.

Crosswalks and Intersections

Crosswalk markings provide guidance for pedestrians crossing roadways by defining and delineating paths across intersections or other crossing points. There are several reasons to install marked crosswalks, including:

- To indicate a preferred pedestrian crossing location
- To alert drivers to an often-used pedestrian crossing
- To indicate school walking routes

Main Street in Lehi

Sidewalk in Lehi

Students walking near Lehi High School

Schools such as Willow Creek Middle School, pictured here, are important generators of pedestrian and bicycle traffic.

Most major intersections in Lehi are striped with standard "transverse" crosswalks (two parallel lines). Crosswalk striping in school zones is a mixture of transverse striping and typical "piano key" striping. Signalized intersections have pedestrian push buttons that activate walk signals. Some intersections use pedestrian countdown timers that provide pedestrians with the number of seconds remaining in the crossing phase before the signal changes. Such devices increase safety by reducing the likelihood that pedestrians will become stranded in the middle of the crossing when the signal changes.

Walking Routes to Schools

Lehi's student population is nearly 13,000 and is projected to reach 15,000 by 2014. The students are housed within eight elementary schools, two junior high schools, and one high school. Walking routes to schools are important for the safety of all students. Alpine School District works with each elementary and junior high school to provided designated safe walking routes from neighborhoods to the schools.

The federal Safe Routes to School (SRTS) program funds infrastructure improvements and non-infrastructure programs to make it safer and more enjoyable for elementary and junior high children to walk and bike to school. UDOT administers this program in Utah. Currently, there are three SRTS sidewalk construction projects for Lehi schools in the design phase. The three projects are located near Sego Lily, Fox Hollow, and Traverse Mountain Elementary Schools.

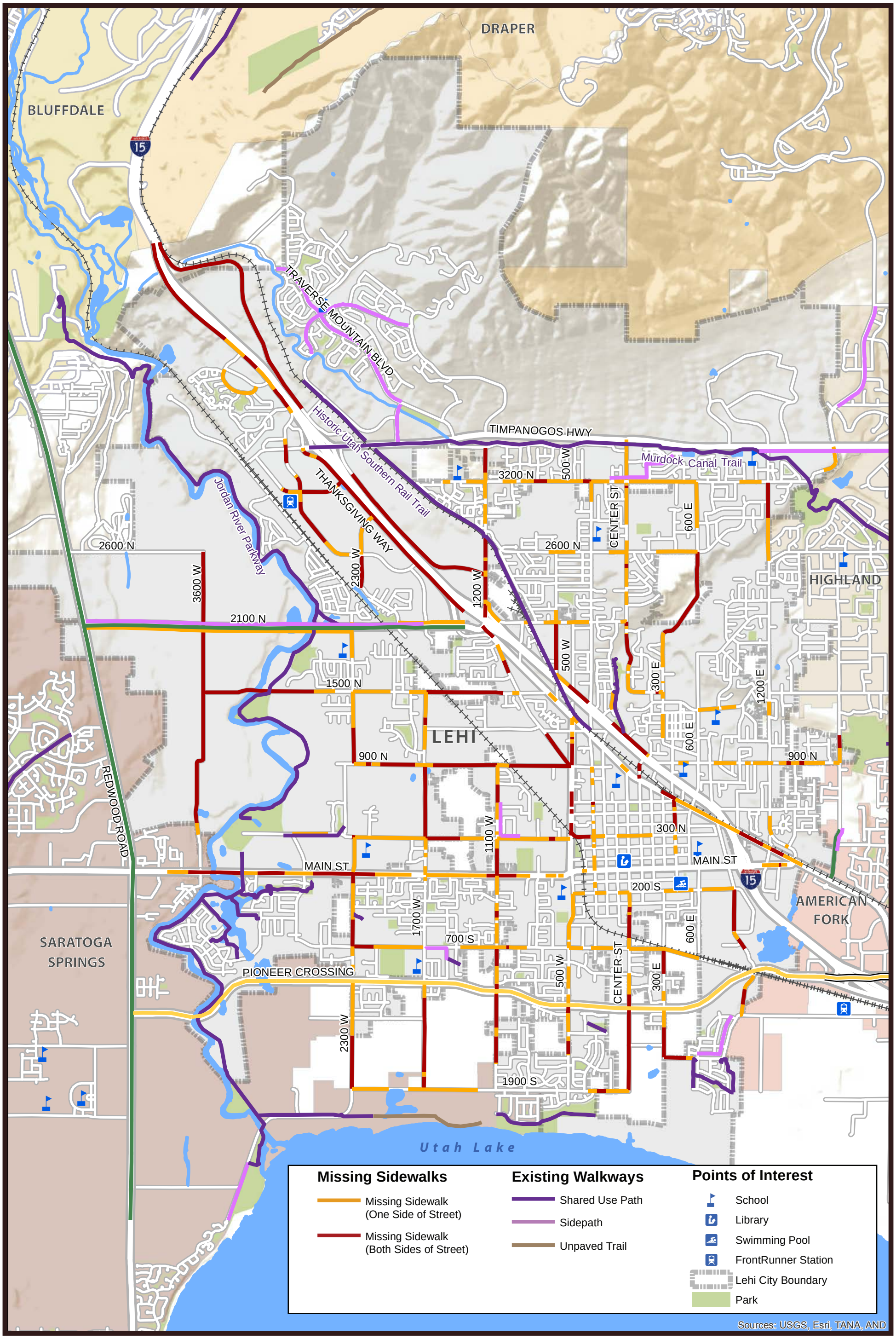


Figure 3-7: Missing Sidewalks

UTA express bus

3.3 Transit Connections

3.3.1 Bus Service

UTA operates several bus routes that serve Lehi. Most service intervals range between 30-60 minutes. Bicycle racks that accommodate two bicycles per bus are available on all UTA routes aside from Ski Service and Paratransit service routes.

Below is list of current routes in Lehi. **Figure 3-8** shows where each route goes.

- Route 850 (State Street) begins in downtown Lehi, and runs to Provo along the State Street/US-89 corridor with service every 30 minutes on weekdays from 8 a.m. to 7 p.m.
- Route 811 (Utah Valley-TRAX Connector) runs every 15 minutes for short parts of the commute period and every 30-60 minutes for the rest of the day on its route between UVU and Sandy TRAX. It stops along State Street throughout the length of Lehi.
- Routes 806 (Saratoga Springs/Lehi Station), 807 (North County/Lehi Station), 809 (Eagle Mountain/American Fork Station), and 853 (Lehi Station/Adobe/IM Flash) provide feeder service from the surrounding communities to the FrontRunner stations in Lehi and American Fork.
- Route F868 (American Fork/Alpine Lift) is a flex route that roughly loops the boundary with American Fork nearly every hour and half from 6 a.m. to 8 p.m. It serves stops at the eastern edge of Lehi.

3.3.2 FrontRunner Commuter Rail

FrontRunner is a commuter train operated by UTA. This service presently operates between Pleasant View (north of Ogden) and Provo from Monday through Saturday. FrontRunner trains typically have room for 12 bicycles in a designated bicycle car as well as additional space in the normal passenger cars. The FrontRunner station in Lehi is near Thanksgiving Point, although residents of southern Lehi are closer to the American Fork station. New residential developments are already present in the area and the vacant land surrounding the station is slated for professional office development.

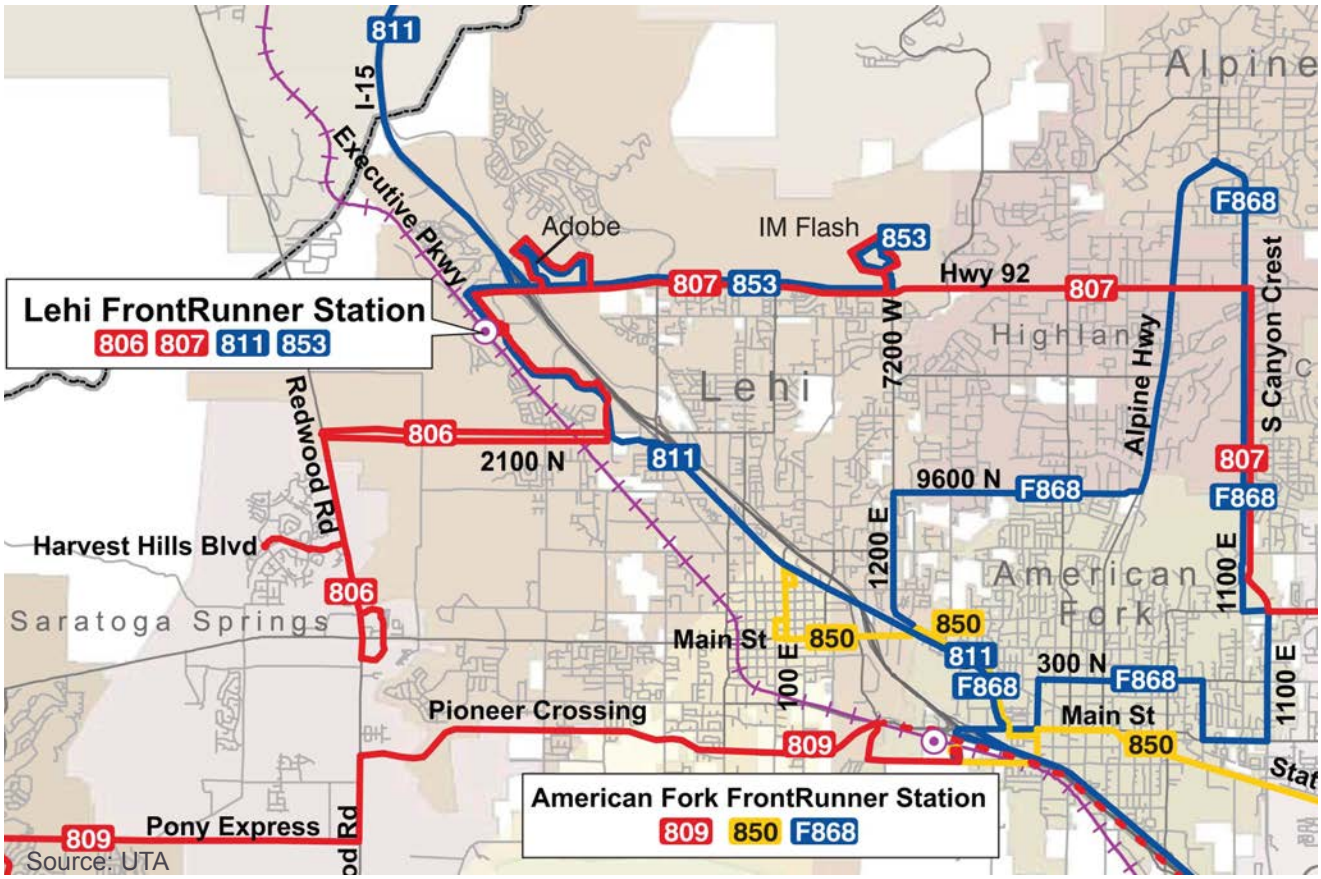


Figure 3-8: Lehi Transit Service

Walking and bicycling connections to the Lehi FrontRunner station are important

3.4 Opportunities

3.4.1 Proposed Network

Many future bicycle and pedestrian facilities are planned in Lehi. Some of them come from the Lehi General Plan, while others are from regional trail plans such as the Murdock Canal, Utah Lake Parkway, and Jordan River Parkway. Additionally, UDOT plans to include some facilities within their roadway projects. **Table 3-6** shows the total mileages planned for each category.

Table 3-6: Planned Bicycle and Pedestrian Facilities

Facility Type	Mileage
Shared-Use Paths (paved)	32.00
Shared-Use Paths (unpaved)	2.20
Bike Lanes	16.30

3.4.2 Roads

Lehi roads are classified by proposed street sections, outlined in the 2010 Master Transportation Plan. Drawings of typical street sections provide basic parameters for street layout. One element of all street section types is a border area that includes curb and gutter, park strips, and sidewalks. Details of different street types are provided with the width for lanes, medians, and shoulders.

- Principal Arterial (1900 South and 3600 West) - 106’ section (four 12’ lanes, 14’ median lane, two 11’ shoulders, and two 11’ border areas)
- Major Arterial - 80’ section (two 11’ lanes, 14’ median lane, two 11’ shoulders, and two 11’ border areas)
- Minor Arterial (700 South) – 80’ section (two 12’ lanes, 14’ median lane, two 10’ shoulders, and two 11’ border areas)
- Minor Arterial (2600 North) – 74’ section (two 12’ lanes, 12’ median lane, two 8’ shoulders, and two 11’ border areas)
- Major Collector – 70’ section (two 11’ lanes, 12’ median lane, two 7’ shoulders, and two 11’ border areas)
- Minor Collector – 60-66’ section (two 12’ lanes, 7-10’ shoulders, two 11’ border areas)
- Border Area – the border area is a minimum of 11’ with various configurations of curb and gutter, sidewalks, and landscaping or park strips. Actual dimensions are determined on a case-by-case basis based on existing conditions.

At present, the street typical sections do not include bikeways. Under current design standards, some of the existing street sections could include on-street bicycle facilities with slight reallocations of roadway space. Examining on-street bikeway feasibility is an integral part of this master plan.

The Dry Creek Trail provides transportation and recreation options

3.4.3 Expansion of Shared-Use Path Network

Lehi's existing shared-use path network is a significant amenity to pedestrians and bicyclists. These paths are highly desired because they provide separation from motor vehicle traffic, making them a more comfortable place to ride and walk for many people. Some paths like the Jordan River Parkway are nearly complete, while others like the Utah Lake Shoreline Trail and Dry Creek Trail have room to expand. Opportunities to expand existing trails or develop new trails can be challenging where there is limited land available for new development. Since Lehi is still a developing community, opportunities exist to expand the shared-use path network by incorporating paths into development approvals and by proactively planning and constructing paths before the corridors are changed in ways that could preclude path development.

3.4.4 Rail Corridors

Unused railroad rights-of-way are good candidates for shared-use pathways because they typically provide links that road networks cannot, exist in rights-of-way separate from roads, and have relatively few roadway crossings. The practice of constructing shared-use paths in dormant railroad rights-of-way is called "Rails to Trails". Lehi already has a long segment of shared-use path along one dormant railroad line. Expansion of this facility to the northwest and southeast would connect Lehi residents to Draper and American Fork via a single, continuous path.

Adding bicycle facilities to active rail corridors is often referred to as "Rails with Trails" (RWT). RWT describes any shared-use path or trail located on or directly adjacent to an active railroad corridor. There are over 60 RWTs presently active in the United States, totalling more than 240 miles in 30 states. RWTs are located adjacent to active rail lines ranging from a few slow-moving short-haul freight trains weekly, to high-frequency passenger trains traveling as fast as 140 mph. In addition to the existing trails, dozens of additional RWTs are proposed or planned. The rail line shared by Union Pacific and UTA's FrontRunner commuter train is a potential candidate for RWT in Lehi.

3.4.5 Waterways

Waterways provide another opportunity for expanding the shared-use path network. One major opportunity is completing the portion of the Utah Lake Shoreline Trail that lies within Lehi's city boundaries. This trail is envisioned to eventually encircle the entire circumference of Utah Lake. The Dry Creek Waste Ditch, Dry Creek natural streambed, and Spring Creek also provide opportunities

to establish shared-use pathways. Paths along these corridors would provide a valuable transportation function as well as scenic recreational amenities.

3.4.6 Transit

UTA's FrontRunner South commuter rail service in Utah County began operations in December 2012. Establishing walking and bicycling connections to the Lehi and American Fork stations will help better connect Lehi residents to this transit option. Working with UTA to enhance short- and long-term bicycle parking amenities will further maximize the potential of FrontRunner service.

3.4.7 Development

A large amount of new development is likely to occur in Lehi over the next 10-20 years. Lehi has the opportunity to include pedestrian and bicycle amenities in the design of future roadways and buildings from the initial concepts through the construction phases of all projects within the city limits.

3.5 Constraints

3.5.1 Physical Barriers

This type of barrier is identified as a physical impediment to travel, such as a freeway where crossings can only occur at interchanges and limited grade-separated locations. I-15 qualifies as a physical barrier. Currently, crossings of I-15 within Lehi are only possible at Timpanogos Highway (SR-92), 1200 West/2100 North, 300 West, 100 East, 500 East, State Street (US-89), and Main Street. Only four of these – 300 West, 100 East, 500 East, and State Street – are not interchanges. Due to their complexity, quantity of auto traffic, traffic speeds, and merging movements, interchanges are often significant barriers to pedestrians and bicyclists. State Street is currently a high-speed thoroughfare that most people would not want to walk or bicycle along. This leaves 300 West, 100 East, and 500 East as the only relatively minor, low-speed streets by which Lehi residents may cross I-15.

Utah Lake Shoreline Trail near 2300 West

Railroad crossings can be physical barriers for people who walk and bicycle

In addition to I-15, other large roads like Pioneer Crossing, Redwood Road, and 2100 North can also act like moats to restrict pedestrian and bicycle mobility within the community. The Jordan River and the two railroad corridors running through Lehi also act as barriers for motorists, pedestrians, and bicyclists alike.

3.5.2 Facility Barriers

Facility barriers can take many forms. They may be gaps in a facility (where a bikeway ends suddenly), or poor facilities that do not provide optimal riding conditions, such as bike lanes that provide little to no buffer between on-street parking.

Lack of proper maintenance can also lead to unusable facilities or undesirable conditions. Shared-use paths and bike lanes frequently collect snow and road debris, making them hazardous to use if they aren't maintained well.

3.5.3 Gaps

Gaps typically exist where physical or other constraints impede pedestrian and bicycle network development. Typical gap constraints include narrow bridges on existing roadways and large intersections where bike lanes are dropped on the approaches in order to accommodate turn lanes. Traffic mobility standards, economic development strategies, and other policy decisions may also lead to gaps in a bikeway network. For instance, a community's desire for on-street parking or increased vehicle capacity may hinder efforts to install continuous bike lanes along a major street. **Figure 3-9** presents a theoretical diagram illustrating different kinds of bikeway gaps.

Gaps in the continuity of bicycle facilities are significant constraints. However, this also means that there is a tremendous opportunity to fix the gaps. Bikeway gaps exist in various forms, ranging from short "missing links" on a specific street or path corridor, to larger geographic areas with

Limited-access highways such as this one are common physical barriers for people who walk and bicycle

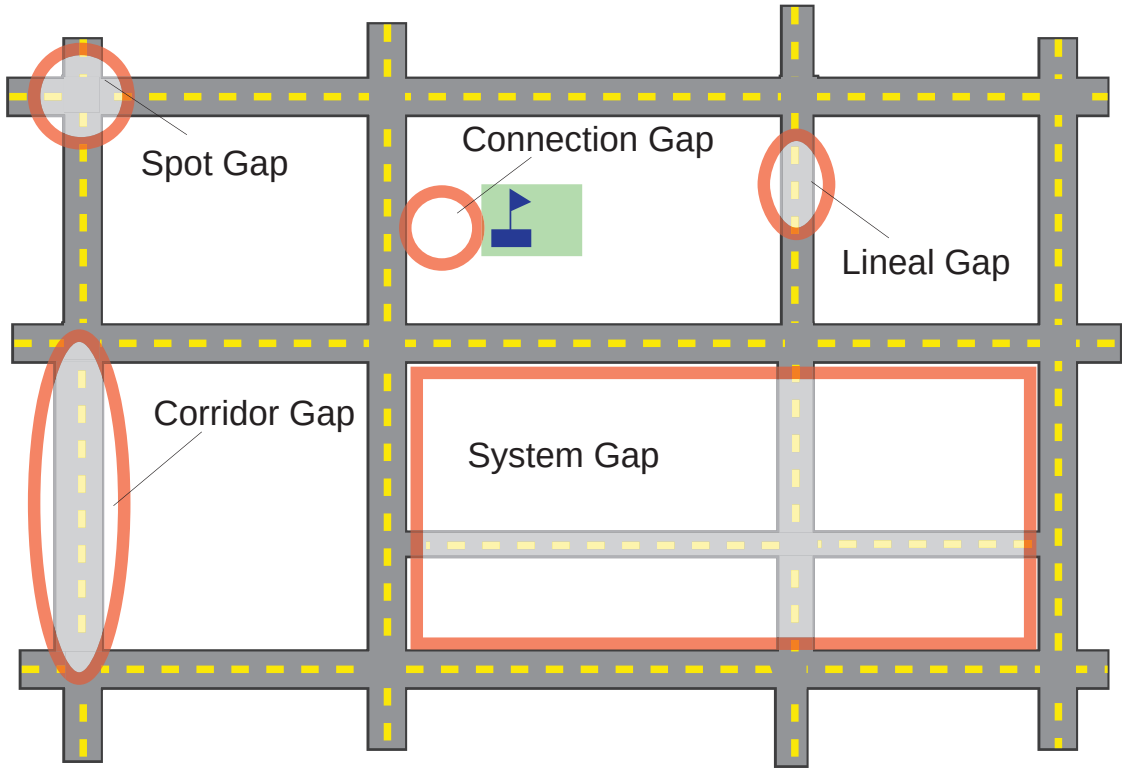


Figure 3-9: Bikeway Gap Types

few or no bicycle facilities at all. Determining specifically what constitutes a gap requires that we set parameters for the bikeway network and determine which activity centers require direct links to the bikeway network. This section classifies bikeway gaps into five main categories.

Spot Gaps

Spot gaps refer to point-specific locations lacking dedicated bicycle facilities or other treatments to accommodate safe and comfortable bicycle travel. Spot gaps primarily include intersections and other vehicle/bicycle conflict areas posing challenges for riders. Examples include bike lanes on a major street "dropping" to make way for right turn lanes at intersections, or a lack of intersection crossing treatments for bicyclists on a route or path as they approach a major street.

Connection Gaps

Connection gaps are missing segments (¼-mile long or less) on a clearly defined and otherwise well-connected bikeway. Major barriers standing between bicycle destinations and clearly defined routes also represent connection gaps. Examples include bike lanes on a major street "dropping" for several blocks to make way for on-street parking or a discontinuous off-street path. The gap between the Waste Ditch Trail and the Jordan River Parkway Trail represents a connection gap.

Lineal Gaps

Lineal gaps are ½- to one-mile long missing link segments on clearly defined and otherwise well-connected bikeways. The unpaved portion of the Utah Lake Parkway Trail could qualify as a lineal gap since the trail is paved on both ends of the unpaved part. However, this unpaved portion is located within Saratoga Springs – not Lehi.

Corridor Gaps

Corridor gaps are similar to lineal gaps, but are longer than one mile. These gaps will sometimes encompass an entire street corridor where bicycle facilities are desired but do not currently exist. An example of a corridor gap is the Historic Utah Southern Rail Trail between the end of the pavement north of Cabela's Boulevard and the paved portion in Draper.

System Gaps

Large geographic areas (e.g. a neighborhood or business district) where few or no bikeways exist are identified as system gaps. The central core of Lehi is an example of a system gap.

3.5.4 Insufficient Rights-of-Way

Along some roadways, the existing rights-of-way may not be sufficient to provide accommodation for optimum pedestrian and bicycle facilities unless parking or travel lane space is sacrificed. This may occur in two distinct scenarios. The first is where the existing right-of-way is narrow, such as Main Street through the downtown core. The second situation occurs where roadways are wide, but are currently striped to the curb with vehicle lanes and the political willpower does not exist to remove any existing car lanes. In both cases, property acquisition either through sale or easement dedication may be needed to provide the necessary width for pedestrian or bicycle facilities.

3.5.5 Snow Removal Practices

Winter brings colder temperatures and ice accumulation. Both of these factors can affect the decision to bicycle or walk for transportation or recreation in the winter. While ice accumulation will always remain a barrier to bicycling, improved maintenance and enforcement practices can minimize the impact to those wishing to bicycle year-round.

4 Needs Analysis

This chapter examines the needs and desires for more walking and bicycling facilities in Lehi. It contains general information about the needs of bicyclists and pedestrians as well as specific feedback received from stakeholders, elected officials, and Lehi residents. Chapter 4 is divided into the following sections:

- Needs and Types of Bicyclists
- Online Needs and Attitudes Assessment
- Public Workshops
- Project Website
- Stakeholder Activities
- Demand and Benefits Model

Different types of bicyclists have varying needs, expectations, and abilities

4.1 Needs & Types of Bicyclists

Similar to motor vehicles, bicyclists and their bicycles come in a variety of types and configurations. This variation ranges from the type of bicycle a person chooses to ride (i.e. a conventional bicycle, a recumbent bicycle, or a tricycle) to the behavioral characteristics and comfort level of the bicyclist. Bicyclists by nature are much more sensitive to poor facility design, construction, and maintenance than motor vehicle drivers. Bicyclists are more exposed to the elements and prone to physical injury due to the lack of protection of the bicycle compared to the automobile.

Bicyclist skill level also leads to a dramatic variance in expected speeds and behavior. Several systems of bicyclist classification are currently in use within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different bicyclists. However, it should be noted that these classifications may change in type or proportion over time as infrastructure and culture evolve. Sometimes an instructional course can instantly change a less confident bicyclist to one that can comfortably and safely share the roadway with vehicular traffic. Bicycle infrastructure should be planned and designed to accommodate as many user types as possible with separate or parallel facilities considered to provide a comfortable experience for the greatest number of bicyclists.

The 1999 AASHTO Guide for the Development of Bicycle Facilities identifies bicyclists as being “Advanced or Experienced”, “Basic or Less Confident” or “Children”. These AASHTO classifications have been the standard for at least 15 years and have been found to be helpful when assessing people who currently bicycle. However, these classifications do not accurately describe all types of bicyclists, nor do they account for the population as a whole, especially potential

bicyclists who are interested in riding but may not feel existing facilities are safe enough. Beginning in the Pacific Northwest in 2004, and then supported by data collected nationally after 2006, alternative categories have been developed to address the attitudes of Americans towards bicycling. **Figure 4-1** illustrates the different viewpoints and their respective proportions.

Figure 4-1: Bicyclist Types by Overall Population

Less than 2% of Americans comprise a group of bicyclists who are **"Strong & Fearless"**. These bicyclists typically ride anywhere on any roadway regardless of roadway conditions or weather. They can ride faster than other user groups, prefer direct routes and will typically choose roadway connections – even if shared with vehicles – over separate bicycle facilities such as shared-use paths.

"Enthused & Confident" bicyclists encompass 10-13% of people. They are mostly comfortable riding on all types of bicycle facilities, usually prefer low traffic streets or shared-use pathways when available, and may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists including commuters, recreationalists, racers, and utilitarian bicyclists.

The third group can be categorized as **"Interested, but Concerned"**. They do not ride a bicycle regularly. 50-60% percent of the population falls into this category, which represents people who typically only ride on low traffic streets or bicycle paths under favorable conditions and weather. This group perceives traffic and safety as significant barriers that prevent them from bicycling more often. They may become more regular riders with encouragement, education, and experience.

The remainder of the American population – 20-30% – are not bicyclists and perceive severe safety issues with riding in traffic. This group is classified as **"Not Interested"**. Some people in this group may eventually give bicycling a second look and may progress to the user types above. However, a significant portion of them will never ride a bicycle under any circumstances.

4.2 Online Needs & Attitudes Assessment

In order to gauge the views of Lehi citizens about bicycling and walking within their community, a comprehensive online survey of attitudes, habits, and perceived needs was conducted. Questions included:

- How often do you walk or bike?
- How often would you walk or bike if better facilities were available?
- What are your chief concerns with walking and biking in Lehi?
- What types of improvements would you like to see?

The survey was available on the project website (www.lehibikepedplan.com). Information cards directing recipients to the survey on the website were placed in local bicycle shops, Lehi City Hall and Library, Legacy Center, other city agencies, and other appropriate locations.

The survey was available from late February to early May 2012, approximately 11 weeks. In total, there were 132 respondents with 98% of respondents being Lehi residents. Other demographic information indicated that 55% of respondents were female and more than 80% were in the 26 to 44 age group. **Figure 4-2** presents basic demographic information about the people who participated in the online survey.

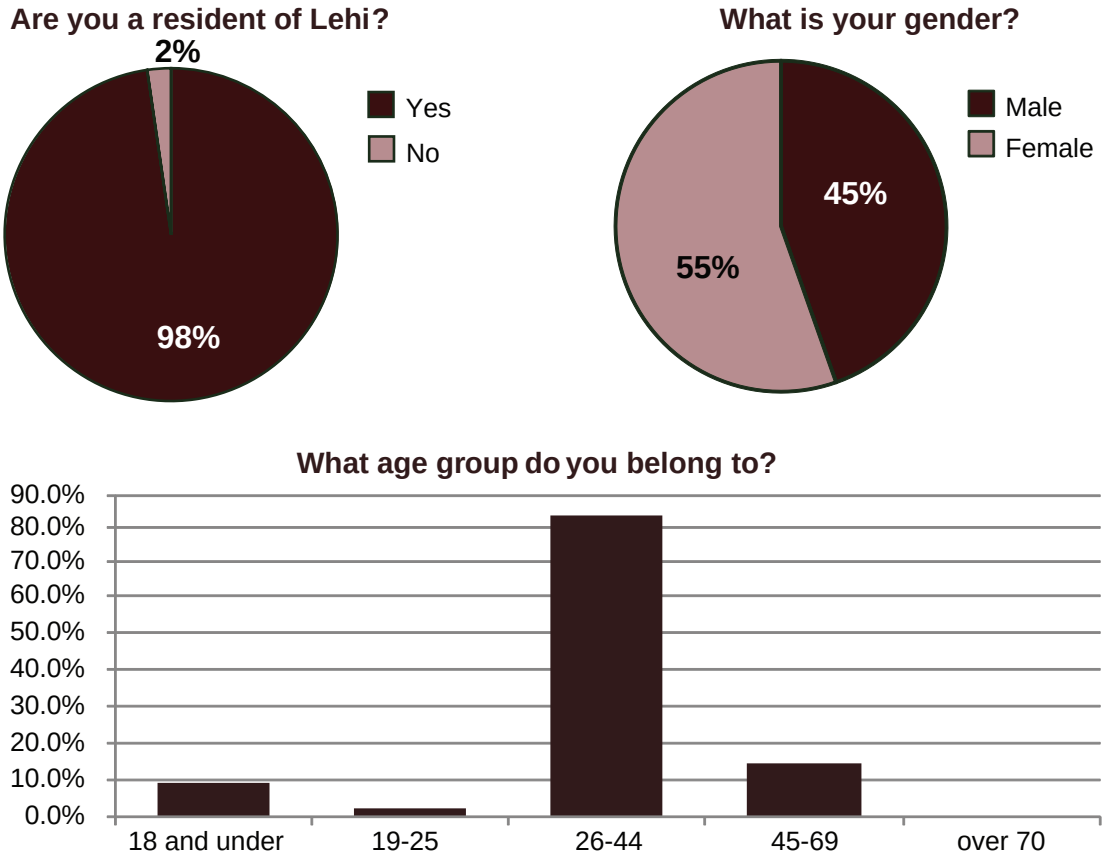


Figure 4-2: Online Survey Demographics

4.2.1 Walking

Respondents cited exercise, recreation, and walking with children or pets as the primary reason for walking. One-third walk daily or almost daily and an additional 41% walk a few times a week.

Survey respondents were also asked about their seasonal walking habits. Not surprisingly, winter ranked the lowest season to walk. Apart from the obvious weather and temperature concerns, maintenance of sidewalks was cited by more than 20% of respondents as a reason why they don't walk more frequently. While Lehi City does not control the weather, there is certainly opportunity to provide better-maintained sidewalks and other pedestrian facilities during cold weather months. Results of walking-related questions are presented in **Figure 4-3**.

4.2.2 Bicycling

Bicycling is a popular activity with Lehi residents. A large majority of respondents have a bicycle and nearly 60% of people who took the online survey ride at least several times a month. Similar to walking, most people cited exercise and recreation among the most popular reasons to ride. However, commuting to work and school and for running errands or other transportation received enough responses that these trips might eventually begin to favorably impact the overall transportation network by replacing car trips. By providing a citywide network of bicycling facilities, the Bicycle and Pedestrian Master Plan can help Lehi City offer its residents alternatives to getting in their car to make trips that might otherwise be done on foot or bicycle.

The top reason cited by respondents for not bicycling more is the lack of bicycle facilities. Weather and seasonal changes account for a steep decrease in bicycle riding in the winter. However, respondents indicated that snow removal, sweeping, and other maintenance activities could help them bicycle more in the winter. Results of bicycling-related questions are presented in **Figure 4-4**.

Walking is a popular activity in Lehi

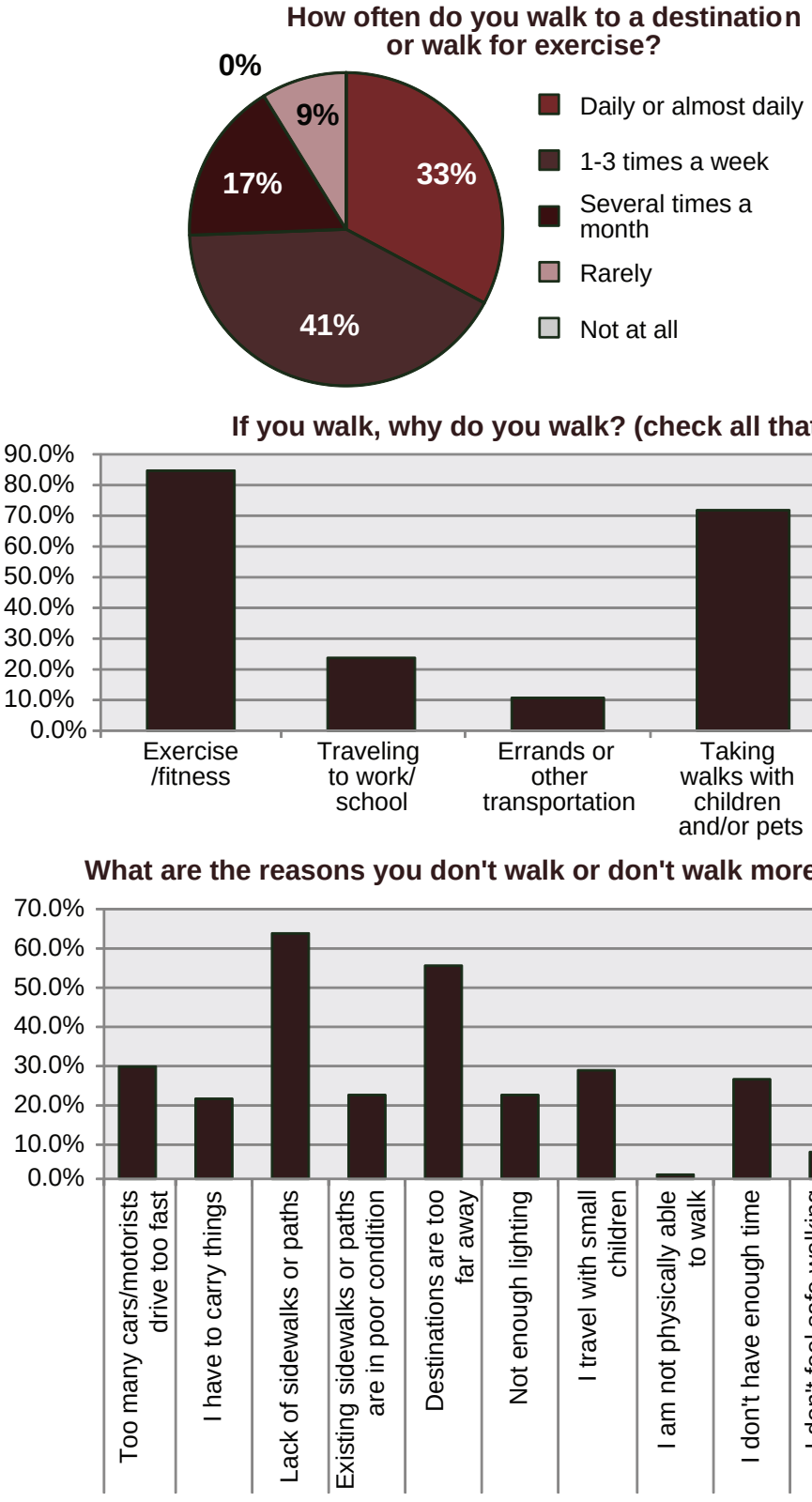
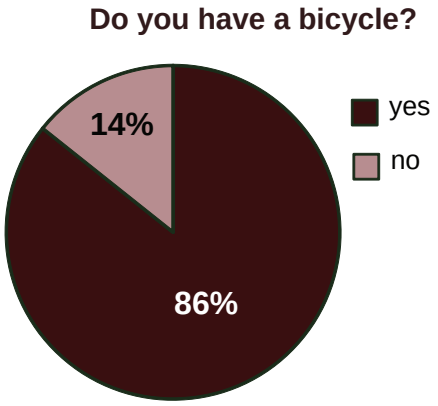
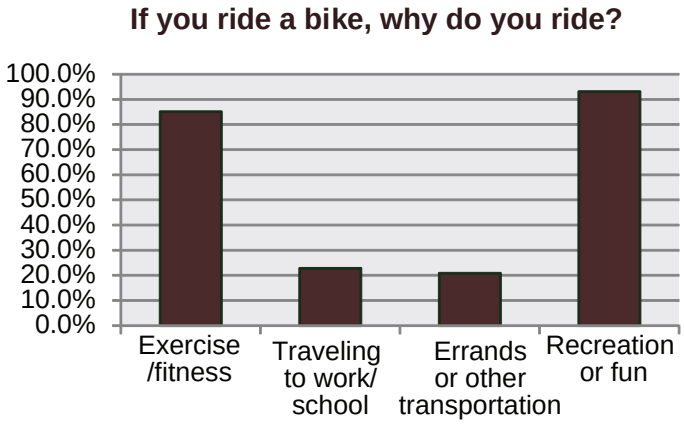
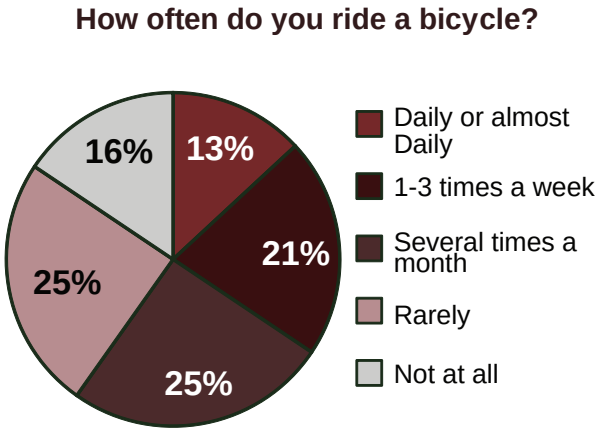
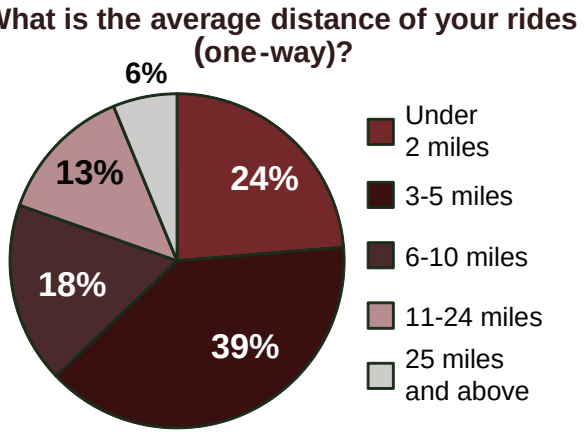


Figure 4-3: Walking Habits









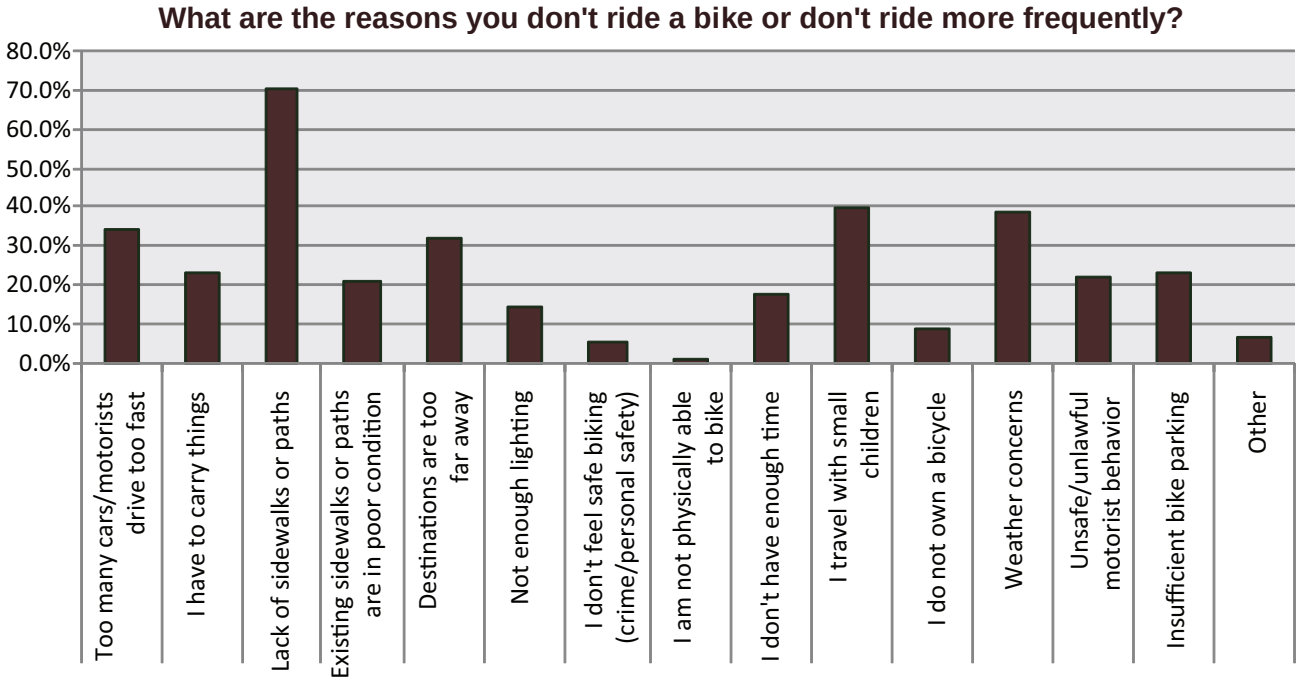


Figure 4-4: Bicycling Habits

4.2.3 Destinations & Priorities

Survey results showed that getting to and from paved trails, recreation areas such as swimming pools and parks, and to neighborhood stores and other commercial areas were the highest priorities. These responses were considered carefully when developing the bicycle and pedestrian infrastructure networks recommended in this plan. A more detailed breakdown of destination priorities is displayed in **Figure 4-5**.

When asked what strategies they believed had the most potential to improve walking and bicycling conditions in Lehi, the number one response was providing more and/or improved paved shared-use paths in the city. Other high-priority improvements included sidewalks, SRTS programs, crosswalks, and increased maintenance of sidewalks and bike facilities. **Figure 4-6** shows the responses regarding project priorities in more detail.

When asked their favorite places to bike and walk in Lehi, the top responses were:

- Jordan River Parkway Trail
- 2100 North
- Traverse Mountain
- Pioneer Crossing

Least favorite places included:

- Main Street
- State Street
- SR-92
- Traverse Mountain

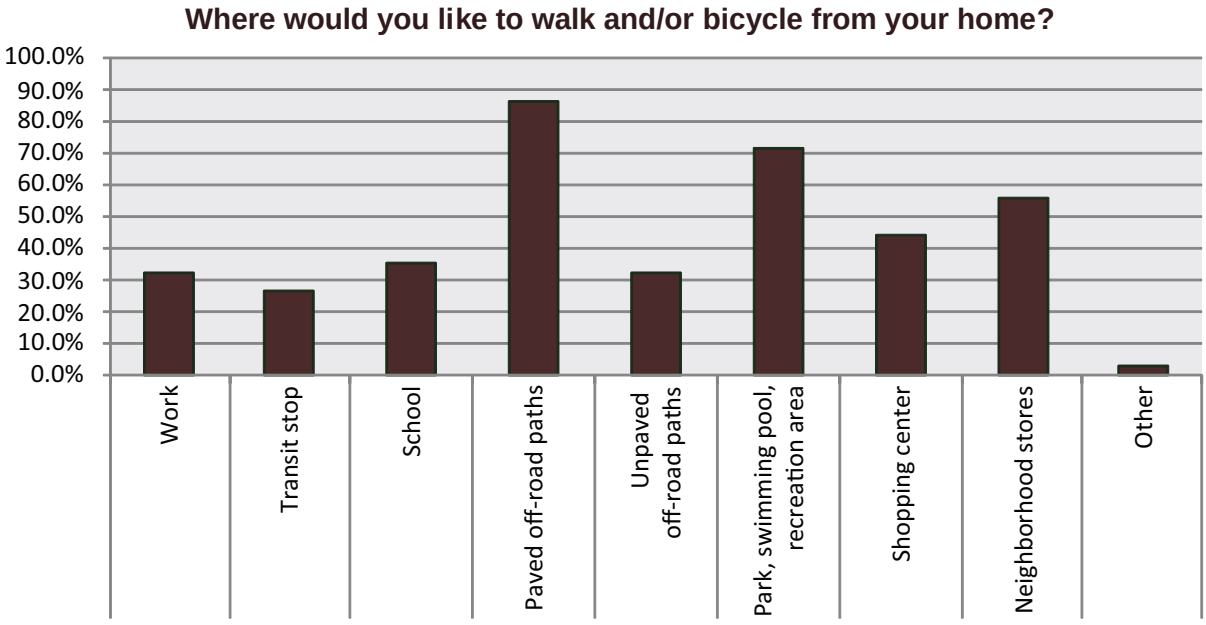


Figure 4-5: Destinations

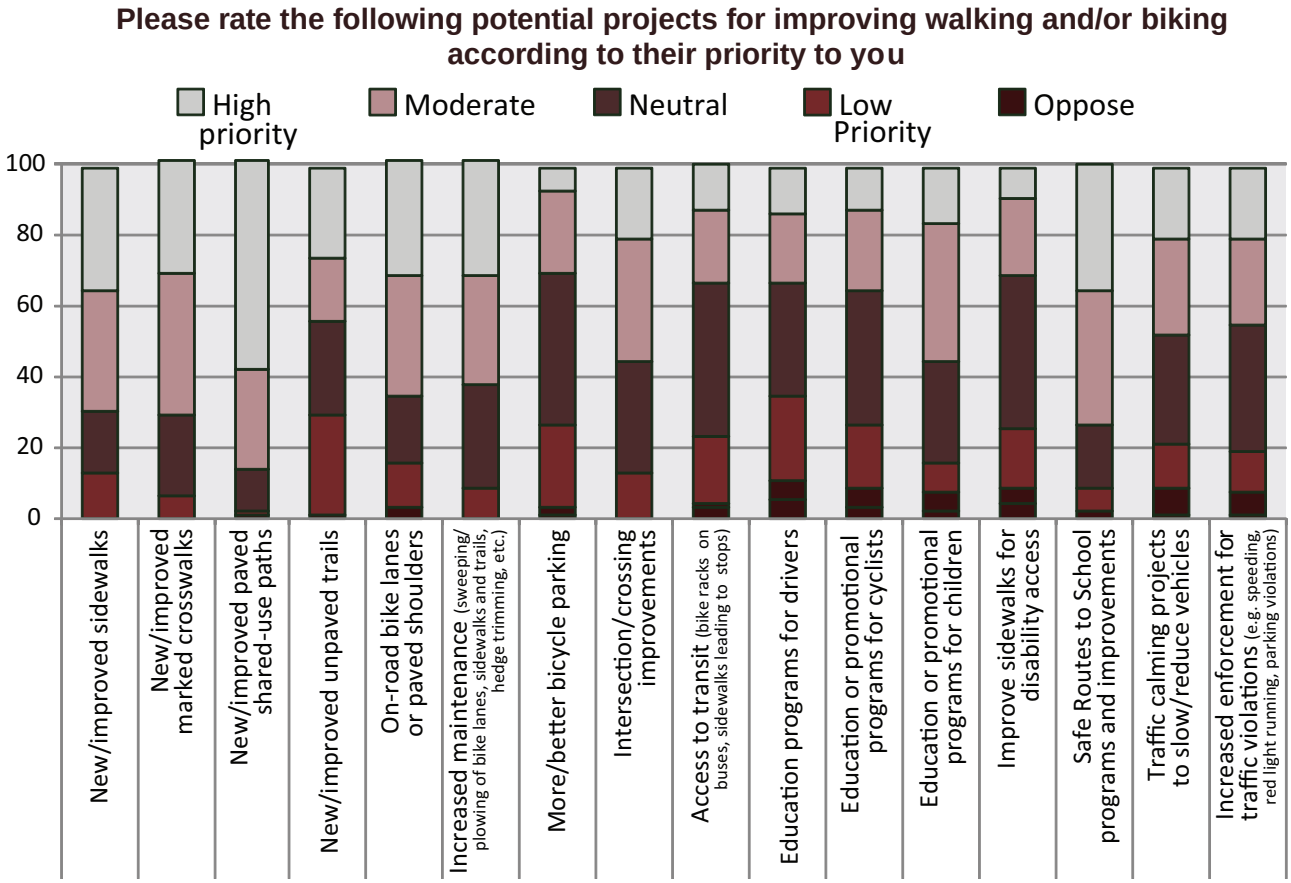


Figure 4-6: Project Priorities

Flyers were distributed advertising the public workshops

4.3 Public Workshops

Two public workshops were held during the planning process. Comments from these workshops served as the foundation for the plan and for revisions to the draft recommendations.

4.3.1 March 2012 Workshop

The first public workshop was held March 21, 2012 at the Legacy Senior Center and 63 people attended. Basic information such as the project timeline, project sponsors, and ultimate objectives was presented.

The main purpose of this meeting was gathering input from Lehi residents before detailed recommendations were put into place. Attendees had the opportunity to leave comments on blank maps. **Figure 4-7** depicts the most commonly identified priority destinations from the March 2012 public workshop. Similarly, **Figure 4-8** depicts the most commonly identified barriers to walking and bicycling. The larger word sizes correspond to more people identifying that item as a barrier.

They also participated in a Visual Preference Survey where they saw graphics and pictures depicting different types of bicycle facilities, and then were able to vote electronically in "real time" for their preferences. At the end of each question, results were displayed on a large screen. A total of 32 people took part in the Visual Preference Survey exercise. **Figure 4-9** displays the facility type preference results. **Figure 4-10** shows what respondents said they would be willing to give up in order to create space for bike lanes.

Facility type preference questions were also asked as part of the online survey. Responses to that survey closely mirrored the results obtained through the Visual Preference Survey conducted at this workshop.

Public workshop comments were placed on sticky-notes by those who attended

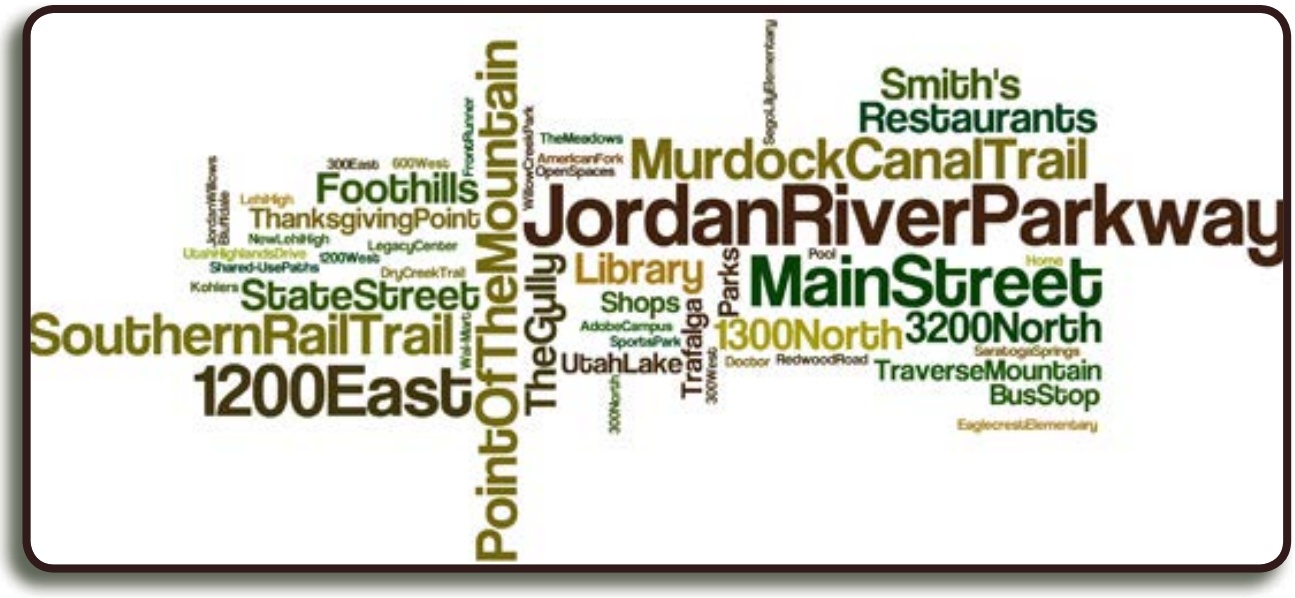


Figure 4-7: Commonly Identified Destinations

Figure 4-8: Commonly Identified Barriers

How do you feel about?:

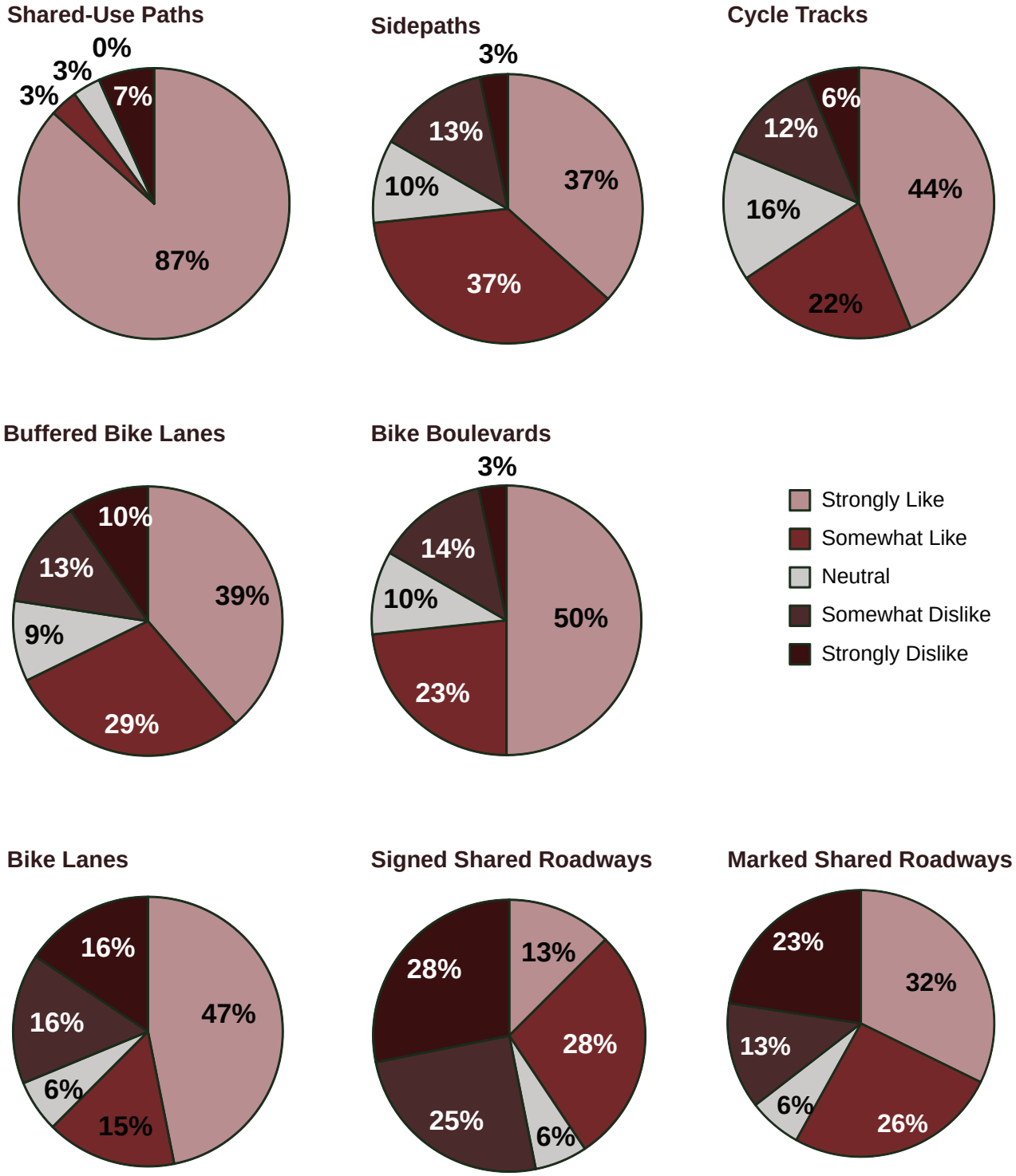


Figure 4-9: Visual Preference Survey Results

Attendees of the first public workshop had the chance to vote for their preferred facility types during the visual preference survey

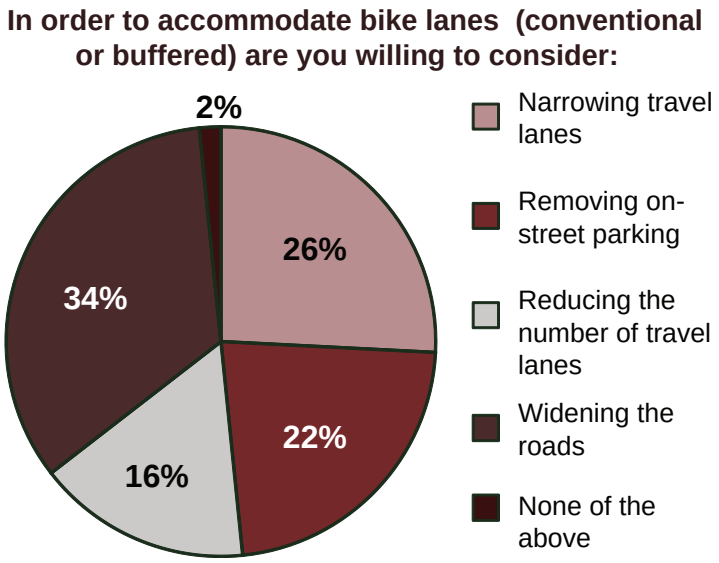


Figure 4-10: Support for Accommodation of Bike Lanes

4.3.2 September 2012 Workshop

The second public workshop was held September 26, 2012, again at the Legacy Senior Center in Lehi. A total of 39 people attended the workshop. Maps showing draft recommendations for walking and bicycling facilities were presented. Nearly all attendees offered comments on these recommendations. Following the open house, comments were evaluated by the steering committee and adjustments to the draft plans were made where possible.

Also available at the open house was a summary of non-infrastructure recommendations for Lehi. Non-infrastructure programs contribute to the overall bicycling and walking environment but are not actual lines on a map. Examples include SRTS programs, establishment of a Bicycle/Pedestrian Coordinator position within the city, and safety campaigns. Attendees were asked to vote for their top five highest priority recommendations in order to provide Lehi decision makers with information to prioritize efforts. Voting results are displayed in **Table 4-1**. These programs are described in detail in **Chapter 6**.

Table 4-1: Support for Programs

Program	Votes
Safe Routes to School	43
Bicycle/Ped Coordinator	23
Complete Streets Policy/Resolution	18
Establish a Bike/Ped Advisory Committee	17
Bicycle Map	17
Safety Campaign	16
Bike Program Website	14
Bicycle Light Campaign	13
City Staff Training	8
Annual Bicycle Counts	5
Valet/Event Parking	5
Police Training Module	3
Youth Bicycling Classes	2

4.3.3 Workshop Advertising

Each of the workshops was advertised by the following means:

- Open house/survey/website flyers were distributed to:
  - Various Lehi City offices
  - Legacy Senior Center
  - Lehi Recreational Center
  - Lehi City Library
  - Area bicycle shops, northern Utah County
- A notice was put in utility statements newsletter
- Announcement on the Lehi City website
- Announcement on the MAG website
- Announcement on the project website (www.lehibikepedplan.com)
- Announcement on the Lehi City Facebook page
- Notices sent home with Lehi elementary school children
- Information was sent to Bike Utah, Bike Utah Valley, and Bike Provo groups
- Information was distributed to list maintained by MAG
- A press release was prepared for the Provo Daily Herald
- Area administrator for the Boy Scouts of America was contacted to distribute information
- General project information flyers distributed at Lehi Round Up civic event

4.4 Project Website

In addition to the public workshops, the Lehi Bicycle and Pedestrian Master Plan had a significant online component as well. The project website (www.lehibikepedplan.com) was kept up to date throughout the process and served as the gateway to the Needs and Attitudes Survey as well as draft facilities maps. The site provided an opportunity to disseminate information to the public and interested stakeholders as well as receive feedback from those same groups. In addition, the website included:

- Summary of master plan process
- Contact information
- Steering committee participants
- Needs and attitudes survey
- Interactive maps
- Comment form

The project website (www.lehibikepedplan.com) provided opportunities for public input, education, and updates on the progress of the plan

Key stakeholders participated in a walking and bicycling tour of Boulder, CO (pictured here)

4.5 Stakeholder Activities

Multiple avenues were used to involve key stakeholders in the development of the Lehi Bicycle and Pedestrian Master Plan. This section discusses those various efforts.

4.5.1 Project Steering Committee

The steering committee included Lehi City staff, residents, and representatives from key agencies with a stake in the plan outcome. The committee provided guidance on the overall approach, tasks, and recommendations of the study and met monthly throughout the process. **Table 4-2** shows a list of those individuals involved in the steering committee.

Table 4-2: Lehi's Bicycle & Pedestrian Plan Steering Committee

Name	Organization
Carolyn Nelson	Planning Commissioner
Casey Brown	Lehi resident
Craig Hancock	UDOT Region 3
Evelyn Tuddenham	UDOT Bike/Ped Coordinator
Jeanne Bates	Alpine School District
Jim Price	MAG
Ken Anson	UTA
Kim Struthers	Lehi City Planner
Lorin Powell	Lehi City - Engineering
Sam Curren	Lehi resident
Scott Sampson	Lehi City - Risk Management
Todd Munger	Lehi City - Parks and Cemetary
Wade Allred	Lehi City - Streets

4.5.2 Planning Commission & City Council Presentations

The consultant team presented to the Lehi City Council and the Lehi Planning Commission on two occasions during the course of the planning process. Presentations to each group came shortly before each of the two public workshops. The presentations prior to the first workshop focused on the project timeline, steering committee composition, and other basic information about the process. The second round of presentations included an update on progress of the project to date and a summary of the information that would be presented at the second public workshop.

4.5.3 Bicycle Design Workshop

Steering committee members in addition to other Lehi City staff had the opportunity to attend a bicycle design workshop offered by Michael Ronkin, a national bicycle and pedestrian expert. The event was a one-day workshop targeted at planners and engineers and offered a wealth of information related to different bicycle and pedestrian facilities and treatments, where these treatments have been appropriately (and inappropriately applied), and other detailed information related to the pros and cons of various strategies.

4.5.4 Boulder Bicycling Tour

Key City staff, elected officials, and steering committee members had the opportunity to travel to Boulder, Colorado for a day trip to view the robust walking and bicycling system that has been created over many decades in that community. Participants were able to see how Boulder implemented their system and receive feedback directly from Boulder City staff regarding planning, funding, implementation, and facility selection. The group explored Boulder's infrastructure both on foot and by bicycle and gained valuable first-hand user experiences.

Key stakeholders participated in a walking and bicycling tour of Boulder, CO (pictured here)

4.6 Demand & Benefits Model

This section describes a model used to estimate the number of current transportation-oriented walking and bicycling trips in Lehi, as well as how those trips benefit the community. The model also quantifies the future benefits of walking and bicycling given certain assumptions about the percentage of trips that will be taken using those two modes of transportation. The model uses a market segment approach to estimate the number of bicycling and walking trips taken by populations that traditionally have higher cycling and walking mode splits than work commuters (such as elementary school and college students). National transportation surveys, in particular the *National Household Travel Survey* (NHTS, 2009), have shown that commute trips are only a fraction of total trips an individual takes on a given day. The model uses the NHTS findings to estimate the number of non-work, non-school trips so that they can be factored in with commute trips to estimate the total number of walking and bicycling trips that occur in a day.

4.6.1 Data Used In the Model

Journey-to-work information collected by the U.S. Census Bureau's *American Communities Survey* (ACS) is the foundation of this analysis. The most recent ACS data available for Lehi is the 2010 five-year estimates. Model variables from the ACS include:

- Total population (42,047 people)
- Employed population (16,320 people)
- School enrollment (9,861 students grade K-12; 2,012 college students)
- Travel-to-work mode split (see **Table 4-3**)
- The 2009 NHTS provides a substantial national dataset of travel characteristics, particularly for bicycling and walking trips. Data used from this survey include:
  - Student mode split, grades K-12
  - Ratio of walking and bicycling work trips to non-work, non-social/recreational trips
  - Ratio of work trips to social and recreational trips
  - Average trip length by trip purpose and mode

Table 4-3: Lehi Commute Mode Share

	Bicycling	Walking	Source
Employed	0.06%	1.05%	2010 ACS
K-12	6.70%	10.57%	Sch. Dist. Surv. (bike); NHTS 2009 (walk)
College	0.06%	1.05%	Assumed same as 2010 ACS "Employed"

Actual bicycle counts at schools were used to estimate K-12 bike trips since the ACS data seemed to be unrealistically low. Several of these variables provide an indirect method of estimating the number of walking and bicycling trips made for non-work reasons, such as shopping and running errands. NHTS data indicate that for every bicycle work trip, there are slightly more than two utilitarian bicycle trips made. Although these trips cannot be directly attached to a certain group of people (not all utilitarian bicycling trips are made by people who bicycle to work), these multipliers allow a high percentage of the community's walking and bicycling activity to be captured in an annual estimate. The SRTS Baseline Data Report (2010) was used to determine the average distances of school-related walking and bicycling trips.

Disclaimer

As with any modeling projection, the accuracy of the result is dependent on the accuracy of the input data and other assumptions. Effort was made to collect the best data possible for input to the model, but in many cases national data were used where local data were unavailable. Examples of information that could improve the accuracy of this exercise include detailed results of local SRTS parent and student surveys, a regional household travel survey, and a travel survey of college students. SRTS surveys will likely be available in the future because UDOT plans to conduct them as part of funded SRTS projects. A statewide household travel survey being conducted in Summer 2012 should provide better estimates of adult travel behavior, including college-age students.

The model generally shows low levels of bicycling and walking in Lehi currently, and the corresponding benefits are also largely unimpressive. However, this is an expected result of the relatively low walking and bicycling mode splits historically observed in Lehi. It is also likely related to the fact that there are relatively few safe, comfortable options for "average" people to walk and bicycle to community destinations such as school, shopping, and errands. As Lehi improves its walking and bicycling environment by linking existing facilities and constructing new routes, more people will walk and bike.

4.6.2 Existing Walking & Bicycling Trips

Table 4-4 shows the results of the model, which estimates that 1,373 bicycle and 3,830 walking trips occur in Lehi each day for transportation purposes. The majority of the trips are attributable to K-12 student travel and non-work utilitarian trips, which include medical/dental services, shopping/errands, family or personal business, obligations, meals, and other trips.

Trips made for social or recreational purposes are not used in the transportation benefits calculations described later in this chapter because the model's underlying goal is estimating the transportation benefits of bicycling and walking. However, it is worth noting that NHTS data show that there are approximately 6.5 and 5.9 social and recreational bicycle trips made for every bicycle and walking work commute trip, respectively. This yields an estimated 117 bicycle trips and 2,030 walking trips being made in Lehi every day for purely social and recreational purposes.

Table 4-4: Model Estimate of Current Bicycling & Walking Trips

	Bicycling	Walking	Source
Work Commute Trips			
Work commuters	9	172	Employed population multiplied by mode split
Weekday trips	18	344	Number of commuters multiplied by two for return trips
K-12 Commute Trips			
K-12 commuters	661	1,043	School children population multiplied by mode split
Weekday trips	1,321	2,085	Numbers multiplied by two for return trips
College Commute Trips			
College commuters	1	21	College population multiplied by mode split
Weekday trips	2	42	College bicyclists multiplied by two for return trips
Utilitarian Trips			
Daily trips (includes Sat/Sun)	32	1,358	Adult trips (sum of work and college) multiplied by ratio of utilitarian to work trips (NHTS)
Total Current Daily Transportation Trips	**1,373**	**3,830**	
Total Current Daily Social and Recreational Trips	**117**	**2,030**	**Work commute trips multiplied by ratio of social/ recreational trips to commute trips (NHTS)**

The Lehi Swimming Pool was identified as a place that residents desire to walk and bike to

Current Trip Replacement

To estimate the total distance that Lehi residents travel to work or school by walking and bicycling, the model isolates different walking and bicycling user groups and applies trip distance information by mode based on the 2009 NHTS. The model values shown in **Table 4-5** estimate that 1.28 million bicycling and walking trips each year replace nearly 895,000 vehicle trips and 616,000 vehicle-miles traveled.

Table 4-5: Current Bicycling & Walking Trip Replacement

	Bicycling	Walking	Source
Commute Trips			
Weekday trips reduced	13	259	Trips multiplied by the drive-alone trip percentage to determine auto trips replaced by bicycle trips
Weekday miles reduced	47	173	Number of vehicle trips reduced multiplied by average bicycle/walking work trip length (NHTS 2009)
School Trips			
Weekday trips reduced	841	1,385	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	840	639	Number of vehicle trips reduced multiplied by average trip length to/from school (SRTS 2010)
College Trips			
Weekday trips reduced	2	32	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	2	18	Number of vehicle trips reduced multiplied by average school/daycare/religious trip length (NHTS 2009) for bicycling/walking
Utilitarian Trips			
Daily trips reduced (includes Sat/Sun)	24	1,021	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Daily miles reduced (includes Sat/Sun)	45	681	Number of vehicle trips reduced multiplied by average utilitarian trip length (NHTS 2009) for bicycling/walking modes
Yearly Results	**Bicycling**	**Walking**	**Total**
Yearly trips by mode	275,250	1,002,177	1,277,427
Yearly vehicle trips replaced by mode	177,039	717,639	894,678
Yearly vehicle-miles replaced by mode	193,491	422,425	615,917

*Note: College and School trips were only counted for nine months of the year.

Current Benefits

To the extent that bicycling and walking trips replace single-occupancy vehicle trips, they reduce emissions and have tangible economic impacts by reducing traffic congestion, crashes, and maintenance costs. In addition, the reduced need to own and operate a vehicle saves families money and the exercise associated with walking and bicycling reduces health care costs. These benefits are shown in **Table 4-6**. The current annual household transportation and health cost savings alone is estimated at $52 per person or $207 per four-person household.

Table 4-6: Benefits of Current Bicycling & Walking Trips in Lehi

	Bicycling	Walking	Source
Yearly vehicle miles reduced	193,491	422,425	
Air Quality Benefits			
Reduced Hydrocarbons (pounds/year)	580	1,267	EPA, 2005[*]
Reduced Particulate Matter (pounds/year)	4	9	EPA, 2005
Reduced Nitrous Oxides (pounds/year)	405	885	EPA, 2005
Reduced Carbon Monoxide (pounds/year)	5,290	11,548	EPA, 2005
Reduced Carbon Dioxide (pounds/year)	157,406	343,645	EPA, 2005
Economic Benefits of Air Quality			
Particulate Matter	$362	$790	NHTSA, 2011 [†]
Nitrous Oxides	$810	$1,769	NHTSA, 2011
Carbon Dioxide	$2,699	$5,892	U.S. Government
Reduced External Costs of Vehicle Travel			
Traffic Congestion	$13,544	$29,570	AAA, 2008[‡]
Vehicle Crashes	$59,982	$130,952	AAA, 2008
Roadway Maintenance Costs	$27,089	$59,140	Kitamura, R., Zhao, H., and Gubby, A. R., 1989[§]
Household Transportation Savings			
Reduction in HH Transportation Spending	$106,420	$232,334	IRS 2010 mileage rates[**]
Health Care Cost Savings			
Reduction in Health Care Spending	$372,500	$1,465,000	Feifei, W., McDonald, T., Champagne, L.J., and Edington, D.W., 2004
Total	**$583,406**	**$1,925,447**	

[*] From EPA report 420-F-05-022 "Emission Facts: Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks." 2005.

[†] NHTSA Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks, Table VIII-5 (http://www.nhtsa.dot.gov/ portal/site/nhtsa/ menuitem.d0b5a45b55bfbe582f57529 cdba046a0/).

[‡] "Crashes vs. Congestion – What's the Cost to Society?" http://newsroom.aaa.com/wp-content/uploads/2011/11/2011_AAA_CrashvCongUpd.pdf

[§] Kitamura, R., Zhao, H., and Gubby, A. R. (1989). Development of a Pavement Maintenance Cost Allocation Model. Institute of Transportation Studies – University of California, Davis (http://pubs.its.ucdavis.edu/publication_detail.php?id=19). $0.08/mile (1989), adjusted to 2010 dollars

[**] http://www.irs.gov/newsroom/article/0,,id=216048,00.html

4.6.3 Future Walking & Bicycling Trips

Estimating future benefits requires additional assumptions regarding Lehi's future population and anticipated commuting patterns in 2030. Future population predictions determined in 2008 by MAG were used in this model. **Table 4-7** shows the demographics used in the future analysis.

Table 4-7: Projected 2030 Demographics

	Number	% of 2030 Population	Source
Population	82,487	100.00%	MAG: 2030 Estimate
Employed population	32,016	38.80%	Assumes same percent as from ACS 2009 estimate
School population, K-12	19,345	23.50%	Assumes same percent as from ACS 2009 estimate
College student population	3,947	4.80%	Assumes same as 2009 ACS estimate

Table 4-8 shows projected 2030 bicycling and walking trips for two assumed bicycle mode share scenarios. The first scenario assumes a 5% bicycle mode share and the second assumes a 10% mode share. For simplicity, these mode shares were assumed to apply for all trip types (commuting, utilitarian, school, etc.). Walking mode share was assumed to remain equal to current levels.

The 5% and 10% assumptions used in this analysis are not intended to be actual predictions of 2030 bicycle mode share. Rather, they are intended to demonstrate the benefits that would accrue to Lehi if those numbers are reached. As more cities across the country track changes in bikeway mileage over time and participate in annual bicycle counts, more data will be available to better understand and refine future mode share predictive measures.

Future Trip Replacement

The same trip replacement factors used for the existing analysis were applied to the numbers in **Table 4-8** in order to generate estimates of bicycling and walking trip replacement for the 2030 scenario. **Table 4-9** shows that a 5% bicycle mode share scenario would result in 5.3 million annual walking and bicycling trips, which will reduce vehicle trips by nearly 4 million and vehicle-miles traveled by 6.5 million. A 10% bicycle mode share would result in nearly 8.7 million annual walking and bicycling trips, with reductions of 6.8 million vehicle trips and nearly 13 million vehicle-miles traveled.

Future Benefits

Table 4-10 shows the air quality and economic benefits of the future projected walking and bicycling trips in Lehi. For the 5% bicycle mode share assumption, annual household transportation and health cost savings are estimated to accrue at a rate of $175 per person or $700 per four-person household. A 10% bicycle mode share would result in an estimated $315 per person cost savings or $1,260 per four-person household.

Table 4-8: 2030 Bicycling & Walking Trips

	Bicycling		Walking	Source
	5% Share	10% Share		
Commute Trips				
Work commuters	1,601	3,202	337	Employed population multiplied by mode split
Weekday trips	3,202	6,403	675	Number of commuters multiplied by two for return trips
School Trips				
K-12 commuters	967	1,935	2,045	School children population multiplied by mode split
Weekday trips	1,935	3,869	4,091	Numbers multiplied by two for return trips
College Trips				
College commuters	197	395	42	College population multiplied by mode split
Weekday trips	395	789	83	College bicyclists multiplied by two for return trips
Utilitarian Trips				
Daily trips	5,633	11,266	2,665	Adult trips (sum of work and college) multiplied by ratio of utilitarian to work trips (NHTS).
Total Future Daily Transportation Trips	**11,164**	**22,327**	**7,513**	
Total Future Daily Social and Rec. Trips	**20,810**	**41,620**	**3,980**	**Work commute trips multiplied by ratio of social/recreational trips to commute trips (NHTS)**

A pedestrian in a crosswalk in a residential neighboorhood of Lehi

Table 4-9: 2030 Bicycling & Walking Trip Replacement

	Bicycling		Walking	Source
	5% Share	10% Share		
Commute Trips				
Weekday trips reduced	2,507	5,292	507	Trips multiplied by the drive-alone trip percentage to determine auto trips replaced by bicycle trips
Weekday miles reduced	8,873	18,732	340	Number of vehicle trips reduced multiplied by average bicycle/walking work trip length (NHTS 2009)
School Trips				
Weekday trips reduced	1,210	2,554	2,717	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	1,208	2,549	1,254	Number of vehicle trips reduced multiplied by average trip length to/from school (SRTS 2010)
College Trips				
Weekday trips reduced	309	652	63	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Weekday miles reduced	457	966	35	Number of vehicle trips reduced multiplied by average school/daycare/religious trip length (NHTS 2009) for bicycling/walking modes
Utilitarian Trips				
Daily trips reduced (includes Sat/Sun)	4,410	9,310	2,003	Trips multiplied by drive alone trip percentage to determine auto trips replaced by bicycle/walking trips
Daily miles reduced (includes Sat/Sun)	8,349	17,626	1,335	Number of vehicle trips reduced multiplied by average utilitarian trip length (NHTS 2009) for bicycling/walking modes
Yearly Results				**Total**
Yearly trips by mode	3,348,404	6,696,808	1,966,051	5,314,456 (8,662,860)
Yearly vehicle trips replaced by mode	2,561,788	5,408,218	1,407,850	3,969,638 (6,816,069)
Yearly vehicle miles replaced by mode	5,690,317	12,012,892	828,706	6,519,023 (12,841,598)

*Note: College and School trips were only counted for nine months of the year.

Table 4-10: Benefits of Future Bicycling & Walking Trips

	Bicycling		Walking	Source
	5% Share	10% Share		
Yearly vehicle miles reduced	5,690,317	12,012,892	828,706	
Air Quality Benefits				
Reduced Hydrocarbons (pounds/year)	17,061	36,018	2,485	EPA, 2005[*]
Reduced Particulate Matter (pounds/year)	127	267	18	EPA, 2005
Reduced Nitrous Oxides (pounds/year)	11,918	25,160	1,736	EPA, 2005
Reduced Carbon Monoxide (pounds/year)	155,558	328,400	22,655	EPA, 2005
Reduced Carbon Dioxide (pounds/year)	4,629,106	9,772,556	674,157	EPA, 2005
Economic Benefits of Air Quality				
Particulate Matter	$10,643	$22,469	$1,550	NHTSA, 2011 [†]
Nitrous Oxides	$23,836	$50,319	$3,471	NHTSA, 2011
Carbon Dioxide	$79,367	$167,553	$11,559	U.S. Government
Reduced External Costs of Vehicle Travel				
Traffic Congestion	$398,322	$840,902	$58,009	AAA, 2008[‡]
Vehicle Crashes	$1,763,998	$3,723,996	$256,899	AAA, 2008
Roadway Maintenance Costs	$796,644	$1,681,805	$116,019	Kitamura, R., Zhao, H., and Gubby, A. R., 1989[§]
Household Transportation Savings				
Reduction in HH transportation spending	$3,129,674	$6,607,090	$455,788	IRS 2010 mileage rates[**]
Health Care Cost Savings				
Reduction in Health Care Spending	$7,993,500	$15,986,750	$2,873,250	Feifei, W., McDonald, T., Champagne, L.J., and Edington, D.W., 2004
Total	**$14,196,000**	**$29,080,900**	**$2,776,500**	

[*] From EPA report 420-F-05-022 "Emission Facts: Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks." 2005.

[†] NHTSA Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks, Table VIII-5 (http://www.nhtsa.dot.gov/ portal/site/nhtsa/ menuitem.d0b5a45b55bfbe582f57529 cdba046a0/).

[‡] "Crashes vs. Congestion – What's the Cost to Society?" http://newsroom.aaa.com/wp-content/uploads/2011/11/2011_AAA_CrashvCongUpd.pdf

[§] Kitamura, R., Zhao, H., and Gubby, A. R. (1989). Development of a Pavement Maintenance Cost Allocation Model. Institute of Transportation Studies – University of California, Davis (http://pubs.its.ucdavis.edu/publication_detail.php?id=19). $0.08/mile (1989), adjusted to 2010 dollars

[**] http://www.irs.gov/newsroom/article/0,,id=216048,00.html

4.6.4 Difficult-to-Quantify Benefits of Bicycling & Walking

Bicycling and walking are low-cost and effective means of transportation that are non-polluting, energy-efficient, versatile, healthy, and fun. Everyone is a pedestrian at some point, whether walking to a parked car, taking a lunch break, or accessing transit. In addition, bicycles offer low-cost mobility to the non-driving public. Bicycling and walking as a means of transportation has been growing in popularity as many communities work to create more balanced transportation systems and individuals seek to be healthier. In addition, more people are willing to bicycle more frequently if better bicycle facilities are provided.[1]

In addition to the tangible economic benefits estimated above, bicycling and walking have many other benefits that are challenging to quantify, but which have been studied by some communities and organizations. The League of American Bicyclists reported that bicycling makes up $133 billion of the US economy, funding 1.1 million jobs.[2] The League also estimates that bicycle-related trips generate another $47 billion in tourism activity. Many communities have enjoyed a high return on their investment in bicycling. For example, the Outer Banks of North Carolina spent $6.7 million to improve local bicycle facilities, and reaped the benefit of $60 million of annual economic activity associated with bicycling.[3] Multiple studies show that walkable, bikeable neighborhoods are more livable and attractive, increasing home values[4], and resulting in increased wealth for individuals and additional property tax revenue.

Bike lanes can improve retail business directly by drawing customers and indirectly by supporting the regional economy. Patrons who walk and bike to local stores have been found to spend more money to visit local businesses than patrons who drive.[5] Other studies show that walkable, bikeable communities attract the young creative class,[6] which can help cities gain a competitive edge and diversify economic base. By replacing short car trips, bicycling can help middle-class families defray rising transportation costs. Families that drive less spend 10% of their income on transportation, compared to 19% for households with heavy car use,[7] freeing additional income for local goods and services.

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1. Pucher, J., Dill, J. and Handy, S. (2010). *Infrastructure, programs, and policies to increase bicycling: An international review*. Preventative Medicine 50:S106-S125.
2. Flusche, Darren for the League of American Bicyclists. (2009). *The Economic Benefits of Bicycle Infrastructure Investments*.
3. N.C. Department of Transportation, Division of Bicycle and Pedestrian Transportation. (). *The Economic Impact of Investments in Bicycle Facilities. atfiles.org/files/pdf/NCbikeinvest.pdf*
4. Cortright, Joe for CEOs for Cities. (2009). *Walking the Walk: How Walkability Raises Home Values in U.S. Cities*.
5. The Clean Air Partnership. (2009). *Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighborhood*.
6. Cortright, Joe for CEOs for Cities. (2007). *Portland's Green Dividend*.
7. Center for Neighborhood Technology. (2005). *Driven to Spend: Pumping Dollars out of Our Households and Communities*.

Bicycling can also improve quality of life. Since bicycling is among the most popular forms of recreational activity in the US[8], when bicycling is available as a daily mode of transportation, substantial health benefits result. The health benefit of bicycling for exercise can reduce the cost of spending on health care by as much as $514 a year, which provides a financial incentive to businesses that provide health coverage to their employees.[9]

Safety concerns are another reason to improve bicycling conditions. Although the incidence of crashes involving bicycles may be low, concerns about safety have historically been the single greatest reason people do not commute by bicycle, as captured in polls as early as 1991.[10] An SRTS survey in 2004 similarly found that 30 percent of parents consider traffic-related danger to be a barrier to allowing their children to walk or bike to school. Addressing those concerns for bicyclists and pedestrians through physical and program improvements is another major objective of the Lehi Bicycle and Pedestrian Master Plan. Improving bicyclist safety can also be accomplished by increasing the number of people who walk and bike. Pedestrians in communities where twice as many people walk are 66% less likely to be injured by a motorist.[11]

8. Almost 80 million people walk and 36 million people bicycle for recreation or exercise nationally. 27.3% of the population over 16 bicycles at least once over the summer. (National Sporting Goods Association survey, 2003)
9. Feifei, W., McDonald, T., Champagne, L.J., and Edington, D.W. (2004). Relationship of Body Mass Index and Physical Activity to Health Care Costs Among Employees. Journal of Occupational and Environmental Medicine. 46(5):428-436
10. Lou Harris Poll (2001).
11. Jacobsen, P.L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Injury Prevention 9:205-209.

Good bicycle and pedestrian infrastructure can help to encourage investment and development in both old and new neighborhoods

5 Infrastructure Recommendations

A primary objective of the Lehi Bicycle and Pedestrian Master Plan is improving the connectivity and quality of the City's walking and bicycling networks. New facilities, safety improvements, and improved connections are needed to enable bicyclists and pedestrians to reach key destinations in a convenient and safe manner. This chapter presents the recommended facility improvements that will create a comprehensive bicycle and pedestrian network in Lehi City over time.

Draft recommendations were crafted in cooperation with the steering committee that helped to guide this master planning effort. The draft recommendations were then presented at a public workshop where attendees had the chance to comment on the recommendations. This public input was used to refine the recommendations into the final set presented in this chapter.

The following guiding principles were used to develop the recommendations:

- Connect all areas of the City
- Fill critical gaps in the walking and bicycling networks

Key stakeholders participated in a walking and bicycling tour of Boulder, CO (pictured here)

- Identify existing and planned facilities on Lehi's perimeter so that recommended facilities provide seamless connections to surrounding communities
- Where possible, recommend facility types that serve the widest range of users, particularly those who are less comfortable riding bicycles in close proximity to traffic
- Recommend facilities that can feasibly be constructed and maintained by the City
- Use a phased implementation approach that provides logical short- and medium-term recommendations, while retaining long-term visionary recommendations
- Avoid impacting on-street parking or traffic lanes along critical roadways where those impacts would be highly undesirable

The following assumptions were used to develop the cost estimates that are presented in the tables later in this chapter:

- The initial raw cost estimates were increased by 28% to account for contractor mobilization, design, and contingency factors
- Facilities will be constructed by contractors, not by City work crews
- Facilities will be constructed with a high degree of quality in conformance with design best practices
- Right-of-way costs were included in the limited cases where right-of-way purchases would be needed
- In relatively undeveloped parts of the city where road cross sections are not fully developed, on-street bikeway costs only include the incremental cost of adding striping, based on the assumption that the bikeway would not be installed until after the road builds out
- Projects would occur separately from one another

Using City crews to perform some of the work may reduce the actual costs. Bundling several projects together into a single project or combining bikeway improvements with other transportation projects could also result in lower costs than are shown here in this master plan. Many of the shared-use paths and sidepaths could also be constructed by developers as part of a PRD, PUD, Planned Community Development, or through a density bonus.

5.1 Bikeways

The bikeways recommended in this master plan consist of strategic routes that interact with the existing system to provide a high quality user experience and enable access to key destinations in and around the city. The bikeways are comprised of the following classifications:

- Shared-use Paths
- Sidepaths
- Cycle Tracks
- Bike Boulevards
- Buffered Bike Lanes
- Bike Lanes
- Uphill Bike Lanes/Downhill Shared Lanes
- Marked Shared Roadways
- Signed Shared Roadways
- Unpaved Trails

Design guidelines for each of these bikeway types are included in **Appendix A**. Readers of this document who are unfamiliar with these terms and would like detailed information will find **Appendix A** helpful for visualizing each bikeway type. **Figure 5-1** is also helpful for visualizing the above-mentioned categories. It shows simple diagrams for the on-street bikeway types.

The following subsections describe the recommendations for each bikeway type. Each type is further broken down into short-term, medium-term, and long-term recommendations. Short-term recommendations are those that could generally be completed within five years. They mostly consist of facilities that can be constructed through re-striping of existing roads or can be combined with other projects that are already being planned for the near future.

Medium-term recommendations consist of facilities that could be constructed within five to ten years. They may require moderate changes to existing infrastructure, longer coordination times, environmental review, higher costs relative to short-term facilities, or could be constructed along with roadway projects being planned for the future.

Long-term recommendations are those that would require major changes to existing infrastructure, cultural or political shifts, right-of-way acquisitions, or significant funding. The anticipated time horizon for long-term recommendations is 10 years or longer.

Figure 5-2 shows all phases of bikeway recommendations combined. **Figures 5-3** and **5-4** show the recommended Phase 1 and Phase 2 bikeway recommendations, respectively. **Figure 5-5** shows what Lehi's bikeway network would look like with build-out of the first two phases. **Figure 5-6** displays the Phase 3 bikeway recommendations. All five of these figures include existing bikeways in order to demonstrate how the recommendations would connect to facilities already on the ground.

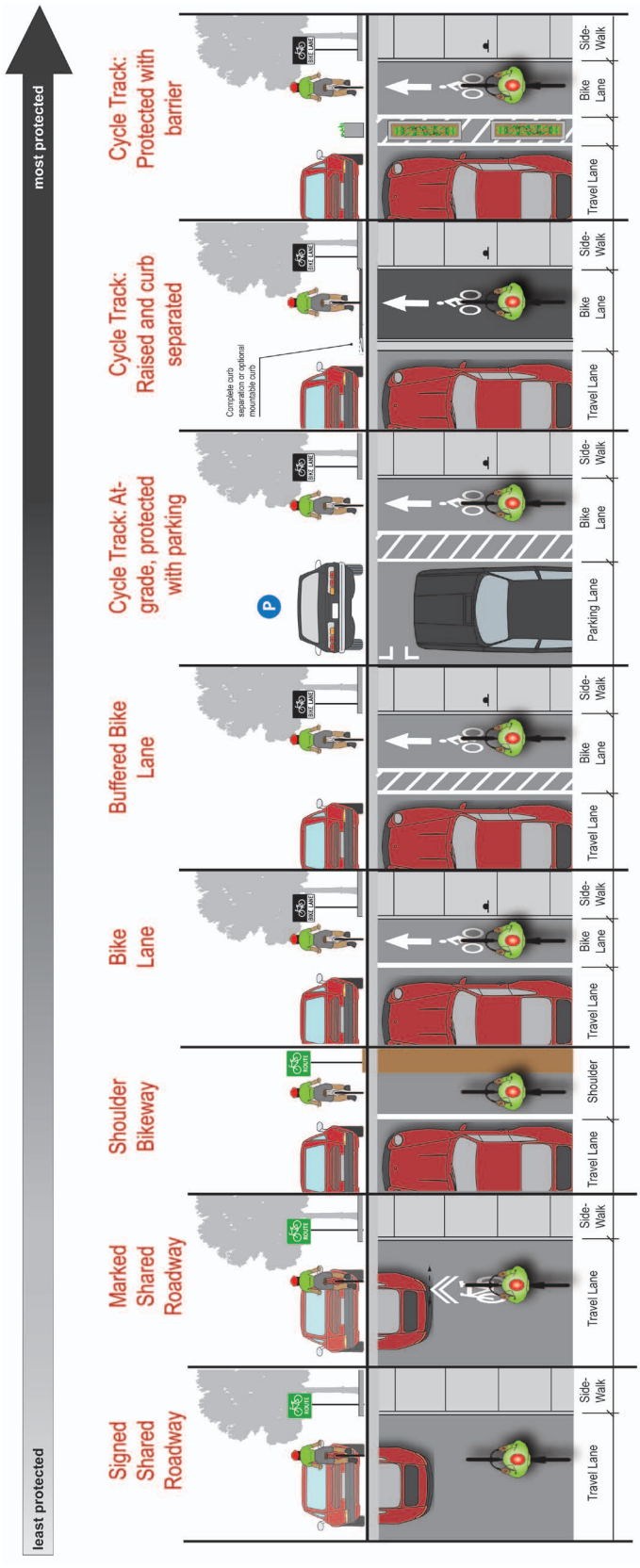


Figure 5-1: On-Street Bikeway Continuum

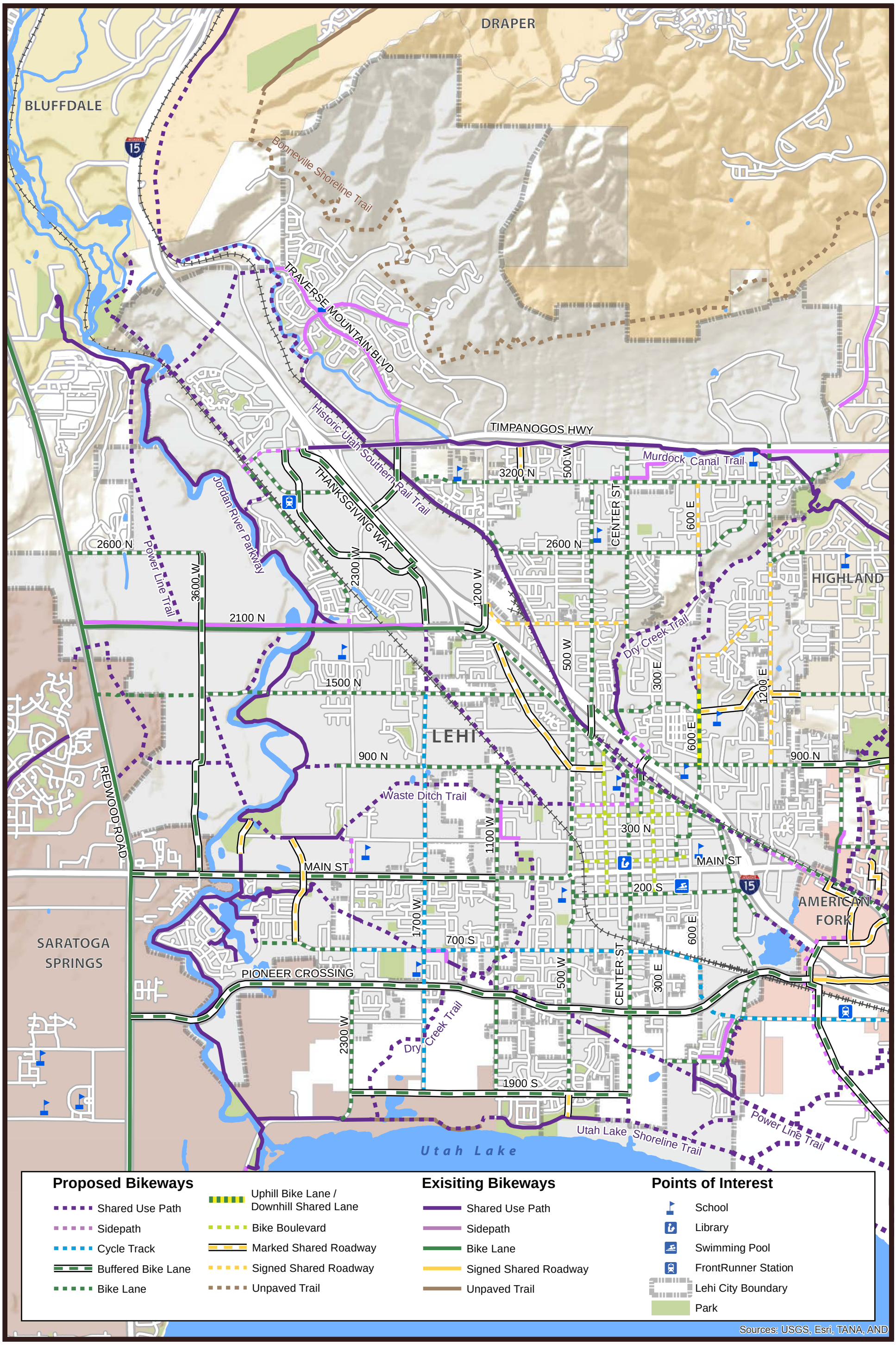


Figure 5-2: Recommended Bikeways - All Phases

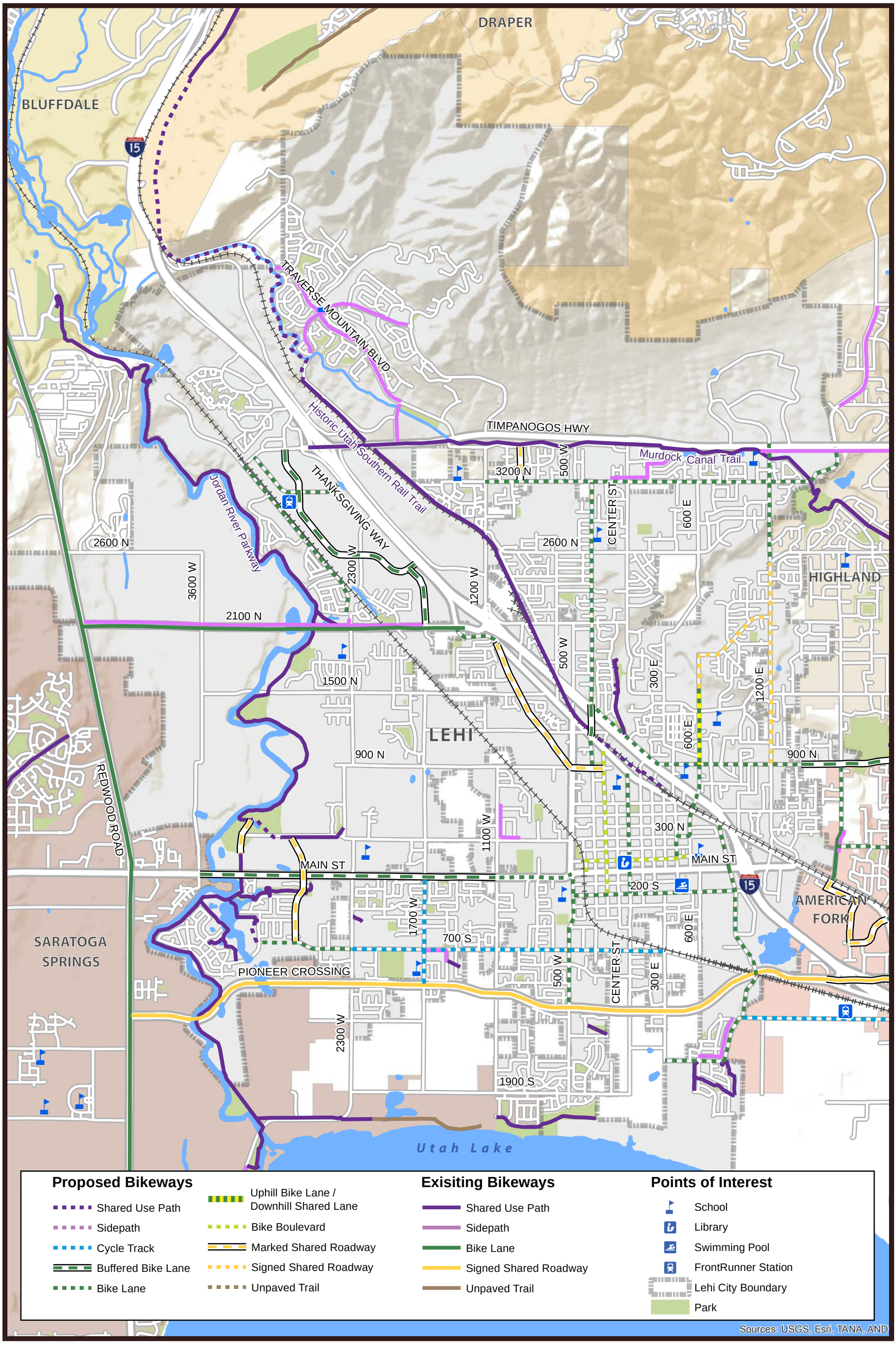


Figure 5-3: Recommended Bikeways - Phase 1

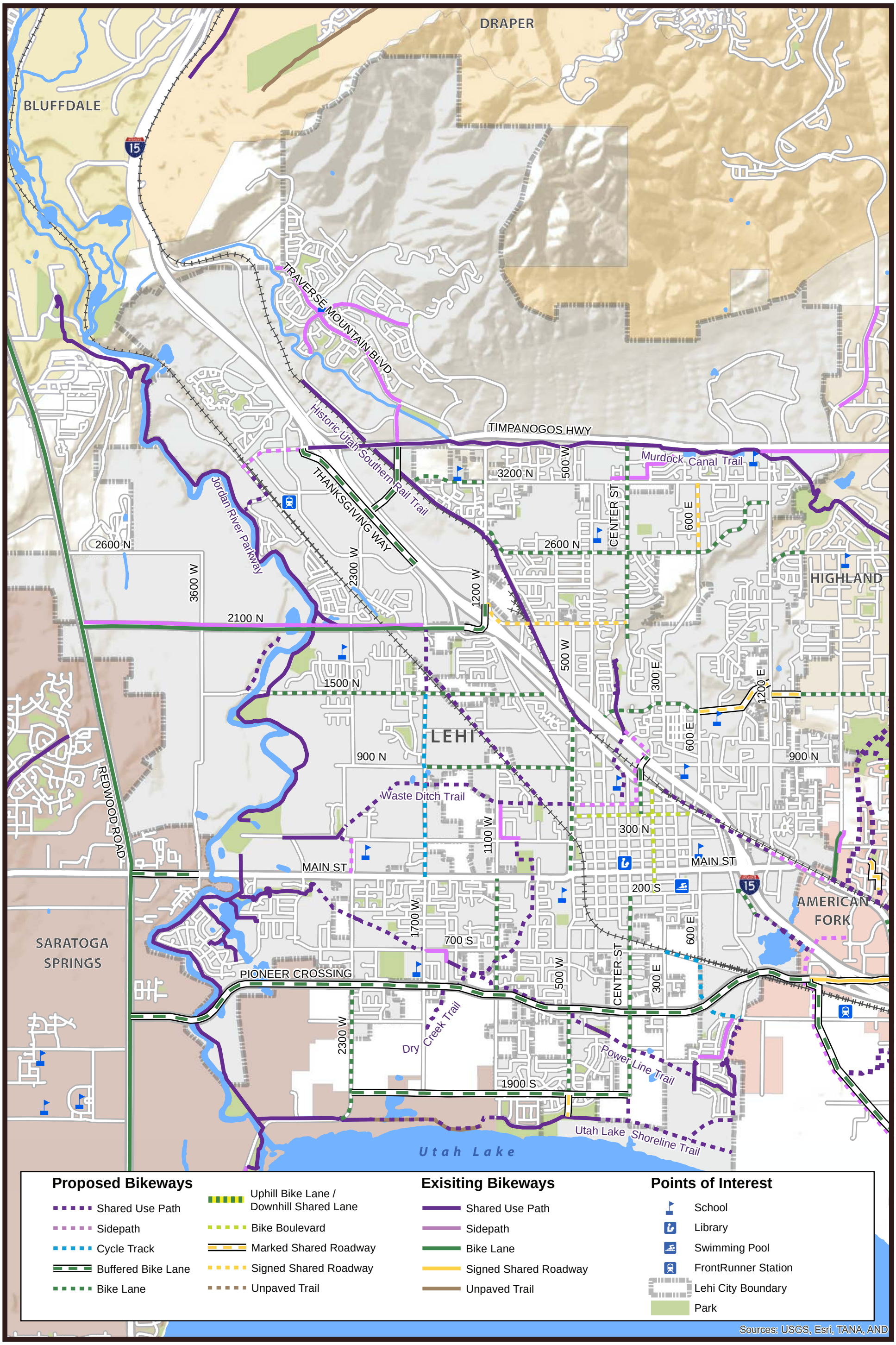


Figure 5-4: Recommended Bikeways - Phase 2

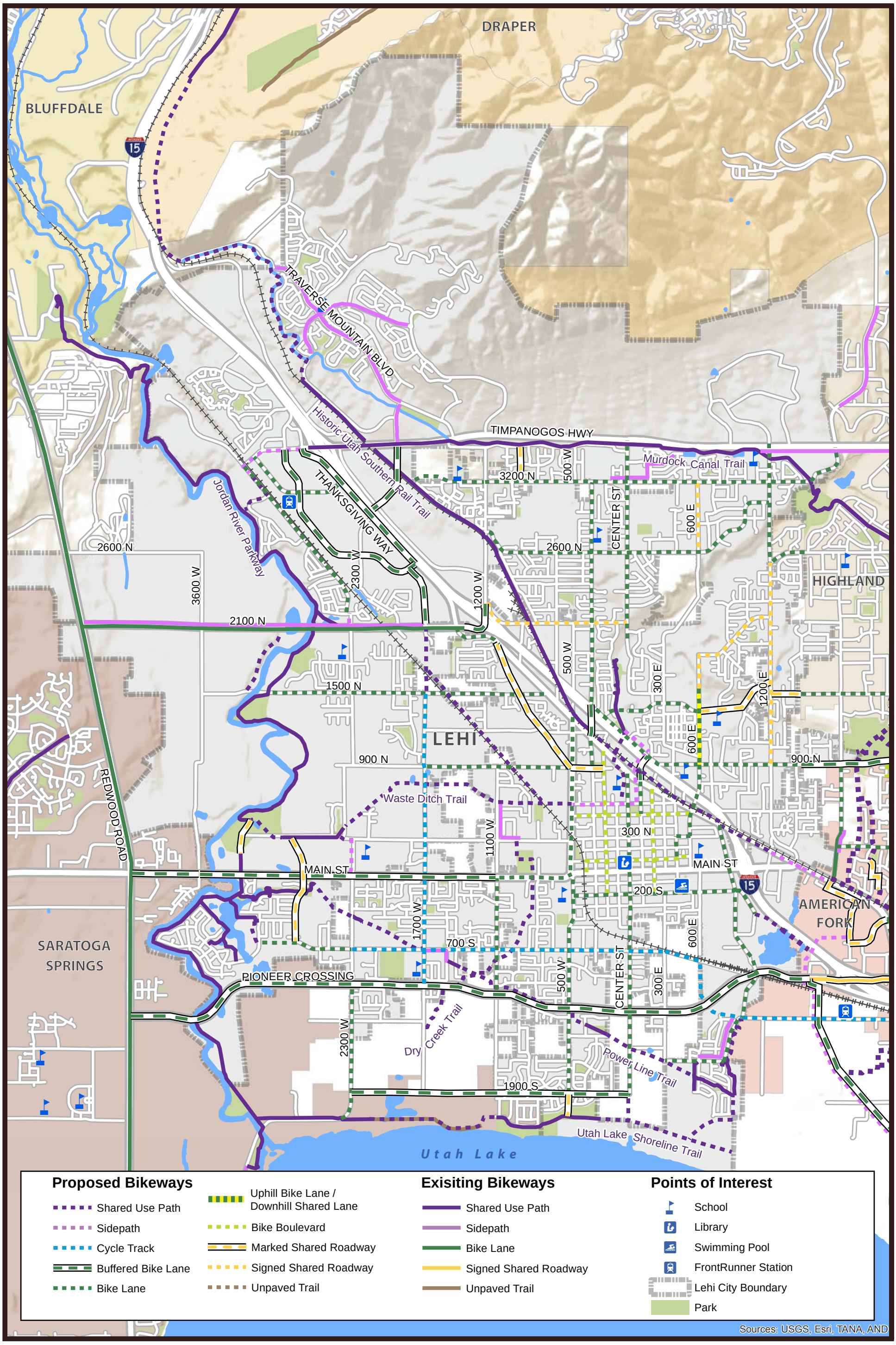


Figure 5-5: Recommended Bikeways - Phase 1& 2

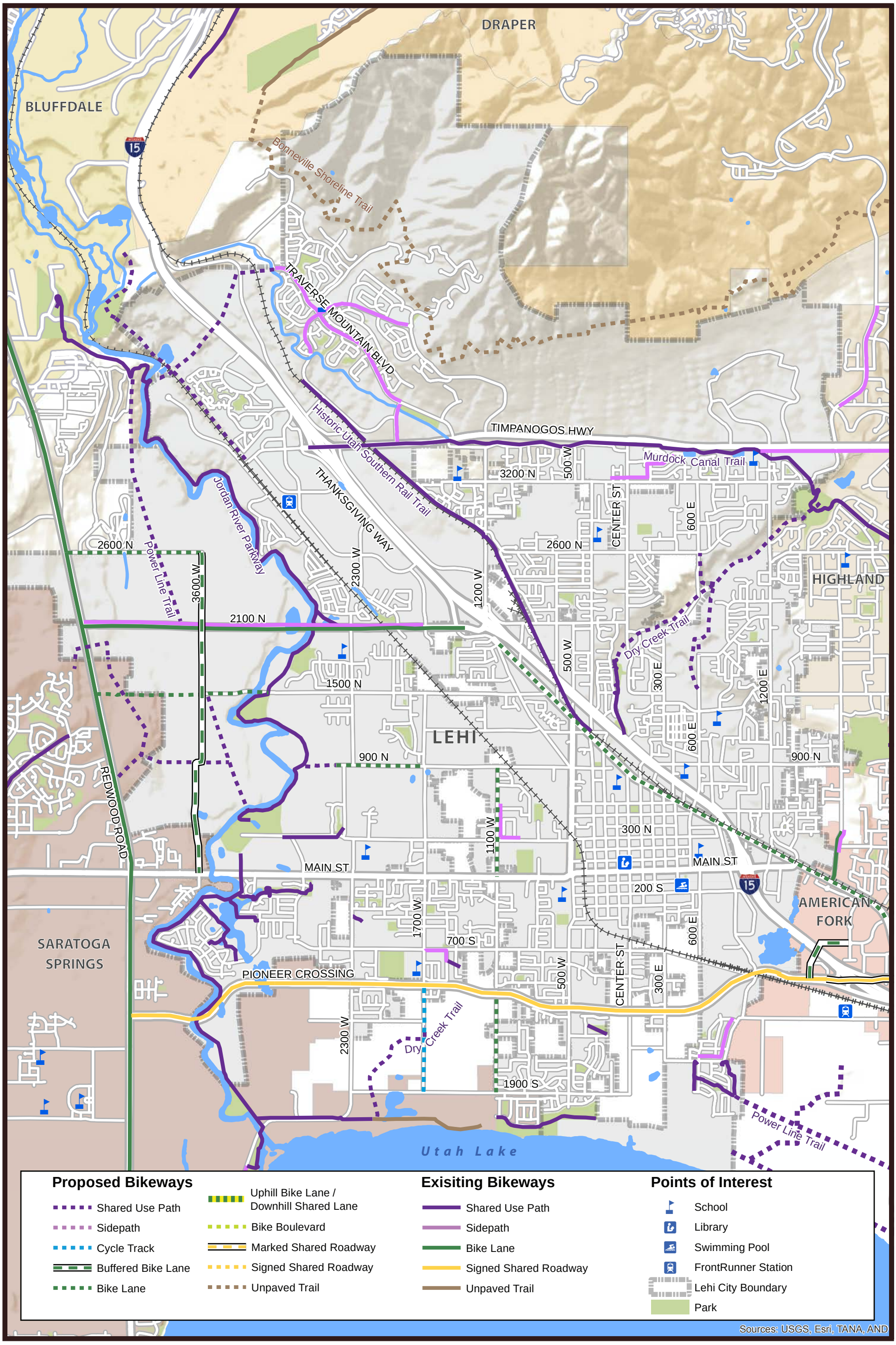


Figure 5-6: Recommended Bikeways - Phase 3

5.1.1 Bikeway Costs By Phase

Table 5-1 shows the total costs of the proposed bikeways by phase.

Table 5-1: Total Bikeway Cost By Phase

Phase	Cost
1	$ 3,555,364
2	$ 15,304,082
3	$ 9,484,981
TOTAL	$ 28,344,427

5.1.2 Shared-Use Paths

Shared-use paths are generally located within rights-of-way separated from roadways (such as streams, utility corridors, and railroads) and serve all types of non-motorized users. They are the facility of choice for many people who wish to avoid bicycling near traffic. However, they are also the most expensive bikeway type, may not serve transportation purposes as well as on-street facilities, and have limited opportunities for development due to the scarcity of non-roadway rights-of-way. Shared-use paths are typically 10' wide or greater and can be constructed of asphalt or concrete. **Tables 5-2** through **5-4** list each proposed shared-use path along with its respective phase, cost estimate, and notes about implementation considerations. The jurisdiction for each proposed facility is Lehi City unless otherwise noted.

5.1.3 Sidepaths

Sidepaths are similar to shared-use paths in terms of pavement, desired width, and user mix, although they are sometimes a few feet narrower than shared-use paths where right-of-way dictates a smaller size. They are called "sidepaths" because they run parallel to roadways and have frequent driveways or intersections where cars cross. This creates an operational difference that distinguishes sidepaths from shared-use paths. Shared-use paths travel for long distances without encountering vehicle crossings and generally cross roads at right angles. Sidepaths, on the other hand, encounter more complex driveway and intersection conflicts with cars, particularly when bicyclists ride in the direction opposite the traffic flow on the road adjacent to the sidepath.

Sidepaths can be useful for pedestrians as well as children and adults who bicycle slowly and exhibit behavior similar to pedestrians. However, they are not a good alternative for faster or more experienced bicyclists because they place bicyclists in places where drivers may not expect them. In situations where a shared-use path is preferred but not feasible, short stretches of sidepath can be used as a substitute to connect shared-use paths on both ends of the sidepath. **Table 5-5** lists proposed sidepaths. Only the sidepaths that are integral to the bikeway system are shown on this map. Other sidepaths that serve a primarily pedestrian function are discussed and displayed later in this chapter.

Table 5-2: Recommended Shared-Use Paths (Phase 1)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**Historic Utah Southern Rail Trail North**	Salt Lake Co. boundary	Existing trail in Lehi	2.13	$ 950,000		Cost estimate encompasses all costs, including ROW
	Historic Utah Southern Rail Trail	300 W	300 E	0.77	$ 594,494		
	Jordan River Trail Connection	Existing Jordan River Trail spur	700 S	0.17	$ 130,560		
	Waste Ditch Trail	Jordan River Parkway	Existing Waste Ditch Trail	0.28	$ 214,320		
	Phase 1 : SUBTOTAL			3.35	$ 1,889,374		

Table 5-3: Recommended Shared-Use Paths (Phase 2)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
2	**1700 W**	1500 N	2100 N	0.50	$ 384,000		
	Center Street Trail	1900 S	Utah Lake Shoreline Trail	0.18	$ 281, 689		Increased unit costs due to anticipated wetland challenges
	Dry Creek Trail	100 W/600 N	North Frontage Rd	0.27	$ 311,040		Does not include structures at State St or I-15; those are included in the spot improvement map
	Dry Creek Trail	300 N	1700 W	1.80	$ 1,654,884		Need a crossing treatment at Main St to safely allow users to cross the street; undercrossing at Pioneer Crossing has already been built
	FrontRunner Trail	1700 W	Waste Ditch Trail	1.24	$ 952,320		
	Historic Utah Southern Rail Trail	300 E	Interstate Plaza Dr	0.84	$ 645,120	UDOT	Parts of this will be within or next to UDOT's ROW along State St
	Jordan River West	2100 N	1500 N	0.54	$ 414,720		Undercrossing of 2100 N already exists
	Mill Pond	Mill Pond Dr	American Fork boundary	0.28	$ 430,080		Increased unit costs due to anticipated wetland challenges

Table 5-3: Recommended Shared-Use Paths (Phase 2 – cont'd)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
2	**Murdock-Jordan River Pkwy Connector**	Thanksgiving Point Golf Course	Existing Jordan River Parkway	0.40	$ 736,296		
	Power Line Trail	1430 W	Parkview Park	1.14	$ 874,459		
	Power Line Trail	2175 W	1700 W	0.48	$ 365,490		
	Power Line Trail	2650 W	2300 W	0.38	$ 294,491		
	Power Line Trail	Parkview Park	575 E	0.70	$ 534,253		
	Spring Creek Trail Extention	Power Line Trail	Utah Lake Shoreline Trail	0.50	$ 576,000		Increased unit costs due to anticipated wetland challenges
	Utah Lake Shoreline Trail	Utah Lake Shoreline Trail	American Fork boundary	1.01	$ 1,164,442		Increased unit costs due to anticipated wetland challenges
	Waste Ditch Trail	Existing Waste Ditch Trail	500 W	2.09	$ 2,105,120		Includes bridge across RR tracks near 800 W
	Waste Ditch Trail Connection	Existing Waste Ditch Trail	2300 W	0.12	$ 47,408		There is already a 5' sidewalk here; just need to add 5' to it
	Phase 2 : SUBTOTAL			12.47	$ 11,771,811		

Table 5-4: Recommended Shared-Use Paths (Phase 3)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
3	**600 E Connector**	600 E	Dry Creek Bisect (proposed)	0.11	$ 84,480		
	900 N	Saratoga Springs boundary	Power Line Trail	0.60	$ 460,800		
	900 N	Jordan River Parkway	2400 W	0.21	$ 164,815		
	Dry Creek Bisect	600 E	2600 N	1.14	$ 875,520		
	Dry Creek Trail	Existing Dry Creek Trail	Highland boundary	1.96	$ 1,807,253		Increased unit costs due to complexity of terrain and brush
	Dry Creek Trail	1300 S	1900 S	0.68	$ 522,240		
	FrontRunner Trail	Clubhouse Dr	Bluffdale boundary	1.75	$ 1,344,000		
	Power Line Trail	1500 N	Jordan River Parkway	0.83	$ 634,004		Would require a bridge over the river to connect with the Jordan River Pkwy; see spot improvement table for cost of that bridge
	Power Line Trail West	Jordan River Parkway	2100 N	1.75	$ 1,344,000		
	Redwood Trail	Saratoga Springs boundary	Saratoga Springs boundary	0.40	$ 307,200		Most of this trail (which spans Redwood Rd) is in Saratoga Springs; may need to coincide with Mountain View Corridor construction
	Traverse Mountain Extension	Traverse Mountain Blvd	Jordan River Parkway	1.29	$ 995,553		This will likely only be built in tandem with a road extension, so unit costs were reduced; bike/ped bridge across RR tracks near Jordan River included
	Phase 3 : SUBTOTAL			10.72	$ 8,539,865		
	All Phases : TOTAL			**26.54**	**$22,201,050**		

Table 5-5: Recommended Bikeway Sidepaths

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**2300 W**	2150 N	2100 N	0.09	$ 24,781		
	Phase 1 : SUBTOTAL			0.09	$ 24,781		
2	**2300 W**	Main St	300 N	0.26	$ 75,168		
	Historic Utah Southern Rail Trail	Interstate Plaza Dr	AF city boundary	0.29	$ 83,841	UDOT	This will be within or next to UDOT's ROW along State St
	Murdock-Jordan River Pkwy Connector	Thanksgiving Way	Thanksgiving Point Golf Course	0.60	$ 1,604,445		Cost estimate encompasses all costs, including ROW and a structure over RR tracks
	Frontage Rd	Dry Creek Trail	100 E	0.22	$ 63,604		Part of an alternate route for connecting the Dry Creek Trail to the Waste Ditch Trail southwest of I-15.
	100 E	Frontage Rd	600 N	0.35	$ 101,188		Part of an alternate route for connecting the Dry Creek Trail to the Waste Ditch Trail southwest of I-15.
	Waste Ditch Trail	500 W	100 W	0.49	$ 212,495		Unit costs were increased because curb, gutter, and drainage may need to be constructed to install the sidepath
	Phase 2 : SUBTOTAL			2.21	$ 2,140,743		
3	**3600 W**	1500 N	2100 N	0.51	$ 147,446		
	Phase 3 : SUBTOTAL			0.51	$ 147,446		
	All Phases : TOTAL			**2.81**	**$ 2,312,970**		

5.1.4 Cycle Tracks

Cycle tracks combine the off-street separation of shared-use paths with on-street elements of bike lanes. Between intersections, they provide the greatest amount of separation between cars and bicyclists of any on-street bikeway type. However, intersections must be treated at a very high level in order to safely transition cycle tracks through. The distinguishing characteristic of a cycle track is some form of barrier between moving cars and bicycles. Less-experienced bicyclists often prefer cycle tracks over other bikeway types because of the separation from car traffic.

In snowy climates such as Lehi, care must be taken to design cycle tracks to facilitate snow removal. Smaller plows or the use of removable bollard posts are ways to construct cycle tracks that can be cleared of snow in the winter. Cycle tracks may also require frequent sweeping to keep the pavement clear and safe for bicycle travel. Proposed cycle tracks in Lehi are listed in **Table 5-6**.

5.1.5 Bike Boulevards

Bike boulevards are a relatively new bikeway type. They take advantage of low-speed, low-traffic streets where many people prefer to bicycle. Typically, these types of streets work well for bicyclists for a few blocks at a time, but pose a challenge as soon as the street intersects a larger or higher speed road. Key components of bike boulevards are intersection improvements such as median islands and signage that allow bicyclists to safely cross busy streets.

Bike boulevards are not typically installed on collector or arterial roads because dedicated space (such as a bike lane) is not provided on bike boulevards to separate bicycles from cars. Neighborhood traffic circles, curb extensions, and other traffic calming measures often accompany bike boulevards in order to keep traffic volumes and speeds low. Maintenance requirements for bike boulevards are generally limited to necessary upkeep of neighborhood traffic circles or intersection treatments. **Table 5-7** lists the proposed bike boulevards.

Key stakeholders participated in a walking and bicycling tour of Boulder, CO (pictured here)

Table 5-6: Recommended Cycle Tracks

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**700 S**	2300 W	300 E	2.22	$ 641,823		
	1700 W	Main St	Pioneer Crossing	0.77	$ 222,614		
	Phase 1 : SUBTOTAL			2.99	$ 864,437		
2	**700 S (Lehi) / 200 S (AF) Connector**	300 E	AF City Boundary	0.88	$ 254,000		Future Road
	1700 W	1500 N	Main St	1.31	$ 378,113		
	Phase 2 : SUBTOTAL			2.19	$ 632,112		
3	**1700 W**	Pioneer Crossing	1900 S	0.74	$ 214,842		
	Phase 3 : SUBTOTAL			0.74	$ 214,842		
	All Phases : TOTAL			**5.92**	**$ 1,711,391**		

Table 5-7: Recommended Bike Boulevards

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**200 W**	State St	200 S	1.03	$ 136,327		Would need median crossing at Main St
	400 W / 100 N	Main St/400 W	500 E	0.90	$ 145,126		
	Phase 1 : SUBTOTAL			1.93	$ 281,453		
2	**200 E**	State St	200 S	0.75	$ 98,793		Would need median crossing at Main St
	500 N	500 W	500 E	0.84	$ 188,684		Short segment of shared use path would be needed to connect to 500 E via fill slope
	Phase 2 : SUBTOTAL			1.59	$ 287,477		
	All Phases : TOTAL			**3.52**	**$ 568,930**		

Bike Boulevards incorporate design treatments to give priority to cyclists

Compared with standard bike lanes, buffered bike banes provide more space between the bike lane and the auto lane

5.1.6 Buffered Bike Lanes

Buffered bike lanes are similar to cycle tracks in that they provide a measure of separation from car traffic. The key characteristic that distinguishes a buffered bike lane from a cycle track is that the former uses a painted buffer to separate car traffic from the bike lane, whereas cycle tracks have some form of physical barrier between moving cars and bicyclists. People who do not like to bicycle near traffic usually prefer buffered bike lanes to “regular” bike lanes.

Like cycle tracks, buffered bike lanes may require more frequent sweeping than car travel lanes. Cars in adjacent traffic lanes tend to kick rocks into the buffered bike lanes. As a result, they accumulate debris without regular sweeping. Proposed buffered bike lanes are shown in **Tables 5-8** through **5-9**.

5.1.7 Bike Lanes

Bike lanes use a single white stripe to separate bicycle traffic from car traffic. Bike lanes will normally accommodate confident and experienced bicycle riders, but they may not provide enough separation from high-speed cars to attract less-experienced riders. As with buffered bike lanes, regular sweeping may be needed to keep the lanes free from debris kicked into them by car tires.

Care must be taken to transition bike lanes through intersections in a safe manner and also protect the lanes from car doors in instances where the bike lanes are next to car parking. **Tables 5-10** through **5-12** show the bike lanes recommended for Lehi.

Table 5-8: Recommended Buffered Bike Lanes (Phase 1)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**300 W**	Frontage Rd	State St	0.23	$ 5,200		Portion through underpass may only be able to accommodate shared lane markings until I-15 is reconstructed; portion between State St and RR tracks may need to be standard bike lanes; parking would need to be prohibited in this entire stretch
	Ashton Blvd	Clubhouse Dr	Thanksgiving Way	1.44	$ 32,554		Parking would need to be prohibited on both sides, but it's a business/commercial area with plentiful parking
	Main St	Jordan River	1100 W	2.05	$ 47,144		Some parts could be done now, but other stretches need to have curb/gutter/shoulder built out first; parking most likely would need to be prohibited unless more ROW is acquired
	Thanksgiving Way	Ashton Blvd	2100 N	0.48	$ 11,651		Parking would need to be prohibited, but it's a business/commercial area with more than adequate off-street parking
	Phase 1 : SUBTOTAL			4.20	$ 96,549		

Table 5-9: Recommended Buffered Bike Lanes (Phase 2 & 3)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
2	**100 E**	Frontage Rd	State St	0.20	$ 4,552		Portion through underpass may only be able to accommodate shared lane markings until I-15 is reconstructed; curb/gutter/shoulder needs to be built out before buffered bike lanes can be done; parking would likely need to be prohibited on both sides, but there doesn't appear to be much demand presently
	1200 W	2100 N (west of I-15)	2100 N (east of I-15)	0.38	$ 10,191	UDOT	
	1900 S	2300 W	Center St	1.98	$ 45,286		Parking would need to be prohibited, but homes do not front on it; most of this road still needs curb/gutter/shoulder finished before buffered bike lanes can be installed
	2300 W / Triumph Blvd	Thanksgiving Way	Timpanogos Hwy	0.58	$ 14,712		
	Pioneer Crossing	Jordan River	Vineyard Connector	4.60	$ 104,392	UDOT	Includes a portion (about 0.25 mi) that's in Saratoga Springs; would require parking prohibition, but there is negligible parking demand
	Thanksgiving Way	Clubhouse Dr	Ashton Blvd	1.22	$ 27,580		Parking would need to be prohibited, but it's a business/commercial area with lots of off-street parking
	Phase 2 : SUBTOTAL			8.96	$ 206,713		
3	**3600 W**	2600 N	Saratoga Springs boundary	1.96	$ 44,309		Needs curb/gutter/shoulder buildout
	Phase 3 : SUBTOTAL			1.96	$ 44,309		
	All Phases : TOTAL			**15.12**	**$ 347,571**		

Table 5-10: Recommended Bike Lanes (Phase 1)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
	200 S	500 W	850 E	1.15	$ 21,195		Would require removal of parking from one side of the road; some parts of the road need curb/gutter/shoulder to be finished
	300 N	400 E	500 E	0.09	$ 1,657		May need to restrict parking on both sides
	300 W	3200 N	Frontage Rd	1.59	$ 29,292		May need to remove parking from one side in some areas; most homes don't front this road
	300 W	State St	900 N	0.20	$ 3,700		May need to remove parking from one side of the road; parking demand appears to be low
	400 E	300 N	100 N	0.15	$ 2,762		May need to restrict parking on one side
	500 W	Main St	Pioneer Crossing	0.94	$ 17,312		Could be done with only one side of parking prohibited; some parts of the east side of the road need to have curb/gutter/shoulder constructed before the bike lanes can be done
	700 S	2300 W	300 E	2.22	$ 40,885		
1	**700 S**	Waterway Rd	2300 W	0.66	$ 12,155		
	850 E / Mill Pond Rd	State St	200 S (AF)	1.45	$ 33,180		Parking may need to be prohibited in some areas; however, there is no residential and the commercial areas have ample off-street parking; large stretches need to have curb/gutter/shoulder finished before buffered bike lanes can be done
	500 E / 600 E	300 N	900 N	0.52	$ 9,577		When bridge structure over I-15 is replaced, bike/ped connections should be made to State St.
	1200 E	Timpanogos Hwy	2600 N	0.84	$ 15,439		Parking may need to be prohibited but there's very few land parcels with access to the road
	1630 S	300 E	Spring Creek Ranch Rd	0.41	$ 7,551		May need to restrict parking on one side, but homes don't front on this street; some areas need curb/gutter/shoulder build out
	3200 N	1200 W	Timpanogos Hwy	2.66	$ 48,988		Some parts may need to restrict parking on one side, but most of the parcels don't have access; many areas still need curb/gutter/shoulder built out

Table 5-10: Recommended Bike Lanes (Phase 1 – cont'd)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**Center St**	State St	200 S	0.86	$ 15,838		Will need to restrict parking on one side for most of the length; parking demand is low except between 100 N and 300 N
	Executive Parkway	Club House Dr	Thanksgiving Way	0.75	$ 13,812		May need to restrict parking on one side, but off-street parking is plentiful
	Garden Dr	Club House Dr	2150 N	1.32	$ 24,223		Parking may need to be prohibited completely in some stretches and at least on one side in others because this is a narrow road; many stretches in the north are devoid of parking demand
	Main St	1100 W	400 W	0.63	$ 11,602		Once a left turn center lane goes in, parking will have to be removed anyway and the leftover shoulder can be used for bike lanes
	N Frontage Rd 900 N	300 W	American Fork boundary	1.95	$ 35,912		May need to remove some parking from Frontage Rd between 300 W and 100 E; may need to restrict parking on one side of the road along parts of 900 N; a few areas need curb/gutter/shoulder build out
	Spring Creek Ranch Rd	200 S (AF)	1630 S	0.35	$ 6,446	UDOT	
	State St	2100 N	Trinnaman Ln	0.39	$ 7,244	UDOT	A median island (not included in cost) in State St would be helpful for enabling northbound cyclists on Triniman to turn left onto State
	Phase 1 : SUBTOTAL			19.13	$ 352,297		

Table 5-11: Recommended Bike Lanes (Phase 2)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
2	**100 E**	State St	500 N	0.23	$ 4,309		Would need to restrict parking on one side; parking demand appears to be light
	500 W	Historic Utah Southern Rail Trail	Main St	1.08	$ 19,890		Many areas need curb/gutter/shoulder build out; parking on one side may or may not need to be restricted depending upon build out width
	500 W	Pioneer Crossing	1900 S	0.56	$ 12,802		Would require curb/gutter/shoulder build out before installing bike lanes; parking may need to be prohibited
	900 N	1700 W	500 W	1.03	$ 18,969		Needs build out of curb/gutter/shoulders
	1000 E	850 E / 200 S	Mill Pond Trail (proposed)	0.22	$ 4,049		Parking would need to be prohibited but there is little demand presently
	1100 W	Main St	Pioneer Crossing	0.81	$ 14,917		May need to restrict parking on one side; however, many parcels do not front on 1100 W
	1450 N / Cedar Hollow	Frontage Rd	600 E	0.73	$ 13,451		May need to restrict parking in some areas, but demand appears to be low
	1500 N	Jordan River Parkway	State St	1.98	$ 36,548		Needs build out of curb/gutter/shoulders; parking may need to be prohibited on one side, but new developments do not front on 1500 N
	2300 W	Pioneer Crossing	Saratoga Springs boundary	0.76	$ 13,997		Will happen when build out of this road section occurs
	2550 N	1200 E	1500 E	0.26	$ 4,788		Parking will have to be restricted on at least one side, but subdivisions do not front the road

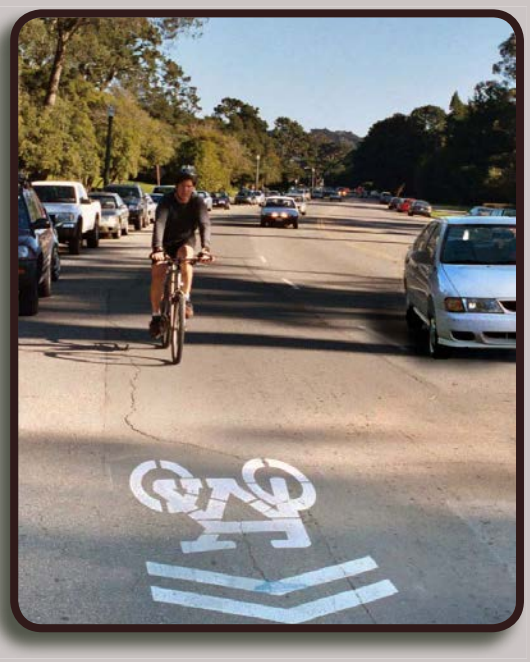
Table 5-11: Recommended Bike Lanes (Phase 2 – cont'd)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
2	**2600 N/Utah Highlands Dr**	1200 W	1200 E	2.28	$ 42,033		Would need to restrict parking on at least one side; some areas still need build out of curb/gutter/shoulders; signed shared roadway could be an alternative if removal of one side of parking is not feasible
	3200 N	Historic Utah Southern Rail Trail South	1200 W	0.54	$ 9,886		Bike lane would be installed when this future road is built
	Center St	Timpanogos Hwy	2100 N	1.30	$ 23,852		May need to restrict parking on one side in some areas; consider replacing standard angle parking with back-in angle parking; some sections needs build out of curb/gutter/shoulders
	Center St	200 S	1900 S	1.41	$ 25,967		May need to restrict parking on one side in some areas; buildout of curb/gutter/shoulders is needed in many areas
Phase 2 : SUBTOTAL				13.19	$ 242,923		

Table 5-12: Recommended Bike Lanes (Phase 3)

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
3	**900 N**	2400 W	1700 W	0.62	$ 11,418		Road section needs to be built out
	1100 W	900 N	Main St	0.80	$ 14,762		Parking may need to be restricted on one side; most segments need curb/gutter/shoulder buildout
	1100 W	Pioneer Crossing	1900 S	0.67	$ 12,431		Most sections need curb/gutter/shoulder buildout; may need to restrict parking on one side, but new subdivisions don't front 1100 W
	1500 N	Saratoga Springs Boundary	Jordan River Parkway	1.06	$ 19,522		Most of this road has not been built yet
	2600 N	Redwood Rd	3600 W	0.97	$ 17,795		Needs curb/gutter/shoulder buildout
	State St	1870 N	American Fork Boundary	2.75	$ 50,646	UDOT	Parking may need to be prohibited in some areas
	Phase 3: SUBTOTAL			6.87	$ 126,574		
	All Phases : TOTAL			**39.19**	**$ 721,794**		

Uphill bike lane/downhill shared lane treatment in Seattle, WA



Marked Shared Roadway

5.1.8 Uphill Bike Lanes/Downhill Shared Lanes

This facility type consists of a dedicated, separated bike lane in the uphill direction and a marked shared roadway in the downhill direction. These are used in instances where steep hills yield downhill bicycle speeds close to the designated speed limit. The bike lane is provided in the uphill direction where car speeds are much higher than bicycle speeds so that cars can easily pass bicyclists without being impeded. Shared lane markings are provided in the downhill direction in order to encourage bicyclists to "take the lane" rather than riding too close to the curb or to parked cars, either of which could be very dangerous. Only one road in Lehi is proposed for this treatment. It is shown in **Table 5-13**.

5.1.9 Marked Shared Roadways

Marked shared roadways are typically implemented in corridors where dedicated space for higher-level treatments cannot be allocated, or where traffic speeds and volumes dictate that a higher-level facility is not warranted. This treatment should not be used on any roadways with a speed limit in excess of 35 mph, although it is preferable to limit them to roads with speed limits of 30 mph or less. Unless speeds and volumes are low, many people will not feel comfortable riding on a road with this treatment. However, in instances where a higher-level facility is not technically or politically feasible, they can serve as valuable treatments to legitimize experienced riders who choose to bicycle there. The markings can be accompanied by optional signage that further notifies automobile drivers that bicyclists should be expected to ride in the lane where the markings are placed. Proposed marked shared roadways are listed in **Table 5-14**.

5.1.10 Signed Shared Roadways

Signed shared roadways do not have any dedicated roadway space for bicycles. They simply provide signage designating the road as a bike route. Signed shared roadways can be created on roads with or without shoulders as well as with or without parking. It is a particularly effective treatment on roads with wide shoulders where parking is permitted, but is infrequently used. In these instances the shoulders behave like de-facto bike lanes for long stretches. Care should be taken when considering implementing this type of bikeway on roads with little or no shoulder, or on roads with heavy parking volumes. In those cases, a marked shared roadway may be a better option as long as the speed limit does not exceed 35 mph. Proposed signed shared roadways are listed in **Table 5-15**.

Signed Shared Roadway

5.1.11 Unpaved Trails

Unpaved trails are normally located in undeveloped parklands or natural open spaces. Although they primarily serve recreational users, they may also serve transportation functions in some cases. Only one unpaved trail – the Bonneville Shoreline – is proposed, largely because the focus of this master plan was on the urban portions of Lehi. This facility was included due to its regional importance and long-standing planning efforts. The proposed unpaved trail is listed in **Table 5-16**. A separate study devoted to unpaved trails would likely yield other valuable recommendations not included within the scope of this master plan.

Table 5-13: Recommended Uphill Bike Lane/Downhill Shared Lane

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**600 E**	1500 N	900 N	0.54	$ 7,071		Bike lane northbound, shared lane southbound; could retain parking on one side
	Phase 1 : SUBTOTAL			0.54	$ 7,071		
	TOTAL			**0.54**	**$ 7,071**		

Table 5-14: Recommended Marked Shared Roadways

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)	Cost	Jurisdiction	Notes
1	**900 N**	500 W	200 W	0.22	$ 1,710		
	900 W	3200 N	Murdock Canal Trail	0.28	$ 2,176		
	Jordan River Connection	Jordan River Parkway	Jordan River Parkway	0.25	$ 1,981		Connector route through Willow Park campground roads
	River Way	300 N	700 S	0.78	$ 6,602		A median crossing and possible RRFB flashers or HAWK signal at Main St (not included in the cost estimate) would be helpful additions
	Trinnaman Ln	State St	900 N	1.00	$ 7,752		
	Phase 1 : SUBTOTAL			2.53	$ 19,682		
2	**500 W**	1900 S	Utah Lake Shoreline Trail	0.14	$ 1,062		
	1450 N Cedar Hollow	600 E	1200 E	0.56	$ 4,383		
	1500 N	1200 E	Highland Boundary	0.21	$ 1,659		
	Phase 2 : SUBTOTAL			0.91	$ 7,104		
	All Phases: TOTAL			**3.45**	**$ 26,786**		

Table 5-15: Recommended Signed Shared Roadways

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)		Cost	Jurisdiction	Notes
1	**1200 East**	2600 N	900 N	1.44	$	13,845		
	Airport Dr	600 E	1200 E	0.61	$	5,875		
	Phase 1 : SUBTOTAL			2.05	$	19,720		
2	**600 E**	3200 N	2600 N	0.50	$	4,791		
	2100 N	1200 W	Center St	1.08	$	10,408		
	Phase 2 : SUBTOTAL			1.58	$	15,199		
	All Phases : TOTAL			**3.63**	**$**	**34,919**		

Table 5-16: Recommended Unpaved Trails

Phase	Bikeway	Extent 1	Extent 2	Length (Miles)		Cost	Jurisdiction	Notes
3	**Bonneville Shoreline Trail**	Draper city boundary	Draper city boundary	5.20	$	411,945		Much of this work could be done by volunteer groups such as Boy Scouts
	Phase 3 : SUBTOTAL			5.20	$	411,945		
	All Phases : TOTAL			**5.20**	**$**	**411,945**		

5.2 Walkways

The walkways recommended in this master plan consist of prioritized sidewalk installations, sidepaths, and shared-use paths. Sidewalks were chosen for prioritized status based on proximity to schools, location on collector and arterials streets where lots of traffic is present, and whether at least one side of the road already has a sidewalk. The walkway recommendations are displayed on **Figure 5-7**. This figure contains the same shared-use paths shown on the bikeway maps included earlier in the chapter. It also contains the sidepaths from the bikeway maps, with additional pedestrian-focused sidepaths added in.

Table 5-17 displays the total mileage of priority sidewalks identified for Lehi and the estimated cost based on the assumption that they will be 5' wide. The additional sidepaths (i.e. the ones not already listed in the bikeway section) are displayed in **Table 5-18**. Many of these sidewalks and sidepaths will likely be constructed by developers during the course of their subdivision construction.

Table 5-17: High Priority Sidewalks

Total Miles of 5'-wide Sidewalk	Estimated Cost	Notes
18.95	$ 2,001,120	Many of these sidewalks will be built by developers as part of subdivision approval

A pedestrian on 500 West in Lehi, a roadway lacking several portions of sidewalk

"Piano key"-style pedestrian crossing

Table 5-18: Recommended Walkway Sidepaths

Name	Extent 1	Extent 2	Miles	Estimated Cost	Notes
600 West	3200 N	Sandhill Dr	0.88	$ 255,775	May be built by developers as part of subdivision approval
Micron Area (multiple paths north of SR-92)	Bonneville Shoreline Trail	11800 N	5.64	$ 1,630,577	May be built by developers as part of city approval process
TOTAL			**6.52**	**$ 1,866,352**	

5.3 Spot Improvements

Examples of spot improvements are bridges, pathway connections, and intersection improvements. The linear bikeway recommendations presented earlier in this chapter already include these types of improvements within their lengths. The improvements described here cover spot locations that are not associated with the linear bikeway recommendations. The master plan steering committee and the public (through comments given at the public workshops) were instrumental in identifying critical locations within the City where spot improvements are needed. The recommended spot improvements are shown in **Figure 5-8**. **Table 5-19** shows their estimated costs and implementation considerations.

5.4 Addendum Items

Following completion of the rest of Chapter 5, two infrastructure projects needed to be added. Rather than insert these projects into the previous sections and maps, they are being incorporated here as an addendum. The projects are:

- An enhanced crossing or bike signal at 2100 North/Redwood Road that would make left turns for bicycles at this location more safe and comfortable.
- A sidepath along 2100 North and 1200 West that would connect the existing sidepath on 2100 North through the I-15 interchange to the Historic Utah Southern Rail Trail.

Table 5-19: Recommended Spot Improvements

Number*	Location	Improvement	Cost	Jurisdiction	Notes
1	**Redwood Rd/ Pioneer Crossing**	Ped/Bike crossing from west side of intersection to the east side	$ 100,000	UDOT	Would likely involve signal modifications and additional striping; this location is in Saratoga Springs, but is of importance to Lehi residents
2	**Pioneer Crossing/ Jordan River Parkway Junction**	Install a shared-use path to connect the Jordan River Parkway with the eastbound shoulder of Pioneer Crossing	$ 100,000	UDOT	May require retaining walls along the toe of the fill slope.
3	**Main St bridge over Jordan River**	Sidewalks on both sides	n/a		Cost is not included because this would likely happen as part of a future rebuild of the entire bridge
4	**Jordan River Parkway undercrossing of Main Street**	Replace existing structure with one that won't flood regularly	$ 600,000		Would likely need to occur along with roadway widening; engineering study needed to better estimate cost
5	**Power Line Trail/Jordan River Parkway Junction**	Bridge to connect the Jordan River Parkway with a future segment of the Power Line Trail	$ 500,000		This segment of the Power Line Trail is a Phase 3 facility
6	**200 W/Main**	Safe crosswalks with median islands	n/a		Costs are included as part of the 200 W Bike Boulevard estimate
7	**200 E/Main**	Safe crosswalks with median islands	n/a		Costs are included as part of the 200 E Bike Boulevard estimate
8	**SR-92/Rail Trail**	Bridge over SR-92	$ 1,000,000	UDOT	Would provide much-need access from the Traverse Mountain area to the rest of Lehi
9	**Chapel Ridge Rd/Cabela's Dr**	Connections to the rail trail	$ 50,000		In conjunction with the bridge over SR-92, would allow much-needed access to the Cabela's/Adobe area from the rest of Lehi
10	**Traverse Mountain**	Mountain bike park	n/a		Cost will vary widely depending upon design chosen
11	**City-wide**	Maps/kiosks at key trail intersections and locations in the urban area	$ 25,000		Cost includes design only; installation costs will vary widely depending upon level of coverage
		TOTAL	**$ 2,375,000**		

* From Figure 5-7

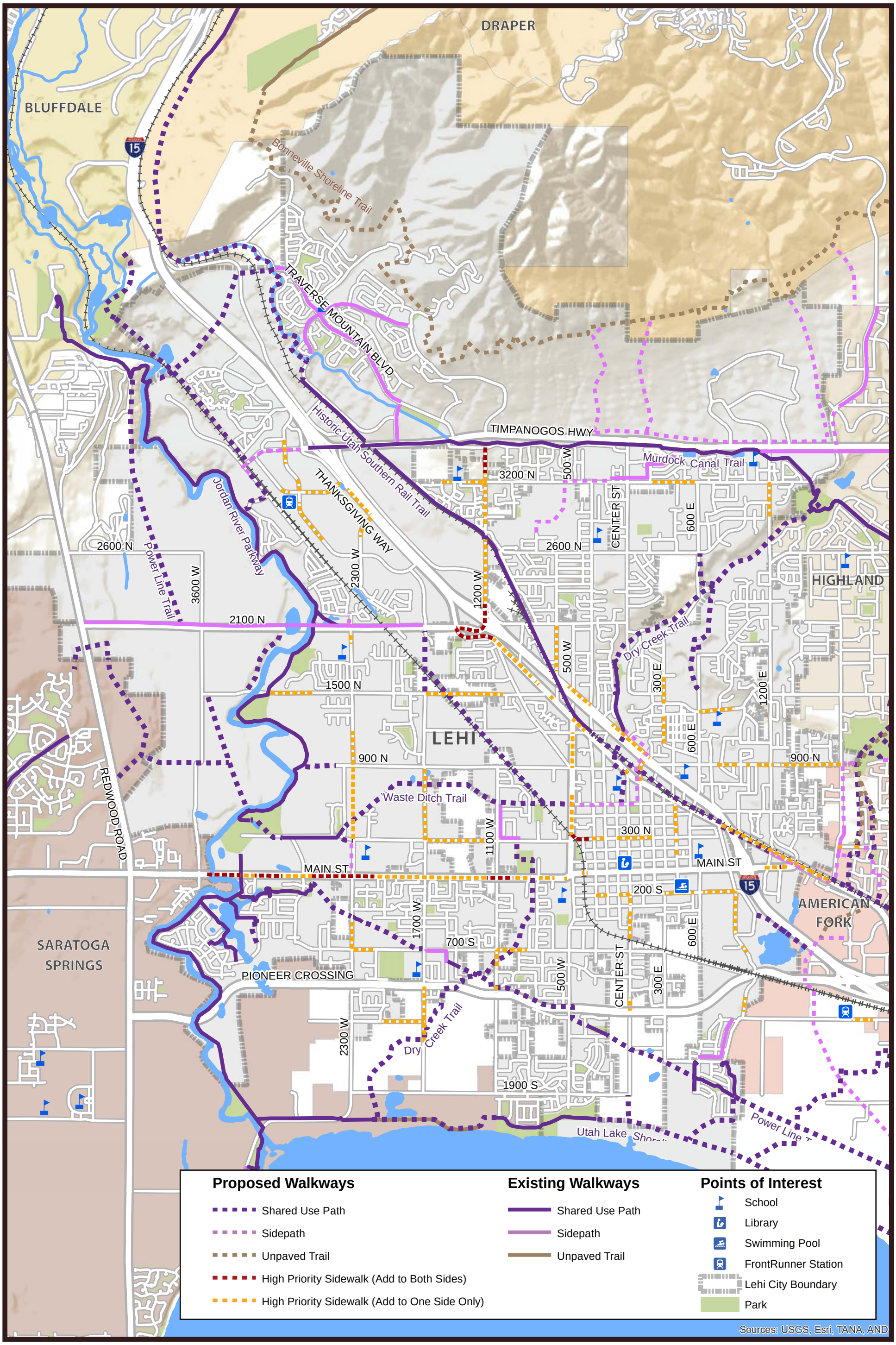


Figure 5-7: Recommended Walkways

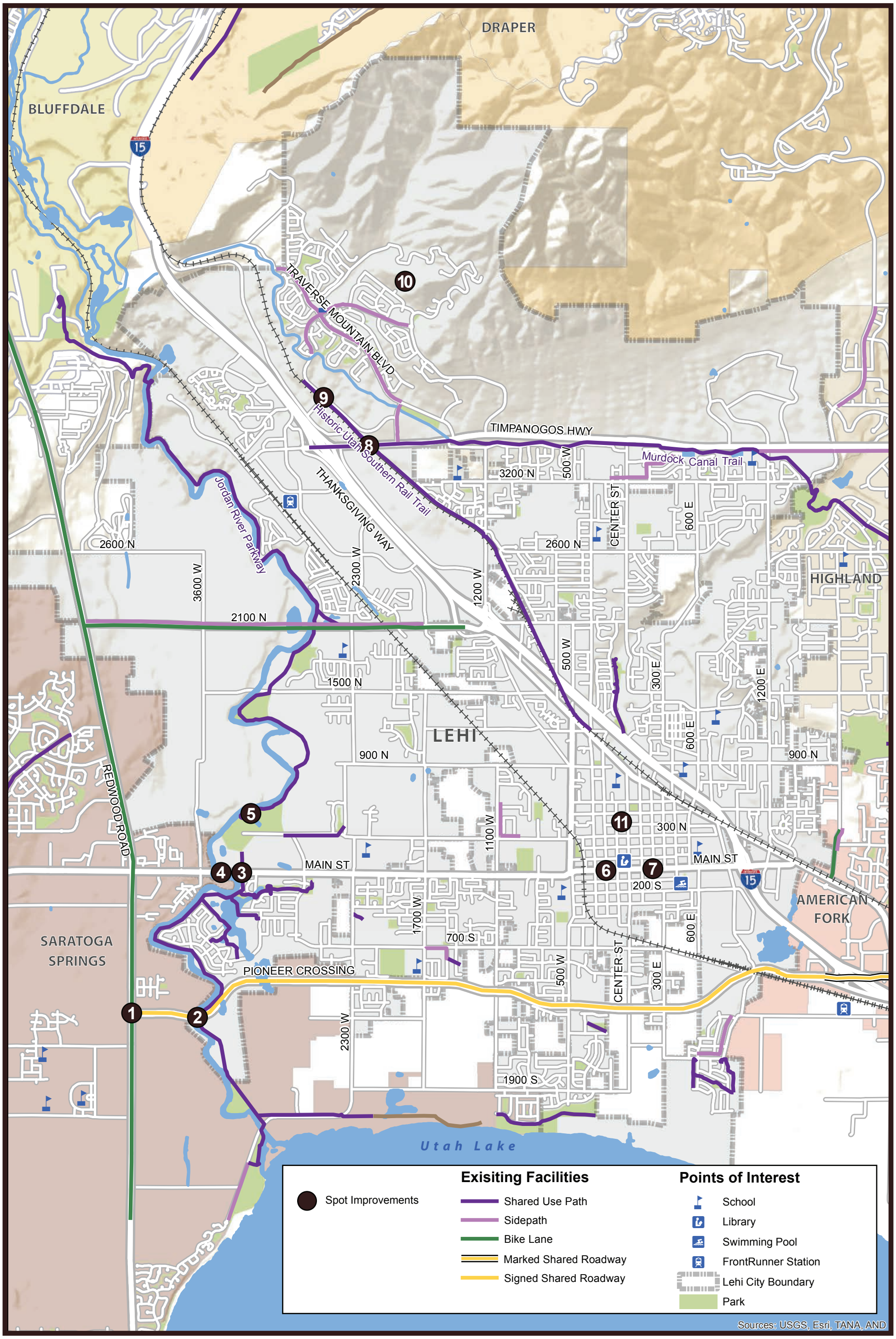


Figure 5-8: Spot Improvements

6 Wayfinding & Bike Parking

This chapter provides recommendations for wayfinding and bicycle parking. These elements will enhance the linear bikeway and walkway improvements recommended in **Chapter 5**.

6.1 Wayfinding

Navigation through a city is informed by landmarks, natural features, and other visual cues. Bicycle wayfinding signs can indicate travel direction, destination location, distance, and riding time. This information increases users' comfort and accessibility to the bicycle system. Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution because bicyclists are likely present.

Bicycle wayfinding signage typically falls into three categories:

- Confirmation Signs
- Turn Signs
- Decision Signs

Based on MUTCD standards and guidance available in the NACTO Guide, **Table 6-1** outlines the three types of bikeway signs, guidance on their use, and an example of what that sign might look like as a part of the Lehi bikeway network.

These signs are recommended to be posted in a manner most visible to bicyclists and pedestrians, rather than according to typical vehicle signage standards.

Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bikeway system
- Helping users identify the best routes to destinations
- Helping to address misperceptions about time and distance
- Helping overcome a barrier for people who do not currently bicycle often (e.g. people who are "interested but concerned" with regard to bicycling)

Recommendation

Develop and implement a Bicycle Wayfinding Signage Plan. Key components of the signage plan should include:

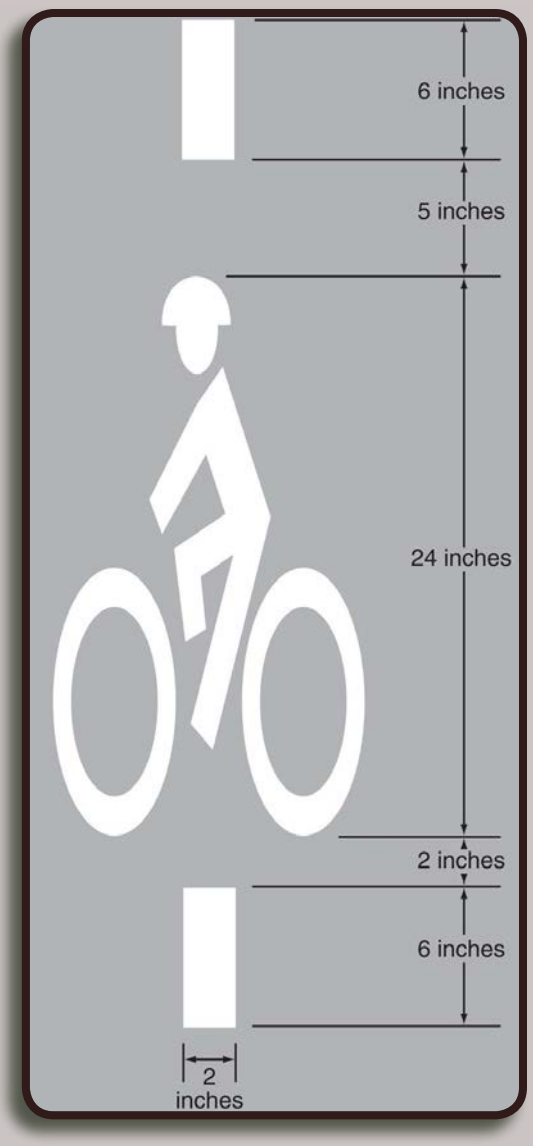
- Sign locations along existing and planned bikeways
- Sign type – what information should be included along with desired design features
- Destinations to be highlighted on each sign
- Approximate distance and riding time to each destination (based on an assumed average riding speed of 10 mph)

A further recommendation is to include bikeway signage in the overall city wayfinding effort.

Wayfinding signage helps bicyclists navigate easily to popular destinations

Table 6-1: Sign Types & Sample Designs

Sign Type	Purpose	Example
Confirmation	Confirmation signs notify bicyclists that they are on a designated bikeway. Information on confirmation signs can include distance and/or time but do not include arrows.	
	Placed at regular intervals along a bike route, confirmation signs can also alert motorists of the bike route and advertise the convenience of bicycling to common destinations in the community.	
Turn	Turn signs alert bicyclists to a bikeway turning from one street to the next. Turn signs should be used at intersections when the bikeway terminates and connects to an adjacent bikeway.	
	Some municipalities use pavement markings in conjunction with turn signs to assist with wayfinding. Turn signs include destinations and arrows. Placement of these signs should be in close proximity to where the bikeway turns. Confirmation signs are often used soon after the turn so that bicyclists know that they have made the turn correctly and are on the bikeway that they intend to be on.	
Decision	Decision signs highlight the intersection of two or more bikeways and inform bicyclists of key destinations accessible from those bikeways.	
	Destinations and arrows should be included on Decision Signs. Travel time and distances are optional but recommended. Signs should be placed near intersections and in advance of other bikeways or popular destinations.	



Recommended loop detector marking design

6.2 Bicycle Detection & Actuation

Providing bicycle detection at intersections is a critical component of well-functioning bikeway networks. Standard intersections are configured to recognize vehicular traffic, but may not be sensitive enough to detect bicycles. Undetected bicyclists at intersections are forced to dismount their bicycle and use the pedestrian push button (if one exists) to activate the green light or illegally run the red light unless a car comes along to trigger the sensor. To better accommodate bicyclists at intersections, bicycle-specific detection devices can be installed. These devices recognize the presence of bicycles, limit wait times, and increase the convenience of bicycling. There are various types of bicycle detection technologies, as outlined in the following section.

This section describes four different types of bicycle detection at intersections. **Tables 6-2** and **6-3** summarize the four types of intersection bicycle detection.

According to the NACTO Guide, proper bicycle detection includes two important criteria:

- Accurately detects bicyclists
- Provides clear guidance to bicyclists on how to actuate the detection

6.2.1 Loop

Bicycle-activated loop detectors are installed within the roadway so that bicycles will trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel and avoid maneuvering to the side of the road to push a button.

Most demand-actuated signals use loop detectors, which can be calibrated to be sensitive enough to detect any type of metal, including steel and aluminum. Some bicycles may lack enough detectable material by the loop, such as models that are mainly composed of carbon fiber or aluminum.

Table 6-2: Bicycle Detection Types

Type	Picture	Guidance	Cost
Loop		From the NACTO Guide: Madison, WI utilizes bicycle signal detector loops to improve access and decrease wait times at signalized intersections for bicyclists. Two to four detector loops are installed along any approach where a local neighborhood road frequented by bicyclists meets a signalized intersection at an arterial road. Loops may also be installed on collector roads and bike lanes where they are deemed necessary. Detector loops are typically 6' by 6' and square or diamond shaped (as opposed to round). They are often installed during street resurfacings, and are placed between 3" and 9" below the surface. Shallow loops saw-cut into the pavement are most prone to damage. Approximately 80% of the City's 285 signalized intersections have bicycle signal detection loops in place. To help bicyclists identify the signal detectors, Madison is considering using pavement markings or striping to identify the most sensitive parts of the loops.	Approximately $2,000-$3,000 per loop, installed.
Video		From the NACTO Guide: As part of the N. 130th Street buffered bike lane project (Seattle, WA), video detection was installed for the westbound approach at Greenwood Ave. N. and N. 130 St. After shifting the existing lane markings to add the bike lanes, existing detection loops on this approach were no longer in the correct locations. Video detection was chosen because it was cost-effective and cheaper to install than cutting loops for three vehicle lanes and one bike lane. The pavement was also in subpar condition for cutting new loop detectors. The other three sections of the intersection continue to function using loop detection.	Video camera system costs range from $20,000 to $25,000 per intersection.

Table 6-2: Bicycle Detection Types (cont'd)

Type	Picture	Guidance	Cost
Push-button		Locate them such that bicyclists can actuate without dismounting bicycle. This option does not help with bicyclists wanting to make left turns, and may also be inappropriate at intersection approaches with a dedicated vehicle right turn lane. Push buttons are most appropriate in areas where bicyclists do not have the option of turning left.	Push-button signals can cost between $300-$700 depending on function and design.
Microwave		From Florida State University: "RTMS is a true presence detector that can provide presence indication as well as volume, lane-occupancy, speed, headway, and classification information in up to eight discrete detection zones. The information is provided to existing controllers by contact closures and to other systems by serial communication. The detector can be mounted facing approaching traffic for single lane detection or sidefire for monitoring multiple detection zones. The mode of operation is configured with the setup program using a computer and serial communication." *http://potentia.eng.fsu.edu/terl/detection/New2006/Non%20Intrusive%20Vehicle%20Detection%20Guidelines/Chapter5.pdf*	Approximately $3,000+ per unit. Installation costs vary and do not include annual maintenance.

Loop detector at signal

Current and future loops that are sensitive enough to detect bicycles should have pavement markings and signage to instruct cyclists where to position themselves to effectively trigger the signal change.

6.2.2 Video

Video detection technology can detect a bicyclist's presence over a larger area by using pixel analysis of an image to detect the change from absence to presence of vehicles or bicycles. With video detection, disturbance to the pavement can be avoided and the amount of metal in the bicycle is inconsequential. Changes to the detection can be made quickly with a few software modifications when lane configurations are changed or bike lanes are added. The detection zones can also be hand drawn to the appropriate size relatively easily if bicyclists are consistently positioning themselves outside of the expected vehicle detection zone. However, video detection cannot differentiate between a motor vehicle and a bicycle in a shared travel lane and therefore cannot be used to extend or create a signal phase unique for bicyclists. This may be possible when a bicycle lane is provided, but would still require evaluation at each intersection.

Shortcomings to video can include poor detection in darkness (a lighted intersection and bicycles well equipped with lights solve this) and the shadows of adjacent vehicles triggering the bicycle area during certain times of day. It should also be noted that video detection is considerably more expensive than loop detection, although the cost of video detection has fallen in recent years.

6.2.3 Push-button

Similar to pedestrian push-button activation, a button positioned on the side of the roadway will allow a cyclist to trigger a signal change without dismounting from his or her bicycle or riding up on the sidewalk to push the button. This design takes advantage of existing infrastructure, diminishes the potential for conflicts between pedestrians and cyclists, and increases the convenience of the route for cyclists. Well-designed push button activation will be curbside and mounted at a height easily reached by cyclists. On-street parking near the push button area should be prohibited. The NACTO Guide provides the following guidance on push-button actuation devices:

> "If provided, push-button activation shall be located so bicyclists can activate the signal without dismounting. If used, push buttons should have a supplemental sign facing the bicyclist's approach to increase visibility."

Though familiar to most pedestrians, push buttons are limited in their efficacy because they do not serve all of a bicyclist's potential movements at an intersection. Push-button activation is not accessible for bicyclists wishing to turn left. For this purpose, push-button activation may only be appropriate at intersections where bicyclists do not have the option to turn left. Additionally, the 2004 Wisconsin Bicycle Facility Design Handbook states that push-button activation "should not be considered as a substitute for detectors, particularly where right turn only lanes exist."

6.2.4 Remote Traffic Microwave Sensor Detection

Remote Traffic Microwave Sensor Detection (RTMS) is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection cameras. In addition to its relatively low cost compared to video detection, other advantages of microwave detection include:

- Elimination of the need for lane closures during installation (unlike loop detectors)
- Ability to be used on any surface
- Ability to be used for pedestrian detection

A disadvantage of microwave detection technology is the complexity of maintaining the units. Maintenance will likely require the education and training of City staff, or a contract with an outside vendor. Microwave detection for bicyclists is currently being used in Pleasanton, CA.

Recommendations

Lehi City can improve intersections for – and detection of – bicyclists by implementing better bicycle detection at its intersections. The City should evaluate current vehicle detection practices to determine which bicycle detection method(s) will work best for the community, then begin trying it out at some key intersections.

Instructional sign for loop detector use

Bicycles parked at North Point Elementary School

6.3 Bike Parking Ordinances & Design Guidance

This section describes current vehicle parking requirements for various land uses as mandated by Lehi City code and provides bicycle parking requirement recommendations for those same land uses. Incorporating such requirements into municipal code is one way to increase the supply of bike parking in Lehi.

In addition to increasing bike parking, the city should also adopt design standards for short- and long-term parking to ensure that quality parking options are available to bicyclists. Recommendations for such standards are also provided in this section.

6.3.1 Bicycle Parking Guidelines

Just as car trips vary in purpose and duration, so too do bicycle trips. As a result, different types of bicycle parking are needed for different contexts. These needs can be met by providing both short- and long-term parking. The Association of Pedestrian and Bicycle Professionals (APBP) addresses the distinction between these two types of parking. A summary of this information is provided in **Table 6-4**.

Unit of Measurement

Cities use different metrics for assigning appropriate levels of bicycle parking, including:

- Unit count
- Percentage of building square footage
- Building occupancy
- Percentage of car parking

Table 6-3: Criteria for Short- & Long-Term Bicycle Parking

Criteria	Short-term	Long-term
Parking Duration	Less than two hours	More than two hours
Fixture Type	Simple bicycle racks	Lockers, racks in secured area
Weather Protection	Unsheltered	Sheltered or enclosed
		Secured, active surveillance
Security	Unsecured, passive surveillance	**Unsupervised**
		"Individual-secure" such as bicycle lockers
		"Shared-secure" such as bicycle room or cage
		Supervised
		Valet bicycle parking
		Paid area of transit station
Typical land uses	Commercial or retail, medical/healthcare, parks and recreation areas, community centers	Residential, workplace, transit

Source: Association of Pedestrian and Bicycle Professionals (APBP) Bicycle Parking Guide, 2010. Page 10.

The current Lehi City standards for vehicle parking and recommendations for accompanying bicycle parking are outlined in **Tables 6-5** and **6-6**. The land uses shown in the left column were taken from Lehi City zoning code. The recommended bike parking rates were developed by blending APBP guidance with other best practices from around the country.

6.3.2 Short-term Bicycle Parking Guidance

Short-term bicycle parking serves short trips, errands, and quick activities. This section provides best practice guidance and dimensions for short-term bicycle parking.

Short-term racks may be placed on sidewalks, in front of stores, or within parking structures in a manner that does not obstruct pedestrian movements or block doors. For security reasons, they should also be placed in well-lit, visible locations. A new type of short-term bicycle parking is called a bike corral. The two graphics below give overviews of short-term bike rack design recommendations and bike corrals.

Table 6-4: Recommended Bike Parking Requirements

Land Use	Current Car Parking Requirement	Recommended Short-Term Bicycle Parking	Recommended Long-Term Bicycle Parking
Residential			
1-, 2-, 3-, and 4-Family Dwellings	2 sp./unir (1 sp./unit to be within a fully enclosed garage except for 1-Family units)	n/a	n/a
Multi-Family Dwellings, Townhouses, Condos	2 sp./unit + 1 guest parking space/ 3 units (1 sp./unit to be within a fully enclosed garage)	0.05 sp./bedroom (2 min.)	0.5 sp/bedroom for units without a private garage; no requirement for units with a secure garage
Manufactured home	2 sp./unit	0.05 sp./bedroom (2 min.)	0.5 sp/bedroom for units without a private garage; no requirement for units with a secure garage
Facilities for the Elderly and Disabled	1 sp./4 residents + 1 sp./2 employees during regular hours	0.10 sp./bedroom (2 min.)	0.05 sp./bedroom (2 min.)
Non-Residential/ Other Uses			
Bed and Breakfast Inn	1 sp./sleeping unit + 1 sp./employee during regular hours	1 sp./10K sq. ft. (2 min.)	n/a
Nursing Home	1 sp./4 patient beds + 1 sp./ employee during regular hours	1 sp./ 20K s.f. of floor area (2 min)	1 sp./20 employees or 1 sp./ 70K s.f. of floor area, whichever is greater (2 min.)
Retirement Home/Center	1 sp./1.5 sleeping units + 1 sp./ employee during regular hours	.10 sp./bedroom (2 min.)	.05 sp./bedroom (2 min.)
Day care (in home)	2 sp.	n/a	n/a
Day care (commercial)	As approved by the Planning Commission	1 sp./20 students planned capacity (2 min.)	1.5 sp./20 employees (2 min.)

Table 6-4: Recommended Bike Parking Requirements (cont'd)

Land Use	Current Car Parking Requirement	Recommended Short-Term Bicycle Parking	Recommended Long-Term Bicycle Parking
Non-Residential/ Other Uses			
Elementary Schools	2.5 sp./classroom	1 sp./20 students	1 sp./10 employees
Junior High Schools	3 sp./classroom	1 sp./20 students	1 sp./10 employees
High Schools	1 sp./staff member + plus 10% of staff parking for visitors + spaces for 40% of student population at capacity or current enrollment, whichever is greater	1 sp./20 students	1 sp./10 employees
Churches	1 sp./4 seats in assembly area	2% of max daily attendance	1 sp./20 employees (2 min.)
Parks, Playgrounds, Open Space, Trails, Greenways	As approved by Planning Commission	Spaces for 2% of max expected daily attendance	n/a
Sports Fields/Facilities, Arenas, Theaters, Public Assembly Areas, Commercial Recreation	1 sp./3 seats at max capacity or as approved by Planning Comm.	Spaces for 2% of max expected daily attendance	1 sp./20 employees (2 min.)
Civic/Public Buildings and Facilities	As approved by Planning Commission	1 sp./8K sq. ft. (2 min.)	1.5 sp./10 employees (2 min.)
Hotels/Motels	1 sp./sleeping unit + 1 sp./employee during reg. hours	1.5 sp./10 employees (2 min.)	1.5 sp./10 employees (2 min.)
Medical Clinics	4 sp./doctor (or dentist) + 1 sp./ each additional employee	1.5 sp./20K sq. ft. (2 min.)	1.5 sp./20 employees or 1 sp./50K sq. ft., whichever is greater (2 min.)
Hospitals	1 sp./2 patient beds + 1 sp./employee during regular working hours	1.5 sp./20K sq. ft. (2 min.)	1.5 sp./20 employees or 1 sp./50K sq. ft., whichever is greater (2 min.)
Manufacturing, Industrial, Wholesale	1 sp./each employee during reg. working hours + adequate space for all company vehicles/visitors	TBD by city planners or Planning Commission; consider 2 sp./building entrance	1 sp./15K s.f. floor area (2 min.)
Funeral Homes, Museums, Civic Uses	20 sp. or 1 sp./30 s.f. in all assembly areas or as approved by the Planning Commision	2% of max daily attendance	1 sp./20 employees (2 min.)
Retail Stores	1 sp./300 s.f. gross floor area	1 sp./5K s.f. floor area (2 min.)	1 sp./12K s.f. floor area (2 min.)
Corporate, Professional, Business Offices	2 spaces + 1 sp./300 s.f. gross floor area	1 sp./20K s.f. floor area (2 min.)	1 sp./10K s.f. floor area (2 min.)
Restaurants, Bars, Lounges, Private Clubs	1 sp./2.5 seats or 1 sp./100 s.f. gross floor area, whichever is	1 sp./2K s.f. floor area (2 min.)	1 sp./12K s.f. floor area (2 min.)

Short-term Bicycle Parking Rack Recommendations

Design Summary

Rack Dimensions: 36” high by 24.5” wide.

Construction: 2 3/8" x 2" x .188" wall single Schedule 40 ASTM A53 Steel pipe, constructed of two 90 degree bends.

Base plate will be constructed of ASTM A36 with a thickness of 3/8” and will be welded onto the steel pipe. The base plate should be constructed to receive mounting hardware with three 0.50” diameter holes space at 120 degrees.

Coating Material Finish: Long wearing, mildew and ultraviolet ray resistant coating made of TGIC powder coating. Coated in the factory prior to delivery. Any damaged surface area resulted from the Contractor’s operation shall be repaired with approved materials in accordance to the manufacturer’s specifications.

Discussion

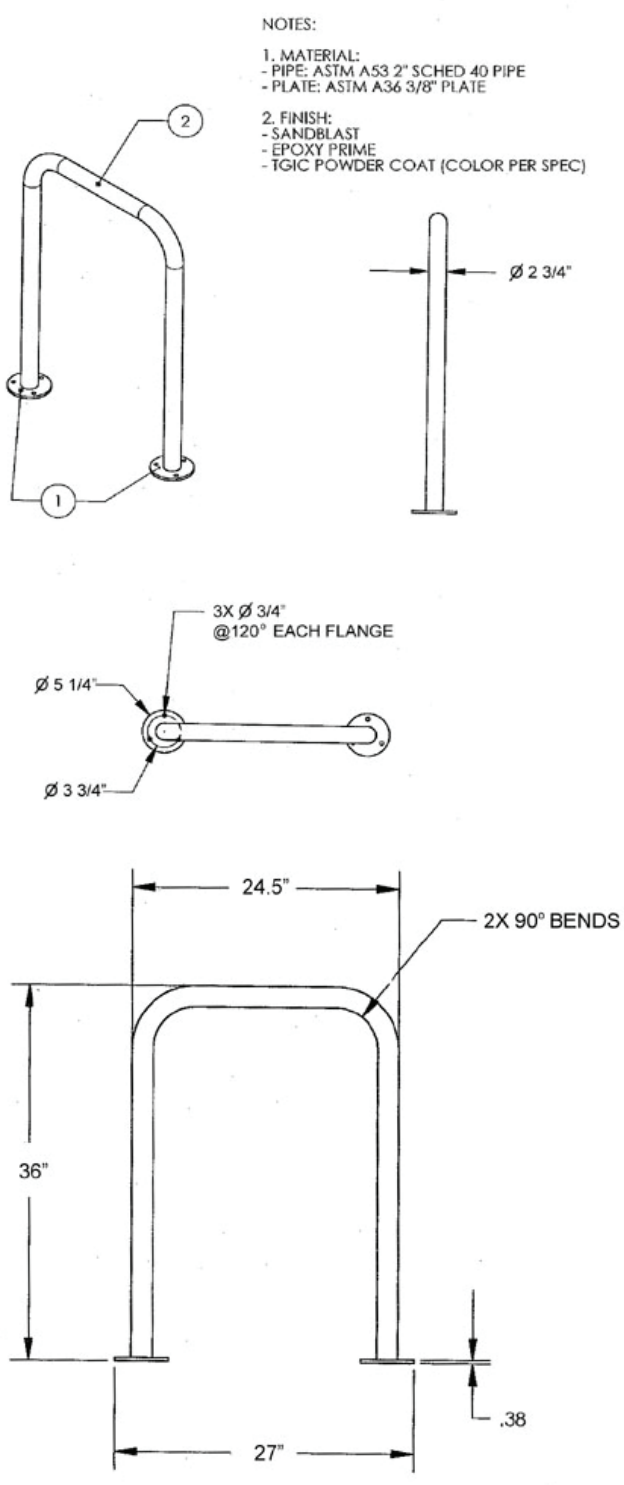
These types of racks, commonly referred to as “Staple”, “U”, or “Inverted U” racks are used throughout the country due to their security, ease of use, and space-efficiency.

Design Example

Guidance

APBP Bicycle Parking Guide, 2010

Preferred Design



Short-Term Bicycle Parking Recommendations: Bicycle Corrals

Design Summary	Design Example
Close to destinations; 50' maximum distance from main building entrance.	
Bicyclists should have an entrance width of 5' – 6' from the roadway.	
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 corrals in areas that cyclists are most likely to travel.	
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.	*Example of bicycle corral. Salt Lake City recently began installing a few such facilities.*

Discussion

Bicycle corrals (also known as "on-street" bicycle parking) consist of bicycle racks grouped together within the street area traditionally used for automobile parking. They are reserved exclusively for bicycles and provide a relatively inexpensive solution for providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces. 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, and other street furniture. 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.

6.3.3 Long-term Bicycle Parking Guidance

Long-term bicycle parking is recommended when providing bicycle storage for long periods of time, overnight, or possibly all day for a work commute. Long-term facilities protect the entire bicycle, its components, and accessories against theft and inclement weather, including snow and wind-driven rain. Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Potential locations for long-term bicycle parking include transit stations, large employers, and institutions where people use their bikes for commuting rather than consistently throughout the day.

Long-term Bicycle Parking Recommendations: Bike Rooms

Design Summary	Design Example
Improve surveillance through public lighting and closed circuit television cameras.	 *Bike rooms can be provided in office or apartment buildings.*
Walls should be solid and opaque from floor to ceiling.	
Install a panic button so as to provide a direct line of security in the event of an emergency.	
Accommodate a maximum of 40 bicycles or 120 if the room is compartmentalized with expanded metal mesh with lockable industrial-grade doors into enclosures containing a maximum of 40 bicycles.	

Discussion

Bike Rooms are interior locked rooms or enclosures accessible only to people needing to park bikes. They are used where there is a moderate to high demand for bike parking, and where people are part of a defined group, such as a department of employees or a small to medium size apartment building where residents are familiar with one another. Depending on the number of users and size of facility, the room may or may not contain bicycle racks for people to lock their bike.

Bike Rooms should be no further from elevators or entrances than the closest motor vehicle parking space. They should be no more than 150' from the nearest building elevator or entrance. Buildings with more than one entrance should consider providing interior bicycle parking close to each entrance, with an emphasis on entrances people are likely to approach by bike. Whenever possible, bike rooms should allow 24-hour secure access and ride-in/ride out convenience.

Buildings should provide dedicated bicycle-only secure access points via secure key cards, non-duplicable keys, or numeric keypads. Unless there is a staffed attendant nearby, people must have a key or passcode prior to using these parking facilities. Therefore, Bike Rooms are best for long term, regular users rather than incidental, opportunistic users.

Long-term Bicycle Parking Recommendations: Bicycle Secure Parking Areas (SPAs)

Design Summary	Design Examples
A Secure Parking Area (SPA) is a theft deterrent space accessible to an identifiable, limited group of people by key card or other controlled access locking device.	
An 18' by 18' SPA can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.	*This BikeSPA in Penn Station, New York City uses a passcard for access.*
Lighting and closed circuit television cameras should be used to provide an additional layer of security.	
Bicycle SPAs have a secure exterior skin consisting of welded or woven metal mesh with no opening larger than 2" from floor to ceiling.	
In an attended parking facility, locate the SPA within 100' of an attendant or security guard, or place it such that it is highly visible to other users of the parking facility or passersby.	
Entry doors must be steel and at least 3'-0" in width, with tamper proof hinges. The door should be constructed so as to provide permanent visual access in and out of the SPA. If the door is made from a solid material, a window may accomplish this function.	
Typical SPAs accommodate between 20 and 120 bikes.	*In the space formerly used for seven cars, a BikeSPA can comfortably park 80 bikes with room for future expansion. Double-height racks take advantage of the vertical space, maximizing parking capacity.*

Discussion

A Secure Parking Area for bicycles, also known as a BikeSPA or Bike & Ride, is a semi-enclosed space that offers a higher level of security and protection than ordinary exposed bike racks. Accessible via key card, BikeSPAs provide high capacity, secure parking for large volumes of bicycles. The increased security measures ease the minds of people uncomfortable leaving their bicycle in an outdoor area exposed to weather and threats of vandalism. BikeSPAs also include features such as benches, bicycle repair stands, bicycle tube and maintenance vending machines, as well as hitching posts that allow regular users to leave their personal bike lock at the SPA. These features make the BikeSPA especially attractive by eliminating some of the barriers that keep people from using the bicycle for transportation. Unless staffed by an attendant, people must have a key or passcode prior to using BikeSPAs. Therefore they are best for long-term, regular users rather than incidental, opportunistic users.

Long-term Bicycle Parking Recommendations: Bicycle Lockers

Design Summary	Design Example
Place in close proximity to building entrances or transit exchanges, or on the first level of a parking garage.	 *Example of bicycle lockers at a transit station*
Provide door locking mechanisms and systems.	
A flat, level site is needed; concrete surfaces preferred.	
Enclosure must be rigid.	
Transparent panels are available on some models to allow surveillance of locker contents.	
Integrated solar panels have been added to certain models for recharging electric bicycles.	
Minimum dimensions: width (opening) 2.5'; height 4'; depth 6'.	
Stackable models can double bicycle parking capacity.	

Discussion

Although bicycle lockers may be more expensive to install, they can make the difference for commuters who are deciding whether or not to cycle. Bicycle lockers are large metal or plastic stand-alone boxes and offer the highest level of bicycle parking security available.

Security requirements may require that locker contents be visible, introducing a tradeoff between security and perceived safety. Though these measures are designed to increase station security, bicyclists may perceive the contents of their locker to be less safe if they are visible and will be more reluctant to use them. Providing visibility into the locker also reduces unintended uses, such as use as homeless shelters, trash receptacles, or storage areas. Requiring that users procure a key or code to use the locker also reduces these unintended uses.

Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available. Bicycle lockers are most appropriate:

- Where demand is generally oriented towards long-term parking.
- At transit exchanges and park-and-rides to help encourage multi-modal travel.
- Medium- or high-density employment areas, commercial districts, and universities.
- Where additional security is required and other forms of covered storage are not possible.

Both short-term (above) and long-term (below) bicycle parking options are important factors to a successful transit station

6.3.4 In-Lieu of Parking

If the short- and long-term bicycle parking requirements outlined in **Tables 6-5** and **6-6** are adopted, Lehi City may also choose to offer an "In-Lieu of Parking" program. This program would allow property owners to pay fees to a fund established for the development of bicycle support facilities instead of installing bike parking on their own. The money collected in this fund can then be used for bicycle facility development anywhere in the city.

6.3.5 Bike Parking with Transit

The FrontRunner system brings a new type of transit to the Utah Valley region. At present, all UTA buses include exterior bicycle racks on the front of the vehicles. UTA plans to explore the feasibility of including bicycle racks and storage areas within BRT vehicles.

FrontRunner trains include space for 12 bicycles in a dedicated bicycle car, plus space for four others in each passenger car.

Recommendation

In order to encourage multi-modal commuting and reduce single occupancy vehicle travel, Lehi City should work with UTA to provide short- and long-term bicycle parking at the Lehi FrontRunner station. A Bike SPA would be ideal for this site.

7 Program Recommendations

Bicycle and pedestrian programs enhance the user experience and can be a cost-effective complement to infrastructure investments. Support programs include educational programs, ordinances, and policies. This document recommends a tailored suite of programs to complement the existing programs in Lehi. The goal of these programs is to:

- Support and enhance the infrastructure recommendations in this master plan
- Increase the number of people walking and riding bicycles in Lehi
- Create a safer and more comfortable environment for walking and bicycling

This chapter discusses new programs for Lehi as well as slight revisions to existing programs.

7.1 New Programs

This section discusses new programs that Lehi City and its partners can choose to implement in order to improve bicycling and walking.

7.1.1 Bicycle & Pedestrian Coordinator

Bicycle and Pedestrian Coordinator	
Purpose	Enhance city capacity for implementing bicycle and pedestrian infrastructure and programs
Target audience	n/a
Primary Agency	Planning Department or Public Works Department
Partners	Parks, Recreation, and Fitness Department
Priority	High
Sample Programs	Salt Lake City Bicycle and Pedestrian Coordinators

The City should create a Bicycle and Pedestrian Coordinator position to implement the projects and programs recommended in this plan. Similar positions in other cities are typically housed within the Planning and Zoning Department or Public Works Department. The position may also be housed parallel to the Planning and Zoning Department and Public Works Department so that the Coordinator has equal access to staff from both of those departments. The key is for the

Safety and awareness campaigns can help educate pedestrians, cyclists, and motorists

Bicycle and Pedestrian Coordinator – wherever the position is housed – to be able to work well across various City departments. This Coordinator position can be either full- or part-time. The job duties could include the following types of activities:

- Monitoring the design and construction of sidewalks, street crossings, and bikeways to ensure that they are built to standard and in a timely fashion
- Working with relevant City departments (e.g. Public Works, Planning, Parks and Buildings), and other agencies to implement the projects and programs recommended in this plan
- Identifying new projects and programs as opportunities arise
- Serving as the primary liaison to a Bicycle Advisory Committee
- Writing an annual "report card" on progress towards bicycle and pedestrian goals
- Applying for recognition through avenues such as the Bicycle Friendly Community program

Experience has shown that agencies and organizations that have a staff person dedicated to bicycling concerns are much more successful at implementing their plans than those that don't. Salt Lake City currently has two full-time staff dedicated to implementing on- and off-street bikeways and a third full-time person focused on non-infrastructure programs. They also have a part-time intern that supports the activities of the three full-time staff. Implementation of bikeways and supporting programs has skyrocketed in Salt Lake City in the approximately three years since they began expanding their bicycle and pedestrian staff (prior to 2009 they had one full-time person dedicated to bicycle and pedestrian projects). During that time, cycling levels have seen a significant uptick. Comparison of standardized citywide bicycle counts showed a 27% increase in cycling levels from 2010 to 2011.

Employing a Bike/Ped Coordinator is critical to the implementation of recommendations in this master plan

Salt Lake City's bicycle program and information website

7.1.2 Bike Program Website

Bike Program Website	
Purpose	Allow residents to easily find information about bicycling
Target audience	General public
Primary Agency	Planning Department; Public Works Department
Partners	Bicycle Advisory Committee
Priority	High
Sample Programs	Vélo Québec: www.velo.qc.ca/english/index.php Salt Lake City: www.bikeslc.com

Residents and visitors will benefit from a "one stop shopping" location for bicycling information. The website should be hosted on the main City website and include:

- A list of local bicycling groups and resources
- Information about current projects and how to get involved (e.g. public meetings, comment periods)
- Maps and brochures (e.g. links to online maps and brochures, where to find hard copies)
- Links to laws and statutes relating to bicycling
- Information about bicycling events (e.g. rides, classes, volunteer opportunities)
- Names, phone numbers, and addresses of local bike shops

7.1.3 Safe Routes to School

Safe Routes to School	
Purpose	Encourage and educate students and their parents about walking and biking to school; improve safety through physical improvements and programs
Target audience	School-aged children and their parents; school administrators, faculty, and staff
Primary Agency	Alpine School District, school staff, and city staff
Partners	Parents, Police Department, Bicycle Advisory Committee, UDOT
Priority	High
Sample Programs	Marin County (CA) National Model Program: http://www.saferoutestoschools.org/index.shtml

SRTS is a program designed to increase the number and safety of children walking and bicycling to school. SRTS programs are often called "Five E'" programs because they include Engineering, Education, Encouragement, Enforcement, and Evaluation strategies. UDOT administers a federally-funded SRTS grant program. Several Lehi schools have benefited from non-infrastructure programs funded by this program.

SRTS programs directly benefit schoolchildren, parents, and teachers by creating safer travel environments near schools and by reducing motor vehicle congestion at school drop-off and pick-up zones. Students that choose to bike or walk to school are rewarded with the health benefits of a more active lifestyle, the responsibility and independence that comes from being in charge of the way they travel, and knowledge at an early age that biking and walking can be safe, enjoyable, and good for the environment as well as their health. SRTS programs offer ancillary benefits to neighborhoods by slowing traffic and providing infrastructure improvements that improve biking and walking for everyone. Identifying and improving routes for children to safely walk and bicycle to school is also one of the most cost-effective means of reducing weekday morning traffic congestion and auto-related pollution.

SRTS programs help to educate children about safe walking and bicycling practices

The two most important actions that can be taken in Lehi to further SRTS efforts are formation of a Safe Routes to School Task Force and creation of a City-wide SRTS Plan. The Task Force could include:

- Representatives from the school district, school administrators, teachers, and families
- City staff from the Planning and Zoning and/or Public Works Departments
- Representative from the police and/or fire departments
- MAG staff
- Neighbors, local volunteers, and any other walking and/or bicycling advocates (e.g. parents, crossing guards, or Bicycle Advisory Committee members)

A Citywide SRTS Plan should interface with the Student Neighborhood Access Program (SNAP). SNAP is mandated by the State and requires all elementary, middle, and junior high schools to create and submit maps showing recommended walking routes between neighborhoods and the schools that they serve. UDOT administers this program (http://www.udot.utah.gov/snap). Walking audits are a good way of developing SNAP maps and identifying needed engineering improvements. Maps of recommended routes should be distributed to parents.

Funding is available through UDOT for constructing sidewalks near schools as well as for implementing non-infrastructure programs that help students safely walk or bike to school and incentivize them to do it more often. It is also strongly recommended that the national standard evaluation activities (parent survey and student travel mode tally) be implemented, along with plans to repeat the evaluation activities annually. The evaluation forms are required by UDOT as a condition of receiving funding, but it is a good idea for other schools to use them even if they are not receiving grant money.

Several of the program recommendations already listed in this chapter will directly help achieve SRTS goals, including:

- Youth Bicycle Safety Education Program
- Bike Light Campaign
- Bicycle Map

Other recommended SRTS programs that can be implemented as stand-alone programs or as part of a larger SRTS Plan include:

"Boltage" Program

This program uses a solar-powered, WiFi-enabled RFID tracking device to track and reward students bicycling and walking to school. Because the tracking tags can be mounted on helmets, there is an added incentive for children to always wear a helmet when bicycling. In prototype programs, walking and bicycling has increased by up to 500% in the first year of the program.

Integrate Walking and Bicycling into the Classroom Curriculum

This program encourages children to keep track of their walking and bicycling miles. Teachers can use this data in different ways depending on the class subject. Mathematics classes can perform calculations using the numbers (e.g. average daily walking/biking miles, predicted mileage over the year). Physical education classes can use mileage to help students "run" a marathon. Social studies classes can use the data to "walk across Utah".

Start a Walking School Bus or Park and Walk Program

Walking School Buses are organized groups of students accompanied by one or more adults along a regular route to school. Children join the bus at set times and stops. If a Walking School Bus cannot be formed, a first step or an alternative activity is to designate a Park and Walk location where parents park at a designated spot (such as a community park) and walk their children the rest of the way to school. Both Walking School Bus and Park and Walk programs can reduce traffic congestion near schools.

SRTS programs help children be active and may save parents driving-related time and money

7.1.4 Establish a Bicycle and/or Pedestrian Advisory Committee

Bicycle and/or Pedestrian Advisory Committee	
Purpose	To provide a forum and a voice for citizens interested in bicycling and walking issues, follow up on master plan goals, and serve as a resource to City staff
Target audience	Citizen advocates
Primary Agency	Planning Department; Public Works Department
Partners	Various City departments; general public
Priority	High
Sample Programs	http://ci.beavercreek.oh.us/boards-commissions/bikeway-advisory/

Establishing an advisory committee emphasizes the commitment to making bicycling and walking safer and more appealing. The charges of the BAC may include some or all of the following:

- Review and provide citizen input on capital project planning and design as it affects bicycling (e.g. corridor plans, street improvement projects, signing or signal projects, and parking facilities)
- Review and comment on changes to zoning, development code, comprehensive plans, and other long-term planning and policy documents
- Participate in the development, implementation, and evaluation of master plans and facility standards
- Provide a formal liaison between local government, staff, and the public
- Develop and monitor goals and indices related to bicycling
- Promote bicycling, including safety and education
- Assist with applications for grant funding or Bicycle Friendly Community designation
- Assist with data collection efforts such as yearly bicyclist counts

Because committee members are volunteers, it is essential to have strong staffing supporting the committee in order for it to be successful. The committee should be created through an enacting City Council resolution that calls it into being and defines the committee's charge, responsibilities, member composition, member selection/appointment process, decision-making structure, and committee meeting frequency.

7.1.5 Complete Streets Policy/Resolution

Complete Streets Policy/Resolution	
Purpose	Ensure that City roadways are accessible and safe for all users
Target audience	City Planners and Engineers
Primary Agency	Planning Department; Public Works Department
Partners	Mountainland Association of Governments; Bicycle Advisory Committee
Priority	High
Sample Programs	http://www.completestreets.org/

Complete streets policies direct transportation planners and engineers to consistently design streets with all users in mind (drivers, transit riders, pedestrians, bicyclists, the elderly, children, and people with disabilities). Many jurisdictions around the country have adopted Complete Streets policies, and national model policies can be used as a starting point. A Complete Streets policy is one effective way to institutionalize the goals of this plan.

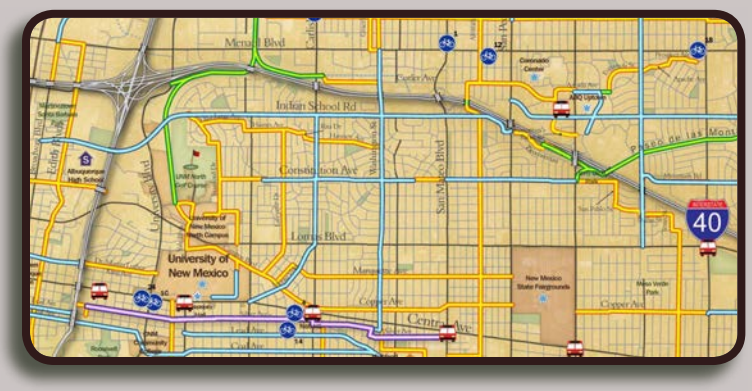
Complete Streets policies complement other efforts to make downtown areas lively, attractive, and economically healthy

7.1.6 Annual Bicyclist Counts

Annual Bicyclist Counts	
Purpose	Gather important benchmarking information about cycling rates
Target audience	For use by agency staff and for general information to the public
Primary Agency	Planning Department; Public Works Department; Parks, Recreation, and Fitness Department
Partners	Bicycle Advisory Committee, Mountainland Association of Governments
Priority	Medium
Sample Programs	http://bikepeddocumentation.org/

To better understand the needs and habits of Lehi residents who bicycle, it is necessary to establish an annual data collection program. At a minimum, this program should tally the number of cyclists at key locations in the city. The same locations should be counted in the same manner annually. It is recommended that the data collection program use the methodology developed by the National Bicycle and Pedestrian Documentation Project. Salt Lake City and the University of Utah are currently using this methodology for their annual bicycle counts.

User counts help to evaluate demand and future needs



Bicycle route maps help to promote cycling among visitors and residents

7.1.7 Bicycle Map

Bicycle Map	
Purpose	Encourage cycling by providing route descriptions, support facility information, and locations of popular destinations
Target audience	General public
Primary Agency	Planning Department; Public Works Department; Parks, Recreation, and Fitness Department; Streets Department
Partners	Mountainland Association of Governments, Bicycle Advisory Committee
Priority	Medium
Sample Programs	Portland (OR) maps: http://www.portlandoregon.gov/transportation/article/322407 Salt Lake City Bikeways Map: http://www.ci.slc.ut.us/transportation/bicycletraffic/map.htm

One of the most effective ways to encourage people to bike is through the use of maps and guides to show that the infrastructure exists, to demonstrate how easy it is to access different parts of a city by bike, and to highlight unique areas, shopping districts, or recreational areas. Cycling maps can be used to promote tourism to specific areas, encourage residents to bike, or promote local business districts. Maps can be city-wide or district-specific. They can be distributed as hard copies at locations throughout a city, posted online as a downloadable and printable map, posted online as an interactive map, or a combination of these options.

MAG is currently publishing a revised regional bicycling map. We recommended that Lehi City create a map that complements the regional map and provides a finer grain of information specific to Lehi, including transit routes and stops, bikeways, bike parking, locations of businesses likely to be frequented by bicyclists, and other information that will be useful to people riding bicycles in the city.

7.1.8 City Staff Training

City Staff Training	
Purpose	Educate and train planners and engineers on bicycle facility design and policy issues.
Target audience	Planning, engineering, and maintenance staff
Primary Agency	Planning Department; Public Works Department; Streets Department
Partners	Bicycle Advisory Committee; Police Department
Priority	Medium
Sample Programs	Cheyenne, WY and Culver City, CA have recently used: http://www.michaelronkin.com/courses.htm

Professional development courses provide training to professionals who do not have extensive experience or training in bikeway design. This can be a successful way to institutionalize knowledge of bicycle and pedestrian facility design and create an agency culture that values these modes of travel.

City staff training is a good way to institutionalize walking and bicycling into standard practices and processes

7.1.9 Youth Bicycling Classes

Youth Bicycling Classes	
Purpose	Educate youth on traffic safety and bicycling skills
Target audience	Children; families
Primary Agency	Bicycle Advisory Committee; Police and/or Fire Departments
Partners	Local LCIs; Boy Scout groups; Alpine School District
Priority	Medium
Sample Programs	http://bikeleague.org/programs/education/courses.php

Most people who bicycle have not received any training on safe bicycling practices, the rules of the road, or bicycle handling skills. Bicycling skills courses can address this education gap. The most common programs are the League of American Bicyclists courses (including Road I, Road II, and Commuting), taught by League Certified Instructors (LCI). Several LCIs reside in Utah and Salt Lake Counties. These courses cover bicycle safety checks, fixing a flat, on-bike skills, crash avoidance techniques, and traffic negotiation.

Youth bicycling classes teach safety skills and help children feel more confident about traveling through their community

A police force that is trained on existing bicycle laws and common crash types can help improve safety through enforcement and education

7.1.10 Police Training Module

Police Training Module	
Purpose	Educate law enforcement officers on bicycle laws and safety
Target audience	Police Department
Primary Agency	Police Department
Partners	Bicycle Advisory Committee
Priority	Medium
Sample Programs	http://webike.org/services/enforcement/continuum-of-training

Most law enforcement professionals do not receive training specific to bicycle laws, handling, or safety. Police education courses can help officers improve public safety and enforce existing laws more effectively by providing them with the training they need. These courses should include:

- Comprehensive information about laws and statutes pertaining to bicycling
- Information about common crash types and causes, and how to prevent and enforce against the most serious offences
- Options for enforcement and education (e.g. guidance for when to issue a citation or warning, diversion class options, and safety materials that can be handed out during traffic stops or public events)

7.1.11 Safety Campaign

Safety Campaign	
Purpose	Promote safety by educating all road users through a high-profile campaign
Target audience	General public
Primary Agency	Planning and Zoning Department; Public Works Department
Partners	Mayor's office, City Council, UDOT, Mountainland Association of Governments
Priority	Medium
Sample Programs	http://www.slobikelane.org/cm/programs/sharetheroad.html

A high-profile media campaign that highlights bicycle safety is an important part of helping all road users understand their roles and responsibilities on city streets. It is an effective way to raise the profile of bicycling and improve safety for everyone. A well-produced safety campaign will be memorable and include clear graphics in a variety of media, such as print or audio/video advertisements, the distribution of free promotional items, and email or in-person outreach. This type of campaign is particularly effective when kicked off in conjunction with other bicycling events or at the beginning of the school year. Partnering with UDOT's annual Road Respect media campaign may also be beneficial.

Messages can focus on the following themes (and others that the City feels are relevant):

- Safe bicycling skills and secure locking practices
- Pedestrian courtesy
- How to share the road (for both motorists and bicyclists)
- Light and helmet use
- Bicyclist rights and responsibilities

7.1.12 Bicycle Light Campaign

Bicycle Light Campaign	
Purpose	Encourage and enforce the use of bike lights
Target audience	General public
Primary Agency	Police Department
Partners	Planning Department; Public Works Department; Police Department; bicycle shops or other retailers; Bicycle Advisory Committee
Priority	Medium
Sample Programs	Bicycle Transportation Alliance Bike Light Videos (Portland, OR): http://vimeo.com/19678357 "See and Be Seen" Campaign (Portland, OR): http://bikeportland.org/2006/11/13/pdot-to-launch-new-safe-cycling-campaign-2522

Many bicyclists are unaware that a front headlight and rear light or reflectors are required by state law, or they simply do not purchase lights. Research shows that bicyclists who do not use lights at night are at much greater risk of being involved in bike-car crashes.

The goal of a bike light campaign is to encourage light use through marketing, outreach, and on-the-spot installation of free or low-cost bike lights. This multi-pronged outreach effort ideally takes place every fall. The Lehi City Police Department and volunteers could lead the outreach efforts and the Bicycle Coordinator could coordinate the campaign. The bike light campaign could include the following elements:

- Well-designed graphic ads throughout the City, perhaps to be included as part of a broader safety campaign
- Continued enforcement of bike light laws
- Discounted or free bike lights and reflective gear distributed at key locations (e.g. City Library, City Hall) and available at local bike shops during the beginning of the school year

7.1.13 Valet/Event Bike Parking

Valet/Event Bike Parking	
Purpose	Encourage bicycling by event attendees
Target audience	General Public
Primary Agency	Bicycle Advisory Committee
Partners	Economic Development Department; community bicycle collectives; bicycle shops or other retailers
Priority	Low
Sample Programs	Salt Lake City Bicycle Collective: www.slcbikecollective.org

Events can bring lots of people and traffic. Whether it is holiday celebrations, popular shopping destinations, or community events, residents can generate a significant number of trips. A Bicycle Advisory Committee or other groups may be able to provide volunteer and administrative support for high demand bicycle parking at such events. The City can encourage bicycle trips to many of the popular events by advertising and providing event bike parking.

Bike valets encourage people to ride bicycles to events that draw lots of traffic

Children learning how to ride safely and responsibly

7.2 Existing Programs

7.2.1 Bicycle Licensing

Lehi currently has a bike licensing program administered by the Police Department. Residents who opt to license their bike must complete paperwork to obtain a sticker and affix it to their bike in a hidden area. Participants then keep their own paperwork, which has the license number on the sticker. In the event that a licensed bike is stolen, participants then take the paperwork to the police department and file a report.

Recommendations

- Discontinue bicycle licensing and associated programs (e.g. fees, inspections, renewals, and transfer of ownership processes)
- For security and tracking measures, the City could promote and encourage the use of private bicycle registration programs (e.g. Boomerangit) and educate the Police Department about where to find those programs so that they can reunite lost or stolen bicycles with their owners

Rationale: Removing the bicycle licensing program is consistent with current best practices observed in other cities, is cost effective, and allows the City to focus attention on other programs and initiatives that have greater potential to expand bicycling in Lehi.

7.2.2 Bicycle Safety Education

Lehi City Police officers offer Bike Safety Demonstrations upon request, most commonly for Boy Scouts, schools, neighborhood parties, and other community events.

Recommendation:

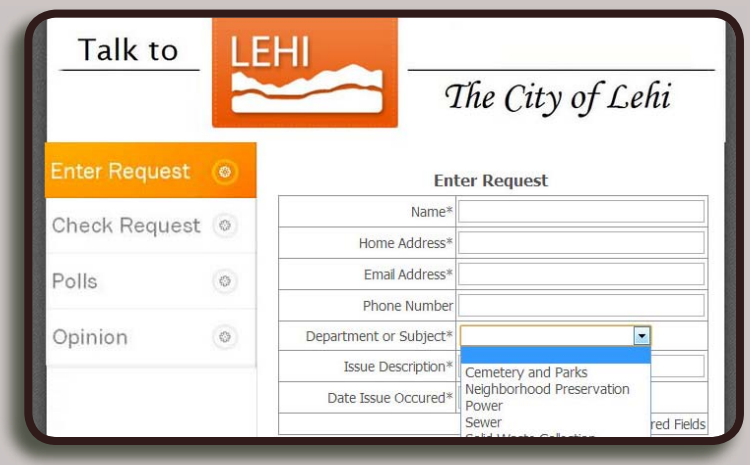
- Involve other Lehi City Departments (such as Fire and maybe Planning and Zoning or Public Works) to improve curriculum and increase participation

7.2.3 Online Maintenance Request Form

The Lehi City website currently provides an email address and phone number where residents can request pothole repairs, street sweeping, snow removal, or other maintenance items. An enhanced practice would be to develop an online form (or a mobile smart phone application) for the following requests, then provide links to the form from a city bicycling website:

- Bike rack installation
- Bicycle information
- General maintenance (e.g. pothole repair, dangerous grates, tree pruning)
- Parking enforcement
- Sweeping
- Snow plowing

A smart phone application to handle other reporting needs could encompass the items listed above and give residents a one-stop-shop for reporting bicycle concerns in the same manner as other non-cycling issues. An example of a good online maintenance request form can be found on Salt Lake City's website at: http://apps.slcgov.com/general/absolutefp/trans_BikeRoute.htm.



An online maintenance request form is availble on the city's website

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8 Funding Sources

Funding for bicycle and pedestrian programs and infrastructure is administered at all levels of government. Summarized here are federal, state, and local funds that can be used for bicycle and pedestrian infrastructure and programs. Each section provides information on the purpose and eligibility requirements along with direction to additional information where available.

This section discusses:

- Federally Administered Funding
- State Administered Funding
- Local Funding
- Other Sources

Marked shared roadways such as this green lane in Salt Lake City help both drivers and bicyclists to understand where bicyclists should ride within the shared lane space

8.1 Federally Administered Funding

In July 2012, the newest federal transportation authorization bill was signed into law. Moving Ahead for Progress in the 21st Century (MAP-21) came about after a series of extensions of the previous federal transportation bill and took effect on October 1, 2012. While the legislation does make significant changes to how programs are packaged and funded and how funds are distributed, it is not expected that program eligibility and funding requirements at the local level will change substantially. Because the MAP-21 legislation is very new and many of the details and "rule making" have yet to be determined, it is likely that some of the individual components of these programs will change in the near future. It is in Lehi City's best interest to ensure that when applying for federal, state, or regional grants, they are operating under the most recent information, regulations, and requirements.

State Departments of Transportation (UDOT in Utah) and Metropolitan Planning Organizations (MPO) administer MAP-21 funding. In Utah County, the MPO is MAG. Most of these funding programs emphasize reliance on multiple transportation modes, reducing auto trips, and providing intermodal connections. Local match requirements are 6.77% or 20%, depending on the given program. Many of the specific programs are discussed in the State Administered Funding section later in this chapter, since funds are typically passed through to DOTs or MPOs.

8.1.1 Rivers, Trails, & Conservation Assistance Program

The Rivers, Trails, and Conservation Assistance Program (RTCA) of the US Department of the Interior National Park Service supports community-led natural resource conservation and outdoor recreation projects. The mission of the RTCA program is to implement the natural resource conservation and outdoor recreation mission of the National Park Service. RTCA works in urban, rural, and suburban communities with the goal of helping communities achieve their on-the-ground conservation successes for their projects.

The RTCA program provides technical assistance to its project partners by:

- Building partner relationships
- Helping partners define goals through consensus
- Developing conceptual, strategic, and workable project plans

- Helping the public participate in defining community goals
- Identifying potential sources of funding for project implementation
- Teaching "hands-on" conservation and other technical skills necessary to successfully realize conservation and outdoor recreation projects

RTCA works with nonprofit organizations, community groups, tribes or tribal governments, and local, state, or federal government agencies. Assistance is provided for one year and may be renewed for a second year, if warranted. Project applications are due annually on August 1st. Prospective applicants should contact their local RTCA office at least two weeks prior to applying for assistance to start the dialogue about a potential project application. RTCA does not award monetary grants or loans. Instead, they supply a staff person with experience in community-based outdoor recreation and conservation to work with partners.

Online resources: www.nps.gov/rtca

Utah RTCA Contact:

Marcy DeMillion
801-741-1012, ext 125
324 South State Street, Suite 200
Salt Lake City, Utah 84111

8.1.2 Congestion Mitigation Air Quality Improvement Program

The Congestion Mitigation Air Quality Improvement (CMAQ) is jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). This program supports surface transportation projects and other related efforts that contribute to air quality improvements and provide congestion relief. It was continued under MAP-21, and project sponsors can apply for funding for a variety of transportation projects that help attain or maintain

The RTCA program can be a valuable planning resource for communities

the National Ambient Air Quality Standards (NAAQS) as set by the Environmental Protection Agency (EPA) as a requirement of the Clean Air Act. Eligible activities include projects that shift traffic demand to non-peak hours or other transportation modes, increase vehicle occupancy rates, or otherwise reduce demand.

Online resources: www.fhwa.dot.gov/map21/cmaq.cfm

8.2 State Administered Funding

8.2.1 Transportation Alternatives Program

The Transportation Alternatives Program (TAP) generally replaces in MAP-21 the Transportation Enhancement Program authorized under the previous federal transportation bill. Funding amounts at the state level are equal to 2% of the total of all authorized federal-aid highway and highway research funds. Each state must use a specific portion of these funds for recreational trails projects (as discussed later in this chapter). Among the eligible activities are:

- Construction, planning, and design of on-road and off-road trail facilities for pedestrians, bicyclists, and other non-motorized forms of transportation, including sidewalks, bicycle infrastructure, and pedestrian and bicycle signals
- Construction, planning, and design of infrastructure-related projects and systems that will provide safe routes for non-drivers, including children, older adults, and individuals with disabilities to access daily needs
- Conversion and use of abandoned railroad corridors for trails for pedestrians, bicyclists, or other non-motorized transportation users

8.2.2 Safe Routes to School

The SRTS program was also continued under MAP-21, although there is no longer a dedicated funding component. UDOT provides Utah schools with walking and biking safety resources through the federally funded SRTS program. Federal SRTS funding can be used for two purposes: (1) educating children about how to walk and bike safely to school and (2) constructing infrastructure improvements, such as sidewalks, that increase the safety of children walking and biking to school.

Online resources: www.udot.utah.gov/srts

UDOT Contact:

Cherissa Wood
Utah Safe Routes to School Coordinator
cwood@utah.gov
801-965-4486

8.2.3 Federal Highway Administration Recreational Trails Program

The Recreational Trails Program (RTP) was also continued under MAP-21 although it now contains an option for governors to opt out. If they do not, the RTP continues to function just like it did under the previous federal transportation bill. It provides funds to states to develop and maintain

recreational trails and trail-related facilities for both non-motorized and motorized recreational users. Federal transportation funds benefit recreation including hiking, bicycling, in-line skating, equestrian use, cross-country skiing, snowmobiling, off-road motorcycling, all-terrain vehicle riding, and four-wheel driving.

The Combined Trails Advisory Council (a Utah-specific body) reviews the funding requests and provides funding recommendations. The Council generally meets in August to finalize the awards list. The finalized list of projects to be funded under RTP is submitted to the Director of the Division of State Parks and Recreation for administrative approval and funding. Projects authorized for funding are placed on UDOT's Statewide Transportation Improvement Program (STIP).

Online resources: www.fhwa.dot.gov/environment/recreational_trails/

Utah's Recreational Trails Program contact:

Chris Haller
801-349-0487
chrishaller@utah.gov
Utah State Parks
1594 West North Temple, Suite 116
Salt Lake City, Utah 84116

8.2.4 Land & Water Conservation Fund

The National Park Service provides oversight for The Land and Water Conservation Fund (LWCF) Act which was established by Congress in 1965 to provide funds for the acquisition and/or development of public outdoor recreation areas. These facilities can include, but are not limited to ball fields, sports courts, spray parks, golf courses, public restrooms, swimming pools, skate parks, and walking trails. Land acquisitions for public outdoor recreation are also LWCF-eligible. The program is administered locally by Utah State Parks. Any site or facility that is purchased, developed, or improved with funding from the LWCF is protected in perpetuity as a public outdoor recreation area. LWCF funding requires a 50% match from the applicant. The grant recipient must be able to fund 100% of the project up front and is reimbursed periodically by LWCF up to 50% of the costs. Eligible recipients include local governments, tribal governments, and state agencies.

Online resources: www.stateparks.utah.gov/grants/land-water; www.nps.gov/lwcf/

Utah's Land & Water Conservancy Fund contact:

Susan Zarekarizi
801-538-7496
susanzarekarizi@utah.gov
Utah State Parks
1594 West North Temple, Suite 116
Salt Lake City, Utah 84116

MAP-21 is the current federal transportation bill

8.2.5 Community Development Block Grants

Through the US Department of Housing and Urban Development (HUD), the Community Development Block Grant (CDBG) program provides annual grants on a formula basis to entitled cities, urban counties, and states to develop viable urban communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for low- and moderate-income persons. Eligible activities include, but are not limited to, acquisition of property for public purposes; construction or reconstruction of streets, water and sewer facilities, neighborhood centers, recreation facilities, and other public works; planning activities; and assistance to nonprofit entities for community development. HUD distributes funds to each State based on a statutory formula which takes into account population, poverty, incidence of overcrowded housing and age of housing. All funds (other than administrations and the technical assistance set-aside) are distributed by states to local government units.

Online resources: portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/stateadmin

For information about local US Department of Housing and Urban Development Community Planning and Development, contact:

Leroy P. Brown
Region 8
Denver Regional Office
1670 Broadway
Denver, Colorado 80202-4801
303-672-5076 ext 1326
Leroy.brown@hud.gov

8.2.6 Utah Department of Transportation – Long Range Plan

As part of the 2011-2040 Long Range Plan (LRP), which is a thirty-year plan for state transportation facilities in urban and rural areas, bicycle improvement projects are listed as part of capacity projects along State highways. Lehi City and UDOT can continue to work together on an ongoing basis to identify opportunities for implementation of bicycle and pedestrian facilities as part of capacity improvements.

8.2.7 Utah Department of Transportation – Maintenance Program

UDOT carries out a number of annual road resurfacing projects that are geared at maintenance. There may be opportunities for road re-striping to be completed as part of regular road maintenance. This will require coordination between Lehi City and UDOT to ensure that the pavement marking design is safe for cyclists and drivers.

8.3 Local Funding

Local funding sources are generally administered by MPOs and other regional agencies although counties or cities may administer some funding sources. Federal, state, and local revenue streams support these funding sources.

8.3.1 General Fund

A City's General Fund is often used to pay for maintenance expenses and limited capital improvement projects. Projects identified for reconstruction or repaving as part of the Capital Facilities Plan list should also implement recommendations for bicycle and pedestrian improvements in order to reduce additional cost.

8.3.2 Special Improvement Districts

Special Improvement Districts (SIDs) are most often used by cities to construct localized projects such as streets, sidewalks, or bikeways. Through the SID process, the costs of local improvements are generally spread out among a group of property owners within a specified area. The cost can be allocated based on property frontage or other methods such as traffic trip generation.

8.3.3 Business Improvement Area

Pedestrian and bicycle improvements can often be included as part of larger efforts aimed at business improvement and retail district beautification. Business Improvement Areas (BIAs) collect levies on business in order to fund area-wide improvements that benefit business and improve access for customers. These districts may include provisions for pedestrian and bicycle improvements, such as wide sidewalks, landscaping, and ADA compliance.

8.3.4 Local Bond Measures

Lehi City could issue bonds to fund bicycle and pedestrian improvements. This would spread the cost of the improvements over the life of the bonds. Certain types of bonds would require voter approval. The debt would have to be retired, so funding for repayment on the bond and the interest would be required.

8.3.5 Tax Increment Financing/Urban Renewal Funds

Tax Increment Financing (TIF) is a tool for using future tax revenue to finance the current improvements that will create those gains. When a public project such as a shared-use path is constructed, surrounding property values generally increase and encourage surrounding development or redevelopment. The increased tax revenues are then dedicated to finance the debt created by the original public improvement project. TIF typically occurs within designated

Lehi is comprised of both new areas with wide streets and rural areas with narrow roads

Urban Renewal Areas (URA) that meet certain economic criteria and are approved by a local governing body. To be eligible for this financing, a project (or a portion of it) must be located within the URA.

8.3.6 Developer Impact Fees

Lehi City could institute developer impact fees to fund bicycle and pedestrian improvements. Developer impact fees are typically tied to trip generation rates and traffic impacts produced by a proposed project. A developer may reduce the number of trips (and hence impacts and cost) by paying for on- and off-site bikeway improvements that will encourage residents to bicycle rather than drive. Establishing a clear nexus or connection between the impact fee and the project's impacts is critical.

8.4 Other Sources

8.4.1 Community Action for a Renewed Environment

The Community Action for a Renewed Environment (CARE) program helps communities address multiple sources of toxic pollutants in their environment. CARE supports communities by providing tools, technical support, and funding to enable them to use other voluntary programs of the community's choice to reduce emissions and exposures. The goals of the CARE Program are to reduce exposure to toxic pollutants through collaborative action at the local level; help communities understand all potential sources of exposure to toxic pollutants; work with communities to set priorities for risk-reduction activities; and create self-sustaining, community-based partnerships that will continue to improve the local environment. Eligible organizations include non-profit organizations, federally-recognized Indian tribal governments, Native American organizations, local governments, colleges, and universities.

CARE offers two different types of grants: Level 1 and Level 2. Level 1 grants help communities to join together to form a broad-based partnership dedicated to reducing toxic pollutants and environmental risks in their local environment. Level 2 grants help communities to identify problems and solutions. They are intended for communities that already have established broad-based collaborative partnerships and have completed environmental assessments.

Online resources: www.epa.gov/care/

8.4.2 Bikes Belong Coalition

The Bikes Belong Coalition accepts grant applications from organizations and agencies that are committed to putting more people on bicycles more often. Fundable projects include paved paths, lanes, and rail-trails as well as mountain bike trails, bike parks, BMX facilities, and large-scale bicycle advocacy initiatives. The Bikes Belong Grants Program has two application categories: facility and advocacy. For the facility category, Bikes Belong will accept applications from non-profit organizations whose missions are bicycle and/or trail specific. They also accept applications from public agencies and departments at the national, state, regional, and local levels. However, Bikes Belong encourages these municipalities to align with a local bicycle advocacy group that will help develop and advance the project or program. A key goal of the Bikes Belong grants program is to support bicycling in as many places as possible.

Online Resources: www.bikesbelong.org

8.4.3 Private Foundations

Various private foundations provide funds for bicycling and walking infrastructure. Through research at the national Foundation Center, individuals and organizations can find funders, instructions, and grant applications to help fund projects.

Online Resources: www.foundationcenter.org

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Appendix A: Design Guidelines

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Contents

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Introduction

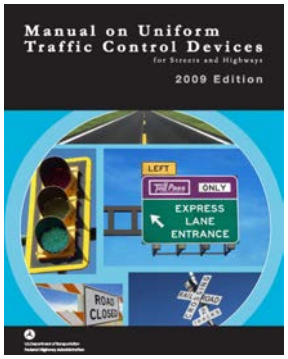
This technical handbook is intended to assist Lehi City in the selection and design of bicycle and pedestrian facilities. The following chapters pull together best practices by facility type from public agencies and municipalities nationwide. Within the design chapters, treatments are covered within a single sheet tabular format relaying important design information and discussion, example photos, schematics (if applicable), and existing summary guidance from current or upcoming draft standards. Existing standards are referenced throughout and should be the first source of information when seeking to implement any of the treatments featured here.

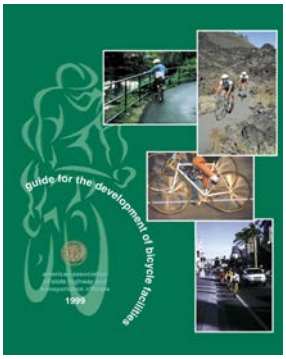
Guiding Principles

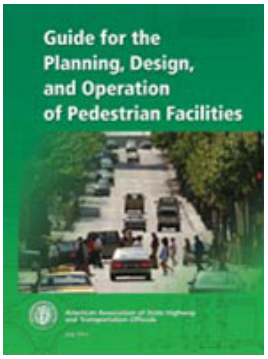
The following are guiding principles for these bicycle and pedestrian design guidelines:

- **The walking and bicycling environment should be safe.** All bicycling and walking routes should 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 should 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 should employ principles of universal design. Bicyclists have a range of skill levels, and facilities should 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 should be economical.** Pedestrian and bicycle improvements should 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 should stimulate, reinforce and connect with adjacent private improvements.
- **The pedestrian and bicycle network should 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 should connect seamlessly to existing and proposed shared use paths to complete recreational and commuting routes.
- **The walking and bicycling environment should be clear and easy to use.** Shared-use paths and crossings should 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 bicyclists (except where they are expressly prohibited). This means that most streets are bikeways and should be designed, marked and maintained accordingly.
- **The walking and bicycling environment should enhance community livability.** Good design should 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 might 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, should 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.
- **Design guidelines are flexible and should 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 should be used.

National Standards







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.

Offering 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.

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]

The 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 standards and 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.

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 many complexities of urban streets.

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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*

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 Federal Guidelines

- American Association of State Highway and Transportation Officials. (2001). *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

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 Chicago and the Pedestrian and Bicycle Information Center (PBIC). (2002). *Bike Lane Design Guide.* http://www.activelivingresources.org/assets/chicagosbikelanedesignguide.pdf
- 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.bicyclinginfo.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.tfhrc.gov/safety/pubs/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. (1995). *Oregon Bicycle and Pedestrian Plan.* http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets.*

Glossary

The following list is comprised of common terms, acronyms and concepts used in bicycle transportation planning, design and operation.

AASHTO – American Association of State Highway and Transportation Officials.

Accessible route – A continuous route on private property that is accessible to persons with disabilities. There must be at least one accessible route linking the public sidewalk to each accessible building.

Actuated signal – A signal where the length of the phases for different traffic movements is adjusted for demand by a signal controller using information from detectors.

ADA – Americans with Disabilities Act of 1990; broad legislation mandating provision of access to employment, services, and the built environment to those with disabilities.

At-grade crossing – A junction where a shared use path or sidewalk users cross a roadway over the same surface as motor vehicle traffic, as opposed to a grade-separated crossing where users cross over or under the roadway using a bridge or tunnel.

Audible pedestrian signals – Pedestrian signal indicators that provide an audible signal to assist visually impaired pedestrians in crossing the street.

Bicycle boulevard - Streets designed to give bicyclists priority by reducing motor vehicle volumes and speeds using barriers or other design elements, in order to enhance bicycle safety and enjoyment.

Bicycle facilities - A general term used to describe all types of bicycle-related infrastructure including linear bikeways and other provisions to accommodate or encourage bicycling, including bike racks and lockers, bikeways, and showers at employment destinations.

Bike lane - A striped lane for one-way bike travel on a street or highway.

Bike route - A shared roadway specifically identified for use by bicyclists, providing a superior route based on traffic volumes and speeds, street width, directness, and/or cross-street priority; designated by signs only.

Bikeway – A generic term for any road, street, path or way that in some manner is specifically designed for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

Bollard – Post used to restrict motor vehicle use of space dedicated to bicyclists and/or pedestrians.

Clearance interval – The length of time that the DON'T WALK indication is flashing on a pedestrian signal indication.

Clearance, lateral – Width required for safe passage of people riding bicycles as measured on a horizontal plane.

Clearance, vertical – Height required for safe passage of people riding bicycles as measured on a vertical plane.

Crosswalk – Any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing. Where there are no pavement markings, there is a crosswalk at each leg of every intersection, defined by law as the prolongation or connection of the lateral lines of the sidewalks.

Curb extension – An area where the sidewalk and curb are extended into the parking lane, usually in order to shorten pedestrian crossing distance. Also called "bulb-out" or "curb bulb."

Curb ramp – A combined ramp and landing to accomplish a change of level at a curb in order to provide access to pedestrians using wheelchairs.

Directional signs – Signs typically placed at road and bikeway junctions (decision points) to guide people riding bicycles toward a destination or experience.

Geometry - The vertical and horizontal characteristics of a transportation facility, typically defined in terms of gradient, radius, and superelevation.

Grade separation - Vertical separation of travelways through use of a bridge or tunnel so that traffic conflicts are minimized.

Grade-separated crossing – A bridge or tunnel allowing pedestrians and bicyclists to cross a major roadway without conflict.

Loop detector - A device placed under the pavement at intersections to detect a vehicle or bicycle and subsequently trigger a signal to turn green.

Medians – Area in the center of the roadway that separates directional traffic; may provide a striped crossing and halfway point for pedestrians (also can be effective traffic calming design). Medians may be level with the surrounding roadway or "raised" using curb and/or gutter. Medians may include landscaping, concrete, paint/striping or any combination thereof.

MUTCD – Manual on Uniform Traffic Control Devices.

Paved shoulder – The edge of the roadway beyond the outer stripe edge that provides a place for people riding bicycles. It only functions well for bicyclists if it is wide enough (4-5 feet), free of debris, and does not contain rumble strips or other obstructions.

Pavement marking – An assortment of markings on the surface of the pavement that provide directions to motorists and other road users as to the proper use of the road (the MUTCD determines these standard markings).

Pedestrian – A person afoot; a person operating a pushcart; a person riding on, or pulling a coaster wagon, sled, scooter, tricycle, bicycle with wheels less than 14 inches in diameter, or a similar conveyance; a person on roller skates, skateboard, wheelchair or a baby in a carriage.

Pedestrian signal indication – The lighted WALK/DON'T WALK (or walking man/hand) signal that indicates the pedestrian phase.

Refuge islands – Corner raised triangles or medians, used by pedestrians and bicyclists at intersections or mid-block crossings for assistance with crossing wide streets, especially where channelized motor vehicle right turn lanes exist.

Right-of-way (ROW) - The right of one vehicle, bicycle or pedestrian to proceed in a lawful manner in preference to another vehicle, bicycle, or pedestrian. Also the strip of property in which a transportation facility or other facility is built.

Shared lane marking (SLM) or **Sharrow** – A pavement marking that designates roadway space to be shared between drivers and people riding bicycles.

Shared roadway - A roadway where bicyclists and motor vehicles share the same space with no striped bike lane. Any roadway where bicycles are not prohibited by law and designated space for bicycles (e.g. bike lanes) is not provided is a shared roadway.

Shared use path – A paved right-of way that permits more than one type of user, such as a trail designated for use by both pedestrians and bicyclists.

Sidewalk – An improved facility intended to provide for pedestrian movement; usually, but not always, located in the public right-of-way adjacent to a roadway. Typically constructed of concrete.

Sight distance - The distance a person can see along an unobstructed line of sight.

Traffic calming - Changes in street alignment, installation of barrier, and other physical measures to reduce traffic speeds and/or cut-through traffic volume in the interest of street safety, livability, and other public purposes.

Traffic control devices - Signs, signals or other fixtures, whether permanent or temporary, placed on or adjacent to a travelway by authority of a public body having jurisdiction to regulate, warn, or guide traffic.

Traffic volume - The number of vehicles that pass a specific point in a specific amount of time (hour, day, year).

Wide curb lane – A 14 foot (or greater) wide outside lane adjacent to the curb of a roadway that provides space for bicyclists to ride to the right of motor vehicles. Also referred to as a "wide outside lane". If adjacent to parking, 22 foot wide pavement may also be considered a wide curb lane.

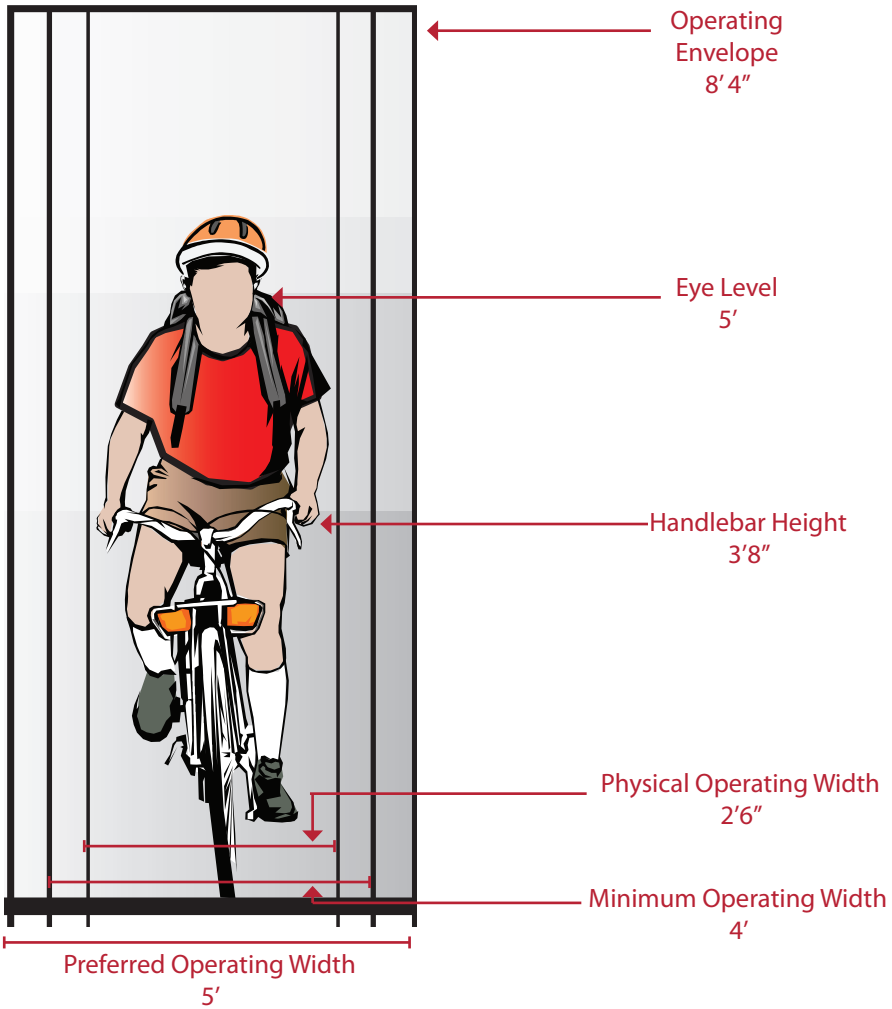
Design Needs of Bicyclists

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.

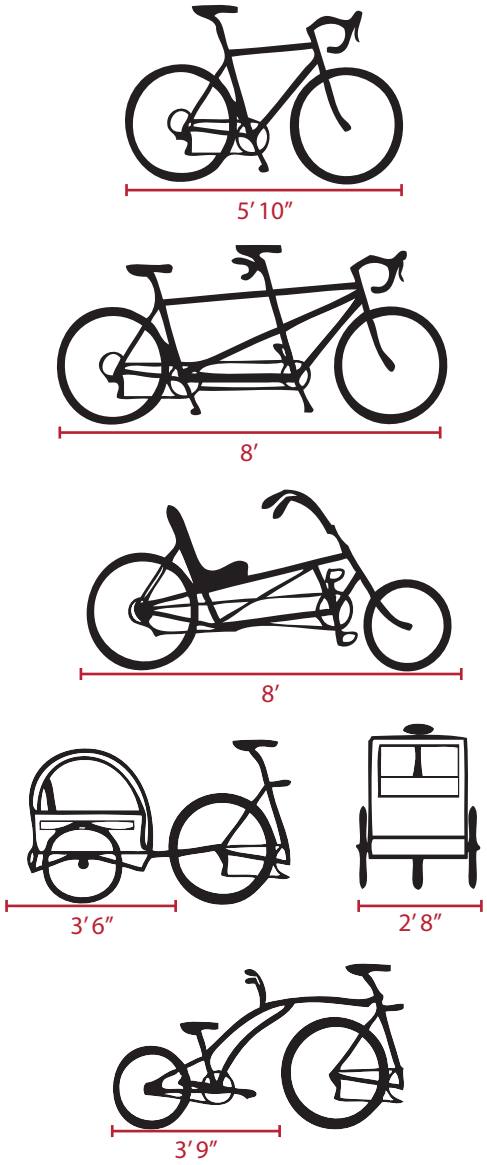
The figure below illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist.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



Standard Bicycle Rider Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition

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 bikeways. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. The figures and tables below summarize the typical dimensions for bicycle types.



Bicycle as Design Vehicle - Typical Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition *AASHTO does not provide typical dimensions for tricycles.

Bicycle as Design Vehicle - Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
	Vertical clearance to obstructions (tunnel height, lighting, etc)	10 ft
	Approximate center of gravity	2 ft 9 in - 3 ft 4 in
Recumbent Bicyclist	Physical length	8 ft
	Eye height	3 ft 10 in
Tandem Bicyclist	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 8 in

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.

Bicycle as Design Vehicle - Design Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	15 mph
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5 -12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

*Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

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 roadways. 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.

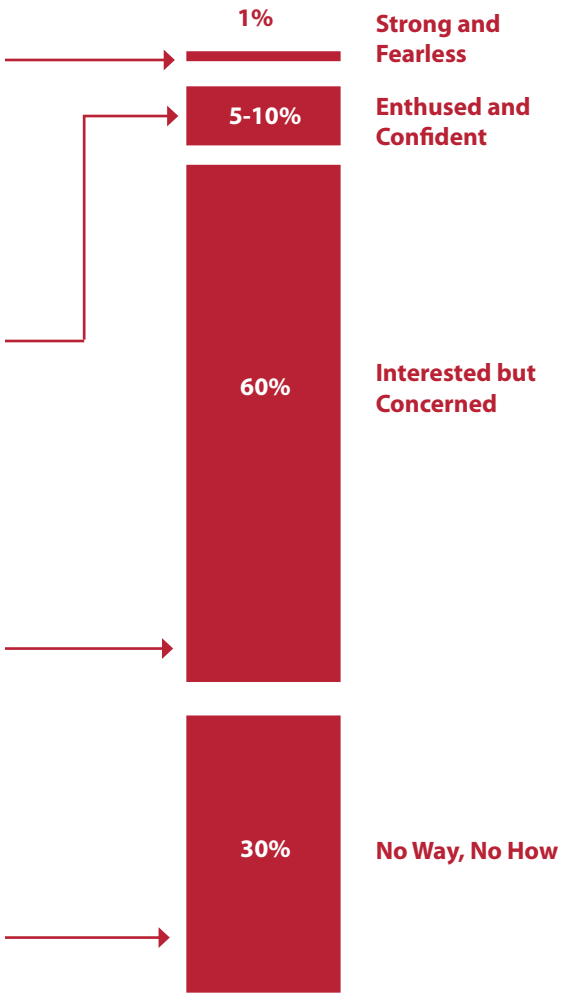
The bicycle planning and engineering professions currently use several systems to classify the population, which can assist in understanding the characteristics and infrastructure preferences of different bicyclists. The most conventional framework classifies the "design cyclist" as *Advanced*, *Basic*, 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:

- **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 bikeways 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 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 population and represents bicyclists who typically only ride on low traffic streets or shared use paths under favorable weather conditions. These peopl perceive significant barriers to increased cycling, specifically traffic and other safety issues. These people may become "Enthused & Confident" with encouragement, education and experience.

- **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.



Typical Distribution of Bicyclist Types

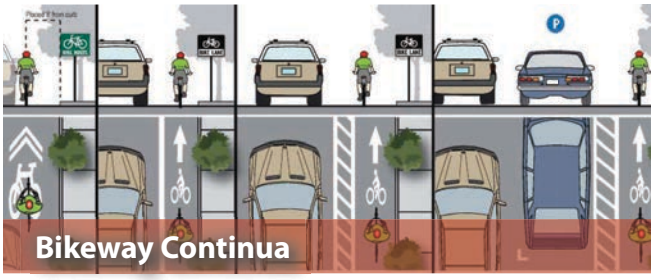
1 *Selecting Roadway Design Treatments to Accommodate Bicycles. (1994). Publication No. FHWA-RD-92-073*

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

Bikeway Selection Guidelines

This section summarizes the bikeway selection typology developed for Lehi City. The specific bikeway type that should be provided depends on the surrounding environment (e.g. auto speed and volume, topography, and adjacent land use) and expected bicyclist needs (e.g. bicyclists commuting on a highway versus students riding to school on residential streets).


Bikeway Classification


Bikeway Continua

Bikeway Selection Guidelines

There are no hard and fast rules for determining the most appropriate type of bikeway for a particular location. Roadway speeds, volumes, right-of-way width, presence of parking, adjacent land uses, and expected bicycle user types are all critical elements of this decision. Studies find that the most significant factors influencing bicycle use are motor vehicle traffic volumes and speeds. Additionally, most people prefer facilities separated from motor vehicle traffic or located on local roads with low motor vehicle traffic speeds and volumes. Because off-street pathways are physically separated from the roadway, they are perceived as safe and attractive routes for bicyclists who prefer to avoid motor vehicle traffic. Consistent use of treatments and application of bikeway facilities allow users to anticipate whether they would feel comfortable riding on a particular facility, and plan their trips accordingly. This section provides guidance on various factors that affect the type of facilities that should be provided.

Bikeway Selection Guidelines

Bikeway Classification

Description

Consistent with bikeway classifications throughout the nation, these Bikeway Design Guidelines identify the following bikeway classes by degree of separation from motor vehicle traffic.

Shared Roadways are bikeways where bicyclists and cars operate within the same travel lane, either side by side or in single file depending on roadway configuration. The most basic type of bikeway is a signed shared roadway. This facility is used to connect other bikeways (usually bike lanes), or designate preferred routes through high-demand corridors.

Shared Roadways may also be designated by pavement markings, signage and other treatments including directional signage, traffic diverters, chicanes, chokers and/or other traffic calming devices to reduce vehicle speeds or volumes. Such treatments often are associated with **Bicycle Boulevards.**

Separated Bikeways, such as bike lanes, use signage and striping to delineate the right-of-way assigned to bicyclists and motorists. Bike lanes encourage predictable movements by both bicyclists and motorists.

Cycle Tracks are bikeways that combine the user experience of a separated path with the on-street infrastructure of conventional bike lanes.

Shared Use Paths are bikeways in rights of way separate from roads, and are for the use of bicyclists, pedestrians, and other non-motorized users such as skateborders and rollerbladers.

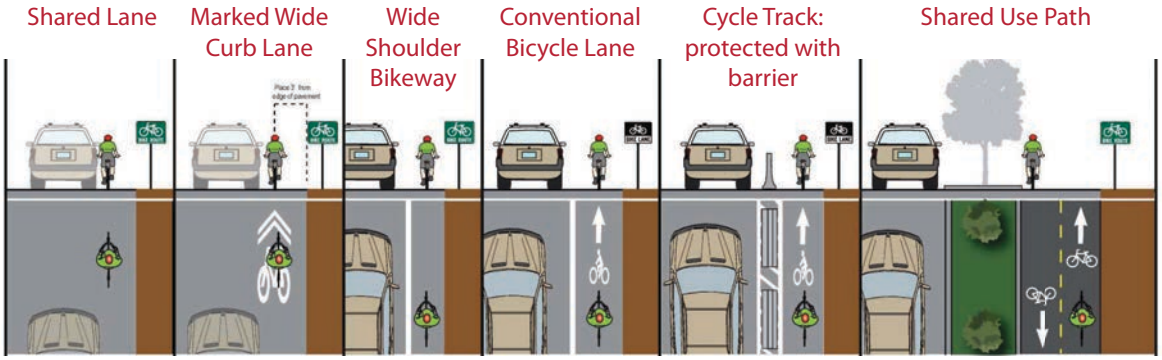
Bikeway Selection Guidelines

Bikeway Continua

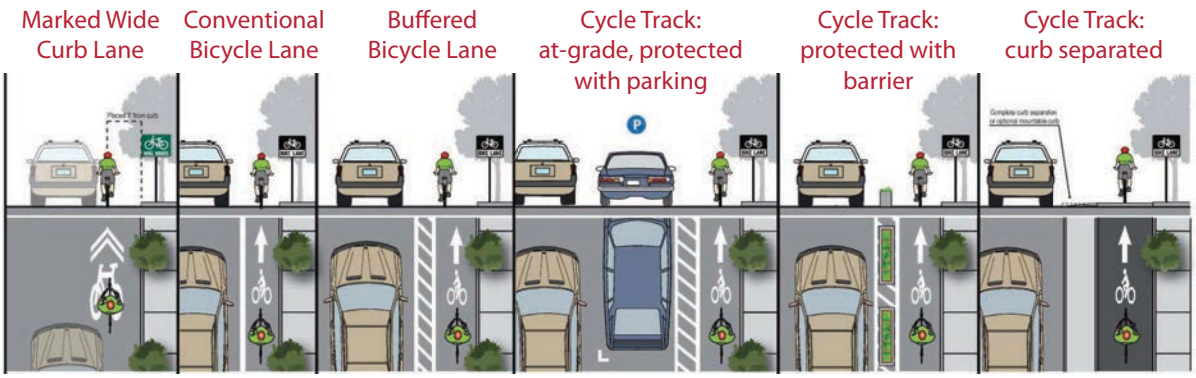
The following continua illustrate the range of bikeways applicable to various roadway environments, based on the roadway type and desired degree of separation. Engineering judgment, traffic studies, previous municipal planning efforts, community input and local context should be used to refine criteria when developing bikeway recommendations for a particular street. In some corridors, it may be desirable to construct facilities to a higher level of treatment than those recommended in relevant planning documents in order to enhance user safety and comfort. In other cases, existing and/or future motor vehicle speeds and volumes may not justify the recommended level of separation, and a less intensive treatment may be acceptable.

Least Protected → Most Protected

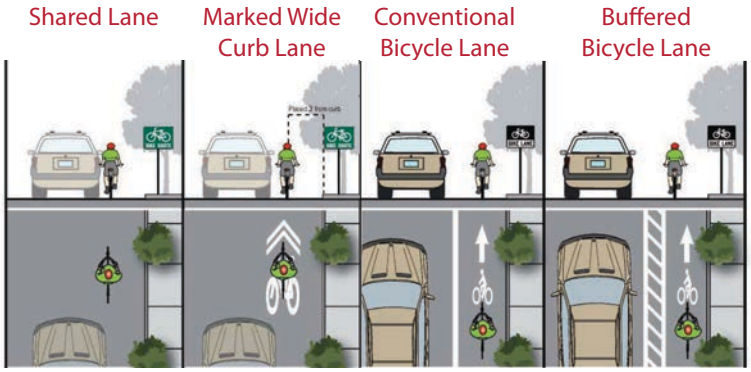
Arterial/Highway Bikeway Continuum (without curb and gutter)



Arterial/Highway Bikeway Continuum (with curb and gutter)



Collector Bikeway Continuum



Design Needs of Pedestrians

Types of Pedestrians

Similar to bicyclists, pedestrians have a variety of characteristics and the transportation network should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have low eye height and walk at slower speeds than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing. The table below summarizes common pedestrian characteristics for various age groups.

The MUTCD recommends a normal walking speed of three and a half feet per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to three feet per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the transportation system should accommodate these users to the greatest reasonable extent.

The table on the following page summarizes common physical and cognitive impairments, how they affect personal mobility, and recommendations for improved pedestrian-friendly design.

Pedestrian Characteristics by Age

Age	Characteristics
0-4	Learning to walk
	Requires constant adult supervision
	Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision
	Poor depth perception
9-13	Susceptible to "dart out" intersection dash
	Poor judgment
	Sense of invulnerability
14-18	Improved awareness of traffic environment
	Poor judgment
19-40	Active, fully aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street
	Vision loss
	Difficulty hearing vehicles approaching from behind

Source: AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities (July 2004), Exhibit 2-1.

Disabled Pedestrian Design Considerations

Impairment	Effect on Mobility	Design Solution
Wheelchair and Scooter Users	Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
	Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
	Require wider path of travel.	Sufficient width and maneuvering space.
Walking Aid Users	Difficulty negotiating steep grades and cross slopes; decreased stability.	Smooth, non-slipperly travel surface.
	Slower walking speed and reduced endurance; reduced ability to react.	Longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture.
Hearing Impairment	Less able to detect oncoming hazards at locations with limited sight lines (e.g. driveways, angled intersections, channelized right turn lanes) and complex intersections.	Longer pedestrian signal cycles, clear sight distances, highly visible pedestrian signals and markings.
Vision Impairment	Limited perception of path ahead and obstacles; reliance on memory; reliance on non-visual indicators (e.g. sound and texture).	Accessible text (larger print and raised text), accessible pedestrian signals (APS), guide strips and detectable warning surfaces, safety barriers, and lighting.
Cognitive Impairment	Varies greatly. Can affect ability to perceive, recognize, understand, interpret, and respond to information.	Signs with pictures, universal symbols, and colors, rather than text.

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

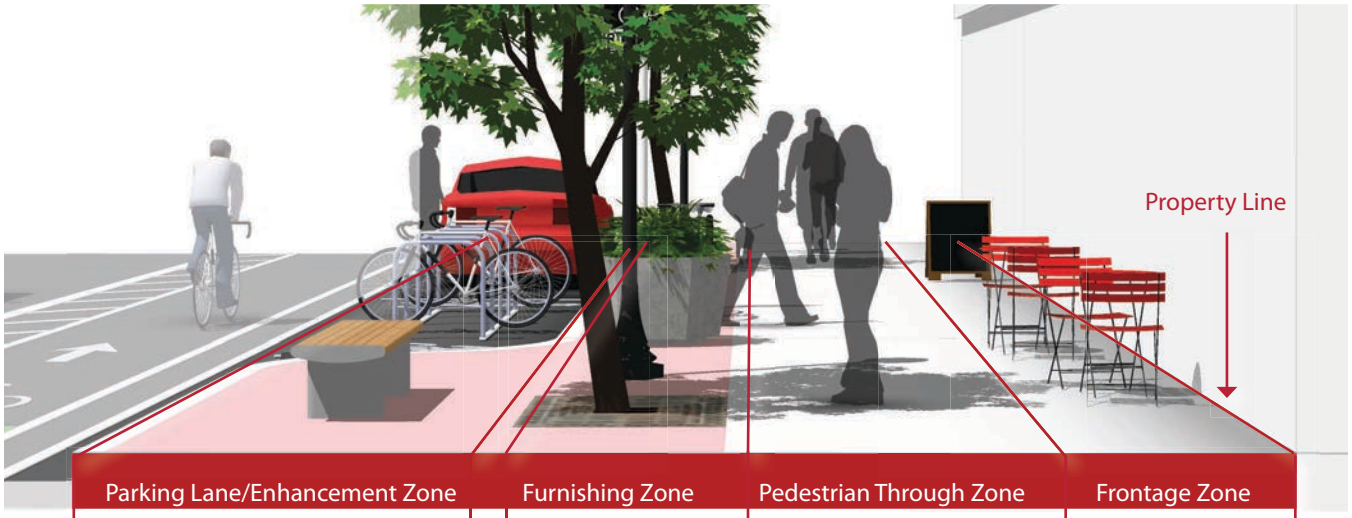
Pedestrian Access Through Construction Areas

Sidewalks

Zones in the Sidewalk Corridor

Description

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. A variety of considerations are important in sidewalk design. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved safety, and the creation of social space.



Parking Lane/Enhancement Zone	Edge Zone	Furnishing Zone	Pedestrian Through Zone	Frontage Zone
The parking lane can act as a flexible space to further buffer the sidewalk from moving traffic. Curb extensions and bike corrals may occupy this space where appropriate. In the edge zone there should be a 6 inch wide curb.		The furnishing zone buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, signs, and other street furniture are properly located.	The through zone is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects. Wide through zones are needed in downtown areas or where pedestrian flows are high.	The Frontage Zone allows pedestrians a comfortable "shy" distance from the building fronts. It provides opportunities for window shopping, to place signs, planters, or chairs. Not applicable if adjacent to a landscaped space.

Discussion

Sidewalks should be more than areas to travel; they should provide places for people to interact. There should be places for standing, visiting, and sitting. Sidewalks should contribute to the character of neighborhoods and business districts, strengthen their identity, and be an area where adults and children can safely participate in public life.

Additional References and Guidelines

USDOJ. (2010). ADA Standards for Accessible Design.
United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped space. Colored, patterned, or stamped concrete can add distinctive visual appeal.

Sidewalks

Sidewalk Widths

Description

The width and design of sidewalks will vary depending on street context, functional classification, and pedestrian demand. Below are preferred widths of each sidewalk zone according to general street type. Standardizing sidewalk guidelines for different areas of the city, dependent on the above listed factors, ensures a minimum level of quality for all sidewalks.

Street Classification	Parking Lane/ Enhancement Zone	Furnishing Zone	Pedestrian Through Zone	Frontage Zone	Total
Local Streets	Varies	2 - 5 feet	4 - 6 feet	N/A	6 - 11 feet
Commercial Areas	Varies	4 - 6 feet	6 - 12 feet	2 - 10 feet	12 - 28 feet
Arterials and Collectors	Varies	2 - 6 feet	4 - 8 feet	2 - 5 feet	8 -19 feet

Areas that have significant accumulations of snow during the winter may prefer a wider furnishing zone for snow storage.

Six feet enables two pedestrians (including wheelchair users) to walk side-by-side, or to pass each other comfortably

Discussion

It is important to provide adequate width along a sidewalk corridor. Two people should be able to walk side-by-side and pass a third comfortably. In areas of high demand, sidewalks should contain adequate width to accommodate the high volumes and different walking speeds of pedestrians. ADA requires a 4 foot clear width in the pedestrian zone plus 5 foot passing areas every 200 feet.

Additional References and Guidelines

United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
USDOJ. (2010). ADA Standards for Accessible Design.
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped space. Surfaces must be firm, stable, and slip resistant. Colored, patterned, or stamped concrete can add distinctive visual appeal.

Sidewalks

Sidewalk Obstructions and Driveway Ramps

Description

Obstructions to pedestrian travel in the sidewalk corridor typically include driveway ramps, curb ramps, sign posts, utility and signal poles, mailboxes, fire hydrants and street furniture.

Guidance

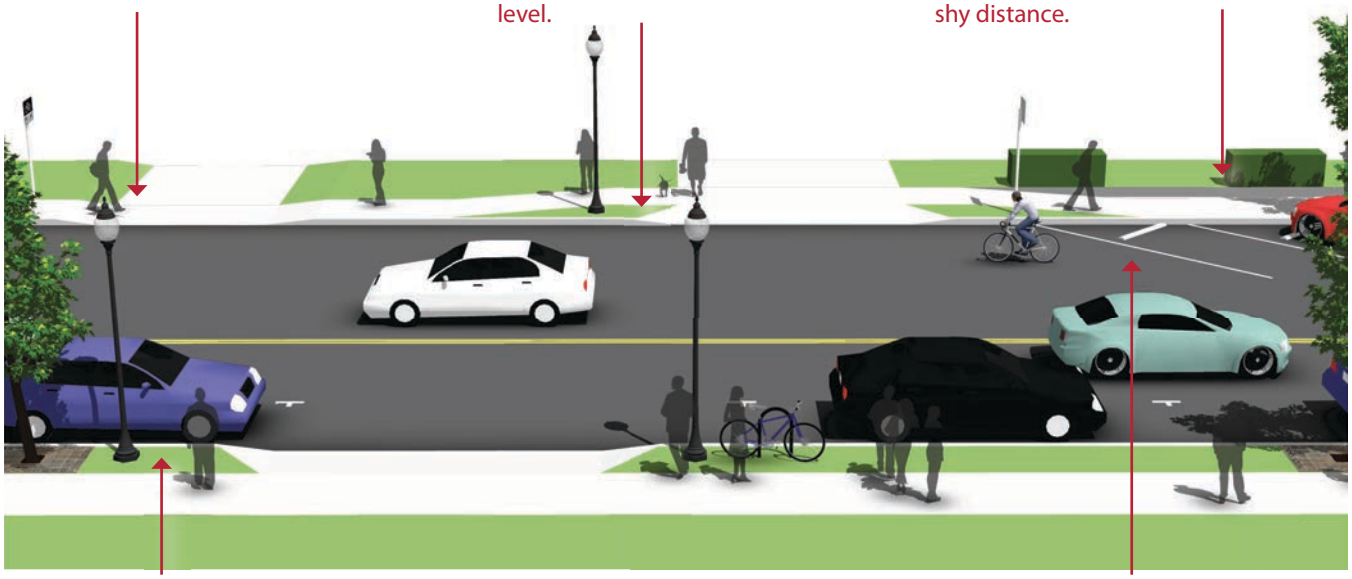
Reducing the number of accesses reduces the need for special provisions. This strategy should be pursued first.

Obstructions should be placed between the sidewalk and the roadway to create a buffer for increased pedestrian comfort.

Dipping the entire sidewalk at the driveway approaches keeps the cross-slope at a constant grade. This is the least preferred driveway option.

Where constraints preclude a planter strip, wrapping the sidewalk around the driveway allows the sidewalk to still remain level.

When sidewalks abut hedges, fences, or buildings, an additional two feet of lateral clearance should be added to provide appropriate shy distance.



Planter strips allow sidewalks to remain level, with the driveway grade change occurring within the planter strip.

When sidewalks abut angled on-street parking, wheel stops should be used to prevent vehicles from overhanging in the sidewalk.

Discussion

Driveways are a common sidewalk obstruction, especially for wheelchair users. When constraints only allow curb-tight sidewalks, dipping the entire sidewalk at the driveway approaches keeps the cross-slope at a constant grade. However, this may be uncomfortable for pedestrians and could create drainage problems behind the sidewalk.

Additional References and Guidelines

USDOJ. (2010). ADA Standards for Accessible Design.
United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped space. Surfaces must be firm, stable, and slip resistant.

Sidewalks

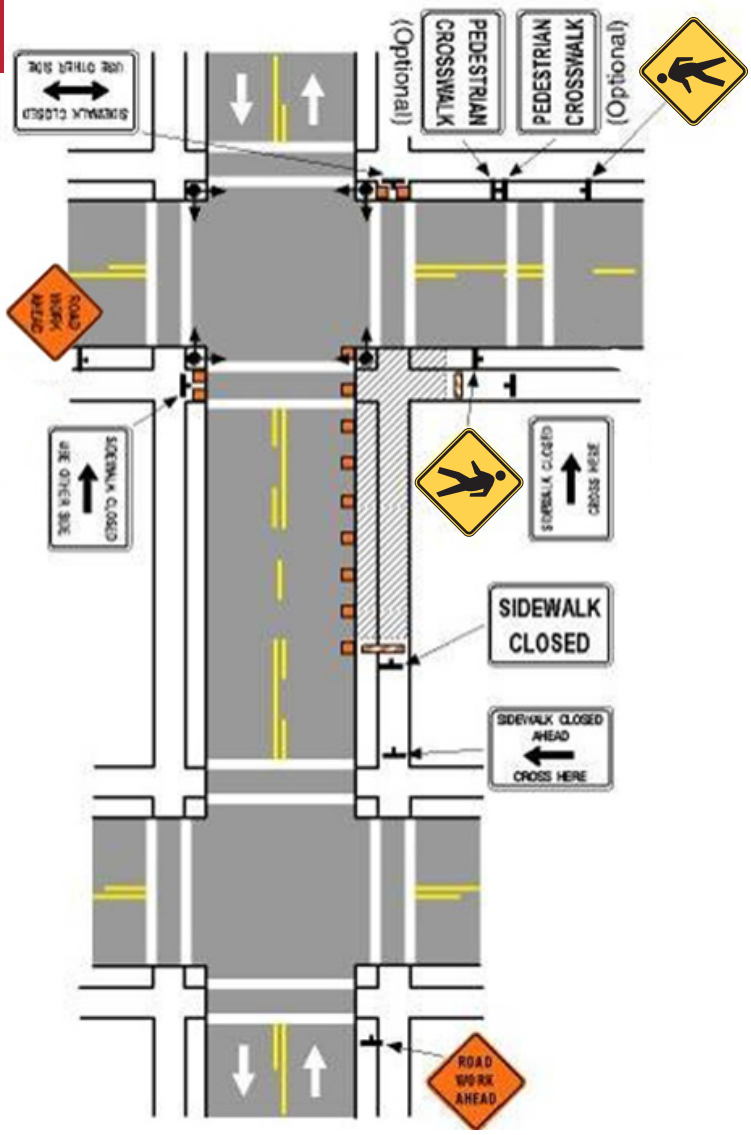
Pedestrian Access Through Construction Areas

Description

Measures should be taken to provide for the continuity of a pedestrian's trip through a construction closure. Only in rare cases should pedestrians be detoured to another street when travel lanes remain open.

Guidance

- Pedestrians should be provided with a safe, accessible, convenient path that replicates as nearly as practical the most desirable characteristics of the existing sidewalks. The alternate circulation path should be parallel to the disrupted pedestrian access route, be located on the same side of the street, and accommodate the disabled.
- The alternate route should have a width of 5 feet minimum.
- In rare cases where access is not available on the same side of the street, the alternate pedestrian route may be located on the opposite side of the street as long as the distance of the disrupted pedestrian route does not exceed 300 feet.
- Signage related to construction activities should be placed in a location that does not obstruct the path of bicycles or pedestrians, including bicycle lanes, wide curb lanes, or sidewalks.



Discussion

The removal of a pedestrian access route, curb ramp, or pedestrian street crossing, even for a short time, may severely limit or totally preclude pedestrians, especially those with a disability, from navigating in the public right-of-way. It might also preclude access to buildings, facilities, or sites on adjacent properties.

Additional References and Guidelines

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

Materials and Maintenance

The alternate route should include sidewalks and pedestrian access routes, curb ramps, pedestrian crossings, lighting, and all other elements included in these standards.

Pedestrians at Intersections

Attributes of pedestrian-friendly intersection design include:

Clear Space: Corners should be clear of obstructions. They should also have enough room for curb ramps, for transit stops where appropriate, and for street conversations where pedestrians might congregate.

Visibility: It is critical that pedestrians on the corner have a good view of vehicle travel lanes and that motorists in the travel lanes can easily see waiting pedestrians.

Legibility: Symbols, markings, and signs used at corners should clearly indicate what actions the pedestrian should take.

Accessibility: All corner features, such as curb ramps, landings, call buttons, signs, symbols, markings, and textures, should meet accessibility standards and follow universal design principles.

Separation from Traffic: Corner design and construction should be effective in discouraging turning vehicles from driving over the pedestrian area. Crossing distances should be minimized.

Lighting: Adequate lighting is an important aspect of visibility, legibility, and accessibility.

These attributes will vary with context but should be considered in all design processes.

See **Accommodating Pedestrians at Signalized Crossings** for a discussion of signalization in support of pedestrians.


Median Refuge Islands


Minimizing Curb Radii


Curb Extensions


Advance Stop Bar


Marked Crosswalks

Parking Control


Raised Crosswalks


ADA Compliant Curb Ramps

Pedestrians at Intersections

Marked Crosswalks

Guidance

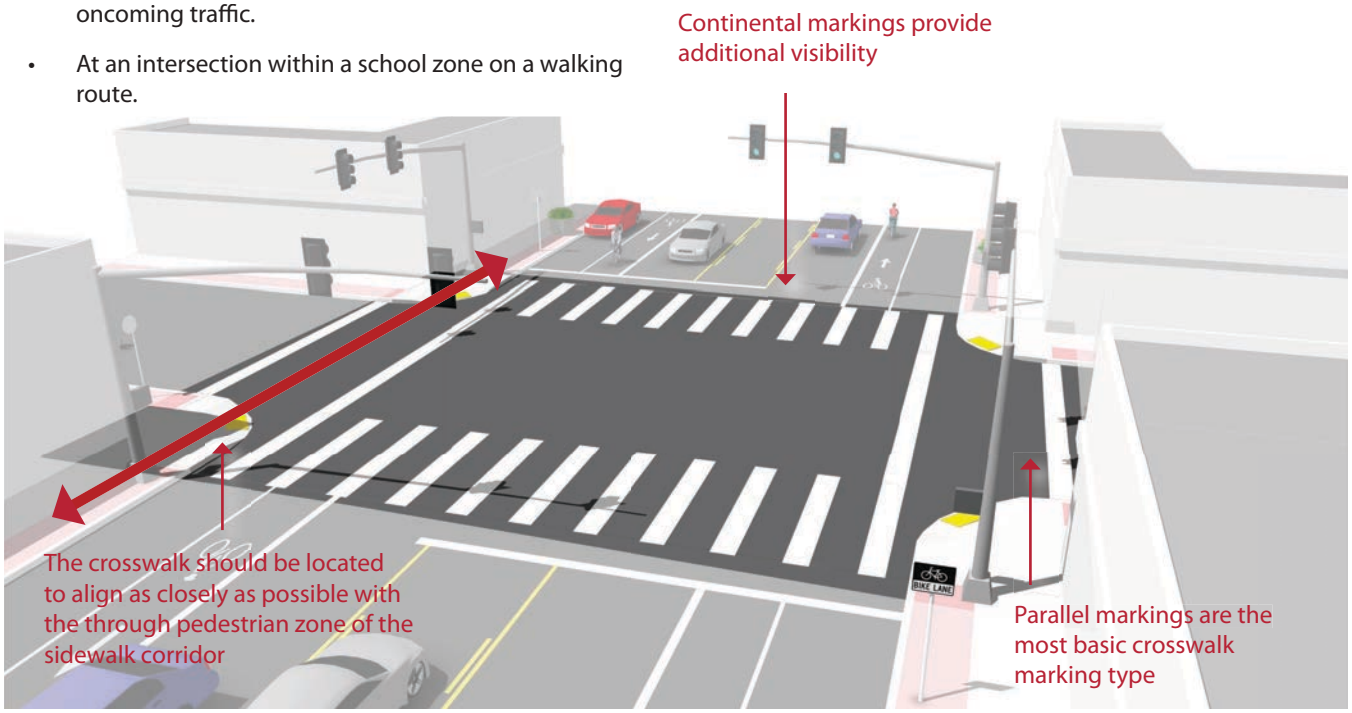
At signalized intersections, all crosswalks should be marked. At un-signalized intersections, crosswalks may be marked under the following conditions:

- 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.
- At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.
- At an intersection within a school zone on a walking route.

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.



Discussion

Continental crosswalk 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 **Accommodating Pedestrians at Signalized Crossings** 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 greater durability than conventional paint.

Pedestrians at Intersections

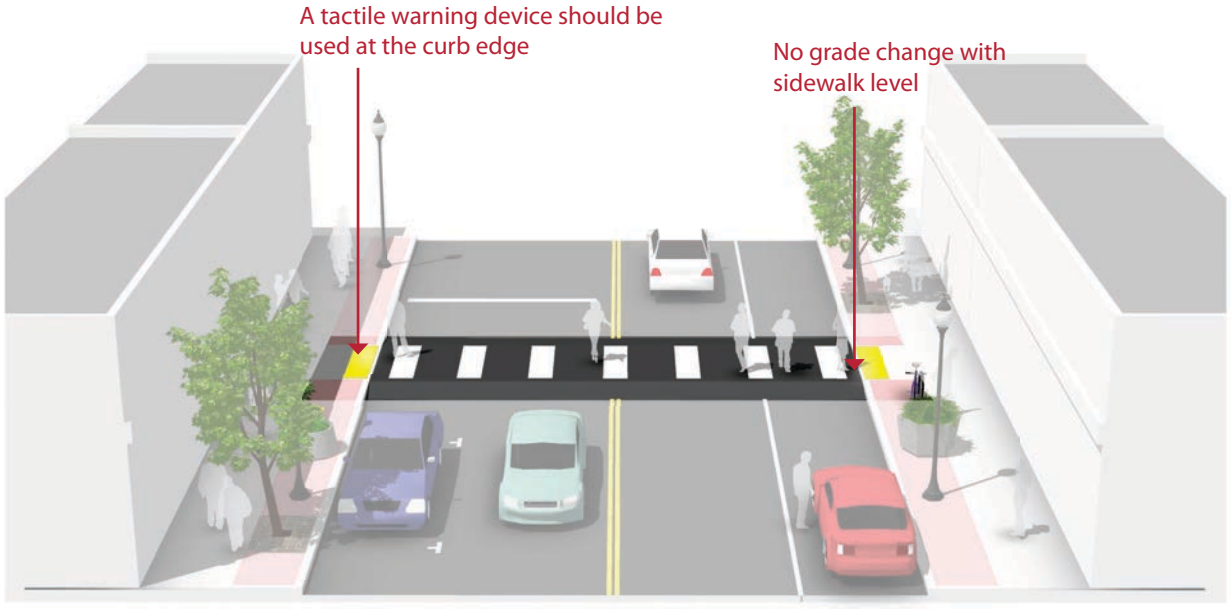
Raised Crosswalks

Guidance

- Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- Approaches to the raised crosswalk may be designed to be similar to speed humps.
- Raised crosswalks can also be used as a traffic calming treatment.

Description

A raised crosswalk or intersection can eliminate grade changes from the pedestrian path and give pedestrians greater prominence as they cross the street. Raised crosswalks should be used only in very limited cases where a special emphasis on pedestrians is desired; review on case-by-case basis.



Discussion

Like a speed hump, raised crosswalks have a traffic slowing effect which may be unsuitable on emergency response routes.

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.
USDOJ. (2010). ADA Standards for Accessible Design.

Materials and Maintenance

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

Pedestrians at Intersections

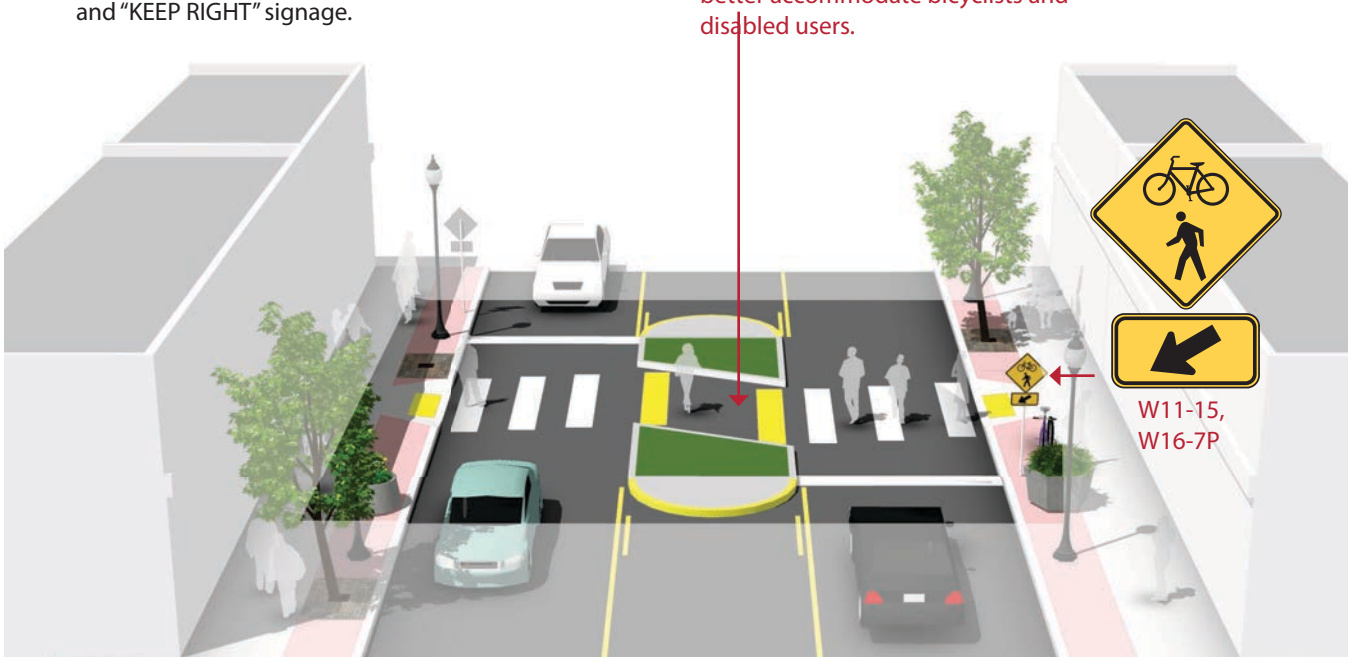
Median Refuge Islands

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.

Description

Median refuge islands 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.



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.

Pedestrians at Intersections

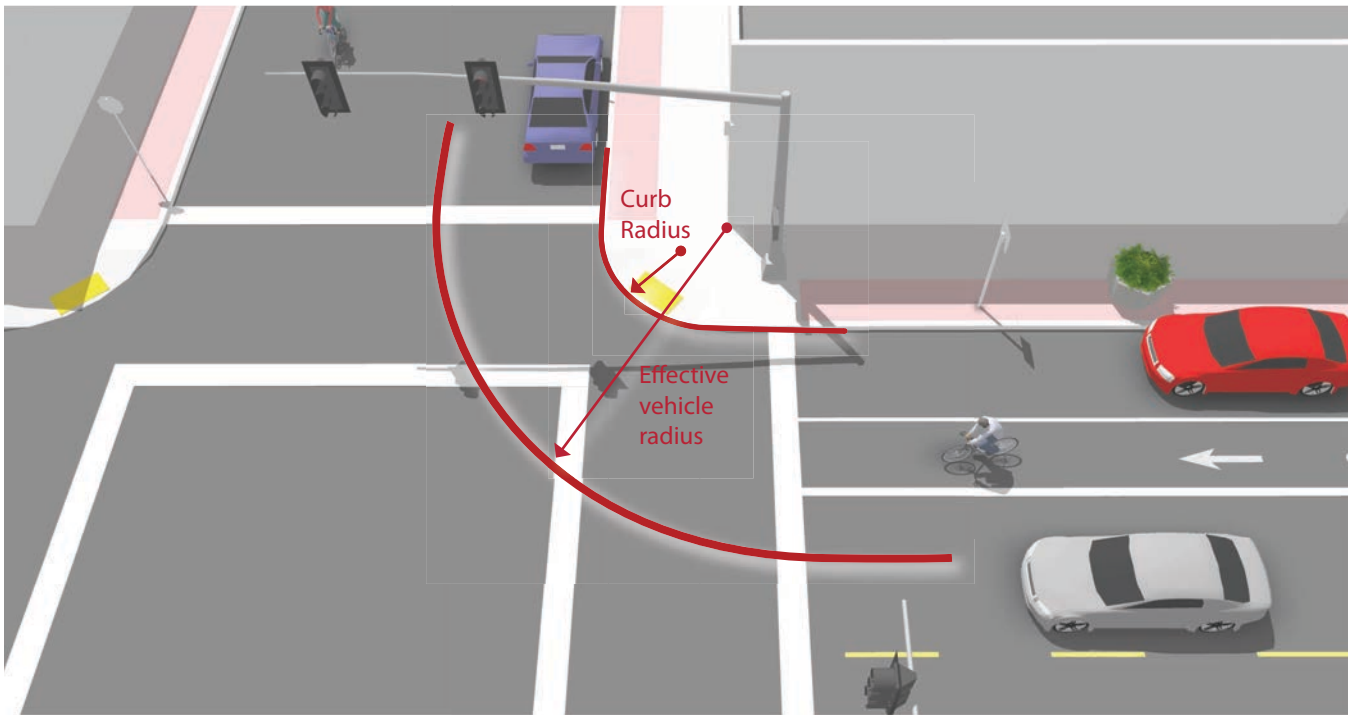
Minimizing Curb Radii

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.

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.



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.

Pedestrians at Intersections

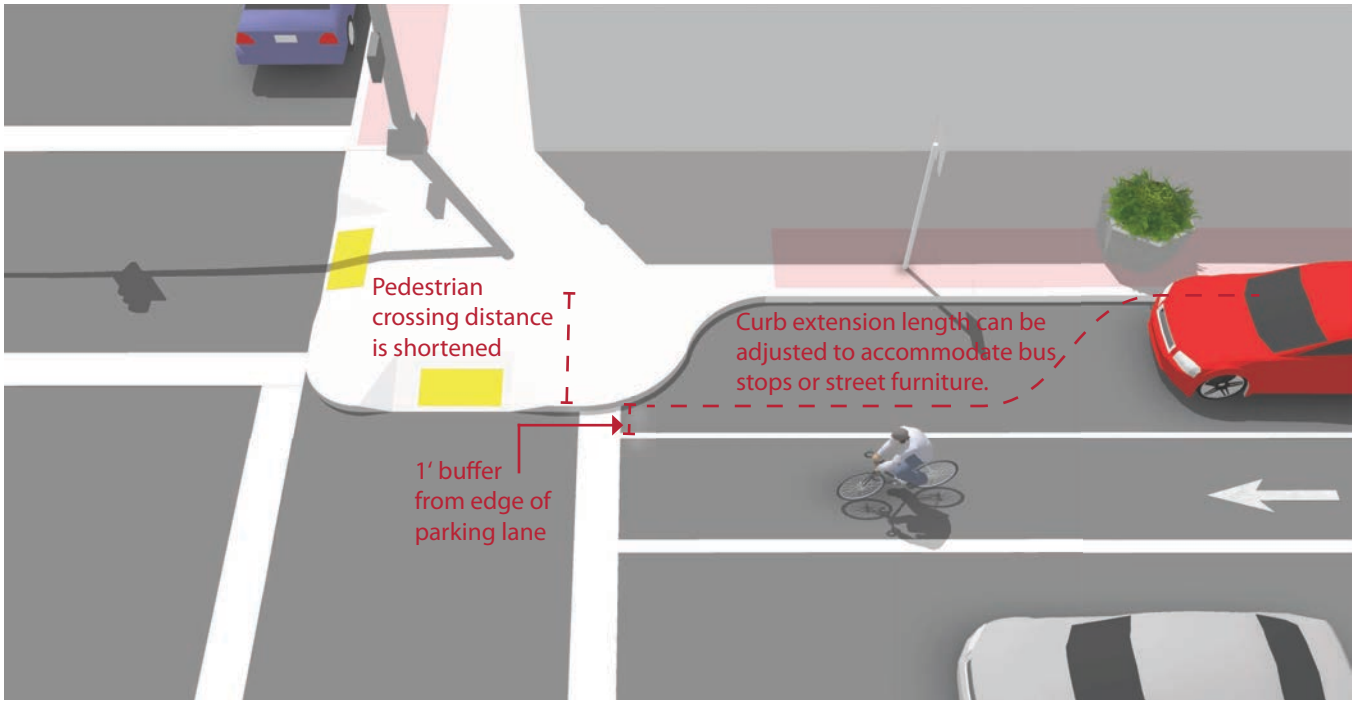
Curb Extensions

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.

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 are appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.



Discussion

If there is no parking lane, adding curb extensions may be a problem for bicycle travel and truck or bus turning movements.

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.

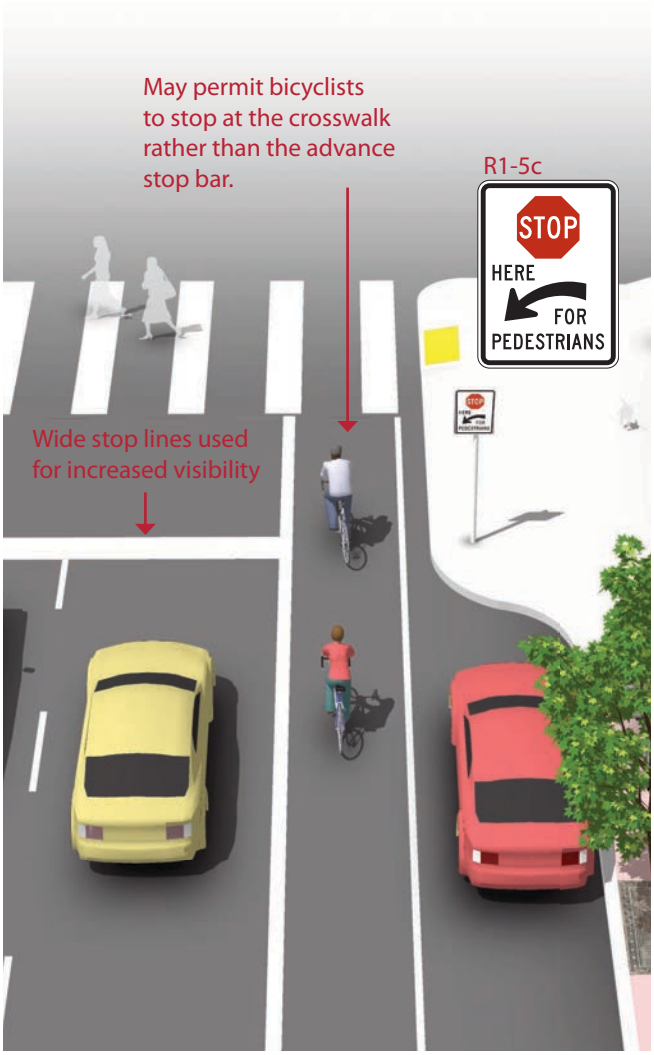
Materials and Maintenance

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

Advance Stop Bar

Description

Advance stop bars increase pedestrian comfort and safety by stopping motor vehicles well in advance of marked crosswalks, allowing vehicle operators a better line of sight of pedestrians and giving inner lane motor vehicle traffic time to stop for pedestrians.



Guidance

- On streets with at least two travel lanes in each direction.
- Prior to a marked crosswalk.
- In one or both directions of motor vehicle travel.
- Recommended 15-50 feet or more in advance of the crosswalk.
- A "Stop Here for Pedestrians" sign should accompany the advance stop bar.

Discussion

If a bicycle lane is present, mark the advance stop bar to permit bicyclists to stop at the crosswalk ahead of the stop bar.

If the State law requires drivers to YIELD to pedestrians in crosswalks, a Yield Line marking must be used rather than a stop line in these cases.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.

Materials and Maintenance

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

Pedestrians at Intersections

Parking Control

Guidance

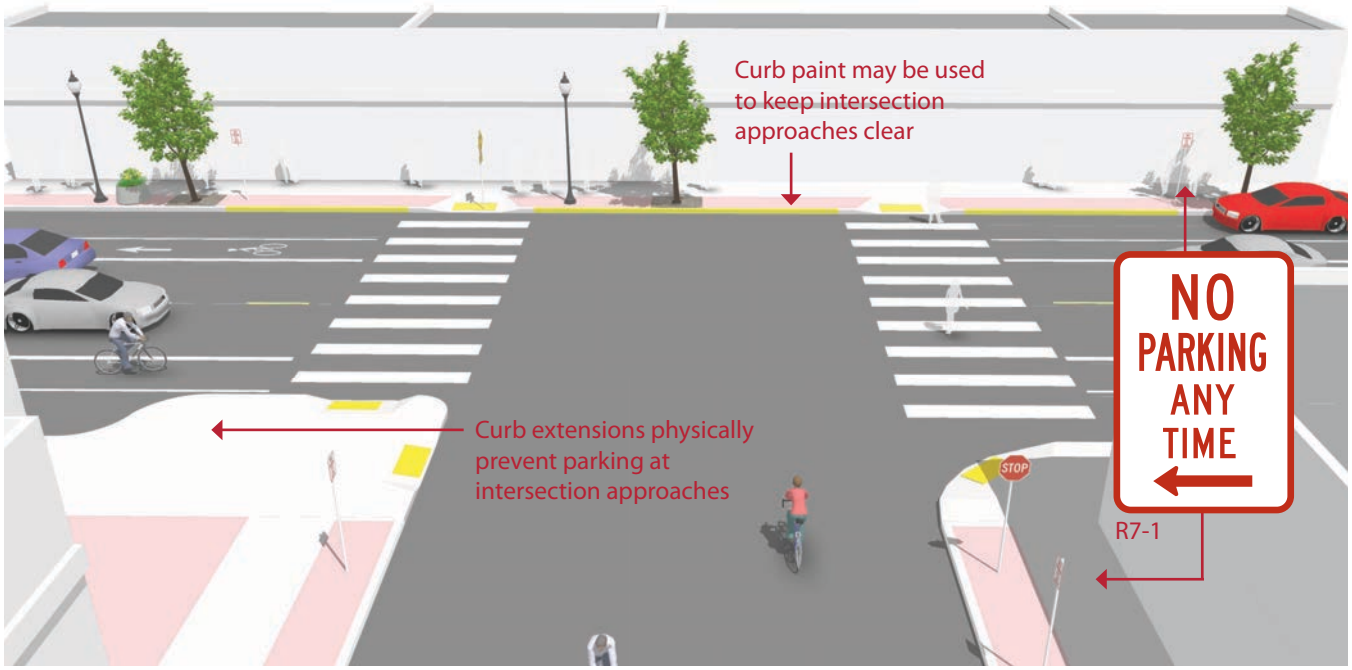
Curb extensions, NO PARKING signage, or curb paint can be used to keep the approach to intersections clear of parked vehicles.

At "T" and offset intersections, where the boundaries of the intersection may not be obvious, this prohibition should be made clear with signage.

Parking should not be allowed within any type of intersection adjacent to schools, school crosswalks, and parks. This includes "T" and offset intersections.

Description

Parking control involves restricting or reducing on-street parking near intersections with high pedestrian activity. Locating parking away from the intersection improves motorist's visibility on the approach to the intersection and crosswalk. Improved sight lines at intersections reduces conflicts between motorists and pedestrians.



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

Signage and striping require routine maintenance.

Pedestrians at Intersections

ADA Compliant Curb Ramps

Guidance

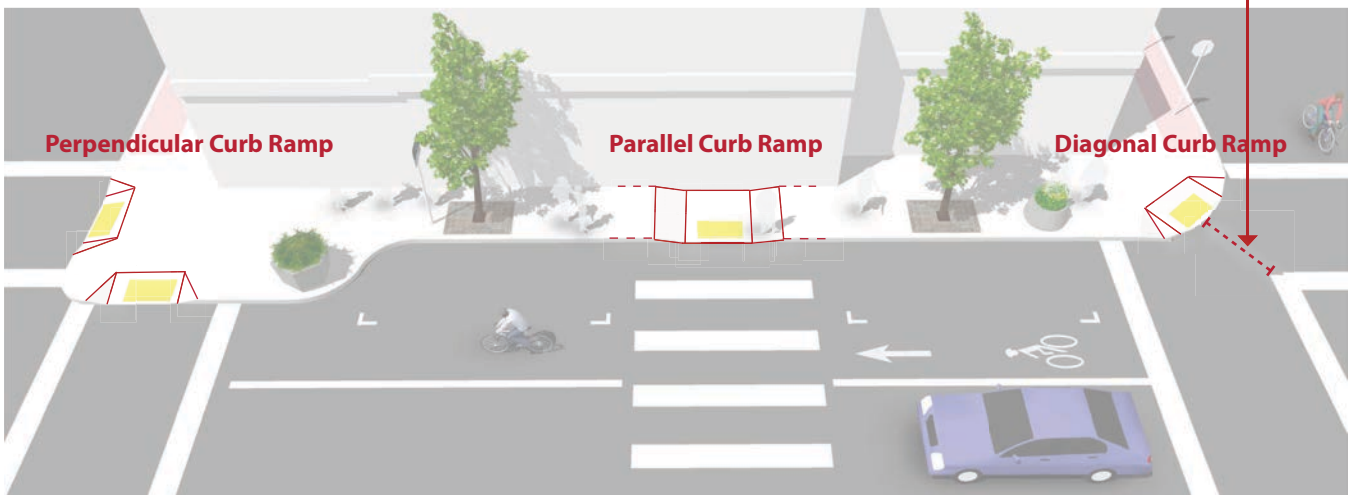
- The landing at the top of a ramp shall be at least 4 feet long and at least the same width as the ramp itself.
- The ramp shall slope no more than 1:50 (2.0%) in any direction.
- If the ramp runs directly into a crosswalk, the landing at the bottom will be in the roadway.
- If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5'-0" long and at least as wide as the ramp, although a width of 5'-0" is preferred.

Description

Curb ramps are the design elements that allow all users to make the transition from the street to the sidewalk. There are a number of factors to be considered in the design and placement of curb ramps at corners. Properly designed curb ramps ensure that the sidewalk is accessible from the roadway. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access.

Although diagonal curb ramps might save money, they create potential safety and mobility problems for pedestrians,including reduced maneuverability and increased interaction with turning vehicles, particularly in areas with high traffic volumes. Diagonal curb ramp configurations are the least preferred of all options.

Curb ramps shall be located so that they do not project into vehicular traffic lanes, parking spaces, or parking access aisles. Three configurations are illustrated below.



Crosswalk spacing not to scale. For illustration purposes only.

Discussion

The edge of an ADA compliant curb ramp will be marked with a tactile warning device (also known as truncated domes) to alert people with visual impairments to changes in the pedestrian environment. Contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident. These devices are most effective when adjacent to smooth pavement so the difference is easily detected. The devices must provide color contrast so partially sighted people can see them.

Additional References and Guidelines

United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
USDOJ. (2010). ADA Standards for Accessible Design.

Materials and Maintenance

It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections can develop potholes at the foot of the ramp, which can catch the front wheels of a wheelchair.

Signalization

Crossing beacons and signals facilitate crossings of roadways for pedestrians and bicyclists. Beacons make crossing intersections safer by clarifying when to enter an intersection and by alerting motorists to the presence of pedestrians and bicyclists.

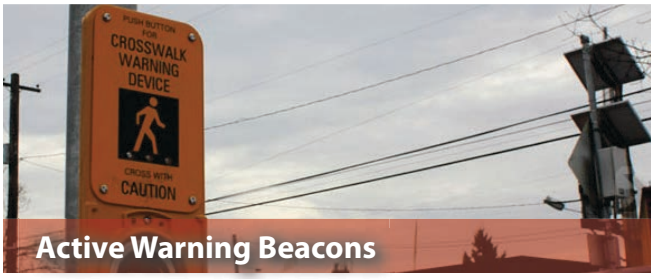
Flashing amber warning beacons can be utilized at un-signalized intersection crossings. Push buttons, signage, and pavement markings may be used to highlight these facilities for pedestrians, bicyclists and motorists.

Determining which type of signal or beacon to use for a particular intersection depends on a variety of factors. These include speed limits, traffic volumes, and the anticipated levels of pedestrian and bicycle crossing traffic.

An intersection with crossing beacons may reduce stress and delays for a crossing users, and discourage illegal and unsafe crossing maneuvers.

Accommodating Pedestrians at Signalized Crossings


Bicycle Detection and Actuation



Active Warning Beacons


Hybrid Beacon

Signalization

Accommodating Pedestrians at Signalized Crossings

Description

Pedestrian Signal Head

Pedestrian signal indicators demonstrate to pedestrians when to cross at a signalized crosswalk. All traffic signals should be equipped with pedestrian signal indications except where pedestrian crossing is prohibited by signage.

Countdown pedestrian signals are particularly valuable for pedestrians, as they indicate whether a pedestrian has time to cross the street before the signal phase ends. Countdown signals should be used at all signalized intersections.

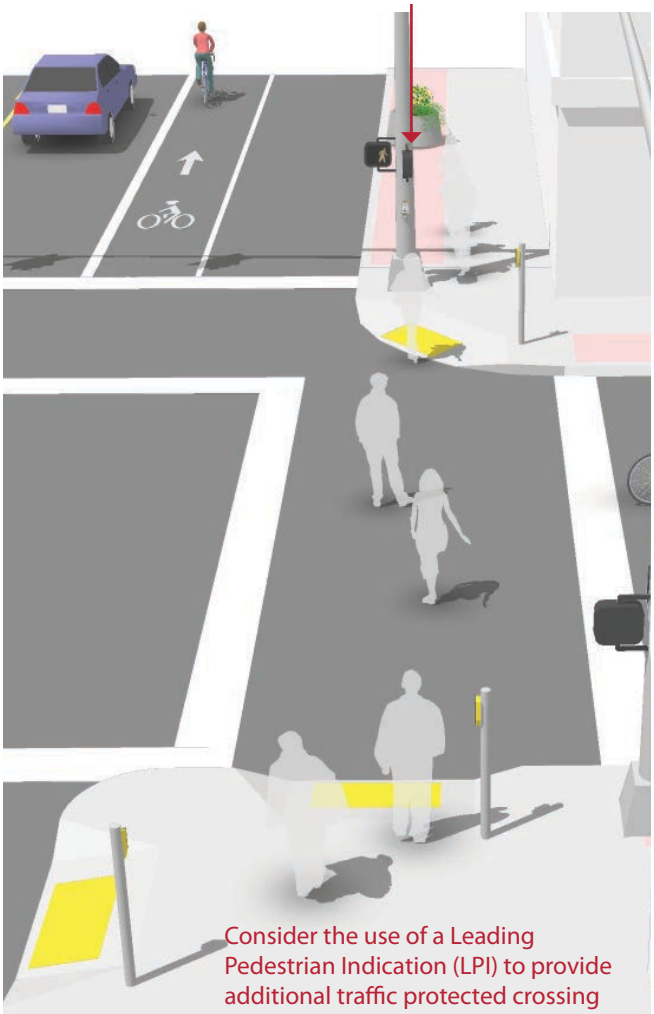
Signal Timing

Providing adequate pedestrian crossing time is a critical element of the walking environment at signalized intersections. The MUTCD recommends traffic signal timing to assume a pedestrian walking speed of 4' per second, meaning that the length of a signal phase with parallel pedestrian movements should provide sufficient time for a pedestrian to safely cross the adjacent street.

At crossings where older pedestrians or pedestrians with disabilities are expected, crossing speeds as low as 3' per second may be assumed. Special pedestrian phases can be used to provide greater visibility or more crossing time for pedestrians at certain intersections.

In busy pedestrian areas such as downtowns, the pedestrian signal indication should be built into each signal phase, eliminating the requirement for a pedestrian to actuate the signal by pushing a button.

Audible pedestrian traffic signals provide crossing assistance to pedestrians with vision impairment at signalized intersections



Consider the use of a Leading Pedestrian Indication (LPI) to provide additional traffic protected crossing time to pedestrians

Discussion

When push buttons are used, they should be located so that someone in a wheelchair can reach the button from a level area of the sidewalk without deviating significantly from the natural line of travel into the crosswalk, and marked (for example, with arrows) so that it is clear which signal is affected.

Additional References and Guidelines

United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.
USDOJ. (2010). ADA Standards for Accessible Design.

Materials and Maintenance

It is important to repair or replace traffic control equipment before it fails. Consider semi-annual inspections of controller and signal equipment, intersection hardware, and loop detectors.

Signalization

Bicycle Detection and Actuation

Description

Push Button Actuation

User-activated button mounted on a pole facing the street.

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to trigger a push button.

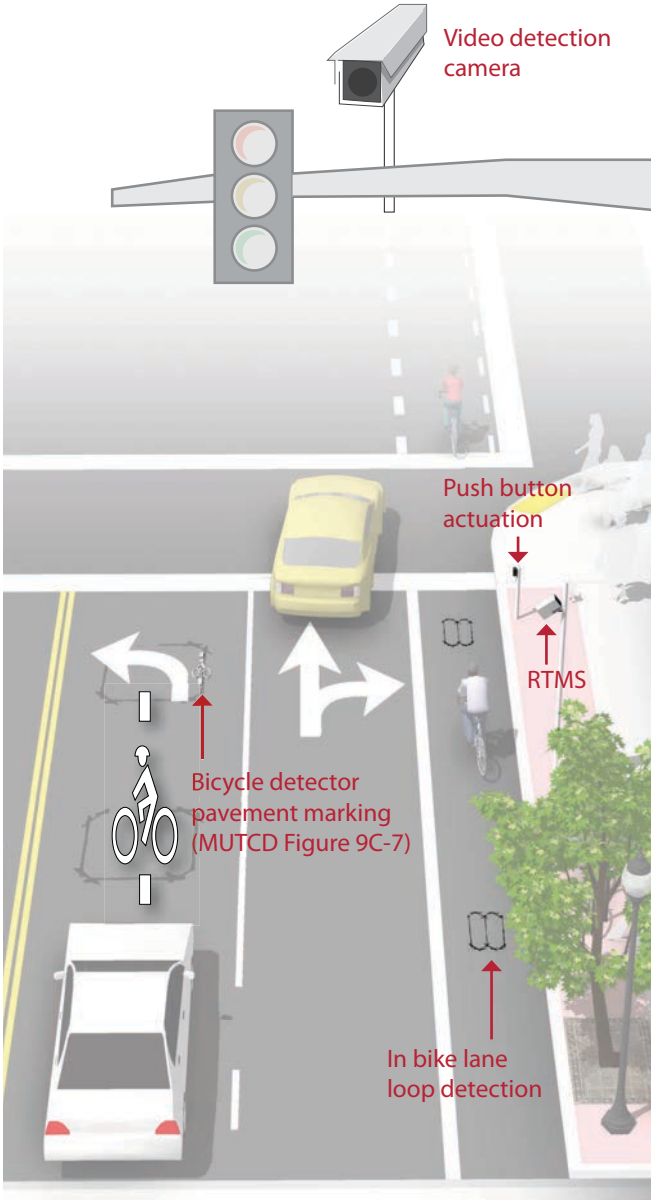
Loops that are sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.

Video Detection Cameras

Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycles. Video camera system costs range from $20,000 to $25,000 per intersection.

Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.



Discussion

Proper bicycle detection should meet two primary criteria: 1) accurately detects bicyclists and 2) provides clear guidance to bicyclists on how to actuate detection (e.g. what button to push, where to stand).

Bicycle loops and other detection mechanisms can also provide bicyclists with an extended green time before the light turns yellow so that bicyclists of all abilities can reach the far side of the intersection.

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

Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

Signalization

Active Warning Beacons

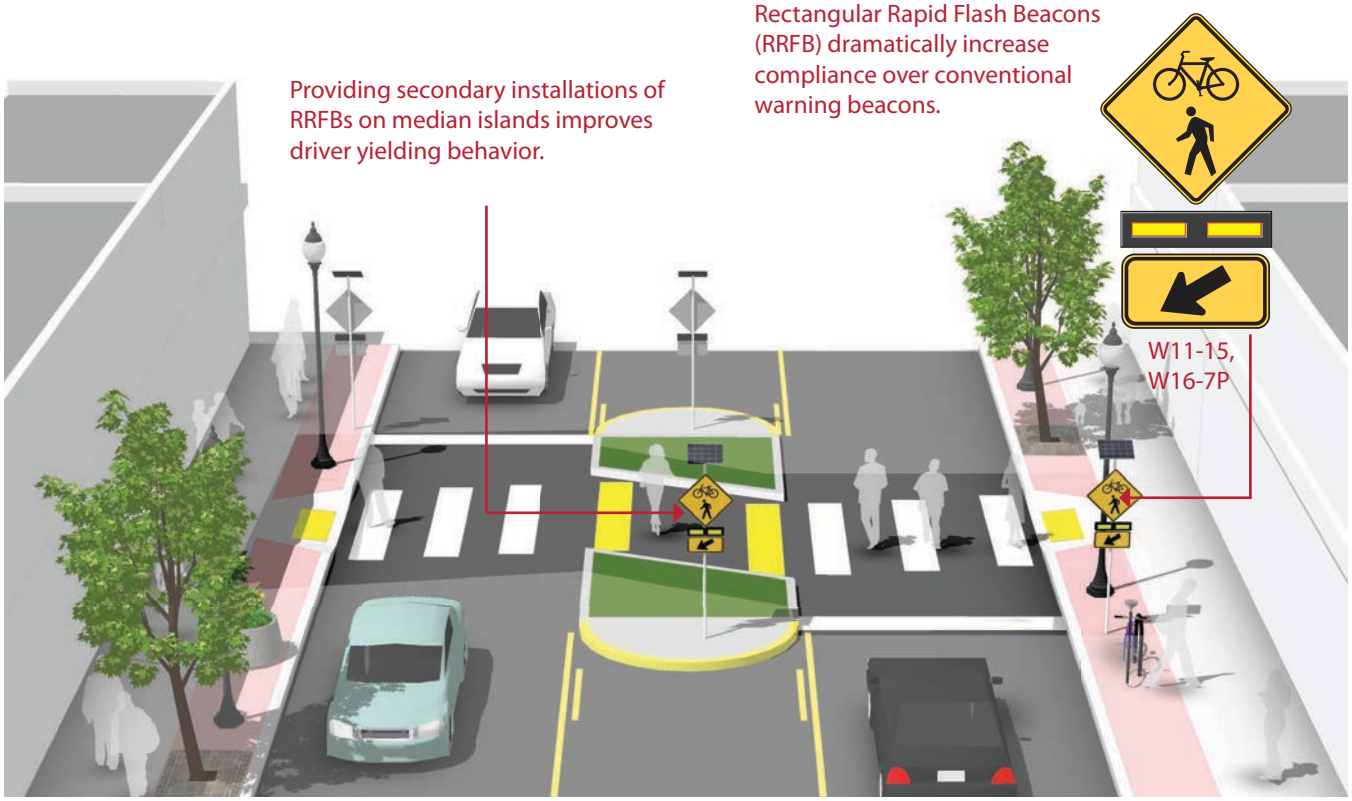
Guidance

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.

Description

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways.

Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB).



Discussion

Rectangular rapid flash beacons have the highest compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long-term installations show little to no decrease in yielding behavior over time.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2008). MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)

Materials and Maintenance

Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs should run for years without issue.

Signalization

Hybrid Beacon for Mid-Block Crossing

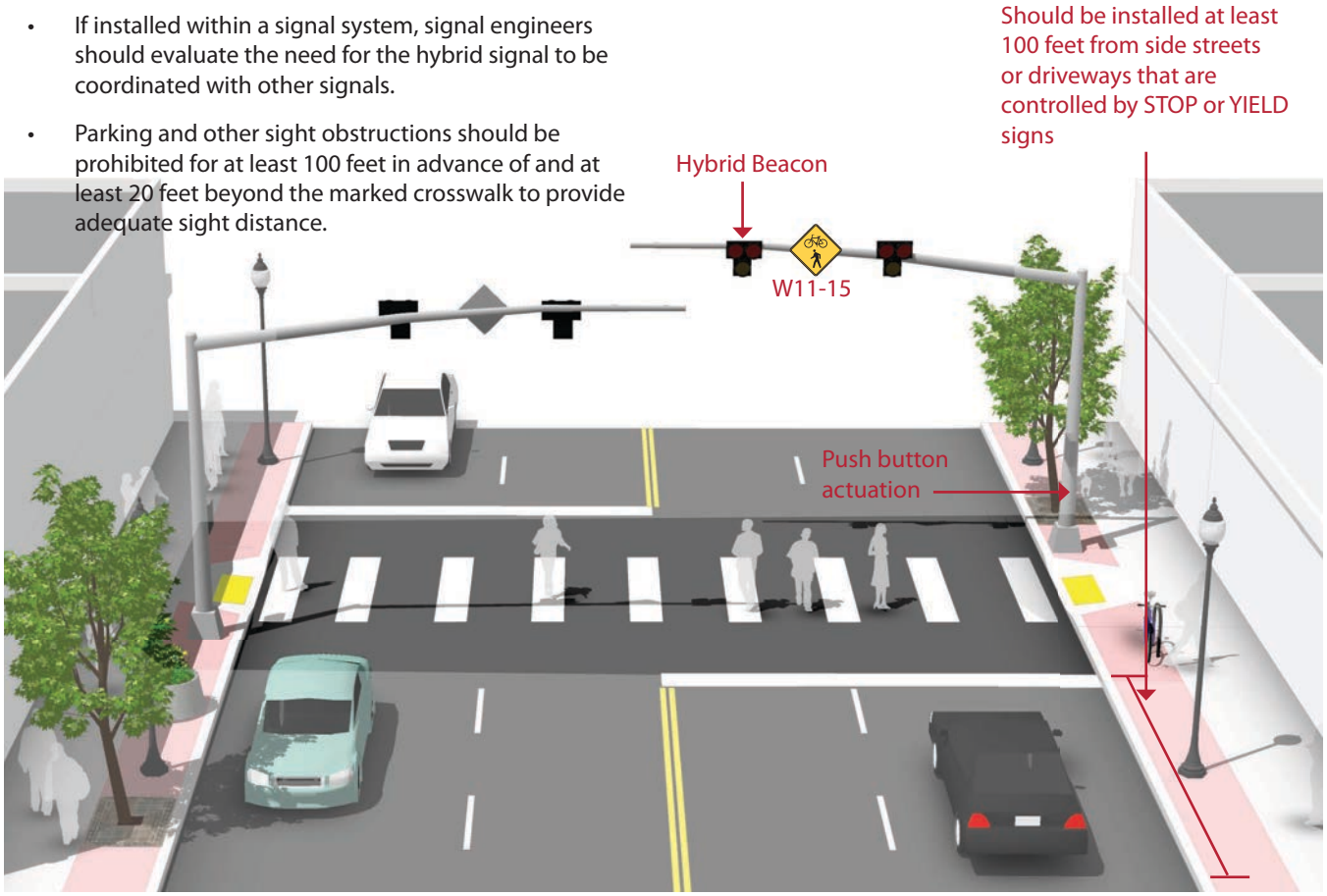
Guidance

Hybrid beacons may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable pedestrian crossings.

- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.

Description

Hybrid beacons are used to improve non-motorized crossings of major streets. A hybrid beacon consists of a signal-head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk



Discussion

Hybrid beacon signals are normally activated by push buttons, but may also be triggered by infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.

Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Signalization

Hybrid Beacon for Bikeway Crossing

Guidance

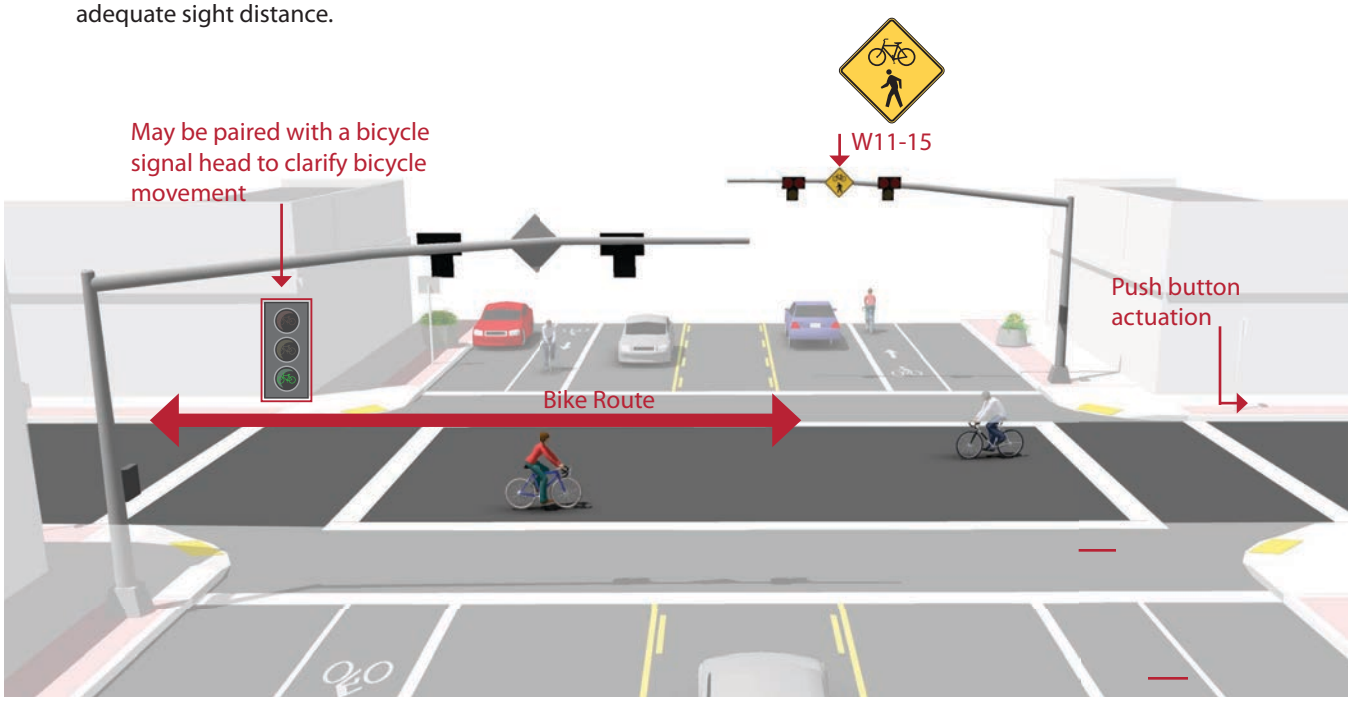
Hybrid beacons may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable user crossing.

- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.

Description

A hybrid beacon, previously known as a High-intensity Activated Crosswalk (HAWK), consists of a signal head with two red lenses over a single yellow lens on the major street, and pedestrian and/or bicycle signal heads for the minor street. There are no signal indications for motor vehicles on the minor street approaches.

Hybrid beacons are used to improve non-motorized crossings of major streets in locations where side-street volumes do not support installation of a conventional traffic signal (or where there are concerns that a conventional signal will encourage additional motor vehicle traffic on the minor street). Hybrid beacons may also be used at mid-block crossing locations.



Discussion

The hybrid beacon can significantly improve the operation of a bicycle route, particularly along **Bicycle Boulevards**. Because of the low traffic volumes on some bikeways, intersections with major roadways are often unsignalized, creating difficult and potentially unsafe crossing conditions for bicyclists.

Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Shared Roadways

On shared roadways, bicyclists and motor vehicles use the same roadway space. These bikeways are typically used on roads with low speeds and traffic volumes. However, they can be used on higher volume roads with wide outside lanes or shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Shared roadways employ a large variety of treatments from simple signage and shared lane markings to more complex treatments including directional signage, traffic diverters, chicanes, chokers, and/or other traffic calming devices to reduce vehicle speeds or volumes.

Signed Shared Roadway


Marked Shared Roadway

Shared Roadways

Signed Shared Roadway

Guidance

Lane width varies depending on roadway configuration.

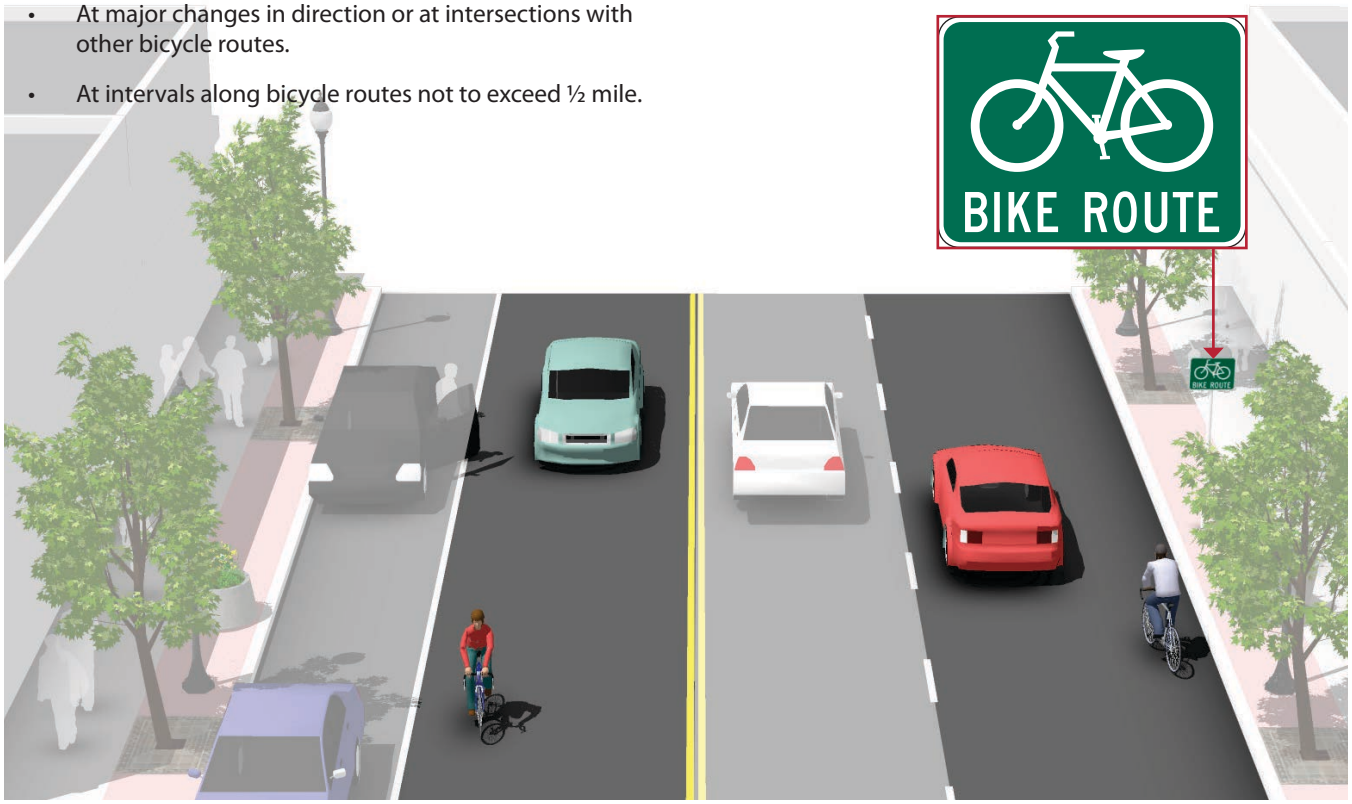
Bicycle Route signage (D11-1) should be applied at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists. Commonly, this includes placement at:

- Beginning or end of Bicycle Route.
- At major changes in direction or at intersections with other bicycle routes.
- At intervals along bicycle routes not to exceed ½ mile.

Description

Signed Shared Roadways are bikeways shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes. However, they can be used on higher volume roads with wide outside lanes or shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

MUTCD D11-1



Discussion

Signed Shared Roadways serve either to provide continuity with other bikeways (usually bike lanes) or to designate preferred routes through high-demand corridors.

This configuration differs from a **Bicycle Boulevard** due to a lack of traffic calming, wayfinding, pavement markings and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

Additional References and Guidelines

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

Materials and Maintenance

Signs will need to be replaced periodically.

Shared Roadways

Marked Shared Roadway

Guidance

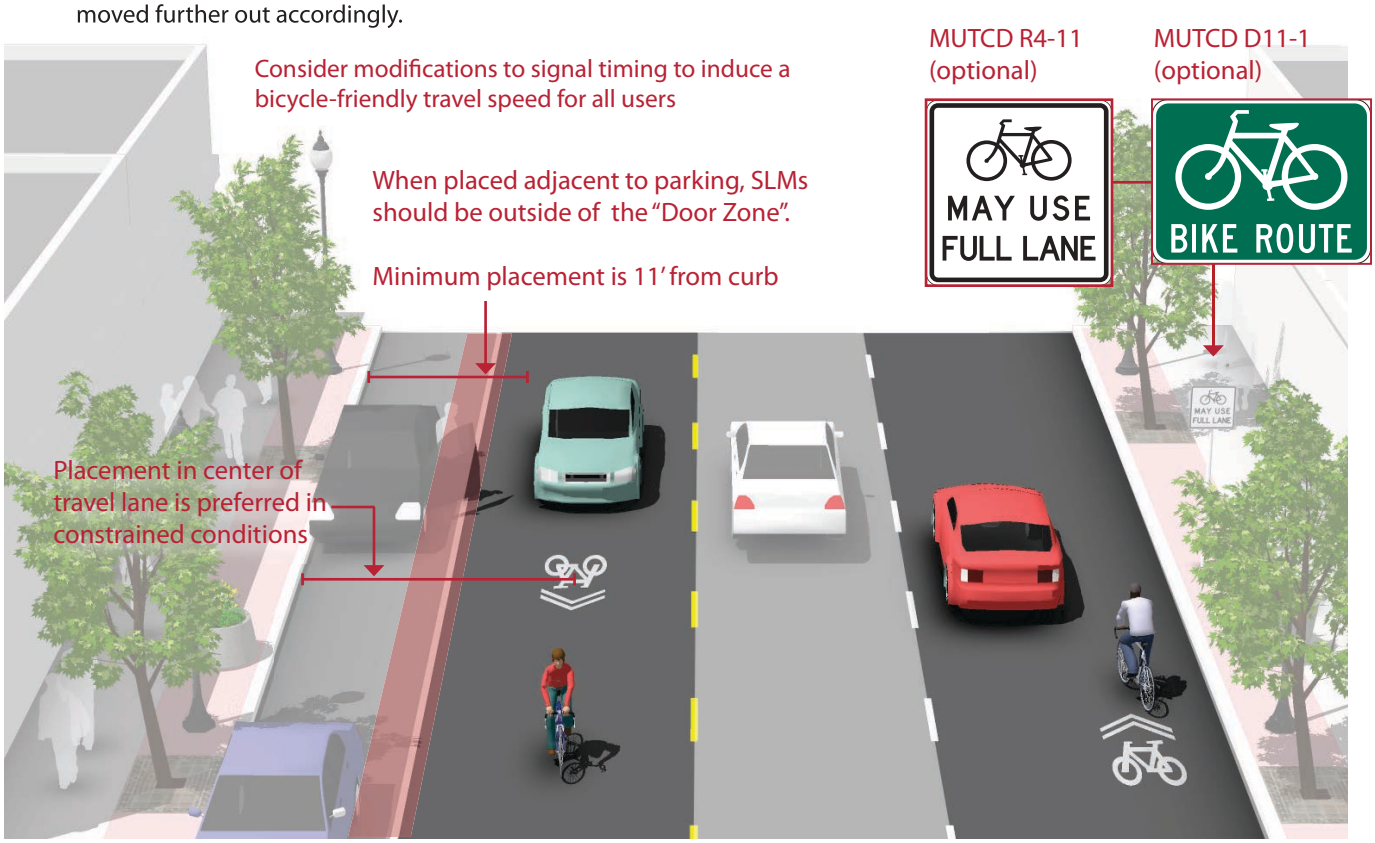
- In constrained conditions, preferred placement is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet, the SLM should be moved further out accordingly.

Description

A marked shared roadway is a general purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane.

In constrained conditions, the SLMs are placed in the middle of the lane to discourage unsafe passing by motor vehicles. On a wide outside lane, the SLMs can be used to promote bicycle travel to the right of motor vehicles.

In all conditions, SLMs should be placed outside of the door zone of parked cars.



Discussion

Bike Lanes should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. SLMs shall not be used on shoulders, in designated **Bike Lanes**, or to designate **Bicycle Detection and Actuation** at signalized intersections. (MUTCD 9C.07)

This configuration differs from a **Bicycle Boulevard** due to a lack of traffic calming, wayfinding, and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

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

Placing SLMs between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.

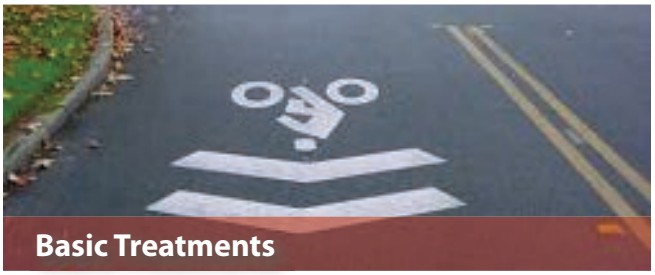
Bicycle Boulevards

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist by using treatments such as signage, pavement markings, traffic calming and/or traffic reduction, and intersection modifications. These treatments allow through movements of bicyclists while discouraging similar through trips by non-local motorized traffic.

Jurisdictions throughout the country use a wide variety of strategies to determine where specific treatments are applied. While no federal guidelines exist, several best practices have emerged for the development of bicycle boulevards. At a minimum, bicycle boulevards should include distinctive pavement markings and wayfinding signs. They can also use combinations of traffic calming, traffic diversion, and intersection treatments to improve the bicycling environment. The appropriate level of treatment to apply is dependent on roadway conditions, particularly motor vehicle speeds and volumes.

Traffic conditions on bicycle boulevards should be monitored to provide guidance on when and where treatments should be implemented. When motor vehicle speeds and volumes or bicyclist delay exceed the preferred limits, additional treatments should be considered for the bicycle boulevard.

Route Selection


Basic Treatments

Traffic Calming

Traffic Diversion


Intersection Treatments

Bicycle Boulevards

Route Selection

Guidance

- Streets are signed at 25 mph or less to improve the bicycling environment and decrease the risk and severity of crashes.
- Traffic volumes are limited to 3,000 vehicles per day (ideally less than 1,500) to minimize passing events and potential conflicts with motor vehicles.
- Use of streets that parallel major streets can discourage non-local motor vehicle traffic without significantly impacting motorists.
- Use of streets where a relatively continuous route for bicyclists exists and/or where treatments can provide wayfinding and improve crossing opportunities at offset intersections.
- Use of streets where bicyclists have right-of-way at intersections or where right-of-way is possible to assign to bicyclists.

Description

Bicycle boulevards should be developed on streets that improve connectivity to key destinations and provide a direct route for bicyclists. Local streets with existing traffic calming, traffic diversions, or signalized crossings of major streets are good candidates, as they tend to be existing bicycle routes and have low motor vehicle speeds and volumes. Other streets where residents have expressed a desire for traffic calming are also good options.

Bicycle boulevards parallel to commercial streets improve access for "interested but concerned" bicyclists and complement bike lanes on major roadways.

In Portland, OR, the bicycle network includes a high density of bicycle boulevards parallel to streets with bike lanes.

Discussion

Bicycle boulevards should form a continuous network of streets or off-street facilities that accommodate bicyclists who are less willing to ride on streets with motorized traffic. Most bicycle boulevards are located on residential streets, though they can also be on commercial or industrial streets. Due to the presence of trucks and commercial vehicles, as well as the need to maintain good traffic flow and retain motor vehicle parking, bicycle boulevards on commercial or industrial streets can tolerate higher automobile speeds and volumes than would be desired on neighborhood streets. Vertical traffic calming can minimize impacts to large vehicles and parking.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.
City of Emeryville. (2011). Bicycle Boulevard Treatments.

Materials and Maintenance

Repaving, street sweeping and other maintenance should occur with higher frequency than on other local streets.

Bicycle Boulevards

Basic Treatments

Description

Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard. Together, they visibly designate a roadway to both bicyclists and motorists. Signs, and in some cases pavement markings, provide wayfinding to help bicyclists remain on the designated route.

Guidance

Pavement Markings

Place symbols every 250-800 feet along a linear corridor, as well as after every intersection.

On narrow streets where a motor vehicle cannot pass a bicyclist within one lane of traffic, place stencils in the center of the travel lane.

See **Marked Shared Roadway** guidance for additional information on the use of shared lane markings.

A bicycle symbol can be placed on a standard road sign, along with distinctive coloration.

Signs

See **Bikeway Signing** for guidance on developing bicycle wayfinding signage. Some cities have developed unique logos or colors for wayfinding signs that help brand their bicycle boulevards.

Be consistent in content, design, and intent; colors reserved by the MUTCD for regulatory and warning road signs are not recommended.

Signs can include information about intersecting bikeways and distance/time information to key destinations.

Discussion

Wayfinding signs displaying destinations, distances, and riding time can dispel common misperceptions about time and distance while increasing users' comfort and accessibility to the bicycle boulevard network. Bicycle boulevards frequently include offset intersections or jog onto another street. Signs and pavement markings can help bicyclists remain on the route. In addition, fewer businesses or services are located along local streets, and signs inform bicyclists of the direction to key destinations, including commercial districts, transit hubs, schools, universities, and other bikeways.

Additional References and Guidelines

City of Milwaukie. (2009). Milwaukie Bicycle Wayfinding Signage Plan
City of Oakland (2009). Design Guidelines for Bicycle Wayfinding Signage
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Pavement markings should be repainted and signs replaced as needed. Wayfinding signs should be regularly updated with new major destinations and bikeways.

Bicycle Boulevards

Vertical Traffic Calming

Description

Motor vehicle speeds affect the frequency at which automobiles 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 on a street. Slower vehicular speeds also improve motorists' ability to see and react to bicyclists and minimize conflicts at driveways and other turning locations.

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

Guidance

- Bicycle boulevards 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. Speed humps can be challenging for bicyclists, gaps can be provided in the center or by the curb for bicyclists and to improve drainage. Speed humps can also be offset to accommodate emergency vehicles.
- 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.

Speed Hump

Offset Speed Hump

Temporary Speed Cushion

Raised Crosswalk

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

NACTO. (2012). Urban Bikeway Design Guide.
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.

Bicycle Boulevards

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

NACTO. (2012). Urban Bikeway Design Guide.
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.

Bicycle Boulevards

Traffic Diversion

Description

Motor vehicle traffic volumes affect the operation of a bicycle boulevard. Higher vehicle volumes reduce bicyclists' comfort and can result in more conflicts.

Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day, above which the route should be striped as a **Bike Lane** or considered a **Signed Shared Roadway**.

Guidance

- Traffic diversion treatments reduce motor vehicle volumes by completely or partially restricting through traffic on a bicycle boulevard.
- Partial closures allow full bicycle passage while restricting vehicle access to one way traffic at that point.
- Diagonal diverters require all motor vehicle traffic to turn.
- Median diverters (see **Major Intersection Treatments**) restrict through motor vehicle movements while providing a refuge for bicyclists and pedestrians to cross in two stages.
- Street closures create a "T" that blocks motor vehicles from continuing on a bicycle boulevard, while bicycle travel can continue unimpeded. Full closures can accommodate emergency vehicles with the use of mountable curbs (maximum of six inches high).

Partial Closure

Diagonal Diverter


Median Diverter


Full Closure

Discussion

Bicycle boulevards on streets with volumes higher than 3,000 vehicles per day are not recommended, although a segment of a bicycle boulevard may accommodate more traffic for a short distance if necessary to complete the corridor. Providing additional separation with a **Bike Lane**, **Cycle Track** or other treatment is recommended where traffic calming or diversion cannot reduce volumes below this threshold.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
Alta Planning + Design and IBPI. (2009). Bicycle Boulevard Planning and Design Handbook.
Ewing, Reid. (1999). Traffic Calming: State of the Practice.
Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.
Oregon Department of Transportation. (1998). Right-In Right-Out Channelization.

Materials and Maintenance

Depending on the diverter type, these treatments can be challenging to keep clear of snow and debris. Vegetation should be regularly trimmed to maintain visibility and attractiveness.

Bicycle Boulevards

Minor Intersection Treatments

Description

Treatments at minor roadway intersections are designed to improve the visibility of a bicycle boulevard, 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 bicycle boulevard, 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 bicycle boulevard, 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


Bicycle Forward Stop Bar


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. Bicycle boulevards 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 bicycle boulevard.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
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.

Bicycle Boulevards

Major Intersection Treatments

Description

The quality of treatments at major street crossings can significantly affect a bicyclist's choice to use a bicycle boulevard, as opposed to another road that provides a crossing treatment.

Guidance

- Bike Boxes increase bicyclist visibility to motorists and reduce the danger of right "hooks" by providing a space for bicyclists to wait at signalized intersections.
- Median islands provided at uncontrolled intersections of bicycle boulevards and major streets allow bicyclists to cross one direction of traffic at a time as gaps in traffic occur.
- **Hybrid Beacons**, **Active Warning Beacons** and bicycle signals can facilitate bicyclists crossing a busy street on which cross-traffic does not stop.

Bike Box

Median Island

Hybrid Beacon (HAWK)

Rectangular Rapid Flash Beacon (RRFB)

Discussion

Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard and compromise safety.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
Transportation Research Board. (2006). *Improving Pedestrian Safety at Unsignalized Crossings.* NCHRP Report # 562.
Federal Highway Administration. (2004). *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.* FHWA-RD-04-100

Materials and Maintenance

Maintain signs, markings, and other treatments and replace as needed. Monitor intersections for bicyclist delay to determine if additional treatments are warranted.

Offset Intersection Treatments

Description

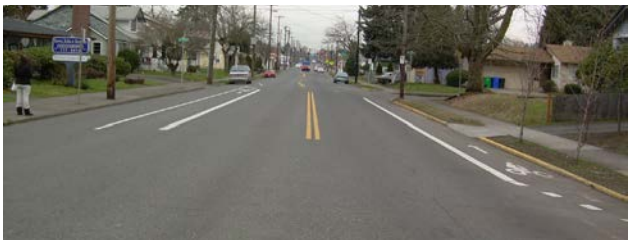
Offset intersections can be challenging for bicyclists who are required to briefly travel along the busier cross street in order to continue along the bicycle boulevard.

Guidance

- Appropriate treatments depend on volume of traffic including turning volumes, traffic speeds, and the type of bicyclist using the crossing.
- Contraflow Bike Lanes allow bicyclists to travel against the flow of traffic on a one-way street and can improve bicycle boulevard connectivity.
- Bicycle left-turn lanes can be painted where a bicycle boulevard is offset to the right on a street that has sufficient traffic gaps. Bicyclists cross one direction of traffic and wait in a protected space for a gap in the other direction. The bike turn pockets should be at least 4 feet wide, with a total of 11 feet for both turn pockets and center striping.
- Short **Bike Lanes** on the cross street assist with accessing a bicycle boulevard that jogs to the left. Crossing treatments should be provided on both sides to minimize wrong-way riding.
- A **Cycle Track** can be provided on one side of a busy street. Bicyclists enter the cycle track from the bicycle boulevard to reach the connecting segment of the bicycle boulevard. This maneuver may be signalized on one side.

Contraflow Bike Lane

Left Turn Bike Lanes



Short Bike Lanes on the Cross Street

Cycle Track Connection

Discussion

Because bicycle boulevards are located on local streets, the route is often discontinuous. Wayfinding and pavement markings assist bicyclists with remaining on the route.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
Hendrix, Michael. (2007). *Responding to the Challenges of Bicycle Crossings at Offset Intersections.* Third Urban Street Symposium.

Materials and Maintenance

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

Separated Bikeways

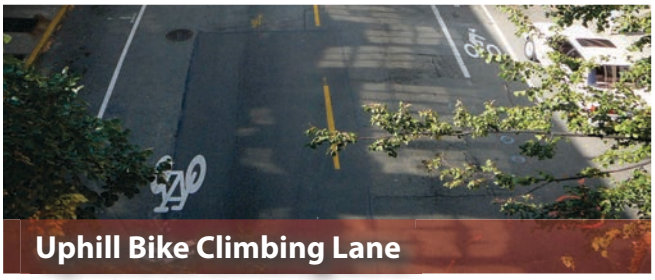
Designated exclusively for bicycle travel, separated bikeways are segregated from vehicle travel lanes by striping, and can include pavement stencils and other treatments. Separated bikeways are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

Separated bikeways can increase safety and promote proper riding by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the bicyclists' path.
- Discouraging bicyclists from riding on the sidewalk.
- Reducing the incidence of wrong way riding.
- Reminding motorists that bicyclists have a right to the road.


Bike Lanes


Floating Bike Lane


Uphill Bike Climbing Lane


Buffered Bike Lane


Shared Use Paths along Roadways

Separated Bikeways

Bike Lane Without On-Street Parking

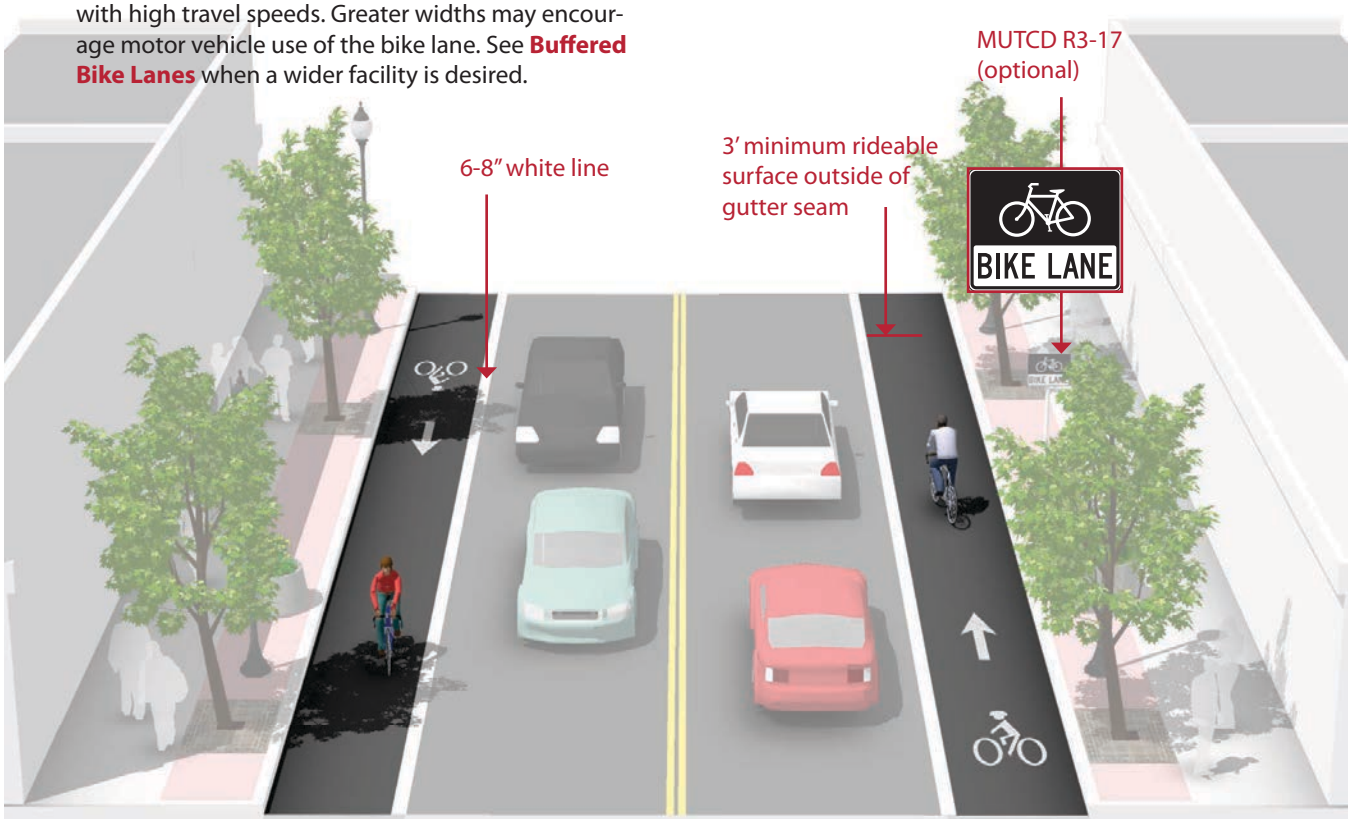
Guidance

- 4 foot minimum when no curb and gutter is present.
- 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.
- 7 foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of the bike lane. See **Buffered Bike Lanes** when a wider facility is desired.

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.

A bike lane width of 7 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, thereby increasing the capacity of the lane.



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 Bike Lanes** when further separation is desired.

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.

Separated Bikeways

Bike Lane Adjacent to On-Street Parallel Parking

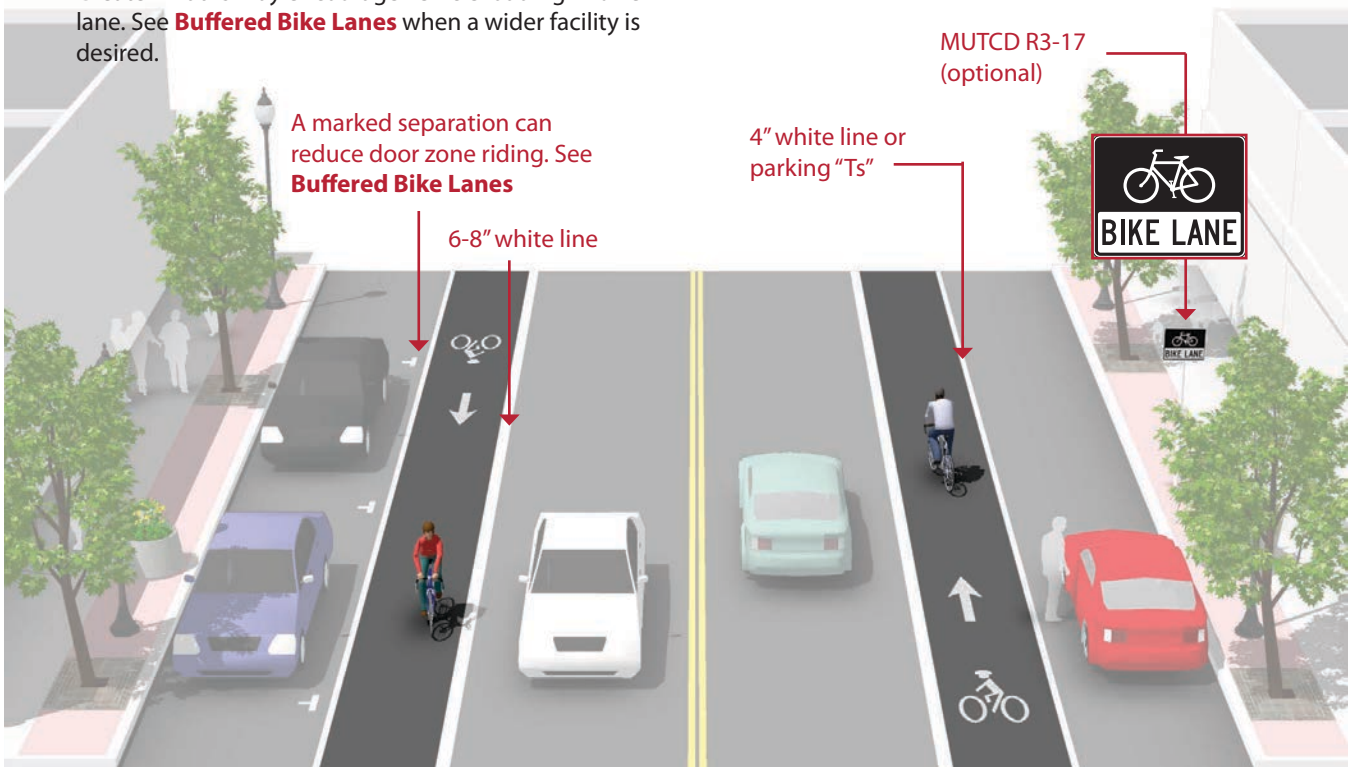
Guidance

- 12 foot minimum from curb face to the stripe that delineates the bike lane from the motor vehicle lane.
- 14.5 foot preferred from curb face to the stripe that delineates the bike lane from the motor vehicle lane.
- 7 foot maximum for marked width of bike lane. Greater widths may encourage vehicle loading in bike lane. See **Buffered Bike Lanes** when a wider facility is desired.

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.



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. Parking stall markings, such as parking "Ts" and double white lines 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.

Separated Bikeways

Bike Lane Adjacent to On-Street Back-in Diagonal Parking

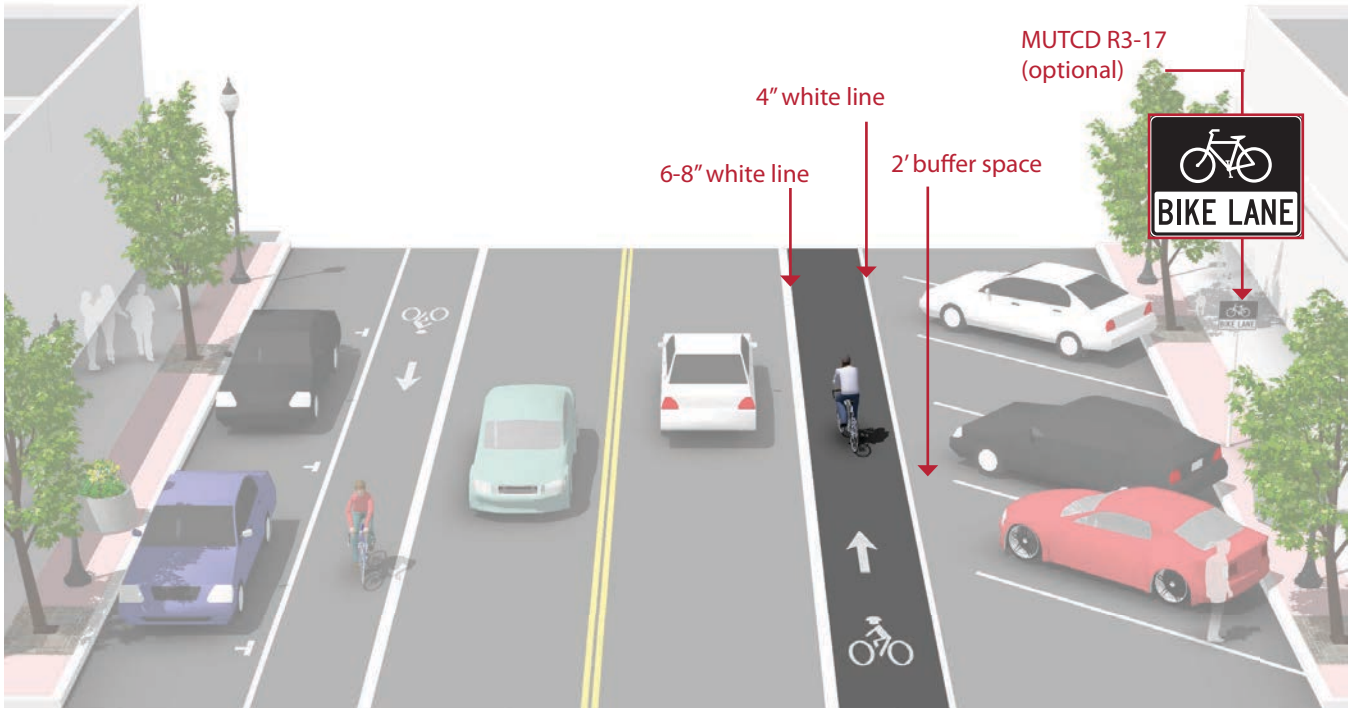
Guidance

- 5 foot minimum marked width of bike lane.
- Parking bays should be sufficiently long to accommodate most vehicles (so vehicles do not block bike lane).

Description

In certain areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply.

Back-in diagonal parking improves sight distances between drivers and bicyclists when compared to conventional head-in diagonal parking. Back-in diagonal parking provides other benefits including loading and unloading of the trunk at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb and there is no door conflict with bicyclists. While there may be a learning curve for some drivers, back-in diagonal parking is typically an easier maneuver than conventional parallel parking.



Discussion

Conventional front-in diagonal parking is not compatible or recommended in conjunction with high levels of bicycle traffic or with the provision of bike lanes, as drivers backing out of conventional diagonal parking have limited visibility of approaching bicyclists.

Additional References and Guidelines

There is no currently adopted Federal or State guidance for this treatment.

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.

Separated Bikeways

Floating Bike Lane

Guidance

Peak hour configuration:

- 5 foot curbside bike lane. width.
- 10 foot adjacent travel lane.

Off-peak configuration:

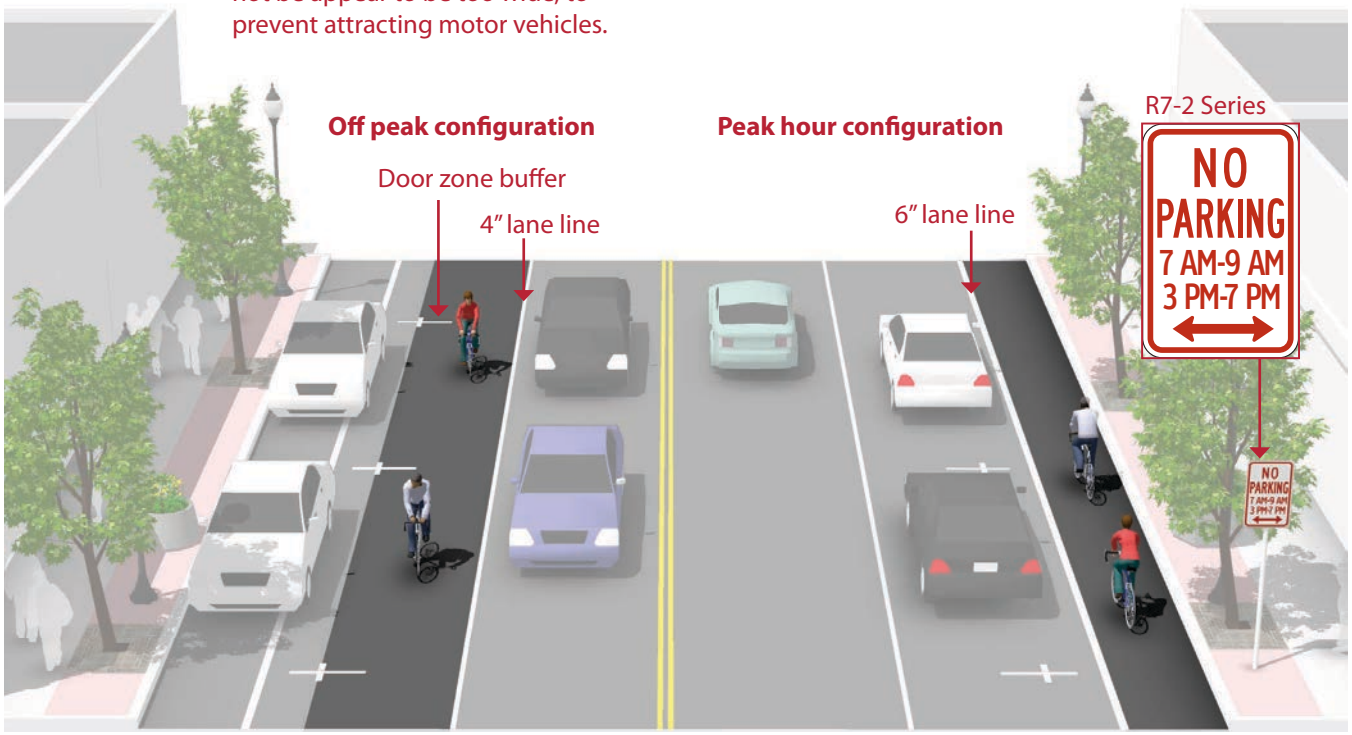
- 8 foot parking lane.
- 5 foot bike lane with 2 foot door zone buffer.

Description

A floating bike lane treatment is a bikeway with a flexible peak/off-peak travel/parking lane.

During peak hours, parking is not allowed and bicyclists utilize the curbside bike lane.

During off-peak hours, parking is permitted and bicyclists travel in an adjacent space between the parking and travel lane.



Discussion

The floating bike lane may be confusing to both bicyclists and motorists. Enforcement is required.

Additional References and Guidelines

This treatment is not currently present in any state or federal design standards.

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.

Separated Bikeways

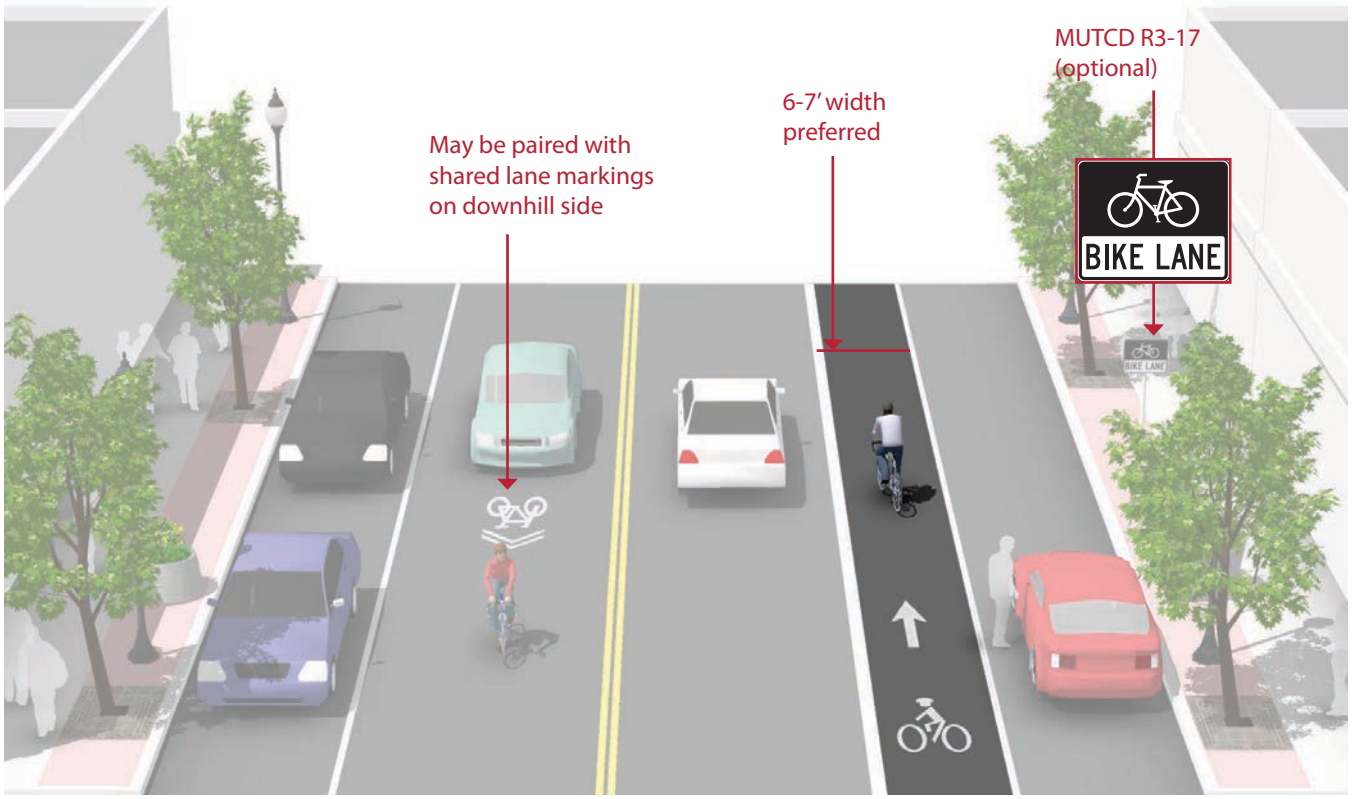
Uphill Bike Climbing Lane

Guidance

- Uphill bike lanes should be 6-7 feet wide (wider lanes are preferred because extra maneuvering room on steep grades can benefit bicyclists).
- Can be combined with **Marked Shared Roadway** for downhill bicyclists who can more closely match prevailing traffic speeds.

Description

Uphill bike lanes (also known as "climbing lanes") enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes.



Discussion

This treatment is typically found on retrofit projects as newly constructed roads should provide adequate space for bicycle lanes in both directions of travel. Accommodating an uphill bicycle lane often includes delineating on-street parking (if provided), narrowing travel lanes and/or shifting the centerline if necessary.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
AASHTO. (2012). Guide for the Development of Bicycle Facilities.

Partial Guidance:
FHWA. (2009). Manual on Uniform Traffic Control Devices.

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.

Separated Bikeways

Buffered Bike Lane

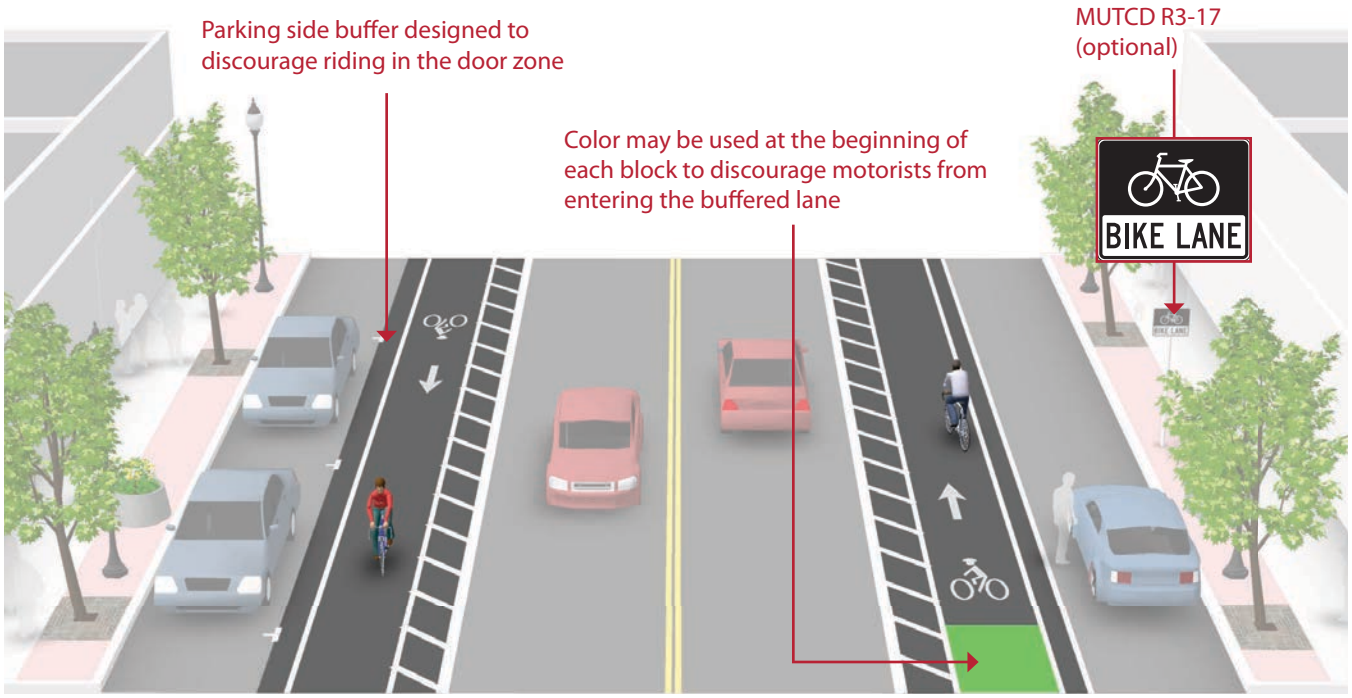
Guidance

- Where bicyclist volumes are high or where bicyclist speed differentials are significant, the desired bicycle travel area width is 7 feet.
- Buffers should be at least 2 feet wide. If 3 feet or wider, mark with diagonal or chevron hatching.
- For clarity at driveways or minor street crossings, exclude the diagonal hatching and use a dotted line for the buffer and lane lines.

Description

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. Buffered bike lanes are allowed per MUTCD guidelines for buffered preferential lanes (section 3D-01).

Buffered bike lanes are designed to increase the space between the bike lane and the travel lane or parked cars. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speed, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic.



Discussion

Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the door zone of parked cars.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices. (3D-01)
NACTO. (2012). Urban Bikeway Design Guide.
AASHTO. (2012). Guide for the Development of Bicycle Facilities.

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.

Separated Bikeways

Shared Use Paths Along Roadways

Description

A separated path outside of the roadway allows for two-way, off-street bicycle use and also may be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users. These **Shared Use Path** facilities are frequently found in parks, along rivers, beaches, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles.

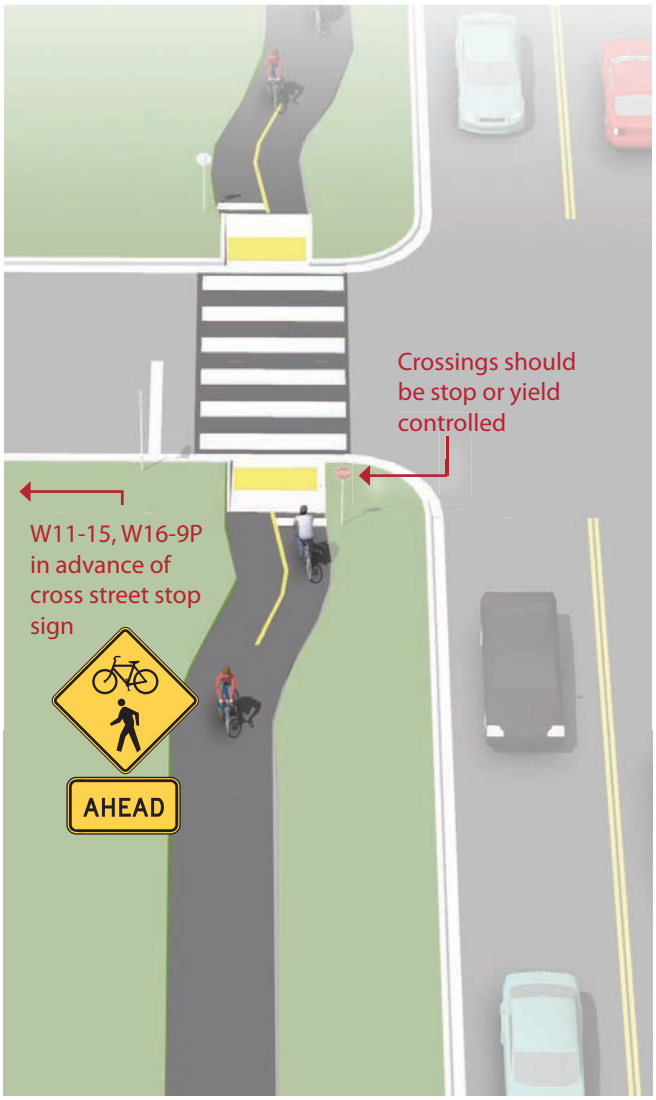
Along roadways, these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding where bicyclists enter or leave the path.

The AASHTO Guide for the Development of Bicycle Facilities generally recommends against the development of shared-use paths directly adjacent to roadways. Shared use paths along roadways are often referred to as "sidepaths".

Guidance

- 8 feet is the minimum allowed for a two-way shared use path and is only recommended for low traffic situations.
- 10 feet is recommended in most situations and will be adequate for moderate to heavy use.
- 12 feet is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and pedestrians. A separate track (5' minimum) can be provided for pedestrian use.
- Bicycle lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

Pay special attention to the entrance/exit of the path as bicyclists may continue to travel on the wrong side of the street.



Discussion

When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bicycle lane width on the roadway, as the on-street bikeway will generally be superior for experienced bicyclists and those who are cycling for transportation purposes.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
NACTO. (2012). Urban Bikeway Design Guide. See entry on Raised Cycle Tracks.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

Cycle Tracks

A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A cycle track is physically separated from motor traffic and distinct from the sidewalk. Cycle tracks have different forms but all share common elements—they provide space that is intended to be exclusively or primarily used by bicycles, and are separated from motor vehicle travel lanes, parking lanes, and sidewalks. In situations where on-street parking is allowed, cycle tracks are located to the curb-side of the parking (in contrast to bike lanes).

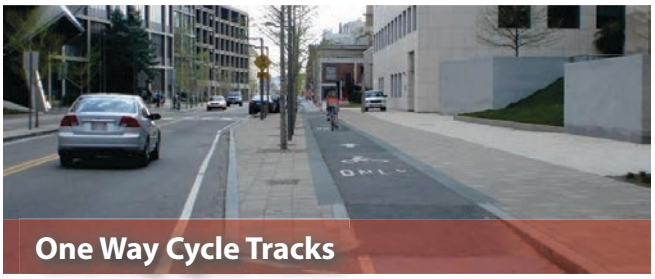
Cycle tracks may be one-way or two-way, and may be at street level, sidewalk level or at an intermediate level. If at sidewalk level, a curb or median separates them from motor traffic, while different pavement color/texture separates the cycle track from the sidewalk. If at street level, they can be separated from motor traffic by raised medians, on-street parking or bollards.

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings) if the facility connects to a path or other bikeway on one side of the street, or if there is not enough room for a cycle track on both sides of the road.

By separating bicyclists from motor traffic, cycle tracks can offer a higher level of comfort than bike lanes and are attractive to a wider spectrum of the public.

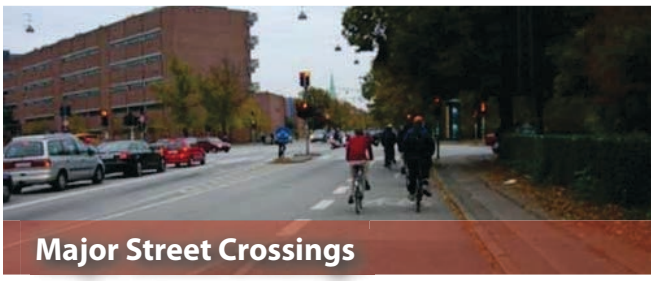
Intersections and approaches must be carefully designed to promote safety and facilitate left-turns from the right side of the street. See **Separated Bikeways at Intersections** for more information.

Cycle Track Separation and Placement



One Way Cycle Tracks

Driveways and Minor Street Crossings



Major Street Crossings

Cycle Tracks

Cycle Track Separation and Placement

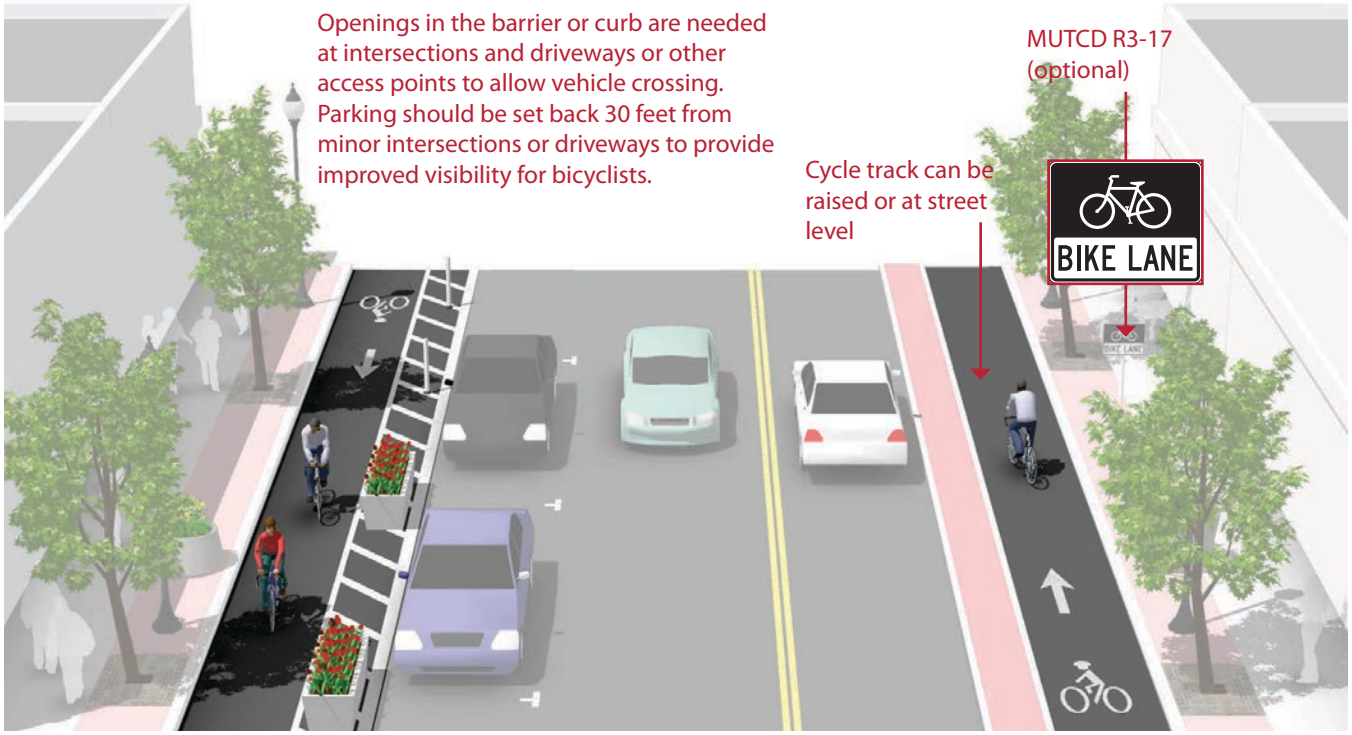
Guidance

- Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles. Cycle tracks located on one-way streets have fewer potential conflict areas than those on two-way streets.
- In situations where on-street parking is allowed, cycle tracks shall be located between the parking lane and the sidewalk (in contrast to bike lanes).

Description

Protection is provided through physical barriers and can include bollards, parking, a planter strip, an extruded curb, or on-street parking. Cycle tracks using these protection elements typically share the same elevation as adjacent travel lanes.

Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.



Discussion

Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycle track as pedestrians will likely walk on the cycle track if sidewalk capacity is reduced. Visual and physical cues (e.g. pavement markings & signage) should be used to make it clear where bicyclists and pedestrians should be travelling. If possible, separate the cycle track and pedestrian zone with a furnishing zone.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
AASHTO. (2012). Guide for the Development of Bicycle Facilities.
(see one-way sidepath)

Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

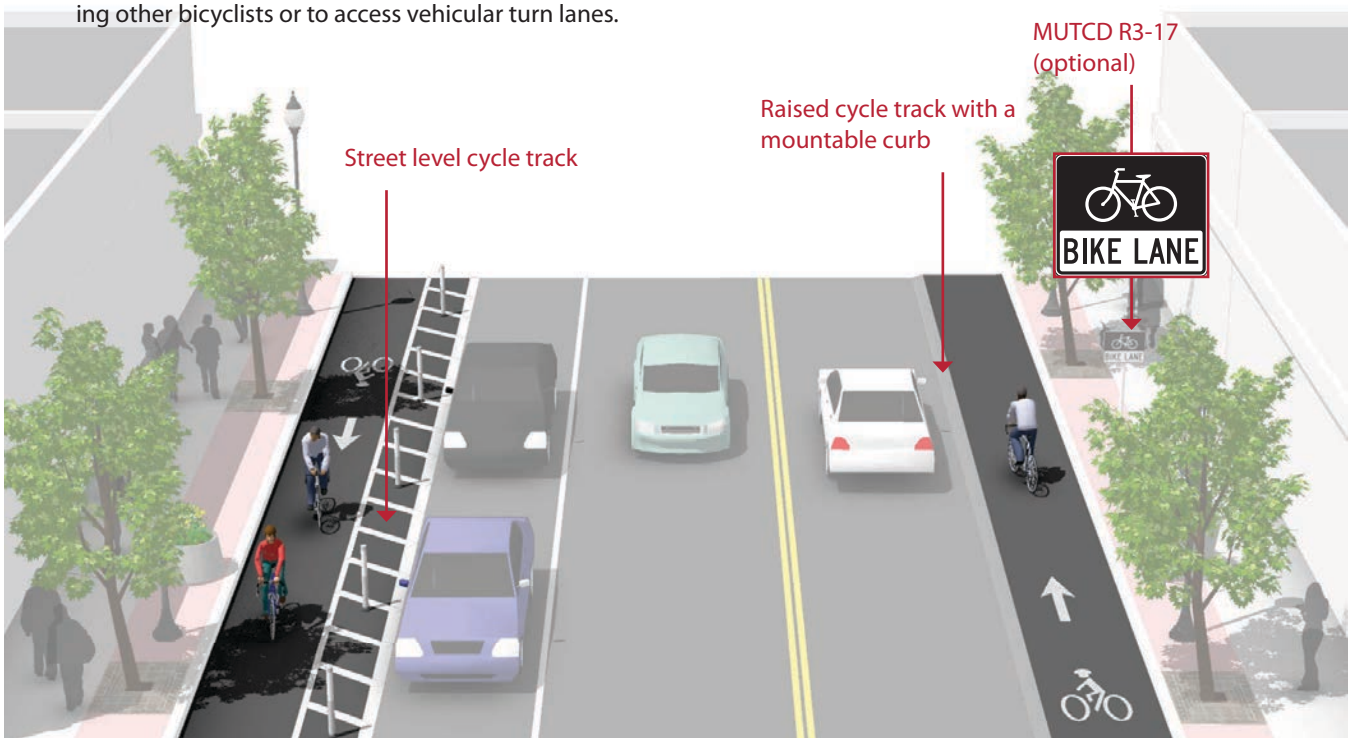
One-Way Cycle Tracks

Guidance

- 7 foot recommended minimum width to allow passing.
- 5 foot minimum width in constrained locations.
- When placed adjacent to parking, the parking buffer should be three feet wide to allow for passenger loading and to prevent door collisions.
- When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.

Description

One-way cycle tracks are physically separated from motor traffic and distinct from the sidewalk. Cycle tracks are either raised or at street level and use a variety of elements for physical protection from passing traffic.



Discussion

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility. Color, yield markings and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic. If configured as a raised cycle track, the crossing should be raised so that the sidewalk and cycle track maintain their elevation through the crossing.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Driveways and Minor Street Crossings

Guidance

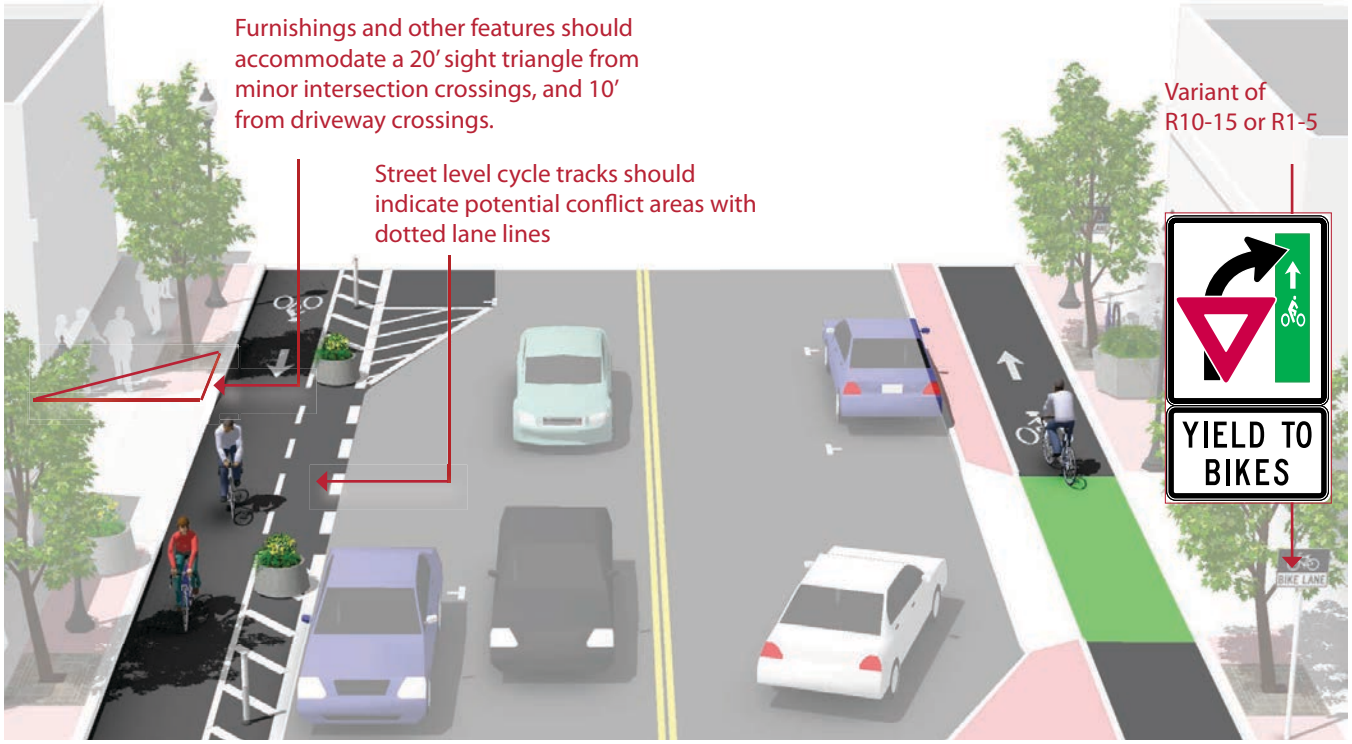
- If raised, maintain the height of the cycle track through the crossing, requiring automobiles to cross over.
- Remove parking 30 feet prior the intersection.
- Use colored pavement markings and/or shared lane markings through the conflict area.
- Place warning signage to identify the crossing.

Description

The added separation provided by cycle tracks creates additional considerations at intersections that should be addressed.

At driveways and crossings of minor streets a smaller fraction of automobiles will cross the cycle track. Bicyclists should not be expected to stop at these minor intersections if the major street does not stop.

Openings in the barrier or curb are needed at intersections and driveways or other access points to allow vehicle crossing.



Discussion

At these locations, bicyclist visibility is important, as a buffer of parked cars or vegetation can reduce the visibility of a bicyclist traveling in the cycle track. Markings and signage should be present to make it easy to understand where bicyclists and pedestrians should be travelling. Access management should be used to reduce the number of crossings of driveways on a cycle track. Driveway consolidations and restrictions on motorized traffic movements reduce the potential for conflict.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

Cycle Tracks

Major Street Crossings

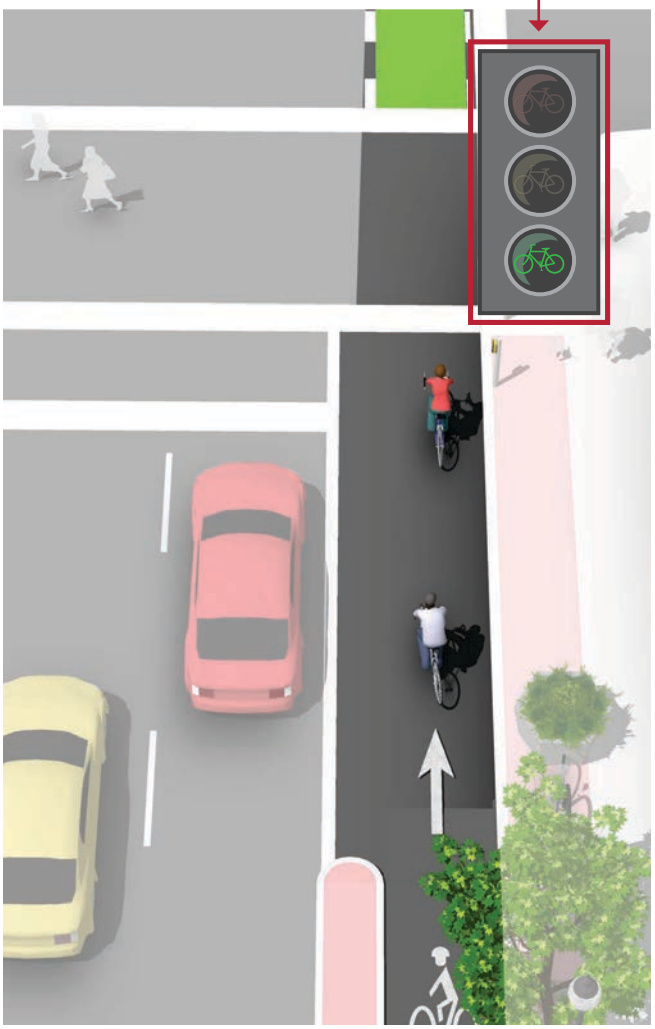
Description

Cycle tracks approaching major intersections must minimize and mitigate potential conflicts and provide connections to intersecting facility types.

Cycle track crossings of signalized intersections can also be accomplished through the use of a bicycle signal phase which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements.

Guidance

- Drop cycle track buffer and transition to bike lane 16' in advance of the intersection.
- Remove parking 16'-50' in advance of the buffer termination.
- Use a bike box or advanced stop line treatment to place bicyclists in front of traffic.
- Use colored pavement markings through the conflict area.
- Provide for left-turning movements with **Two-Stage Turn** boxes.
- Consider using a protected phase bicycle signal to isolate conflicts between bicyclists and motor vehicle traffic.
- In constrained conditions with right turn only lanes, consider transitioning to a **Shared Bike Lane/Turn Lane.**



Discussion

Signalization utilizing a bicycle signal head can also be set to provide cycle track users a green phase in advance of vehicle phases. The length of the signal phase will depend on the width of the intersection.

The same conflicts exist at non-signalized intersections. Warning signs, special markings and the removal of on-street parking in advance of the intersection can raise visibility and awareness of bicyclists.

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

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

Separated Bikeways at Intersections

Intersections are junctions at which different modes of transportation meet and facilities overlap. An intersection facilitates the interchange between bicyclists, motorists, pedestrians and other modes in order to advance traffic flow in a safe and efficient manner. Designs for intersections with bikeways should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting clear right-of-way and facilitating eye contact and awareness with other modes. Intersection treatments can improve both queuing and merging maneuvers for bicyclists, and are often coordinated with timed or specialized signals.

The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection and pavement markings. Intersection design should take into consideration existing and anticipated bicyclist, pedestrian and motorist movements. In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the bikeway type used, whether bikeways are intersecting, the adjacent street function and land use.

Bike Lanes at Right Turn Only Lanes

Shared Bike Lane/Turn Lane

Intersection Crossing Markings

Two-Stage Turn Boxes

Bicyclists at Single Lane Roundabouts

Bike Lanes at High-Speed Interchanges

Separated Bikeways at Intersections

Bike Lanes at Right Turn Only Lanes

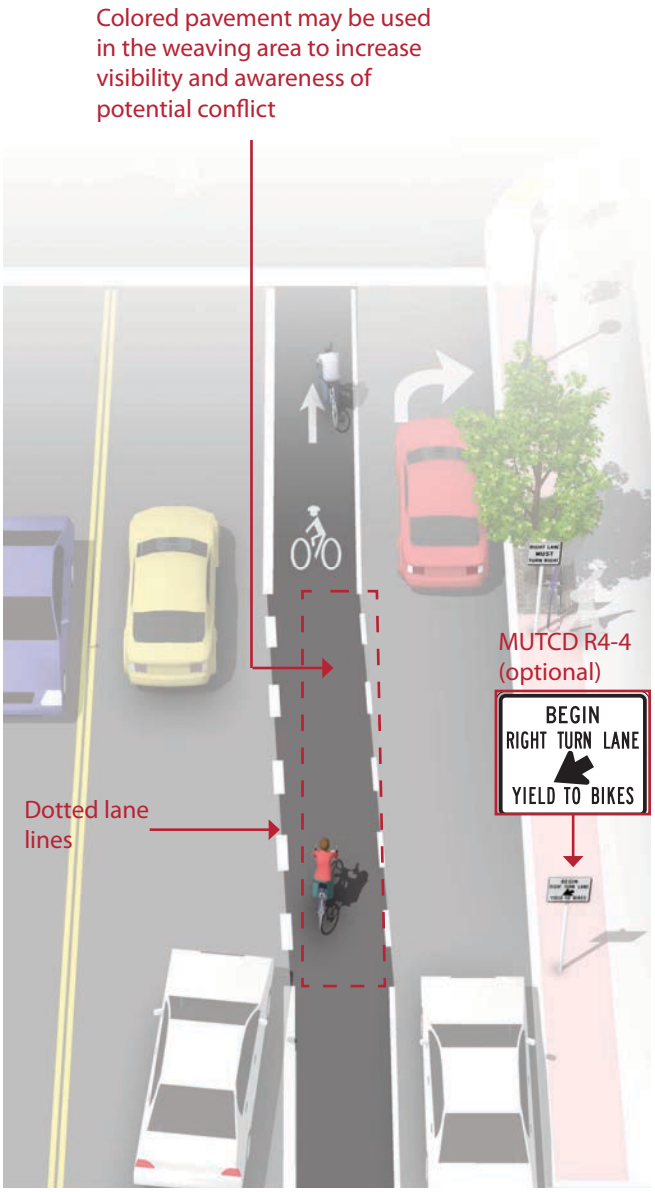
Description

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to use a **Shared Bike Lane/Turn Lane**.

The design (right) illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area.

Guidance

- Continue existing bike lane width (standard width of 5-6′).
- Use signage to indicate that motorists should yield to bicyclists through the conflict area.
- Consider using colored conflict areas to promote visibility of the mixing zone.



Discussion

For other potential approaches to providing accommodations for bicyclists at intersections with turn lanes, please see **Shared Bike Lane/Turn Lane**.

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

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

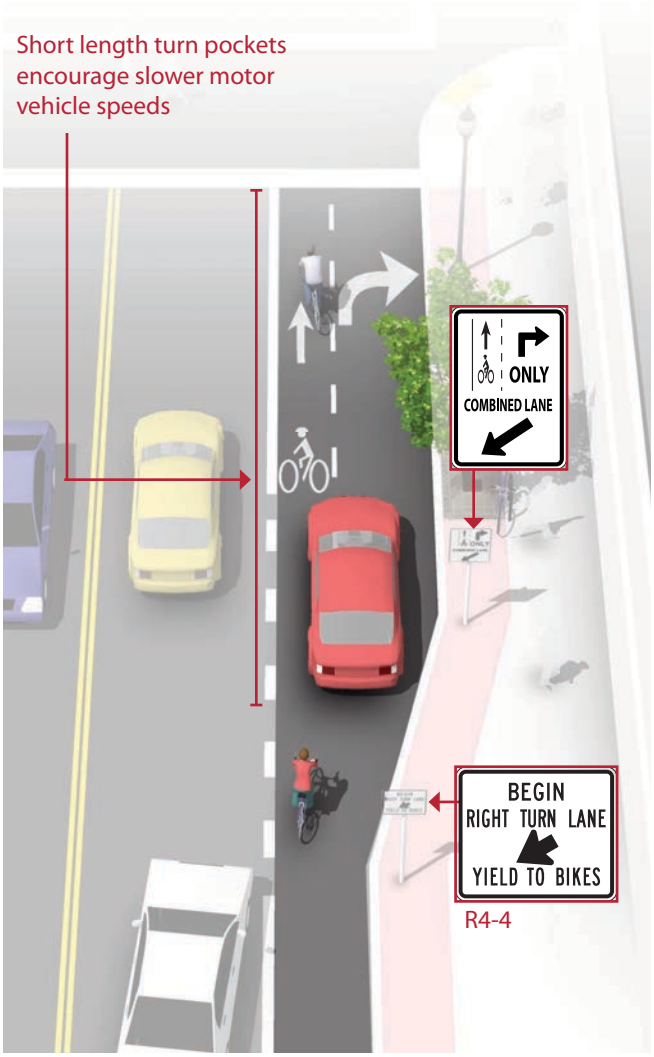
Separated Bikeways at Intersections

Shared Bike Lane / Turn Lane

Description

The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dotted line delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane.

This treatment is recommended at intersections lacking sufficient space to accommodate both a standard bike lane and right turn lane.



Guidance

- Maximum shared turn lane width is 13 feet; narrower is preferable.
- Bike lane pocket should have a minimum width of 4 feet with 5 feet preferred.
- A dotted 4 inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane, without excluding cars from the suggested bicycle area.
- A "Right Turn Only" sign with an "Except Bicycles" plaque may be needed to make it legal for through bicyclists to use a right turn lane.

Discussion

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less). May not be appropriate for high-speed arterials or intersections with long right turn lanes. May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
This treatment is currently slated for inclusion in the next edition of the AASHTO Guide for the Development of Bicycle Facilities.

Materials and Maintenance

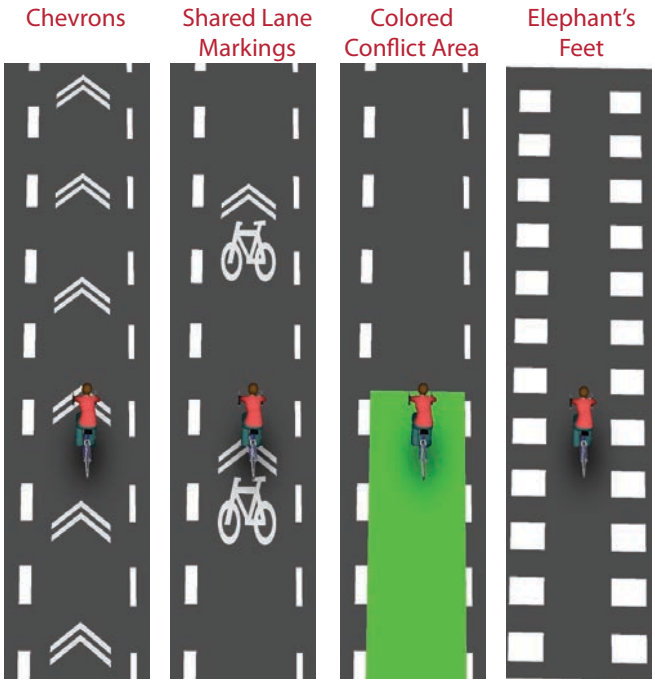
Locate markings out of tire tread to minimize wear. Because the effectiveness of markings depends on their visibility, maintaining markings should be a high priority.

Separated Bikeways at Intersections

Intersection Crossing Markings

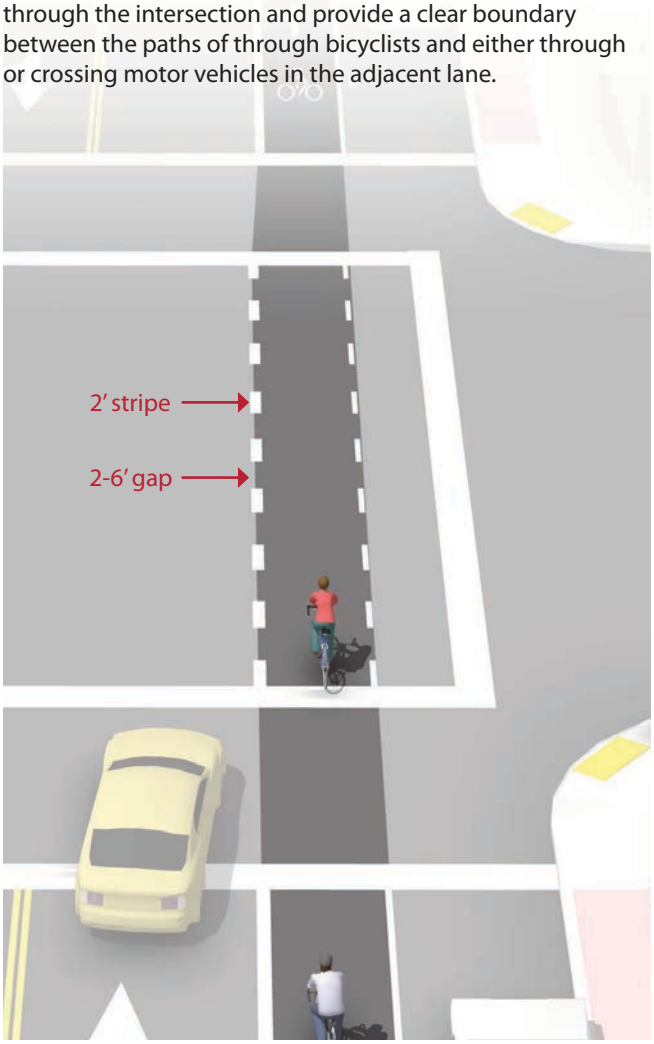
Guidance

- 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.
- Chevrons, shared lane markings, or 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.



Description

Bicycle pavement markings 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.



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

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

Materials and Maintenance

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

Separated Bikeways at Intersections

Two-Stage Turn Boxes

Description

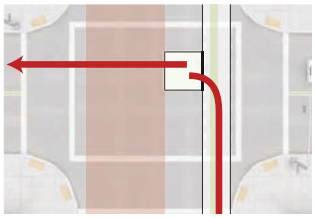
Two-stage turn queue boxes offer bicyclists a safe way to make left turns at multi-lane signalized intersections from a right side cycle track or bike lane.

On right side cycle tracks, bicyclists are often unable to merge into traffic to turn left due to physical separation, making the provision of two-stage left turn boxes critical. Design guidance for two-stage turns apply to both bike lanes and cycle tracks.

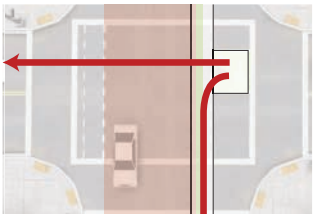
Guidance

- The queue box shall be placed in a protected area. Typically this is within an on-street parking lane or cycle track buffer area.
- 6' minimum depth of bicycle storage area.
- Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning.
- A "No Turn on Red" (MUTCD R10-11) sign may need to be installed on the cross street if sufficient space isn't available for vehicles to turn right without encroaching on the two-stage turn box.

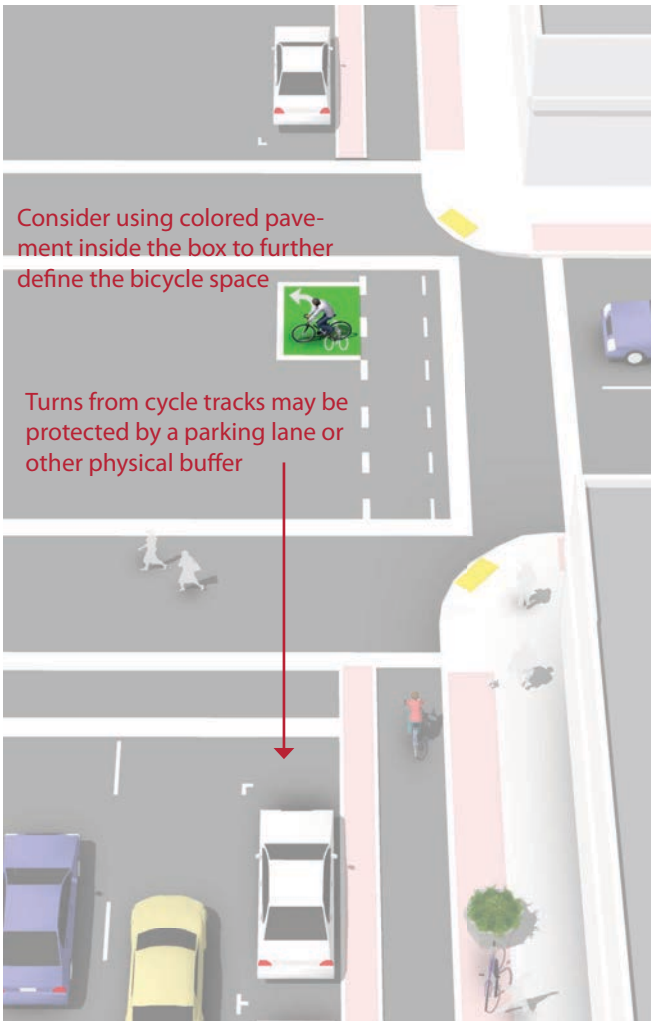
Cycle track turn box protected by physical buffer:



Bike lane turn box protected by parking lane:



Turns from a bicycle lane may be protected by an adjacent parking lane or crosswalk setback space



Discussion

While two stage turns may increase bicyclist comfort in many locations, this configuration will typically result in higher average signal delay for bicyclists due to the need to receive two separate green signal indications (one for the through street, followed by one for the cross street) before proceeding.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates.

Separated Bikeways at Intersections

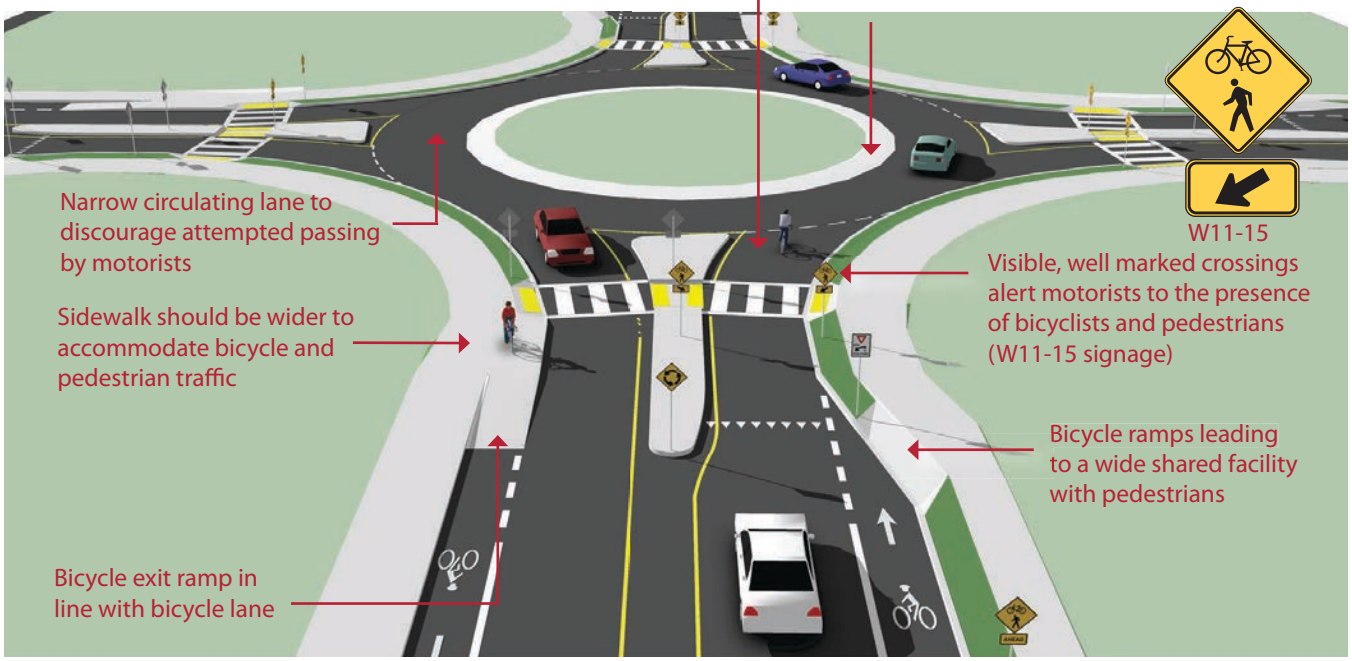
Bicyclists at Single Lane Roundabouts

Guidelines

- 25 mph maximum circulating design speed.
- Design approaches/exits to the lowest speeds possible.
- Encourage bicyclists navigating the roundabout like motor vehicles to "take the lane."
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.

Description

In single lane roundabouts it is important to indicate to motorists, bicyclists and pedestrians the right-of-way rules and correct way for them to circulate, using appropriately designed signage, pavement markings, and geometric design elements.



Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may present greater challenges and significantly increase safety problems for these users.

Additional References and Guidelines

FHWA. (2000). Roundabouts: An Informational Guide
FHWA. (2010). Roundabouts: An Informational Guide, Second Edition. NCHRP 672

Materials and Maintenance

Signage and striping require routine maintenance.

Separated Bikeways at Intersections

Bike Lanes at High Speed Interchanges

Guidance

Entrance Ramps:

Angle the bike lane to increase the approach angle with entering traffic. Position crossing before drivers' attention is focused on the upcoming merge.

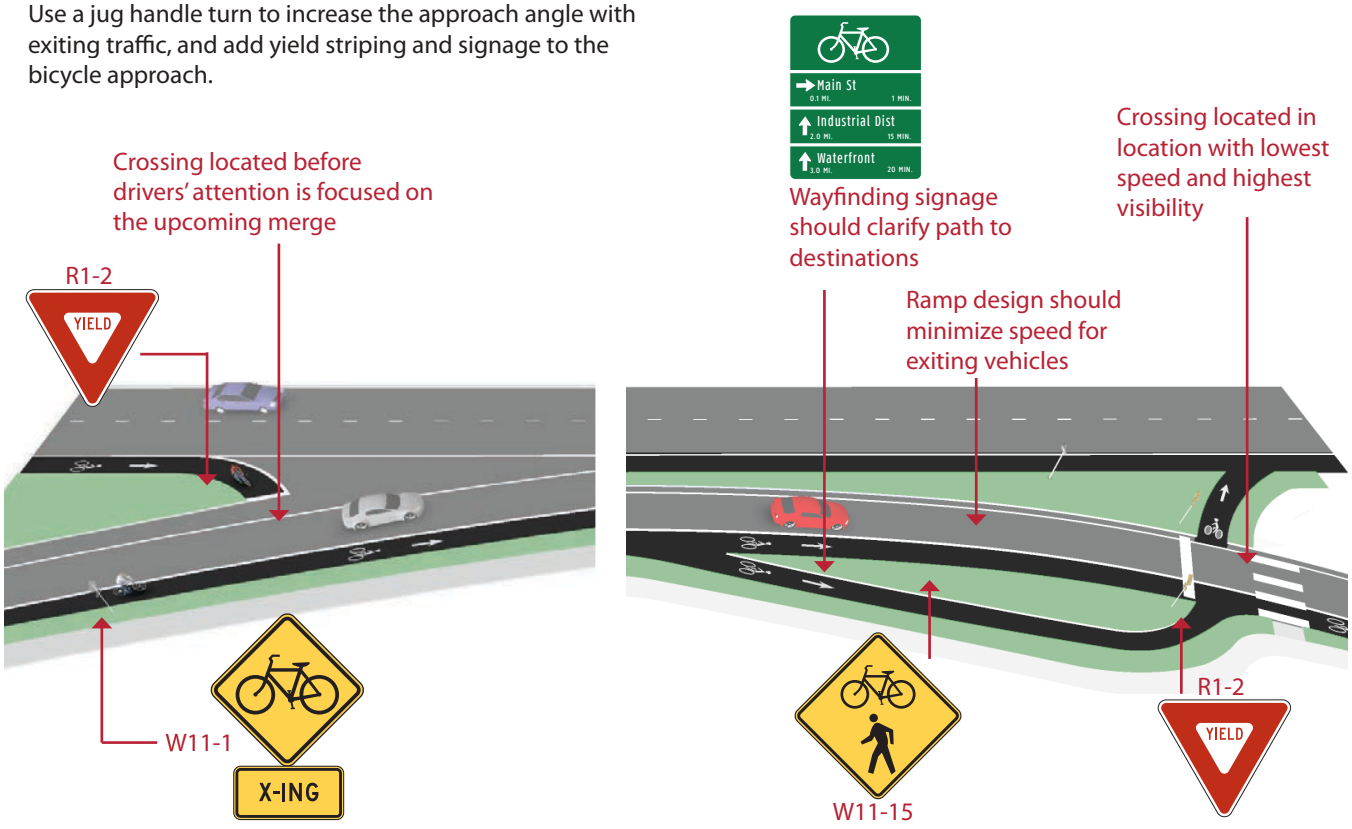
Exit Ramps:

Use a jug handle turn to increase the approach angle with exiting traffic, and add yield striping and signage to the bicycle approach.

Description

Some arterials may contain high speed freeway-style designs such as merge lanes and exit ramps, which can create difficulties for bicyclists. The entrance and exit lanes typically have intrinsic visibility problems because of low approach angles and feature high speed differentials between bicyclists and motor vehicles.

Strategies to improve safety focus on increasing sight distances, creating formal crossings, and minimizing crossing distances.



Discussion

While the jug-handle approach is the preferred configuration at exit ramps, provide the option for through bicyclists to perform a vehicular merge and proceed straight through under safe conditions.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
Bicycle and Pedestrian Transportation. Lesson 15: Bicycle Lanes

Separated Bikeways at Intersections

Diverging Diamond Interchange Design

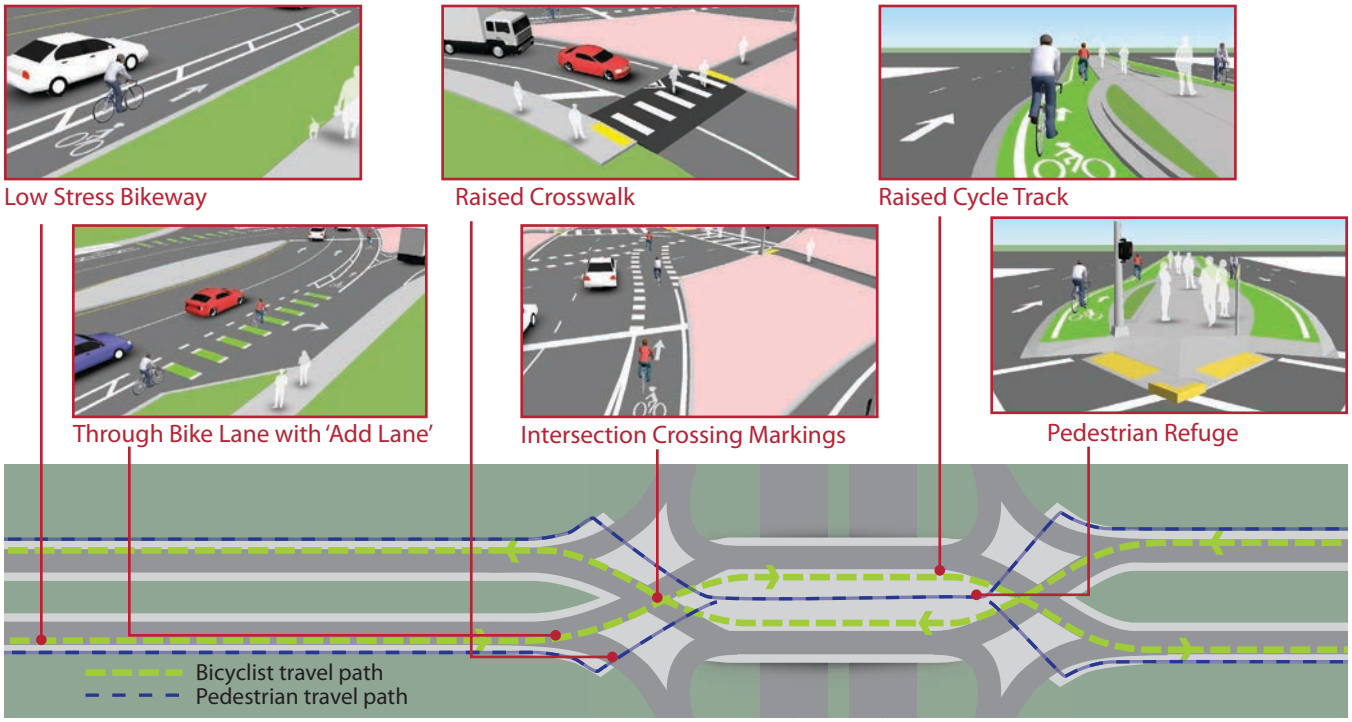
Guidance

- A buffered bike lane or cycle track approaching the interchange offers a lower stress approach for bicyclists.
- Through bike lane striping provides clear priority for bicyclists at right turn 'add lane' on-ramps.
- Raised crosswalks increase yielding compliance at the channelized right turn on- and off- ramps.
- A raised bike lane provides separation from moving traffic, and provides an added buffer for pedestrians.
- Median island offers a safe refuge from moving traffic.

Description

The Diverging Diamond Interchange (DDI) is a modern interchange configuration designed to reduce conflict points and improve safety and performance for automobile users.

Highway interchanges are not typically comfortable for bicyclists or pedestrians due to the high speed and volume of motor vehicle traffic. Key design features at conflict areas in DDIs should be included to improve the experience for vulnerable road users such as bicyclists and pedestrians.



Discussion

The on-ramps should be configured as a right-turn-only "add lane" to assert through bicyclist priority.

The center running island may provide a physical barrier between the auto lanes and the cycle track or pedestrian way to provide additional protection.

Elephant's feet markings (shown) offer more visibility through the intersection than conventional dotted line extensions.

Additional References and Guidelines

TRB. (2011). NCHRP 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities
Missouri DOT. (2012). Engineering Policy Guide. 234.6 Diverging Diamond Interchanges.

Materials and Maintenance

Maintenance issues of DDIs are very similar to other types of interchanges .

Bikeway Signing

The ability to navigate through a city is informed by landmarks, natural features and other visual cues. Signs throughout the city should indicate to bicyclists:

- Direction of travel.
- Location of destinations.
- Travel time/distance to those destinations.

These signs will increase users' comfort and accessibility to the bicycle systems.

Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bicycle network.
- Helping users identify the best routes to destinations.
- Helping to address misperceptions about time and distance.
- Helping overcome a "barrier to entry" for people who are not frequent bicyclists (e.g. "interested but concerned" bicyclists).

A community-wide bicycle wayfinding signage plan would identify:

- Sign locations .
- Sign type – what information should be included and design features.
- Destinations to be highlighted on each sign – key destinations for bicyclists .
- Approximate distance and travel time to each destination .

Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Too many road signs tend to clutter the right-of-way. It is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.

Wayfinding Sign Types

Wayfinding Sign Placement

Wayfinding Signage

Wayfinding Sign Types

Description

A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. There are three general types of wayfinding signs:

Confirmation Signs

Indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route.

Can include destinations and distance/time. Do not include arrows.

Turn Signs

Indicate where a bikeway turns from one street onto another street. Can be used with pavement markings.

Include destinations and arrows.

Decisions Signs

Mark the junction of two or more bikeways.

Inform bicyclists of the designated bike route to access key destinations.

Destinations and arrows are required. Distances and travel times are optional but recommended.

Discussion

Section 1A.12 of the MUTCD establishes the general meaning for signage colors. Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the MUTCD.

Additional References and Guidelines

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

Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

Wayfinding Signage

Wayfinding Sign Placement

Guidance

Signs are typically placed at decision points along bicycle routes – typically at the intersection of two or more bikeways and at other key locations leading to and along bicycle routes.

Decisions Signs

Near-side of intersections in advance of a junction with another bicycle route.

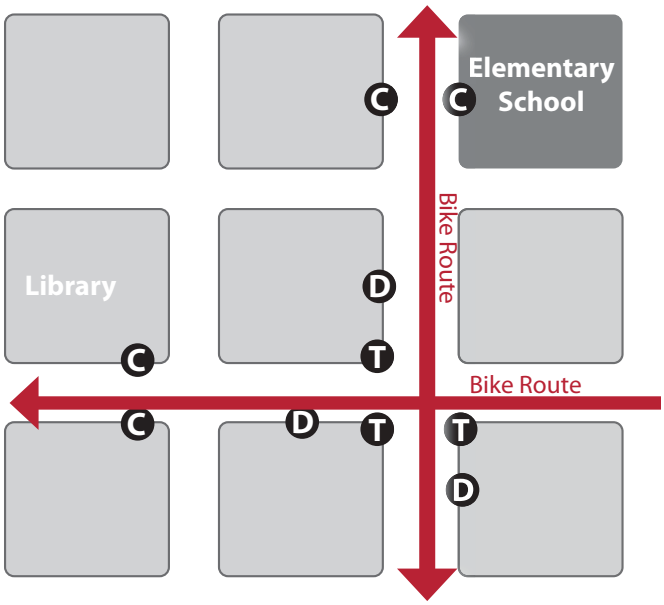
Along a route to indicate a nearby destination.

Confirmation Signs

Every ¼ to ½ mile on off-street facilities and every 2 to 3 blocks along on-street bikeways, unless another type of sign is used (e.g. within 150 ft of a turn or decision sign). Should be placed soon after turns to confirm destination(s). Pavement markings can also act as confirmation that a bicyclist is on a preferred route.

Turn Signs

Near-side of intersections where bike routes turn (e.g. where the street ceases to be a bicycle route or does not go through). Pavement markings can also indicate the need to turn to the bicyclist.



Discussion

It can be useful to classify a list of destinations for inclusion on the signs based on their relative importance to users throughout the area. A particular destination's ranking in the hierarchy can be used to determine the physical distance from which the locations are signed. For example, primary destinations (such as the downtown area) may be included on signage up to five miles away. Secondary destinations (such as a transit station) may be included on signage up to two miles away. Tertiary destinations (such as a park) may be included on signage up to one mile away.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

Retrofitting Existing Streets to add Bikeways

Most major streets are characterized by conditions (e.g. high vehicle speeds and/or volumes) for which dedicated bike lanes are the most appropriate facility to accommodate safe and comfortable riding. Although opportunities to add bike lanes through roadway widening may exist in some locations, many major streets have physical and other constraints that would require street retrofit measures within existing curb-to-curb widths. As a result, much of the guidance provided in this section focuses on effectively reallocating existing street width through striping modifications to accommodate dedicated bike lanes.

Although largely intended for major streets, these measures may be appropriate for any roadway where bike lanes would be the best accommodation for bicyclists.


Roadway Widening


Lane Narrowing


Lane Reconfiguration


Parking Reduction

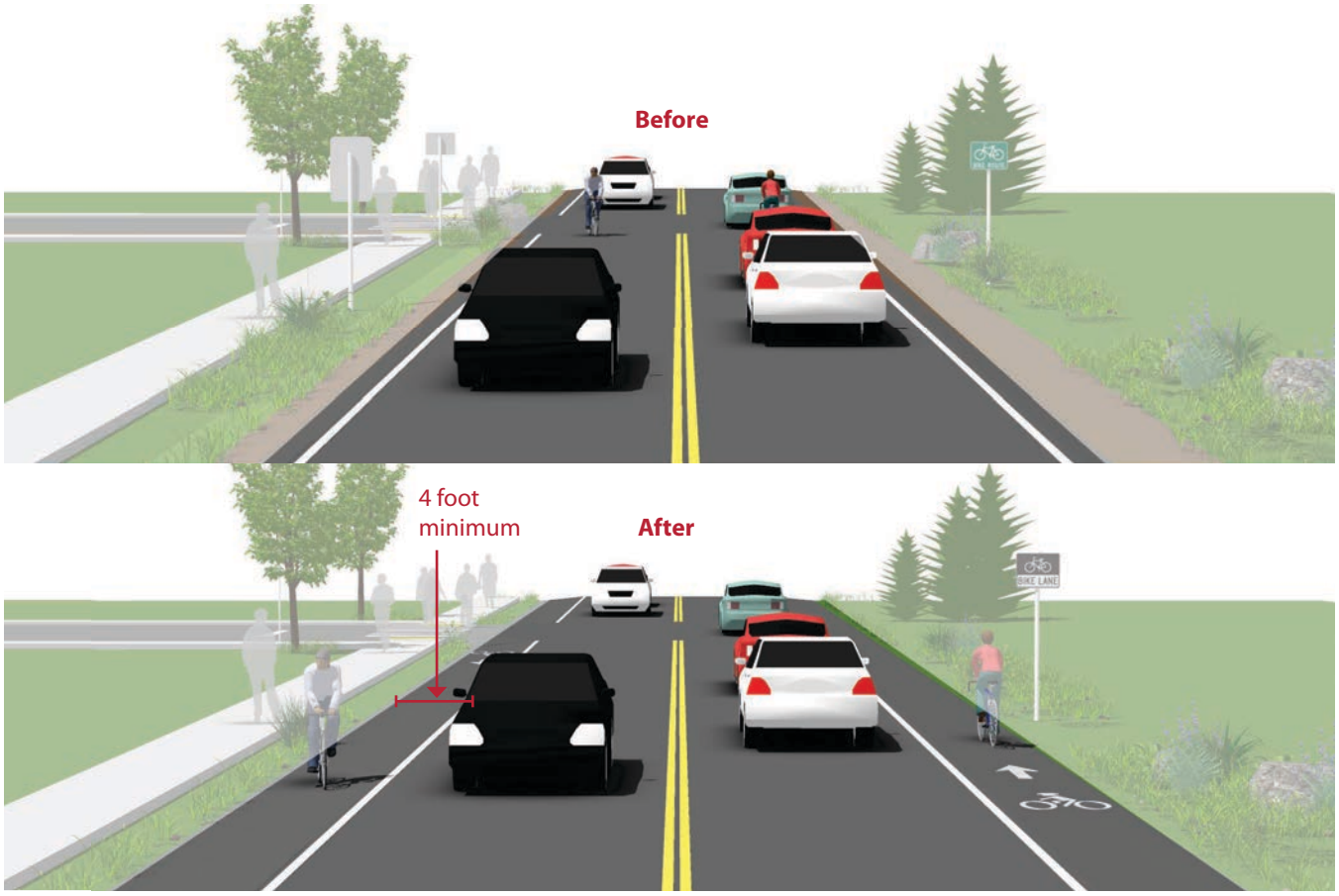
Roadway Widening

Guidance

- Guidance on **Bike Lanes** applies to this treatment.
- 4 foot minimum where the bike lane is not placed next to parking. 5 foot minimum if placed next to parking.
- 6 foot width preferred.

Description

Bike lanes can be accommodated on streets with excess right-of-way through shoulder widening. Although roadway widening incurs higher expenses compared with re-striping projects, bike lanes can be added without incurring the high costs of major reconstruction if the street lacks curbs, gutters, and sidewalks.



Discussion

Roadway widening is most appropriate on roads lacking curbs, gutters and sidewalks.

If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3 feet of shoulder operating space should be provided.

Additional References and Guidelines

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

Materials and Maintenance

The extended bicycle area should not contain any rough joints where bicyclists ride. Saw or grind a clean cut at the edge of the travel lane when widening shoulders.

Retrofitting Existing Streets

Lane Narrowing

Guidance

Vehicle lane width:

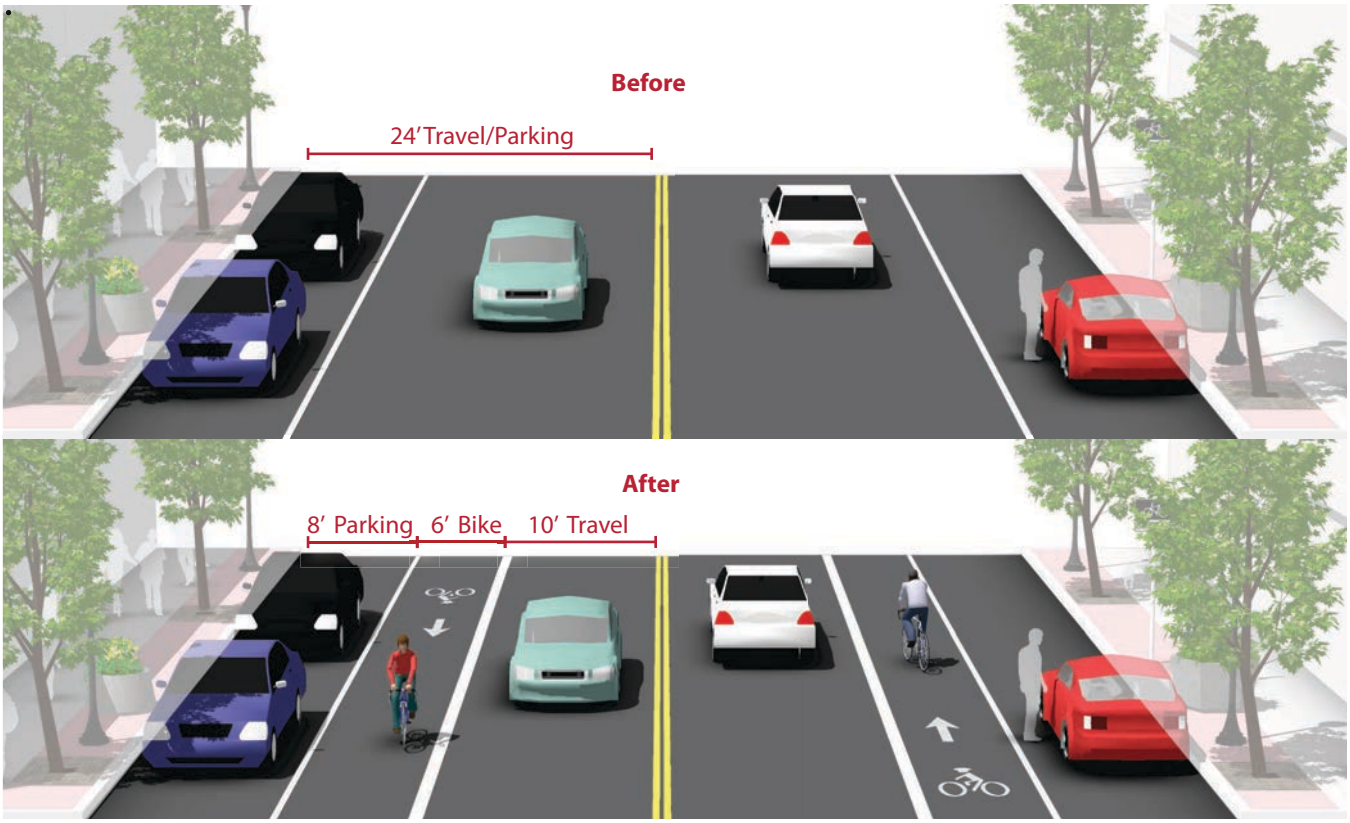
- Before: 11-15 feet.
- After: 10-11 feet.

Bicycle lane width:

- Guidance on **Bike Lanes** applies to this treatment.

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.



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."*

Additional References and Guidelines

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.

Retrofitting Existing Streets

Lane Reconfiguration

Guidance

Vehicle lane width:

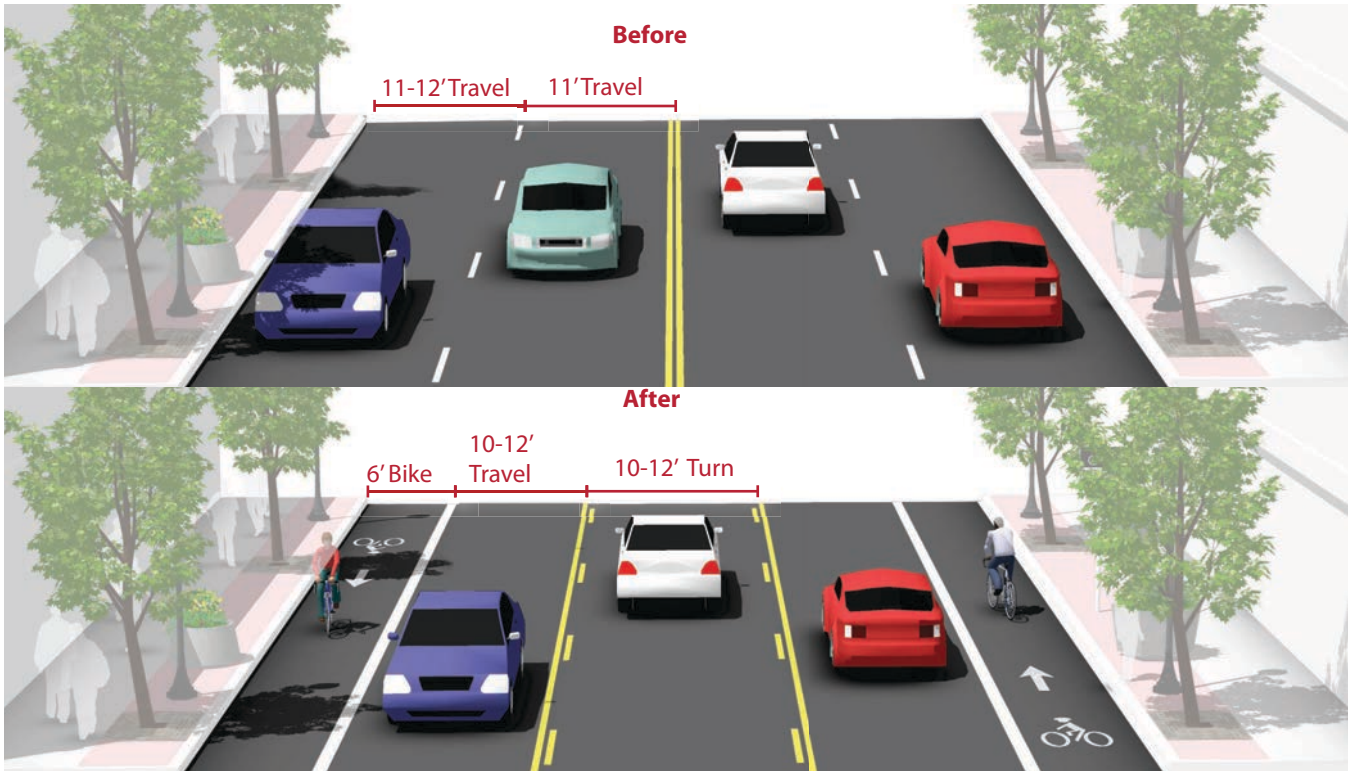
- Width depends on project. No narrowing may be needed if a lane is removed.

Bicycle lane width:

- Guidance on **Bike Lanes** applies to this treatment.

Description

The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects.



Discussion

Depending on a street's existing configuration, traffic operations, user needs and safety concerns, various lane reduction configurations may apply. For instance, a four-lane street (with two travel lanes in each direction) could be modified to provide one travel lane in each direction, a center turn lane, and bike lanes. Prior to implementing this measure, a traffic analysis should identify potential impacts.

Additional References and Guidelines

FHWA. (2010). Evaluation of Lane Reduction "Road Diet" Measures on Crashes. Publication Number: FHWA-HRT-10-053

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.

Retrofitting Existing Streets

Parking Reduction

Guidance

Vehicle lane width:

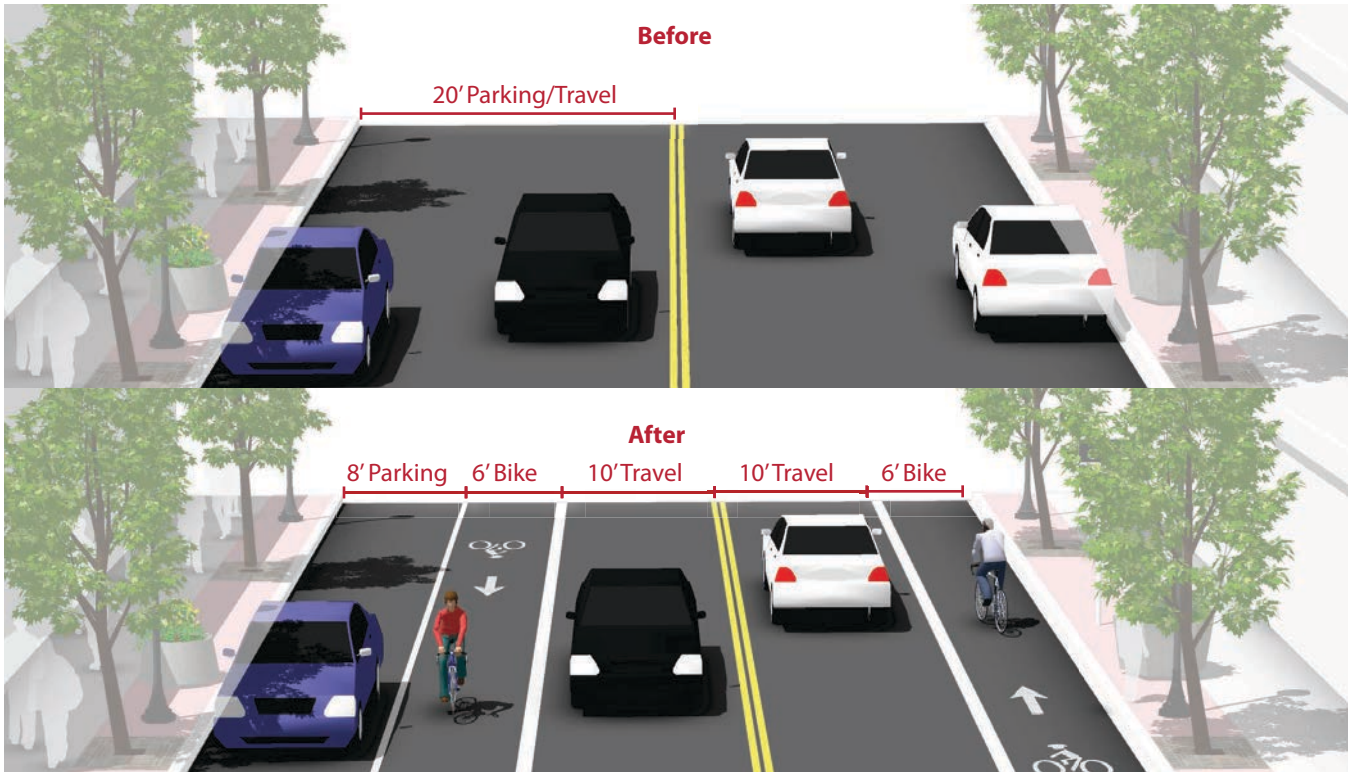
- Parking lane width depends on project. No travel lane narrowing may be required depending on the width of the parking lanes.

Bicycle lane width:

- Guidance on **Bike Lanes** applies to this treatment.

Description

Bike lanes can replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For example, parking may be needed on only one side of a street. Eliminating or reducing on-street parking also improves sight distance for bicyclists in bike lanes and for motorists on approaching side streets and driveways.



Discussion

Removing or reducing on-street parking to install bike lanes requires comprehensive outreach to the affected businesses and residents. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand and to evaluate impacts to people with disabilities.

Additional References and Guidelines

AASHTO. (2004). A Policy on Geometric Design of Highways and Streets.

There is no currently adopted Federal or State guidance for this treatment.

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

Shared Use Paths

A shared use path allows for two-way, off-street bicycle use and also may be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users. These facilities are frequently found in parks, along rivers, beaches, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Path facilities can also include amenities such as lighting, signage, and fencing (where appropriate).

Key features of shared use paths include:

- Frequent access points from the local road network.
- Directional signs to direct users to and from the path.
- A limited number of at-grade crossings with streets or driveways.
- Terminating the path where it is easily accessible to and from the street system.
- Separate space for pedestrians and bicyclists when heavy use is expected.


General Design Practices


Shared Use Paths in River and Utility Corridors


Shared Use Paths in Abandoned Rail Corridors


Shared Use Paths in Active Rail Corridors


Local Neighborhood Accessways

Shared Use Paths

General Design Practices

Guidance

Width

- 8 feet is the minimum allowed for a two-way bicycle path and is only recommended for low traffic situations.
- 10 feet is recommended in most situations and will be adequate for moderate to heavy use.
- 12 feet is recommended for heavy use situations with high concentrations of multiple users. A separate track (5' minimum) can be provided for pedestrian use.

Lateral Clearance

- A 2 foot or greater shoulder on both sides of the path should be provided. An additional foot of lateral clearance (total of 3') is required by the MUTCD for the installation of signage or other furnishings.
- If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

Overhead Clearance

- Clearance to overhead obstructions should be 8 feet minimum, with 10 feet recommended.

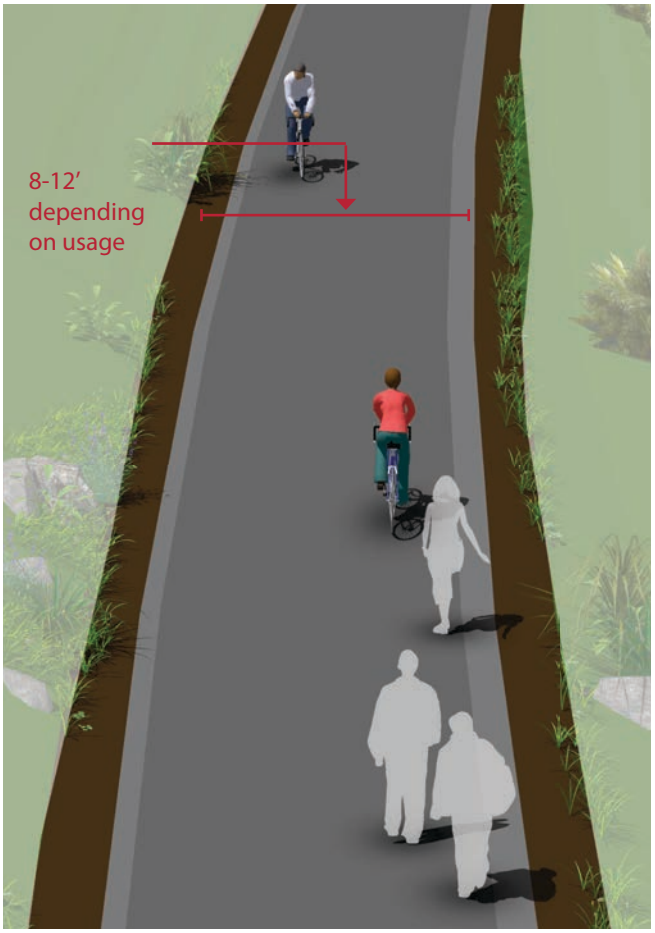
Striping

- When striping is required, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners, and on the approaches to roadway crossings.

Terminate the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street.

Description

Shared use paths can provide a desirable facility, particularly for recreation, and users of all skill levels preferring separation from traffic. Bicycle paths should generally provide directional travel opportunities not provided by existing roadways.



Discussion

The AASHTO Guide for the Development of Bicycle Facilities generally recommends against the development of **Shared Use Paths Along Roadways**. Also known as "sidepaths", these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in wrong-way riding when either entering or exiting the path.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
Flink, C. (1993). Greenways: A Guide To Planning Design And Development.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

Shared Use Paths in River and Utility Corridors

Guidance

Paths in utility corridors should meet or exceed **General Design Practices**. If additional width allows, wider paths and landscaping are desirable.

Access Points

Any access point to the path should be well-defined with appropriate signage designating the pathway as a bikeway and prohibiting motor vehicles.

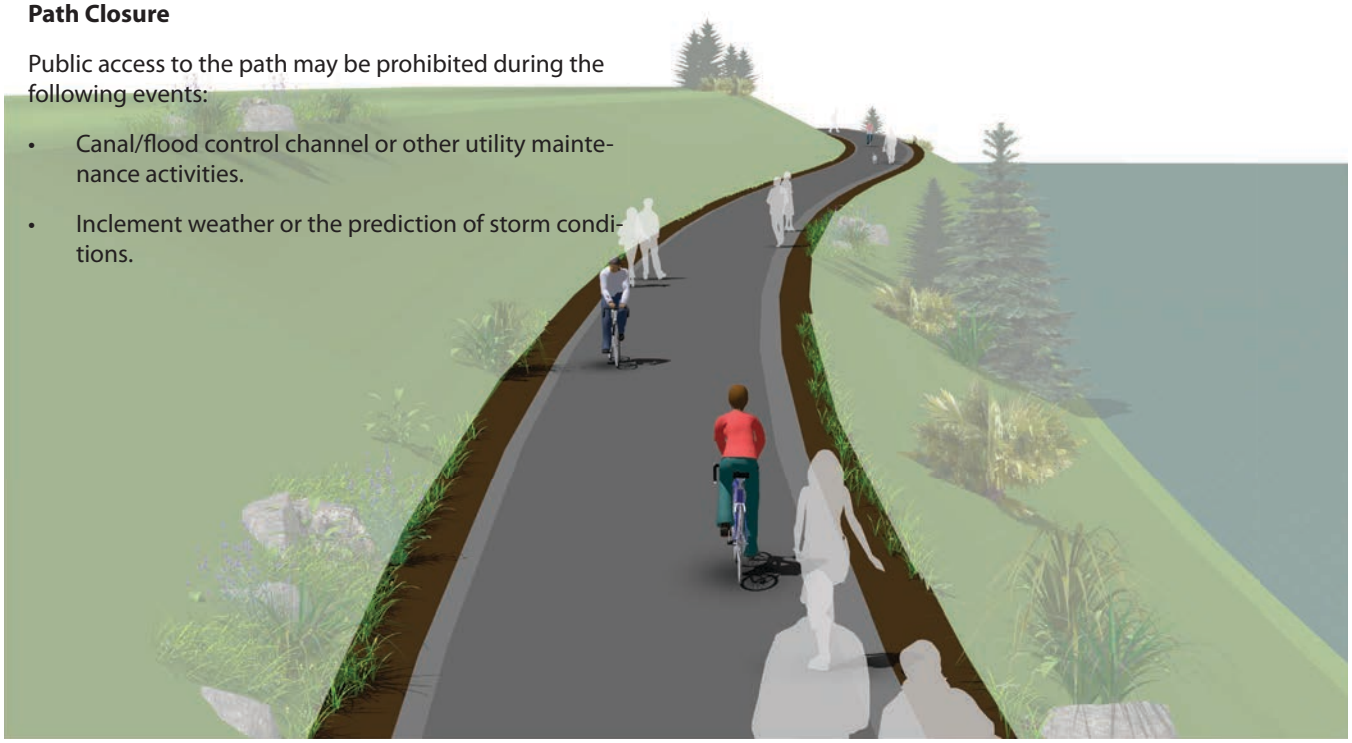
Path Closure

Public access to the path may be prohibited during the following events:

- Canal/flood control channel or other utility maintenance activities.
- Inclement weather or the prediction of storm conditions.

Description

Utility and waterway corridors often offer excellent path development and bikeway gap closure opportunities. Utility corridors typically include powerline and sewer corridors, while waterway corridors include canals, drainage ditches, rivers, and beaches. These corridors offer excellent transportation and recreation opportunities for bicyclists of all ages and skills.



Discussion

Similar to railroads, public access to flood control channels or canals does come with some caveats. Hazardous materials, deep water, swift current, steep or slippery slopes, and debris all constitute risks for public access. Appropriate fencing may be required to keep path users within the designated travel way. Creative design of fencing is encouraged to make the path feel welcoming.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
Flink, C. (1993). Greenways: A Guide To Planning Design And Development.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

Shared Use Paths

Shared Use Paths in Abandoned Rail Corridors

Guidance

Paths in abandoned rail corridors should meet or exceed **General Design Practices**. If additional width allows, wider paths and landscaping are desirable.

In full conversions of abandoned rail corridors, the sub-base, superstructure, drainage, bridges, and crossings are already established. Design becomes a matter of working with the existing infrastructure to meet the needs of a rail trail.

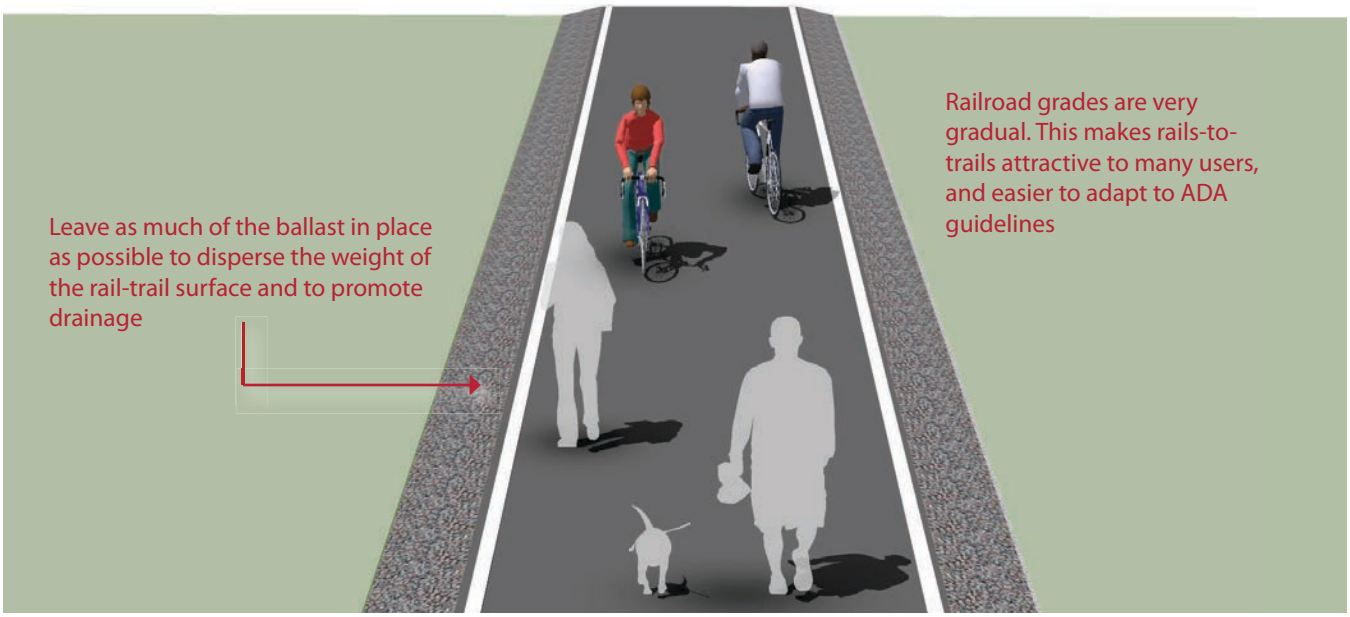
If converting a rail bed adjacent to an active rail line, see **Shared Use Paths in Active Rail Corridors**.

Description

Commonly referred to as Rails-to-Trails or Rail Trails, these projects convert vacated rail corridors into off-street paths. Rail corridors offer several advantages, including relatively direct routes between major destinations and generally flat terrain.

In some cases, rail owners may "rail-bank" their corridors as an alternative to a complete abandonment of the line, thus preserving the rail corridor for possible future use.

The railroad may form an agreement with any person, public or private, who would like to use the banked rail line as a trail or linear park until it is again needed for rail use. Municipalities should acquire abandoned rail rights-of-way whenever possible to preserve the opportunity for path development.



Discussion

It is often impractical and costly to add material to existing railroad bed fill slopes. This results in paths that meet minimum path widths, but often lack preferred shoulder and lateral clearance widths.

Rail-to-trails can involve many challenges including the acquisition of the right of way, cleanup and removal of toxic substances, and rehabilitation of tunnels, trestles and culverts. A structural engineer should evaluate existing railroad bridges for structural integrity to ensure they are capable of carrying the appropriate design loads.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
Flink, C. (1993). Greenways: A Guide To Planning Design And Development.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

Shared Use Paths in Active Rail Corridors

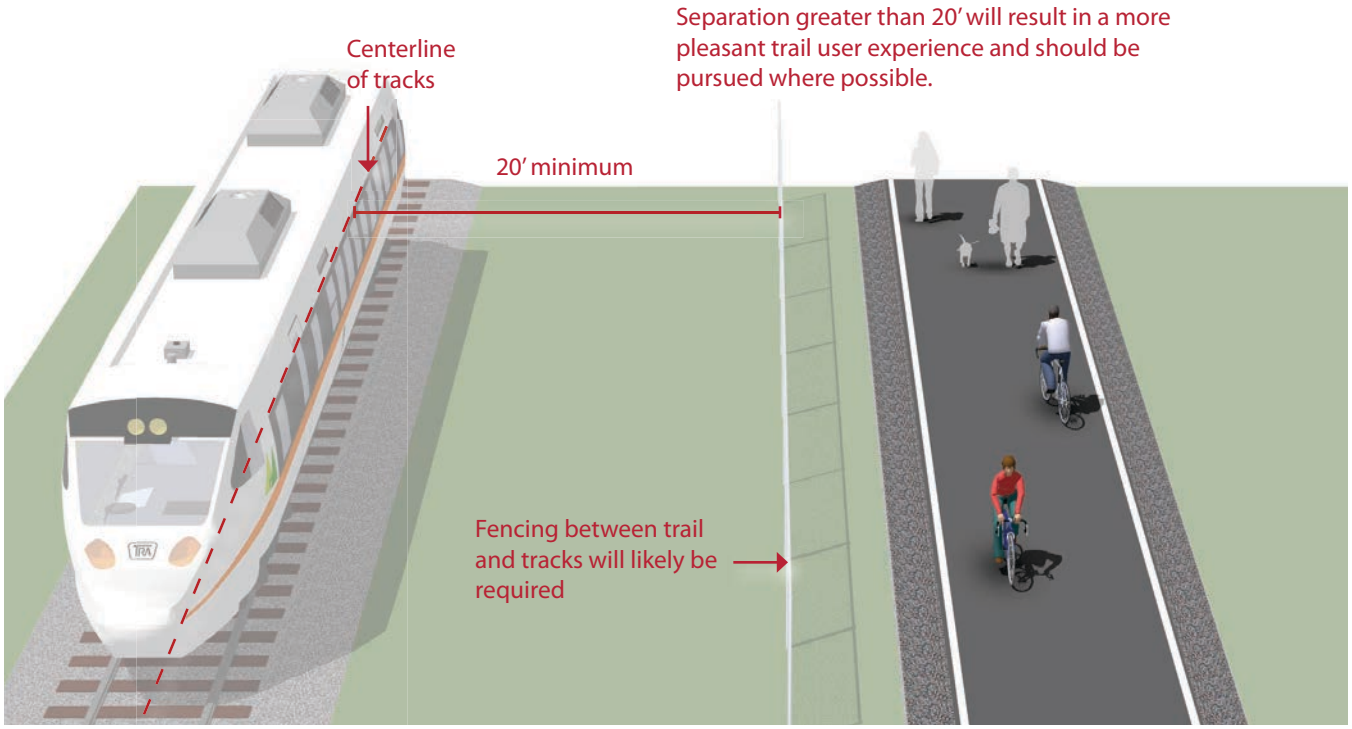
Guidance

Paths in utility corridors should meet or exceed **General Design Standards**. If additional width allows, wider paths and landscaping are desirable.

If required, fencing should be a minimum of 5 feet in height with higher fencing than usual next to sensitive areas such as switching yards. Setbacks from the active rail line will vary depending on the speed and frequency of trains, and available right-of-way.

Description

Rails-with-Trails projects typically consist of paths adjacent to active railroads. It should be noted that some constraints could impact the feasibility of rail-with-trail projects. In some cases, space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about safety/trespassing, and numerous mid-block crossings may affect a project's feasibility.



Discussion

Railroads typically require fencing with all rail-with-trail projects. Concerns with trespassing and security can vary with the amount of train traffic on the adjacent rail line as well as whether the track is in an urban or rural setting.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2002). Rails-with-Trails: Lessons Learned.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

Shared Use Paths

Local Neighborhood Accessways

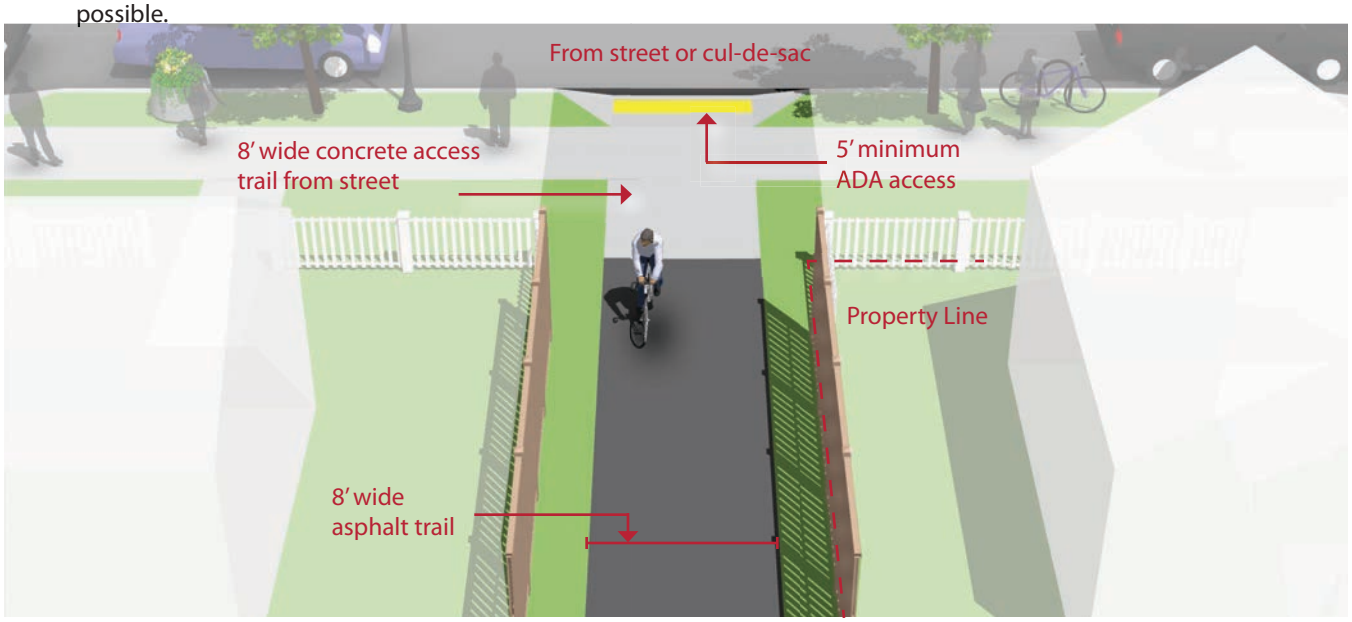
Guidance

- Neighborhood accessways should remain open to the public.
- Trail pavement shall be at least 8' wide to accommodate emergency and maintenance vehicles, meet ADA requirements and be considered suitable for shared use.
- Accessways should be designed to be less than 8' wide only when necessary to protect large mature native trees over 18" in caliper, wetlands or other ecologically sensitive areas.
- Access trails should slightly meander whenever possible.

Description

Neighborhood accessways provide residential areas with direct bicycle and pedestrian access to parks, trails, greenspaces, and other recreational areas. They most often serve as small trail connections to and from the larger shared use path network, typically having their own rights-of-way and easements.

Additionally, these smaller trails can be used to provide bicycle and pedestrian connections between dead-end streets, cul-de-sacs, and access to nearby destinations not provided by the street network.



Discussion

Neighborhood accessways should be designed into new subdivisions at every opportunity and should be required by City/County subdivision regulations. For existing subdivisions, neighborhood and homeowner association groups are encouraged to identify locations where such connects would be desirable. Nearby residents and adjacent property owners should be invited to provide landscape design input.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2006). Federal Highway Administration University Course on Bicycle and Pedestrian Transportation. Lesson 19: Greenways and Shared Use Paths.

Materials and Maintenance

Asphalt is the most common surface for shared use paths. The use of concrete for paths has proven to be more durable over the long term. Using saw cut concrete joints rather than troweled joints improves the experience of path users.

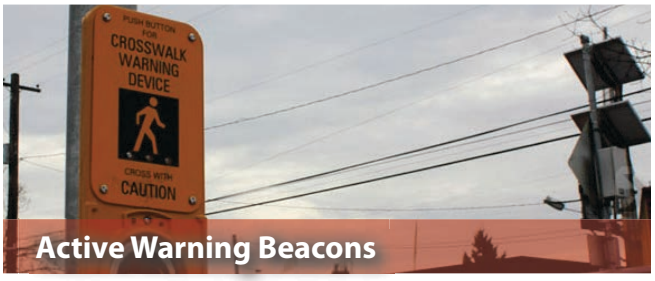
Path/Roadway Crossings

At-grade roadway crossings can create potential conflicts between path users and motorists. However, well-designed crossings can mitigate many operational issues and provide a higher degree of safety and comfort for path users. This is evidenced by the thousands of successful facilities around the United States with at-grade crossings. In most cases, at-grade path crossings can be properly designed to provide a reasonable degree of safety and can meet existing traffic and safety standards. Path facilities that cater to bicyclists can require additional considerations due to the higher travel speed of bicyclists versus pedestrians.

Consideration must be given to adequate warning distance based on vehicle speeds and line of sight, with the sign visibility being absolutely critical. Directing the active attention of motorists to roadway signs may require additional alerting devices such as a flashing beacon, roadway striping or changes in pavement texture. Signing for path users may include a standard "STOP" or "YIELD" sign and pavement markings, possibly combined with other features such as bollards or a bend in the pathway to slow bicyclists. Care must be taken not to place too many signs at crossings lest they begin to lose their visual impact.

A number of striping patterns have emerged over the years to delineate path crossings. A median stripe on the path approach will help to organize and warn path users. Crosswalk striping is typically a matter of local and State preference, and may be accompanied by pavement treatments to help warn and slow motorists. In areas where motorists do not typically yield to crosswalk users, additional measures may be required to increase compliance.


Marked/Unsignalized Crossings



Active Warning Beacons


Route Users to Signalized Crossings


Signalized/Controlled Crossings

Undercrossings


Overcrossings

Path/Roadway Crossings

Marked/Unsignalized Crossings

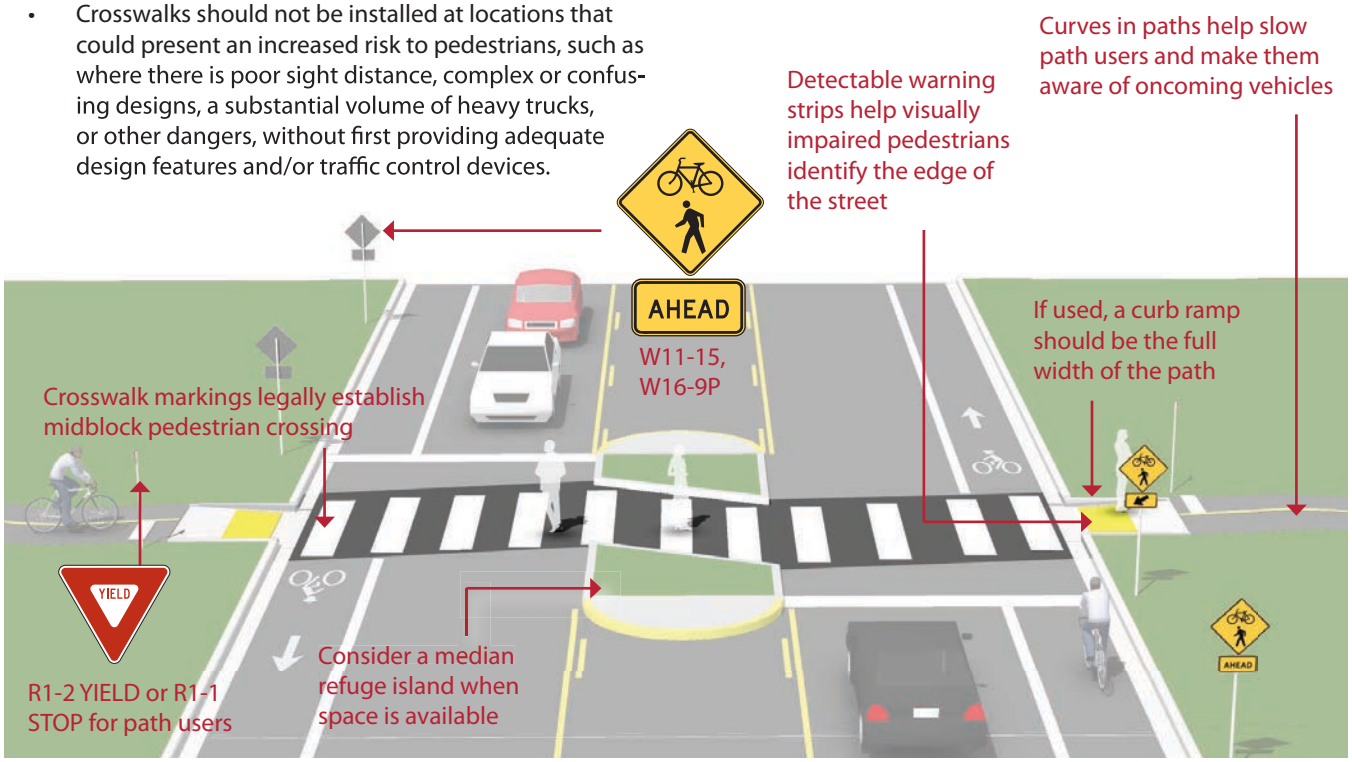
Guidance

- Refer to the FHWA report, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations" for specific volume and speed ranges where a marked crosswalk alone may be sufficient.
- Where the speed limit exceeds 40 miles per hour, marked crosswalks alone should not be used at unsignalized locations.
- Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices.

Description

A marked/unsignalized crossing typically consists of a marked crossing area, signage and other markings to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, pathway traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.

When space is available, using a median refuge island can improve user safety by providing pedestrians and bicyclists space to perform the safe crossing of one side of the street at a time.



Discussion

Crosswalks alone will not make crossings safer, nor will crosswalks necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g. raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions, etc.) as needed to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding which treatment to use.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2002). Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.

Materials and Maintenance

Locate markings out of wheel tread when possible to minimize wear and maintenance costs.

Path/Roadway Crossings

Active Warning Beacons

Guidance

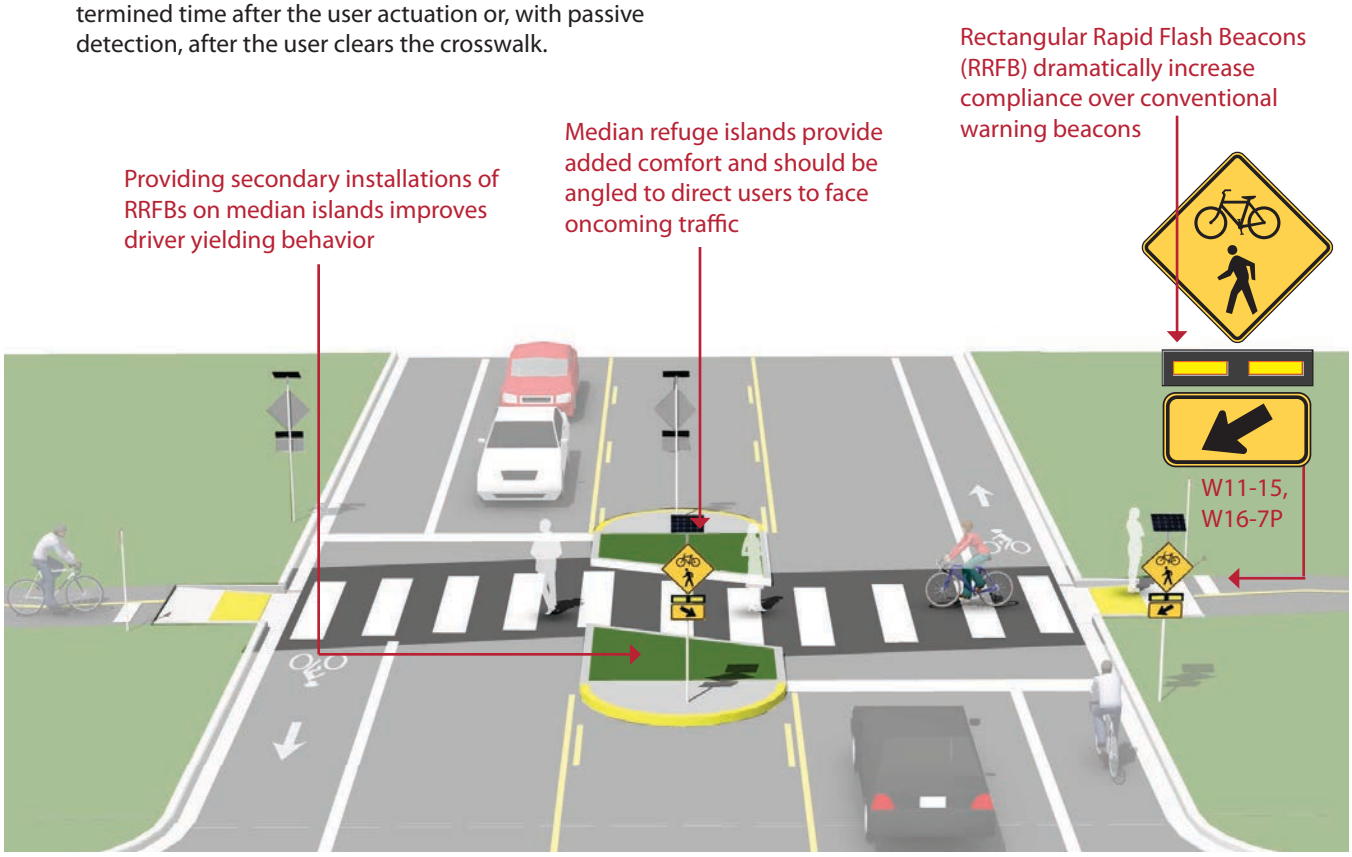
Guidance for **Marked/Unsignalized Crossings** applies.

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.
- Warning beacons shall initiate operation based on user actuation and shall cease operation at a predetermined time after the user actuation or, with passive detection, after the user clears the crosswalk.

Description

Enhanced marked crossings are unsignalized crossings with additional treatments designed to increase motor vehicle yielding compliance on multi-lane or high volume roadways.

These enhancements include pathway user or sensor actuated warning beacons, Rectangular Rapid Flash Beacons (RRFB) shown below, or in-roadway warning lights.



Discussion

Rectangular rapid flash beacons show the most increased compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88%. Additional studies of long-term installations show little to no decrease in yielding behavior over time.

Additional References and Guidelines

NACTO. (2012). Urban Bikeway Design Guide.
FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2008). MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)

Materials and Maintenance

Signing and striping need to be maintained to help users understand any unfamiliar traffic control. Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs should run for years.

Path/Roadway Crossings

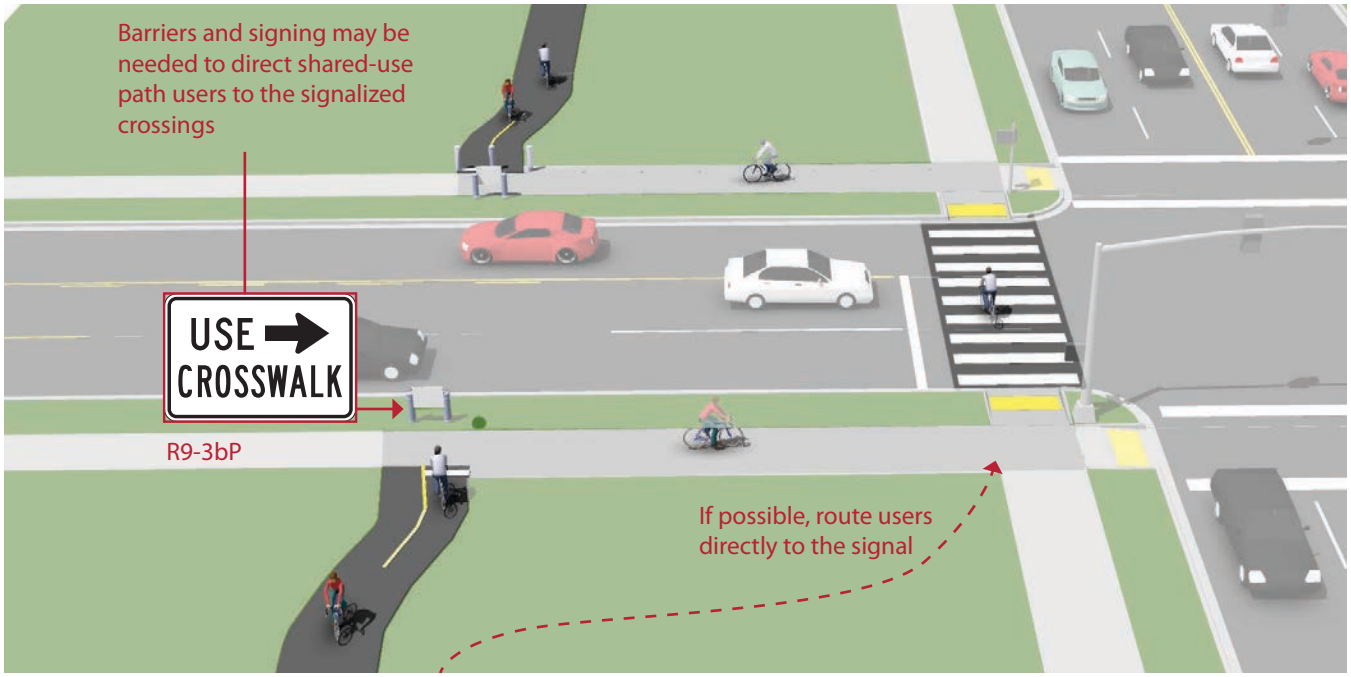
Route Users to Signalized Crossings

Guidance

Path crossings should not be provided within approximately 400 feet of an existing signalized intersection. If possible, route path directly to the signal.

Description

Path crossings within approximately 400 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection to avoid traffic operation problems when located so close to an existing signal. For this restriction to be effective, barriers and signing may be needed to direct path users to the signalized crossing. If no pedestrian crossing exists at the signal, modifications should be made.



Discussion

In the US, the minimum distance a marked crossing can be from an existing signalized intersection varies from approximately 250 to 660 feet. Engineering judgement and the context of the location should be taken into account when choosing the appropriate allowable setback. Pedestrians are particularly sensitive to out of direction travel and jaywalking may become prevalent if the distance is too great.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

If a sidewalk is used for crossing access, it should be kept clear of snow and debris and the surface should be level for wheeled users.

Path/Roadway Crossings

Signalized/Controlled Crossings

Guidance

Hybrid beacons (illustrated here) may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable path crossings.

Full traffic signal installations must meet MUTCD pedestrian, school or modified warrants. Additional guidance for signalized crossings:

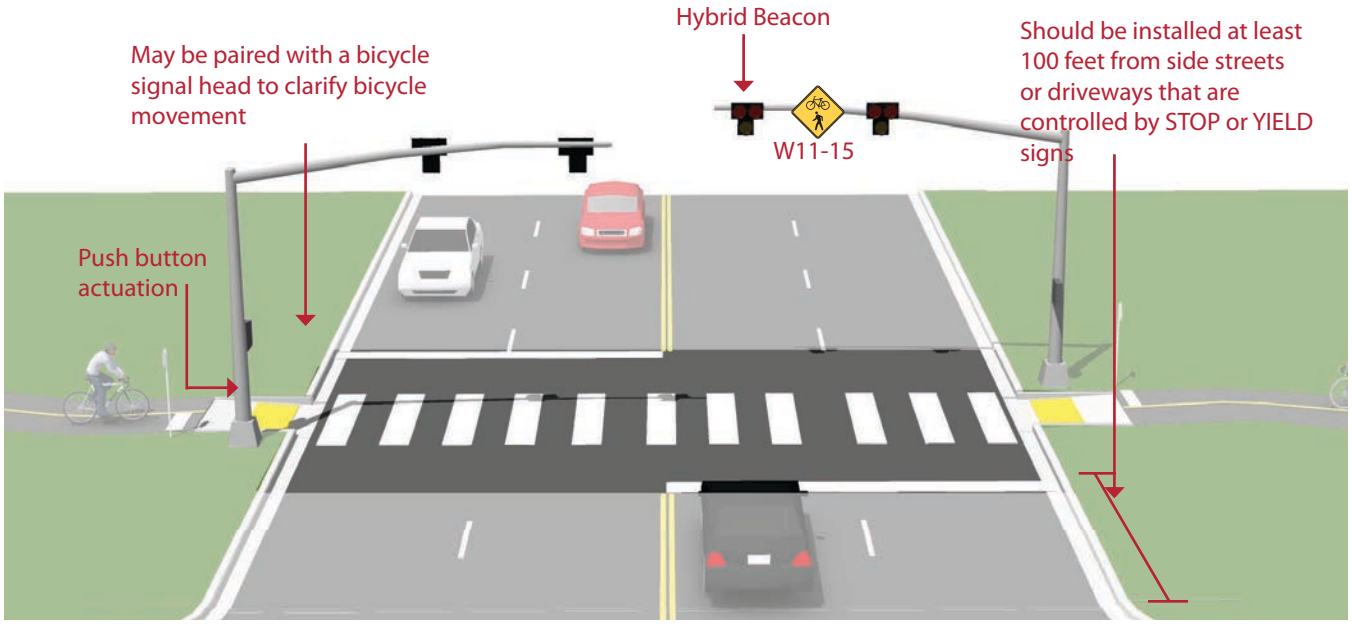
- Located more than 300 feet from an existing signalized intersection.
- Roadway travel speeds of 40 MPH and above.
- Roadway ADT exceeds 15,000 vehicles.

Description

Signalized crossings provide the most protection for crossing path users through the use of a red-signal indication to stop conflicting motor vehicle traffic. The two types of path signalization are full traffic signal control and hybrid signals.

A full traffic signal installation treats the path crossing as a conventional 4-way intersection and provides standard red-yellow-green traffic signal heads for all legs of the intersection.

Hybrid beacon installation (shown below) faces only cross motor vehicle traffic, stays dark when inactive, and uses a unique "wig-wag" signal phase to indicate activation. Vehicles have the option to proceed after stopping during the final flashing red phase, which can reduce motor vehicle delay when compared to a full signal installation.



Discussion

Shared-use path signals are normally activated by push buttons but may also be triggered by embedded loop, infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.

Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity and safety.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
NACTO. (2012). Urban Bikeway Design Guide.

Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Path/Roadway Crossings

Undercrossings

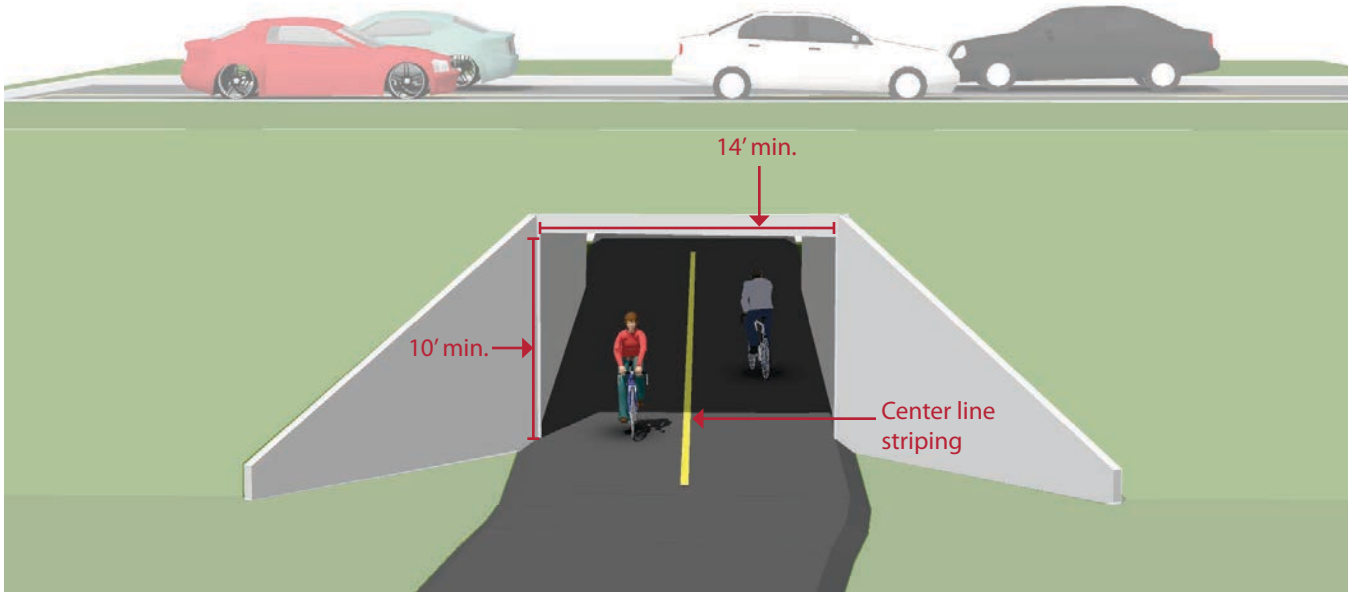
Guidance

- 14 foot minimum width, greater widths preferred for lengths over 60 feet.
- 10 foot minimum height.
- The undercrossing should have a centerline stripe even if the rest of the path does not have one.
- Lighting should be considered during the design process for any undercrossing with high anticipated use or in culverts and tunnels.

Description

Bicycle/pedestrian undercrossings provide critical non-motorized system links by joining areas separated by barriers such as railroads and highway corridors. In most cases, these structures are built in response to user demand for safe crossings where they previously did not exist.

Grade-separated crossings are advisable where existing bicycle/pedestrian crossings do not exist, where ADT exceeds 25,000 vehicles and where 85th percentile speeds exceed 45 miles per hour.



Discussion

Safety is a major concern with undercrossings. Shared-use path users may be temporarily out of sight from public view and may experience poor visibility themselves. To mitigate safety concerns, an undercrossing should be designed to be spacious, well-lit, equipped with emergency phones at each end and completely visible for its entire length from end to end.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

14 foot width allows for maintenance vehicle access.

Potential problems include conflicts with utilities, drainage, flood control and vandalism.

Path/Roadway Crossings

Overcrossings

Guidance

8 foot minimum width, 14 feet preferred. If overcrossing has any scenic vistas, additional width should be provided to allow for stopping. A separate 5 foot pedestrian area may be provided for facilities with high bicycle and pedestrian use.

10 foot headroom on overcrossing; clearance below will vary depending on feature being crossed.

Roadway:	17 feet
Freeway:	18.5 feet
Heavy Rail Line:	23 feet

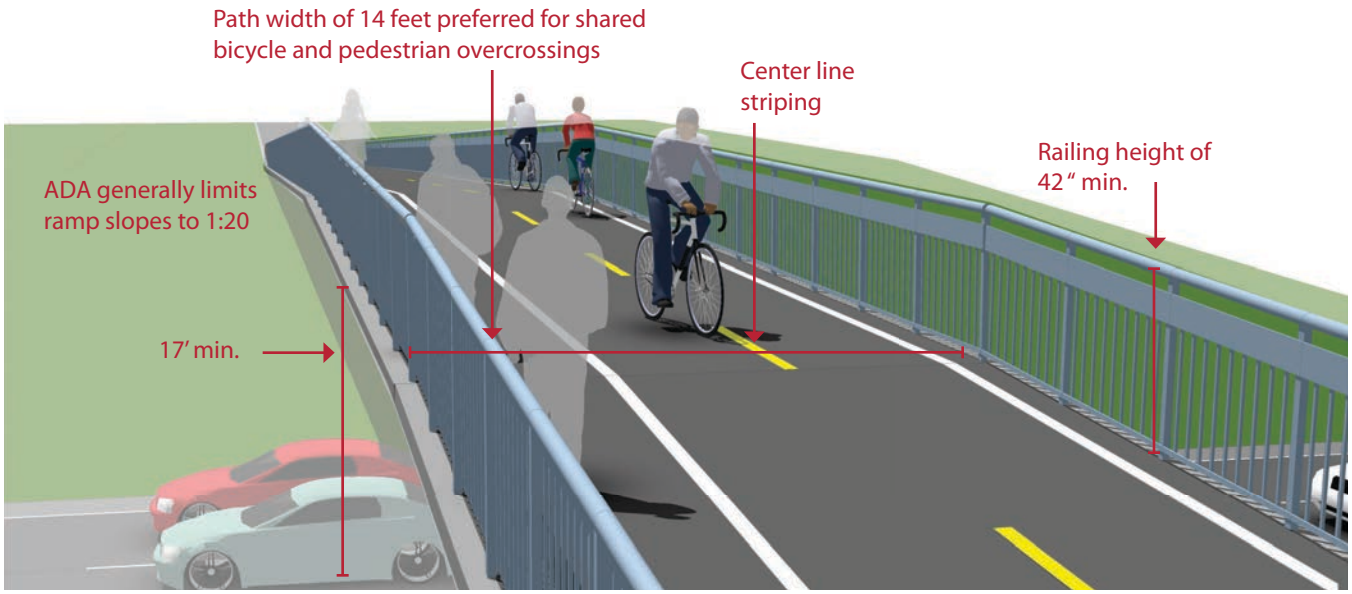
The overcrossing should have a centerline stripe even if the rest of the path does not have one.

Description

Bicycle/pedestrian overcrossings provide critical non-motorized system links by joining areas separated by barriers such as deep canyons, waterways or major transportation corridors. In most cases, these structures are built in response to user demand for safe crossings where they previously did not exist.

Grade-separated crossings may be needed where existing bicycle/pedestrian crossings do not exist, where ADT exceeds 25,000 vehicles, and where 85th percentile speeds exceed 45 miles per hour.

Overcrossings require a minimum of 17 feet of vertical clearance to the roadway below versus a minimum elevation differential of around 12 feet for an undercrossing. This results in potentially greater elevation differences and much longer ramps for bicycles and pedestrians to negotiate.



Discussion

Overcrossings for bicycles and pedestrians typically fall under the Americans with Disabilities Act (ADA), which strictly limits ramp slopes to 5% (1:20) with landings at 400 foot intervals, or 8.33% (1:12) with landings every 30 feet.

Overcrossings pose potential concerns about visual impact and functional appeal, as well as space requirements necessary to meet ADA guidelines for slope.

Additional References and Guidelines

AASHTO. (2012). Guide for the Development of Bicycle Facilities.
AASHTO. (2004). Guide for the Planning, Design, and Operation of Pedestrian Facilities.

Materials and Maintenance

Potential issues with vandalism.

Overcrossings can be more difficult to clear of snow than undercrossings.

Bicycle Support Facilities

Bicycle Parking

Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of 2 hours or less, or long-term parking for employees, students, residents, and commuters.

Access to Transit

Safe and easy access to bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Providing bicycle access to transit and space for bicycles on buses and rail vehicles can increase the feasibility of transit in lower-density areas, where transit stops are beyond walking distance of many residences. People are often willing to walk only a quarter- to half-mile to a bus stop, while they might bike as much as two or more miles to reach a transit station.

Roadway Construction and Repair

Safety of all roadway users should be considered during road construction and repair. Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist's trip through a work zone area.

Only in rare cases should pedestrians and bicyclists be detoured to another street when vehicle travel lanes remain open. Contractors performing work should be made aware of bicyclist needs and be properly trained in how to safely route bicyclists through or around work zones.


Bicycle Parking

Bicycle Access to Transit


Bicycle Access Through Construction Areas

Bicycle Support Facilities

Bicycle Racks

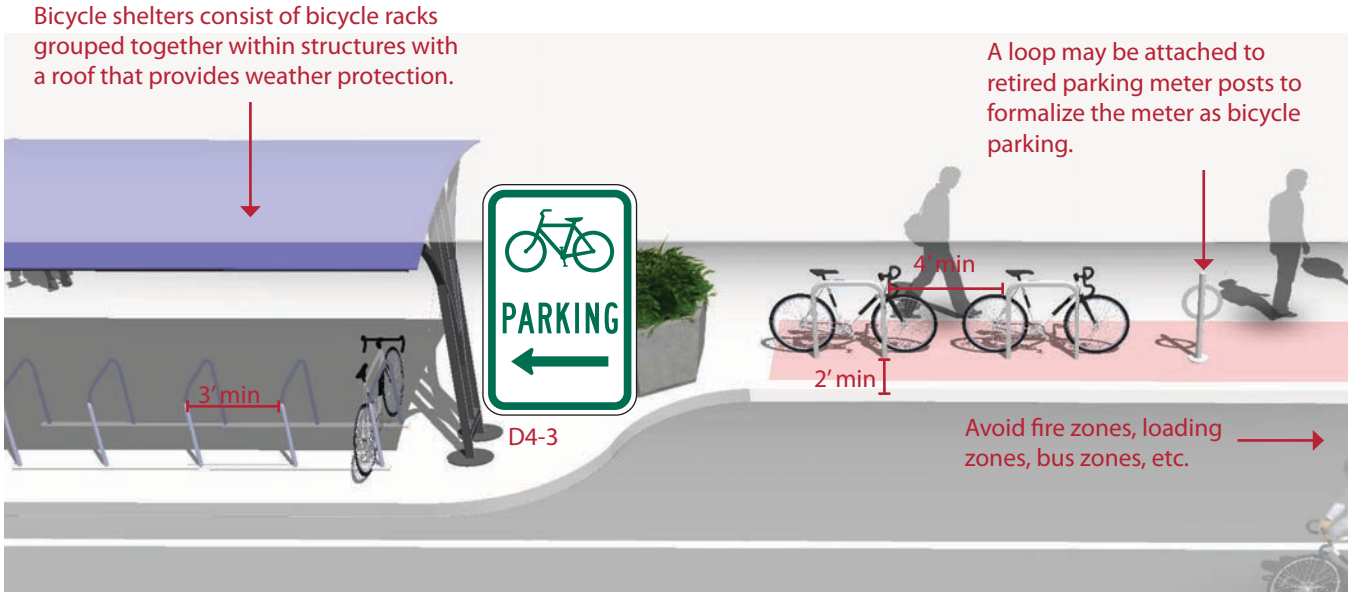
Guidance

- 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.

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 rack 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, bending, or deformation.



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

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.

Bicycle Support Facilities

On-Street Bicycle Corral

Guidance

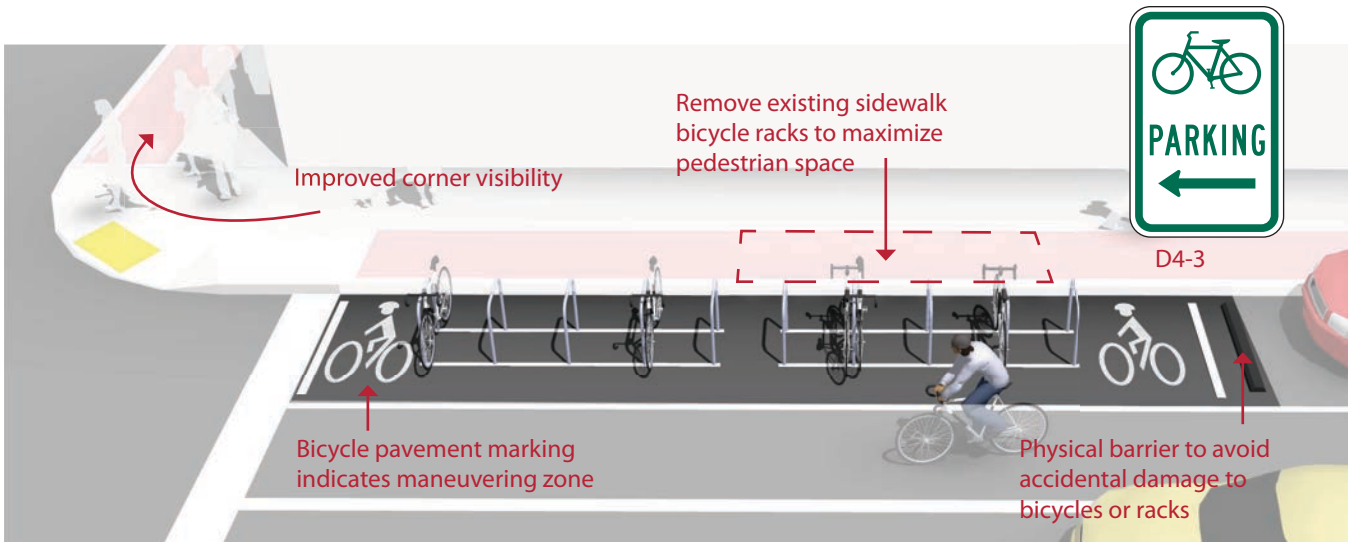
See guidelines for sidewalk **Bicycle Rack** placement and clear zones.

- 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.

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. They 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.



Discussion

In many communities, the installation of bicycle corrals is driven by requests from adjacent businesses, and is not a city-driven initiative. In such cases, the city does not remove motor vehicle parking unless it is explicitly requested. In other areas, the city provides the facility and business associations take responsibility for the maintenance of the facility. Communities can establish maintenance agreements with the requesting business. 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.

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.

Bicycle Support Facilities

Bicycle Lockers

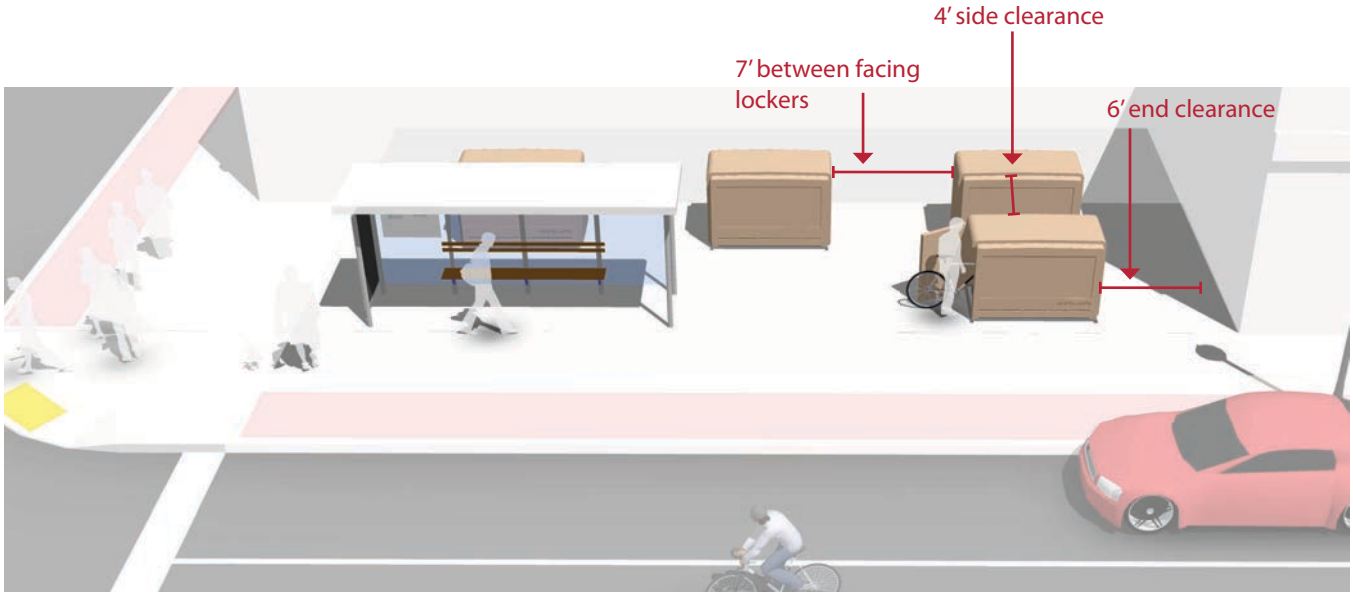
Guidance

- Minimum dimensions: width (opening) 2.5'; height 4'; depth 6'.
- 4 foot side clearance and 6 foot end clearance.
- 7 foot minimum distance between facing lockers.
- Locker designs that allow visibility and inspection of contents are recommended for increased security.
- Access is controlled by a key or access code.

Description

Bicycle lockers are intended to provide long-term bicycle storage for employees, students, residents, commuters, and others expected to park more than two hours. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain.

Bicycle lockers provide space to store a few accessories or rain gear in addition to containing the bicycle. Some lockers allow access to two users - a partition separating the two bicycles can help users feel their bike is secure. Lockers can also be stacked, reducing the footprint of the area, although that makes them more difficult to use.



Discussion

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Potential locations for long-term bicycle parking include transit stations, large employers, and institutions where people use their bikes for commuting and not consistently throughout the day.

Additional References and Guidelines

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

Materials and Maintenance

Regularly inspect the functioning of moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.

Bicycle Support Facilities

Secure Parking Areas (SPA)

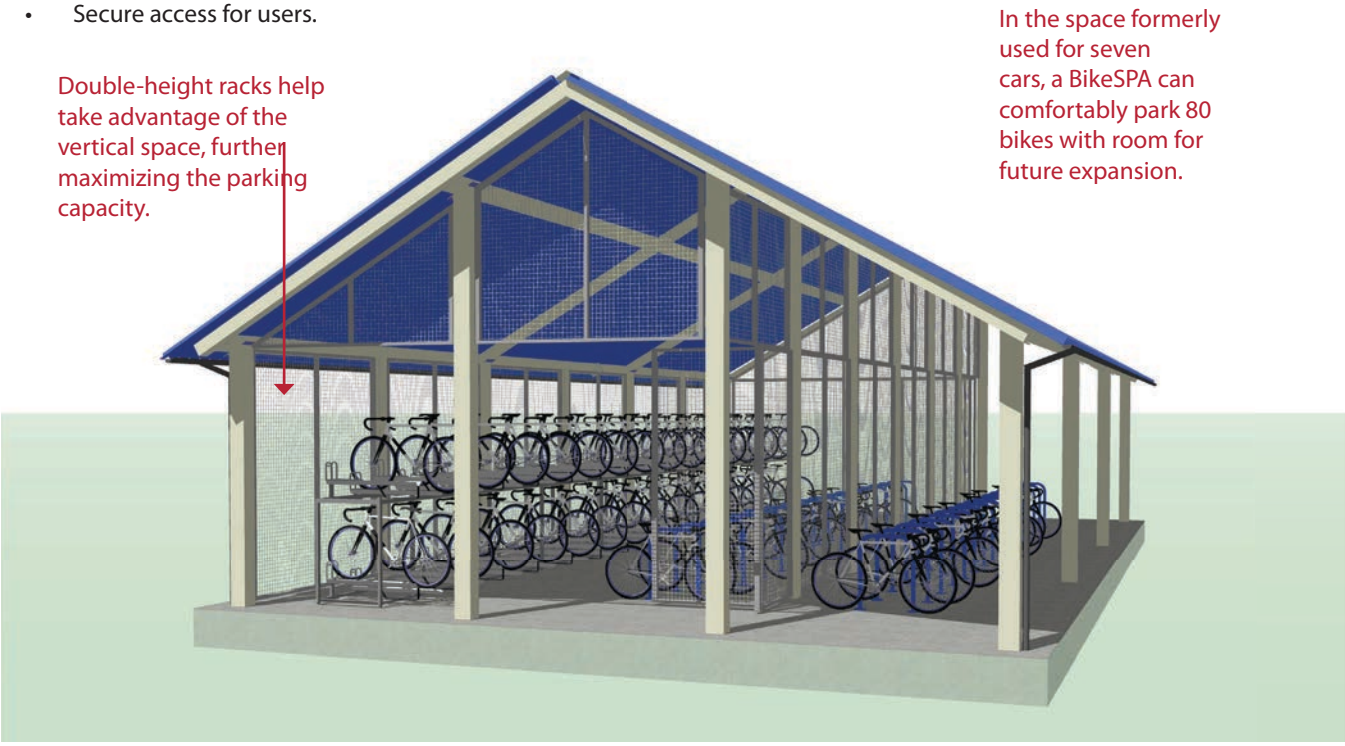
Guidance

Key features may include:

- Closed-circuit television monitoring.
- Double high racks & cargo bike spaces.
- Bike repair station with bench.
- Bike tube and maintenance item vending machine.
- Bike lock "hitching post" – allows people to leave bike locks.
- Secure access for users.

Description

A Secure Parking Area for bicycles, also known as a BikeSPA or Bike & Ride (when located at transit stations), is a semi-enclosed space that offers a higher level of security than ordinary bike racks. Accessible via key-card, combination locks, or keys, BikeSPAs provide high-capacity parking for 10 to 100 or more bicycles. Increased security measures create an additional transportation option for those whose biggest concern is theft and vulnerability.



Discussion

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. BikeSPAs are ideal for transit centers, airports, train stations, or wherever large numbers of people might arrive by bicycle and need a secure place to park while away.

Additional References and Guidelines

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

Materials and Maintenance

Regularly inspect the functioning of moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.

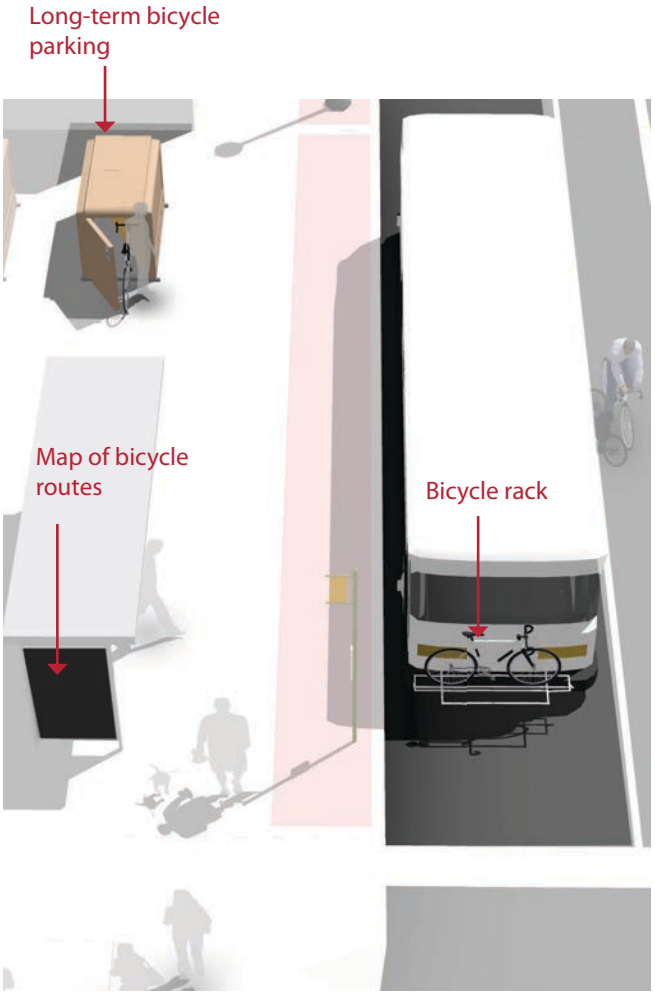
Bicycle Support Facilities

Bicycle Access to Transit

Description

Safe and easy access to transit stations and secure bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive and space-consuming car parking spaces.

Many people who ride to a transit stop will want to bring their bicycle with them on the transit portion of their trip, so buses and other transit vehicles should be equipped accordingly.



Guidance

Access

- Provide direct and convenient access to transit stations and stops from the bicycle and pedestrian networks.
- Provide maps at major stops and stations showing nearby bicycle routes.
- Provide wayfinding signage and pavement markings from the bicycle network to transit stations.
- Ensure that connecting bikeways offer proper **Bicycle Detection and Actuation**.

Bicycle Parking

- The route from bicycle parking locations to station/stop platforms should be well-lit and visible.
- Signing should note the location of bicycle parking, rules for use, and instructions as needed.
- Provide safe and secure long-term parking such as **Bicycle Lockers** at transit hubs. Parking should be easy to use and well maintained.

Discussion

Providing bicycle routes to transit helps combine the long-distance coverage of bus and rail travel with the door-to-door service of bicycle riding. Transit use can overcome large obstacles to bicycling, including distance, hills, riding on busy streets, night riding, inclement weather, and breakdowns. High-visibility crosswalks and mid-block crossings are often appropriate treatments to provide safer bicycle and pedestrian access to bus stops, particularly at high-usage transit stops. If a bus stop is located mid-block, adequate crossing treatments should be provided, based on the level of traffic on the roadway. All transit riders will need to cross the street to access or leave the bus stop.

Additional References and Guidelines

APBP. (2010). Bicycle Parking Guide 2nd Edition.
FHWA. (2006). Federal Highway Administration University Course on Bicycle and Pedestrian Transportation. Lesson 18: Bicycle and Pedestrian Connections to Transit

Materials and Maintenance

Regularly inspect the functioning of long-term parking moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.

Bicycle Support Facilities

Bicycle Access Through Construction Areas

Description

Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist's trip through a work zone area. Bicyclists should not be led into conflicts with work site vehicles, equipment, moving vehicles, open trenches, or temporary construction signage.

Efforts should be made to re-create a bike lane (if one exists) to the left of the construction zone. If this is impossible, then consider the closure of a standard-width travel lane to accommodate bicycle travel.

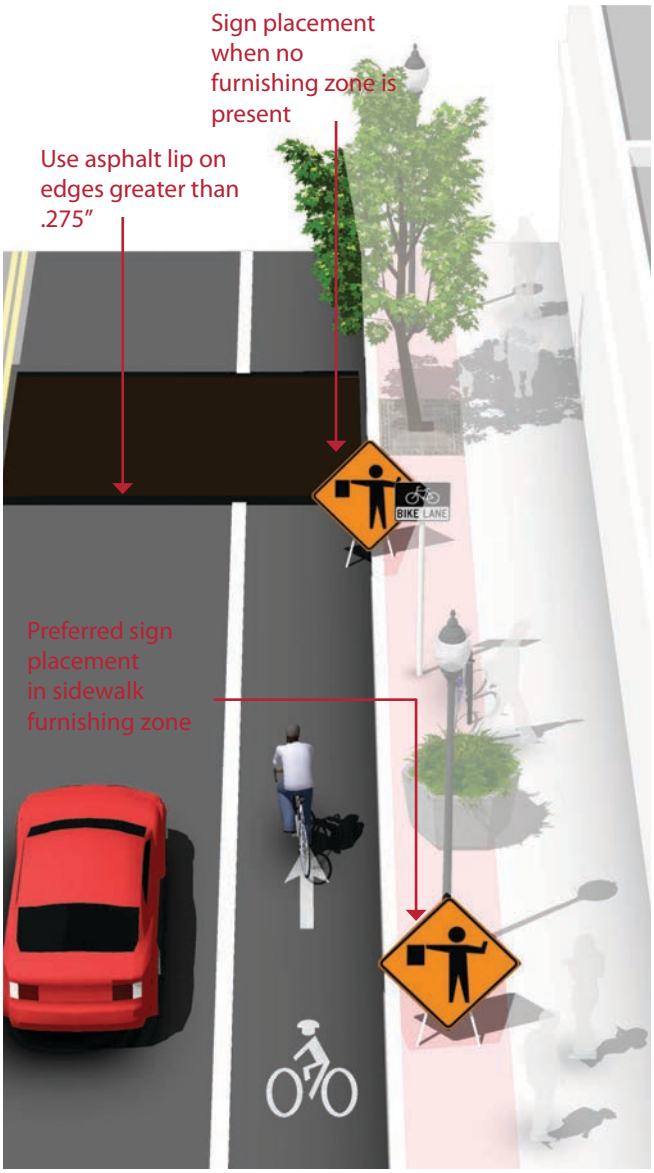
Guidance

Construction Signage

- Place in a location that does not obstruct the path of bicyclists or pedestrians.
- Detour and closure signs related to bicycle travel may be included on all bikeways where construction activities occur. Signage should also be provided on all other roadways.

Bicycle Travel around Steel Grates

- Require temporary asphalt (cold mix) around plates to create a smooth transition.
- Use steel plates only as a temporary measure during construction, not for extended periods.
- Use warning signs where steel plates are in use.
- Require both temporary and final repaving to provide a smooth surface without abrupt edges.



Discussion

Plates used to cover trenches tend to not be flush with pavement and have a 1"-2" vertical transition on the edges. This can puncture a hole in a bicycle tire and cause a bicyclist to lose control. Although it is common to use steel plates during non-construction hours, these plates can be dangerously slippery, particularly when wet.

Contractors performing work should be made aware of the needs of bicyclists and be properly trained in how to safely route bicyclists through or around work zones.

Additional References and Guidelines

FHWA. (2009). Manual on Uniform Traffic Control Devices.
FHWA. (2006). Federal Highway Administration University Course on Bicycle and Pedestrian Transportation. Lesson 21: Bicycle and Pedestrian Accommodation in Work Zones

Materials and Maintenance

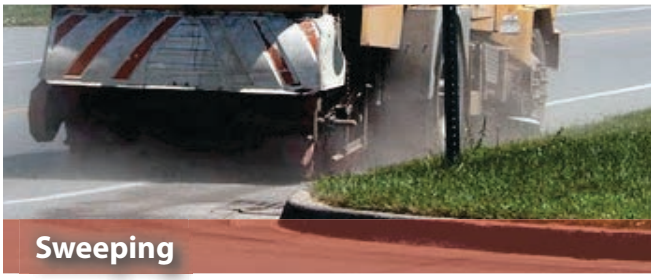
Debris should be swept to maintain a reasonably clean riding surface in the outer 5 - 6 ft of roadway.

Bikeway Maintenance

Regular bikeway maintenance includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flat, and installing bicycle-friendly drainage grates. Pavement overlays are a good opportunity to improve bikeways. The following recommendations provide a menu of options to consider to enhance a maintenance regimen.

Recommended Walkway and Bikeway Maintenance Activities

Maintenance Activity	Frequency
Inspections	Seasonal – at beginning and end of Summer
Pavement sweeping/ blowing	As needed, with higher frequency in the early Spring and Fall
Pavement sealing	5 - 15 years
Pothole repair	1 week – 1 month after report
Culvert and drainage grate inspection	Before Winter and after major storms
Pavement markings replacement	As needed
Signage replacement	As needed
Shoulder plant trimming (weeds, trees, brambles)	Twice a year; middle of growing season and early Fall
Tree and shrub plantings, trimming	1 – 3 years
Major damage response (washouts, fallen trees, flooding)	As soon as possible


Sweeping

Signage


Roadway Surface


Pavement Overlays


Drainage Grates


Gutter to Pavement Transition

Bikeway Maintenance

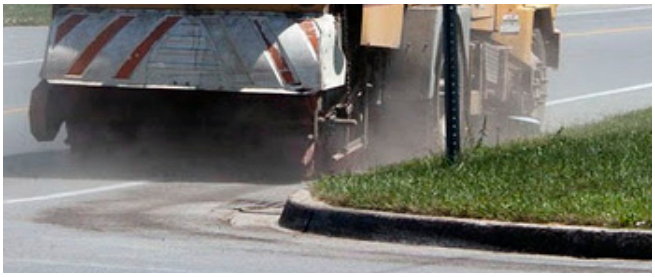
Sweeping

Guidance

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.
- Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders.
- Perform additional sweeping in the Spring to remove debris from the Winter.
- Perform additional sweeping in the Fall in areas where leaves accumulate .

Description

Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris. They will ride in the roadway to avoid these hazards, potentially causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.



Signage

Guidance

- Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear.
- Replace signage along the bikeway network as needed.
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary.
- Create a Maintenance Management Plan.

Description

Bike lanes, shared shoulders, bicycle boulevards and paths all have different signage types for wayfinding and regulations. Such signage is vulnerable to vandalism or wear, and requires periodic maintenance and replacement.

Bikeway Maintenance

Roadway Surface

Guidance

- Maintain a smooth, pothole-free surface.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼".
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
- If chip sealing is to be performed, use the smallest possible chip on bike lanes and shoulders. Sweep loose chips regularly following application.
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only. However, use caution when doing this so as not to create an unacceptable ridge between the bike lane and travel lane.

Description

Bicycles are much more sensitive to subtle changes in roadway surface than are motor vehicles. Various materials are used to pave roadways, and some are smoother than others. Compaction is also an important issue after trenches and other construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks. When resurfacing streets, ensure that the surface is as smooth as possible to improve safety and comfort for bicyclists.

Pavement Overlays

Guidance

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge.
- If the shoulder or bike lane pavement is of good quality, it may be appropriate to end the overlay at the shoulder or bike lane stripe provided no abrupt ridge remains.
- Ensure that inlet grates and manhole/valve covers are within ¼ inch of the finished pavement surface and are made or treated with slip resistant materials.
- Pave gravel driveways to property lines to prevent gravel from being tracked onto shoulders or bike lanes.

Description

Pavement overlays represent good opportunities to improve conditions for bicyclists if done carefully. A ridge should not be left in the area where bicyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects also offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes.

Bikeway Maintenance

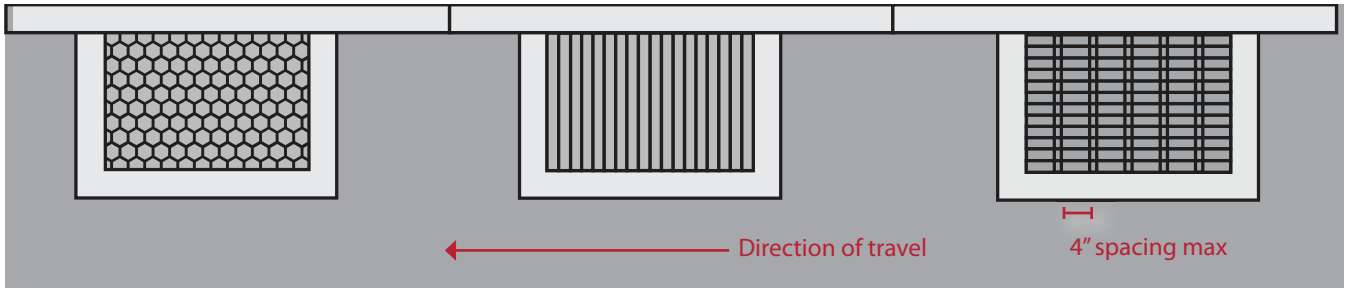
Drainage Grates

Guidance

- Require all new drainage grates to have transverse slats on them so that bicycle tires and assistive devices do not fall through the longitudinal slats.
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary. Temporary modifications such as installing rebar horizontally across the grate should not be an acceptable alternative to replacement.

Description

Drainage grates are typically located in the gutter area near the curb of a roadway. They have slots through which water drains into the municipal storm sewer system. Many older grates were designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicyclist were to ride on them, the front tire could become caught in the slot. This would cause the bicyclist to tumble over the handlebars and sustain potentially serious injuries.



Gutter to Pavement Transition

Guidance

- Ensure that gutter-to-pavement transitions have no more than a ¼" vertical transition.
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
- Provide at least 3 feet of pavement outside of the gutter seam.

Description

On streets with concrete curbs and gutters, 1 to 2 feet of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. This transition can be susceptible to erosion, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, which creates a vertical transition between these segments. This area can buckle over time and creates a hazardous condition for bicyclists.