FORWARD

Bicycling and walking issues have grown in significance throughout the 1990's. As the new millennium dawns, public agencies and public interest groups alike are striving to define the most appropriate way in which to accommodate the two modes within the overall transportation system so that those who walk or ride bicycles can safely, conveniently, and comfortably access every destination within a community.

Public support and advocacy for improved conditions for bicycling and walking has created a widespread acceptance that more should be done to enhance the safety, comfort, and convenience of the non-motorized traveler. Public opinion surveys throughout the 1990's have demonstrated strong support for increased planning, funding and implementation of shared use paths, sidewalks, and on-street facilities.

At the same time, public agencies have become considerably better equipped to respond to this demand. Research and practical experience in designing facilities for bicyclists and pedestrians has generated numerous national, State and local design manuals and resources. An increasing number of professional planners and engineers are familiar with this material and are applying this knowledge in towns and cities across the country.

The 1990 Americans with Disabilities Act, building on an earlier law requiring curb ramps in new, altered, and existing sidewalks, added impetus to improving conditions for sidewalk users. People with disabilities rely on the pedestrian and transit infrastructure, and the links between them, for access and mobility.

Congress and many State legislatures have made it considerably easier in recent years to fund non-motorized projects and programs, and a number of laws and regulations now mandate certain planning activities and design standards to guarantee the inclusion of bicyclists and pedestrians. In fact, the St. Joseph Area Transportation Study Organization, in its recent update to the twenty year long range transportation plan, *St. Joseph 2020: Vision for the Future*, April, 2000 states that bicyclists and pedestrians are *intended users* of the highway and street network.

Despite these many advances, injury and fatality numbers for bicyclists and pedestrians remain stubbornly high, levels of bicycling and walking remain frustratingly low, and most communities continue to grow in ways that make travel by means other than the private automobile quite challenging. Failure to provide an accessible pedestrian network for people with disabilities often requires the provision of costly paratransit (public transit service for the disabled community) service. Ongoing investment in the Nation's transportation infrastructure is still more likely to overlook rather than integrate bicyclists and pedestrians.

--Excerpt from Federal Highway Administration *Design Guidance, Accommodating Bicycle and Pedestrian Travel: A Recommended Approach*, 1999.

St. Joseph Bicycle and Pedestrian Masterplan

This document is an update to the *Urban Trail Masterplan* produced in 1995 for the City of St. Joseph, Missouri by Bucher, Willis & Ratliff. The original document set as its focus the development of an urban trail system throughout the metropolitan area and region. The City of St. Joseph and the Village of Country Club, through a multi-phased approach, have since independently pursued system development through the metropolitan planning organization (MPO).

However, the masterplan also discussed the notion of facility integration and design accommodation, a message that was generally glossed over in the rush to build "trails" that followed the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the sudden availability of funds to develop such systems.

Through the Enhancement Program, funded via ISTEA and continued under its successor legislation, the Transportation Efficiency Act for the 21st Century (TEA-21), design, right-of-way, and construction funds were made available for jurisdictions to accommodate bicyclists and pedestrians. The original concept was that the further cyclists and walkers were from cars, the better; hence, the concept of separated trail systems.

Trails, as one option for non-motorized modes, are appropriate in some instances. The major recognition that is needed in many communities is that trails are NOT a good or safe replacement in all locations or in all situations. Trails, in fact, should generally make up a rather small percentage of bicycle and pedestrian (B&P) modal accommodation and an even smaller percentage of the overall mileage.

The issues of accommodation, inclusion type, and locations of improvements have been up for debate at the state and national levels as well. In Missouri, the Missouri Department of Transportation (MoDot) has taken a leadership role in coordinating bicycle and pedestrian efforts throughout the state. The Missouri Bicycle and Pedestrian Advisory Committee was formed to recommend to the DOT changes in all facets of transportation that effect these modes, be they design issues, maintenance issues, educational issues, safety issues, or planning issues.

To that end a *General Pedestrian and Bicycle Guide* was produced by the committee and adopted by MoDot. It sets forth a first step toward inclusion of bicycle and pedestrian needs in the planning and design of new roadway facilities. The document represents an important first step toward effecting a statewide change in the approach to bicycle and pedestrian accommodation. This masterplan begins at the preliminary levels established by the MoDot plan and the *Urban Trail Masterplan* and extends a logical approach toward the issues that is consistent with national guidance on the subjects.

In general, this plan is intended make clear some of the vagaries of past practice and policy and establish some distinction between tools that should be utilized in certain cases and tools that should left on the shelf in other cases. Additionally, the plan is intended to:

- Create a safe, convenient and attractive bicycling and walking environment.
- Adopt design standards that create safe and convenient facilities to encourage bicycling and walking.
- Provide uniform signing and marking of all bikeways and walkways.
- Enhance the quality of life for St. Joseph area residents.

BIKE TRAIL HISTORY

In the 1982 St. Joseph Transportation Plan, a policy document was formulated for an initial Bikeway Plan. This policy plan recommended that initial routes should be signed on existing City streets, and as streets were reconstructed or new ones built, that the new designs include bicycle facilities. The policy plan also recommended that bicycle safety programs should be continued and expanded. Recommendations were also made regarding the review and enforcement of bicycle ordinances. The only recommendation made regarding facilities was the initial starter segment, which would begin at Krug Park to Hyde Park (located on Northwest Parkway, Noyes/28th Street, Parkway A, Southwest Parkway, and 4th Street).

Unfortunately, no bicycle facilities evolved as a result of the 1982 Bikeway Plan. In 1991, however, ISTEA was authorized by Congress, setting forth policies that advocated the construction of intermodal transportation facilities (which included bicycle and pedestrian facilities). The goal of ISTEA was to offer transportation alternatives for all modes rather than only the automobile (for all trip types).

ISTEA legislation also provided for the use of certain funding sources to design and construct facilities under the Surface Transportation Program (STP) called the Enhancement Fund. Combined with renewed interest from the citizens and local officials in the St. Joseph area, directly generated as an offshoot from the planning process conducted in conjunction with the 1995 edition of 20 Year Long Range Transportation Plan, these factors contributed to the City of St. Joseph developing the *Urban Trail Masterplan*, completed by Bucher, Willis & Ratliff in July, 1995. TEA-21 also includes provisions for the development of non-traditional transportation modes, which has kept the funding side of the Enhancement Program alive.

The Masterplan contained an overall goal to create and maintain an integrated system of bike/walkways that provide for safe and convenient travel for bicyclists throughout the area.

The integration goal in the Masterplan was to require compliance with bikeway policies and standards for new development, including recreational bikeways within greenbelts; determine, prior to approval, how any proposed new path could link to the overall system; and integrate the bicycle into all new construction and reconstruction projects where it will positively effect the overall bicycle network.

The Masterplan set forth basic objectives to be considered:

- ✓ Integrate bike paths into all greenbelt and park designs. Ensure accessibility to these bicycle features by integrating design into the bikeway network.
- ✓ Develop and adopt standards for greenbelt pathway design.
- ✓ Evaluate at-grade and separated grade crossing installations where greenbelts cross streets, and develop and adopt standards for design.
- ✓ Design facilities to allow for adequate access by public safety vehicles.
- ✓ Design bike routes as integral parts of new greenways, open space areas (where appropriate) and green streets to complete and expand the existing bikeway system.
- ✓ Develop criteria for bicycle access to open space areas preserved outside the city limits.
- ✓ Adopt standards for the mixed use of off-street routes by foot traffic and bicycles.
- ✓ Incorporate bicycle considerations into the appropriate public works job that will directly effect a linkage or potential linkage in the City's bicycle system.

With the plan's direction, the City of St. Joseph began developing trails for construction. The initial five segments of this system have been constructed, and more are planned. The following segments have either been constructed, funded, or are expected for approval at this time:

- Corby Parkway – Ashland to Northeast Parkway
  - Constructed 1995 – 1998
  - Phase 1

- Parkway A
  - Constructed 1995 – 1998

    - Phase 1

- Bartlett Park
    - Constructed 1995 – 1998
    - Phase 1

- Northwest Parkway – Northeast Parkway to Lover's Lane
    - Constructed 1997 – 1998
    - Phase 2

- Northwest Parkway – Lover's Lane to Ferndale
    - Constructed 1999
    - Phase 3

- Southwest Parkway – Bartlett Park to 28th & Commercial
    - Constructed 1999
    - Phase 4

- Southwest Parkway – Mansfield Road to Hyde Park
    - Constructed 1999
    - Phase 5

- Southwest Parkway – 28th & Commercial to 22nd Street
    - Constructed (anticipated) 2001
    - Phase 6

- Chicago and Rock Island Corridor – 28th & Commercial to 36th Street
    - Constructed (anticipated) 2001
    - Phase 7

- Chicago and Rock Island Corridor – East of Belt Hwy. to I-29
    - Constructed (anticipated) 2001
    - Phase 8

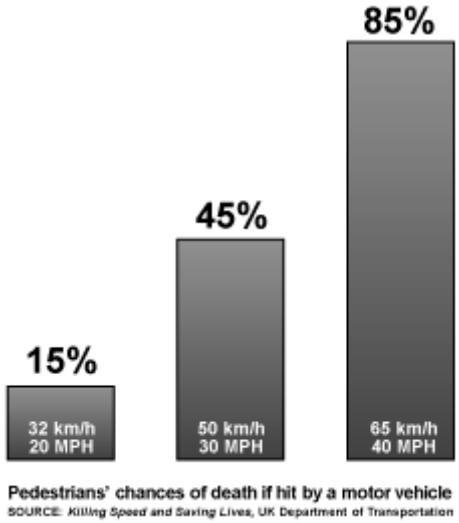
- Chicago and Rock Island Corridor – I-29 east to Riverside Road
- Construction anticipated for 2002
- Phase 9

- Riverfront Trail – Blacksnake Creek north
- Construction anticipated for 2002
- Phase 1

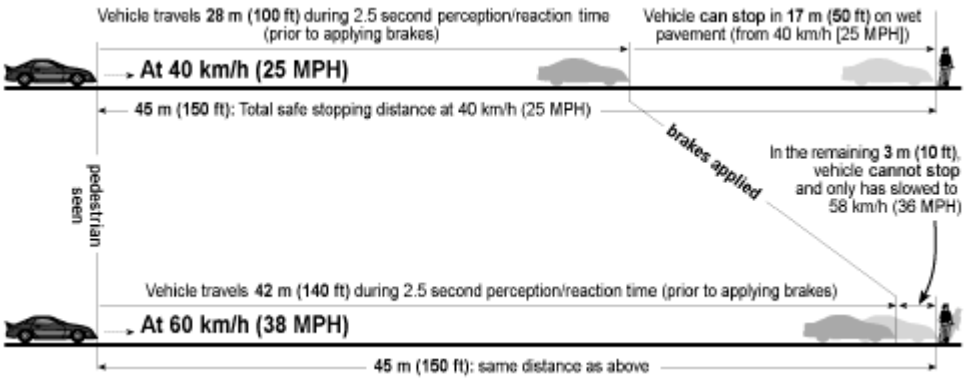
SECTION 1 SAFETY

Compared to bicycle crashes, virtually all reported pedestrian crashes are the result of a collision with a motor vehicle. This is mostly due to our perceptions: when a person trips and falls while walking, the resulting injury is rarely reported as a pedestrian crash. Most pedestrian crashes are the result of an attempt to cross a roadway; fewer occur as pedestrians walk along a roadway. While this document is aimed at both bicycle and pedestrian facility design, perhaps the pedestrian safety issue deserves special attention at the onset because of historical inattention paid the subject over the last forty years.

Effective pedestrian safety programs should target behaviors that cause the majority of crashes. Analysis of pedestrian/motor vehicle crashes can help establish engineering, education and enforcement solutions. One important factor in all pedestrian crashes is speed. A recent study conducted in Great Britain (Killing Speed and Saving Lives) demonstrates a dramatic correlation between motor vehicle speeds and fatality rates.



The relationship between speed and the pedestrian fatality rate.



Relationship between safe stopping distances and travel speed.

Reducing traffic speeds not only reduces the severity of pedestrian crashes, but may reduce their occurrence, as slower speeds decrease braking distances and reaction time. All engineering, education and enforcement programs should include reducing speeds as an important step. This does not necessarily mean reducing existing speed limits, as much as ensuring that the current limits are observed.

According to *National Strategies for Advancing Bicycle Safety* (4/24/01), a study completed by the National Highway Traffic Safety Administration, the National Center for Injury Prevention and Control, and the Federal Highway Administration, "about eighty-five million adults and children ride their bikes

every year. For children and teens, the bicycle is a primary means of transportation when traveling independently. Neighborhoods and communities where bicycle usage is not evident in the stated age groups is most often associated with physical barriers/lack of facilities rather than the interest or predisposition of the subject age groups to not bicycle.

Every morning an estimated half-million people bike to work in the United States. However, injuries do occur. Each year, more than five hundred thousand bicyclists of all ages sustain a cycling injury that requires emergency department care. Of the approximately eight hundred bicyclists killed annually, about seven hundred and fifty are killed in traffic crashes. Perhaps not surprisingly, more than half of the bicyclists riding in or near traffic report feeling unsafe.

In a nation where traffic is increasing and roadways are becoming more congested, we must, to the best of our collective ability, ensure the safety of *all* roadway users".

Long-term trends

The number and severity of pedestrian crashes could rise in the future due to an unintentional consequence of cars being built with more safety features: as drivers and passengers are better protected within their vehicles, and further isolated from the outside world (with quiet interiors and improved sound systems), the unprotected pedestrian will not be noticed or perceived as a threat. This could lead to pedestrians being invisible to or ignored by motorists. Pedestrian fatalities have been on the rise the last few years.

Pedestrian/motor vehicle crashes

There are approximately 700-800 pedestrian injury crashes reported each year in most states. Of these, approximately 60-80 are fatal (+/-10%). Some characteristics follow:

- 80% of the crashes occur in urban areas.
- 80% occur as a pedestrian crosses a street.
- Of the crossing accidents, 50% occur at mid-block locations.
- Of the crossings that occur at intersections, about half are at signalized intersections, and half are at non-signalized intersections.
- In 90% of the intersection crashes, the pedestrian was in a crosswalk.
- At signalized intersections, in 65% of the crashes, the pedestrian was crossing with the signal.

The turning movements of motor vehicles in intersection crashes were:·

- Motor vehicle going straight: 50%
- Motor vehicle turning: 50% (63% turning left, 37% turning right)

Most safety efforts should be aimed at crossing movements; greater education of motorists is necessary to make them aware of the rights of pedestrians and proper design that reinforces the physical dynamics of the driver's ability to identify pedestrians, is required for new roadway projects.

Planning & Engineering Solutions

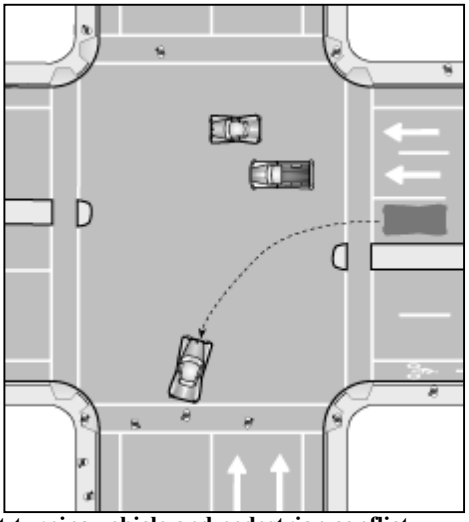
Even though most pedestrian/motor vehicle crashes are caused by improper behavior, many improvements

can be made to roads to reduce the potential for crashes. If facilities are well designed and pedestrians and motorists use them correctly, the likelihood of crashes will decrease.

The most important step that jurisdictions can take is to design bicycle and pedestrian facilities that enable motorists to clearly see users along the roadway and those preparing to cross the roadway. Users must be given opportunities to cross roadways with minimal conflicts with motor vehicles.

Pedestrian Walking along the Roadway·

- The addition of sidewalks in urban areas and wider shoulders in rural areas are the preferred treatments.
- Sidewalks separated from traffic with planter strips increase pedestrian safety.



Left-turning vehicle and pedestrian conflict.

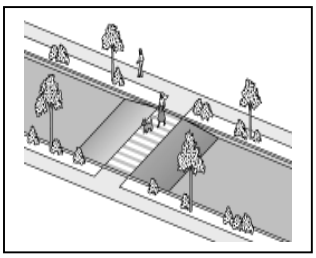
Pedestrian Crossing at Intersection

- Shortening the total distance to be crossed decreases the exposure time; techniques include curb extensions, median islands and islands at complicated turn movements.
- Placement of signs reminding motorists of their duty to yield to pedestrians when they turn left or right can help improve awareness of the pedestrian's right of way.
- Illumination can improve visibility of pedestrians under nighttime conditions.
- Improved marking of crosswalks enhance their visibility.

Pedestrian Crossing Outside an Intersection

- On wide, multiple lane roads, a center median improves crossing opportunities: a pedestrian only has to concentrate on traffic coming from one direction at a time, as the median provides a refuge.
- Mid-block curb extensions can reduce crossing distance and improve the visibility of pedestrians waiting to cross.
- *Illumination improves the visibility of pedestrians under nighttime conditions.*
- Improved marking of crosswalks enhances their visibility.

Motorist Speeding



Though this is usually considered an enforcement issue, there are many roadway design features that influence the speed at which motorists drive - motorists will usually travel at speeds that seem appropriate for the roadway.

Traffic calming measures can be used on local streets and minor collectors. On arterials and major collectors, there are features that can be incorporated that discourage excessive speeds: trees along the road, narrower lanes, landscaping, bike lanes, etc.

Education Solutions

Many pedestrian crashes are due to the ignorance of the rules pertaining to the right-of-way. A recent study conducted by the AAA revealed that close to 50% of Americans do not know some of the basic laws as they apply to pedestrians. More information should be made available to motorists so they know that pedestrians have the right-of-way at crosswalks, *both marked and unmarked.*

The consequences of excessive travel speeds must be made known to the motorists; many do not understand that traveling above the speed limit in residential areas can result in a fatal pedestrian crash.

Pedestrians must know how to safely cross streets. It should never be assumed that a signal guarantees safety; one should always look before crossing. The meaning of "WALK/DON'T WALK" signals is not clearly understood by all (the white WALK phase of a signal is a time during which pedestrians may begin to enter the crosswalk; the flashing red DON'T WALK phase indicates that pedestrians in the crosswalk may safely proceed across the street, but pedestrians approaching the intersection should wait).

Though there are many situations in which the pedestrian is technically at fault (e.g. mid-block dart out), more emphasis needs to be placed on the driver's responsibility, since he or she is the one moving in a high-speed, heavy vehicle.

Enforcement Solutions

Along with education, increased enforcement can have the greatest effect on pedestrian safety. The lack of consequences to motorists who run lights and stop signs or fail to yield at crosswalks is mostly due to the insufficient numbers of law enforcement officers dedicated to traffic enforcement.

Increased education efforts aimed at law enforcement officers can help them understand the severity of pedestrian infractions. An effective program in Seattle combined increased citation of motorists at crosswalks with extensive media coverage. The result was a dramatic decrease in the number of pedestrian crashes following these efforts.

Attitudes towards the relative severity of pedestrian crashes need to change among prosecutors and judges. Motorists often get off fairly lightly following crashes that result in pedestrian injuries or deaths. The pedestrian is often assumed to be partially at fault for simply "being in the road." The consequences of failing to yield to pedestrians need to be more severe and better publicized for motorists to change behavior.

SECTION 2 SYSTEM USERS

Cyclists and pedestrians, and how each level of user is categorized, are defined by many different methods. The most common definitions are as follows:

Cyclists-

Class 1 – Advanced or Experienced riders are generally using their bicycles as they would a motor vehicle. They are riding for convenience and speed and want direct access to destinations with a minimum of detour or delay. They are typically comfortable riding with motor vehicle traffic; however, they need sufficient operating space on the traveled way or shoulder to eliminate the need for either themselves or a passing motor vehicle to shift position.

Class 2 – Basic or Less Confident adult riders may also be using their bicycles for transportation purposes, e.g., to get to the store or to visit friends, but prefer to avoid roads with fast and busy motor vehicle traffic unless there is ample roadway width to allow easy overtaking by faster motor vehicles. Thus, basic riders are comfortable riding on neighborhood streets and trails and prefer designated facilities such as bike lanes or wide shoulder lanes on busier streets.

Class 3 – Children, riding on their own or with their parents, may not travel as fast as their adult counterparts but still require access to key destinations in their community, such as schools, convenience stores and recreational facilities. Residential streets with low motor vehicle speeds, linked with trails and busier streets with well-defined pavement markings between bicycles and motor vehicles, can accommodate children without encouraging them to ride in the travel lane of major arterials.

Pedestrians-

The *child pedestrian*, 14 years of age or younger, shares many of the characteristics of the Class 2 cyclist. Supervision is often needed in heavier traffic. Children are limited to walking to areas in their immediate neighborhood whether it is for social interaction or errands for the family.

The *recreational pedestrian* may be of all ages. This group tends to utilize pedestrian facilities, such as sidewalks and trails whenever available to minimize potential vehicular conflict and improve the overall experience. A common activity shared by the recreational pedestrian is often the family walk.

The *fitness pedestrian* can be adults of all ages. This group ranges from joggers and competitive runners to senior citizens walking for health purposes. Fitness pedestrians typically exercise on a frequent basis. Consequently, they are more experienced in handling traffic conditions. Senior citizens also may utilize walks or trails with limited conflict.

The *utilitarian pedestrian* is of all ages as well. Utilitarian pedestrians walk or jog with a specific destination in mind, such as work, school, or shopping areas. For people without automobiles, walking may be their only source of transportation. Walking may be combined with other forms of public transportation.

The wisdom of recognizing different types and user levels in design is not to simply provide facilities for one group instead of another, but to make one aware that sometimes a single accommodation may not be serving users adequately, or all users safely. Many times, a multi-faceted approach is needed depending upon the community/neighborhood/corridor in question.

Trip Purpose

Many authorities on the subject of bicycle and pedestrian modes focus upon the purpose of the trip. The concept is that the needs of both modes differ in direct relationship to whether the trip is recreational, work, or other. If the purpose can be determined, then the appropriate accommodation can be made.

In practical application, trip purpose could be tied to the same concepts applied toward the functional classification of a roadway. That is, treatments in some areas should not be as extensive in some areas as in others. For example, a local street through a neighborhood would typically not require a design speed for arterial traffic, nor are lane width requirements as important as collectors and arterials where both travel speed and traffic volumes are much higher.

In a typical neighborhood, perhaps the minimum approach from the toolkit would be applied: sidewalks on both sides, bike traffic sharing space with automobile travel lanes. On a collector street, perhaps a wider sidewalk with a wider automobile lane to more efficiently/safely "share" the lane with bikers. On an arterial, perhaps a wider sidewalk and either providing a shared lane or a bicycle lane.

Trip purpose for non-automobile traffic would logically mimic that of motorized traffic. If a common destination along a given street is the mall, then B&P traffic would likely be similar along the same route. An observation of many experts in the field has been that the vast majority of trips on facilities within neighborhoods is of short duration (two blocks), but longer in other corridors depending upon functional class and adjoining land use (i.e. commercial or retail vs. residential).

Perhaps the most effective method of analyzing trip type is to do so by turning the table around by focusing not upon where the B&P user is going, but instead upon what's in the area that would attract traffic – much as a traffic model uses the concept of generators and attractors.

As a practical matter, a large percentage of walkers will not travel over a certain distance to the job or for certain types of shopping, whether that is established at one mile or four miles. Given this assumption, perhaps it would be more accurate to focus upon trip types as they correspond the land use activity.

For example, facilities on the Belt Highway (largely retail) will likely carry a predominant percentage of users whose trip purpose is shopping. For those individuals that live within a personally determined feasible proximity to their workplace, some of the users may use the same for a means to travel to and from work.

In retail areas where B&P facilities are extant, the trip is often of short duration. Perhaps it is a short walk to investigate the prices of a CD at Hastings and then a competitor at East Hills Mall. The ability to access each site without having to drive the automobile reduces stress on the roadway system, but results in a trip purpose that is short in duration and classified as "other" in type.

In a region where accommodations are inconsistent at best, with miles of community that entirely lack appropriate facilities terminating in sections that do, it is difficult to apply professionally recognized criteria to determine where people walk/bike and for what purpose. At present the system is too disconnected for an objective analysis of this, but over time it may be possible to apply traditional approaches toward monitoring use and purpose.

Lacking such data, common sense must prevail to determine trip purpose. Depending upon the nature of the generator and the attractor, it is generally accurate to associate the trip purpose with the adjacent land use on roadways of collector and lower. One could assume that arterials would also have a general association with the land use, but also a strong relationship with providing connections to and from areas served by the collector and local street, as would be expected with the function of an arterial. One thing is certain, all logic breaks down when there are no connections and no facilities.

SECTION 3 POLICY STATEMENT

1. Bicycle and pedestrian ways shall be established in new construction and reconstruction projects throughout the metropolitan area, unless one or more of three conditions are met:

A. Bicyclists and pedestrians are prohibited by law from using the roadway. In this instance a greater effort may be necessary to accommodate bicyclists and pedestrians elsewhere within the right-of-way or within the same transportation corridor (interstates).

B. The cost of establishing bikeways or walkways would be excessively disproportionate to the need or probable use. Excessively disproportionate is defined as exceeding twenty percent of the cost of the larger transportation project, exclusive of right-of-way costs.

C. Where sparsity of population indicate an absence of need. For example, all construction of new public streets shall include sidewalk improvements on both sides, unless the street is a cul-de-sac with four or fewer dwellings or the street has severe topographic or natural resource constraints.

2. In rural areas, paved shoulders should be included in all new construction and reconstruction projects on roadways used by more than 1,000 vehicles per day. In conservation design subdivisions, "bike friendly" lanes may be provided in lieu of other accommodations such as trails or sidewalks. These treatments have safety and operational advantages for all road users in addition to providing a place for bicyclists and pedestrians to operate.

Rumble strips are not recommended where shoulders are used by bicyclists unless there is a minimum clear path of four feet in which a bicycle may safely operate. The exact location of the rumble strip in relation to the automobile travel lane may be determined by the agency concerned until such time that sufficient research has been completed to indicate safe placement of this safety feature.

3. Sidewalks, shared use paths, street crossings (including over-and undercrossings), pedestrian signals, signs, street furniture, transit stops and facilities, and all connecting pathways shall be designed, constructed, operated and maintained so that all pedestrians, including people with disabilities, can travel safely and independently. Americans with Disabilities Act Standards design shall be in compliance with guidance set forth by the Americans with Disabilities Act Accessibility Guidelines (ADAAG), *Designing Sidewalks and Trails for Access*, July 1999 and its successor updates/revisions.

4. The design and development of the transportation infrastructure shall improve conditions for bicycling and walking through the following additional steps:

- Planning projects for the long-term. Transportation facilities are long-term investments that remain in place for many years. The design and construction of new facilities should anticipate likely future demand for bicycling and walking facilities and not preclude the provision of future improvements. For example, a bridge that is likely to remain in place for 50 years might be built with sufficient width for safe bicycle and pedestrian use in anticipation that facilities will be available at either end of the bridge, even if that is not the existing condition.
- Addressing the need for bicyclists and pedestrians to cross corridors as well as travel along them. Even where bicyclists and pedestrians may not commonly use a particular travel corridor that is being improved or constructed, they will likely need to be able to cross that corridor safely and conveniently. Therefore, the design of intersections and interchanges shall accommodate bicyclists and pedestrians in a manner that is safe, accessible, and convenient.
- Designing facilities to the best currently available standards and guidelines. The design of facilities for bicyclists and pedestrians shall follow design guidelines and standards that are commonly used, such as the Missouri Department of Transportation's *General Pedestrian and Bicycle Guide*, the ITE Recommended Practice *Design and Safety of Pedestrian Facilities*, AASHTO *Guide for the Development of Bicycle Facilities*, and AASHTO's *A Policy on Geometric Design of Highway and Streets*. Where these standards are in conflict with the Americans with Disabilities Act Accessibility Guidelines (ADAAG), *Designing Sidewalks and Trails for Access*, July 1999, the ADAAG shall have precedence. However, except in the case of ADA standards, the standards set forth in this document

shall have precedence, followed in descending order by MoDot's *General Pedestrian and Bicycle Guide* and the remaining citations listed in this paragraph in the order listed.

SECTION 4. THE IMPORTANCE OF GOOD DESIGN

The Masterplan, and its predecessor, focused primarily upon bicycles as a mode of transportation, never really discussing the inclusion of pedestrian needs or the notion of a "walkable" or "livable" community. The Masterplan, although mentioning the concept of a network, focused primarily upon the design and development of a separated trail system. Trails, however, are only a single tool in the transportation planner's toolkit.

To quote from Dan Burden's "Walkable Communities" course booklet, walkable communities is "about place making, town building and rebuilding, making sense out of our strip mall lined streets, the making of real neighborhoods, sensible blocks, the creation of real community".

As Mr. Burden puts it, creating a walkable community is not accomplished by simply adding an ingredient to the mix. Rather, it is an ongoing goal accomplished by changing one's approach and perception of "place". To point out some of the elements of this concept, Mr. Burden's material will be leaned upon in this section. The following selections are taken from Dan Burden's "Walkable Communities – A Search for Quality" by Dan Burden, March, 1997.

The 1980's Wake Up Call

Many transportation planning specialists received a jolt when analyzing the 1990 U.S. Census. Despite some efforts to promote walking, transit, bicycling and ride sharing, all four modes lost significant ground to those driving alone. In the 1980's land use practices and transport incentives all went to single occupant motoring – the public responded.

Pedestrian Oriented Design

An emerging pattern for street conversion is to change the orientation of buildings back to the way they were before the 1950's. Pedestrian related design pushes footprints of buildings forward, calls for more green space and street detail, and ample walking spaces. Pockets of pedestrian activity in a city, or entire zones are called for in modern planning documents produced in Canada and the Western USA (British Columbia, Washington, Oregon and California).

Typical Strip Street

Post World War II auto-oriented streets are dull in appearance. Buildings are set back and lack architectural detail. Signs are made large to shout "look at me" as passing motorists test their stamina in the strong competing visual urban soup. An example of this description would be the Belt Highway. A future potential on this and many similar strips is to build up the center and edges – to provide medians, bike lanes, and sidewalks.

Case Studies

Ft. Lauderdale in the 1980's boasted U.S. Highway A-1-A. Five lanes along the beach was not enough as motorists climbed over one another to get to available parking. Sidewalks were narrow on the commercial side of the street and missing on the beach side. For safety and convenience, everyone wanted to drive to the waterside. This created patterns of constant cruising to find a parking space.

On weekends, traffic would often remain motionless most of the time. In order to attract an international crowd, the street was converted. The change eliminated the center scramble (so-called "chicken lane" or continuous left-turn lane) along with beach side parking, and provided instead a continuous raised median with parallel sidewalks.

Now pedestrians can walk on ten foot wide sidewalks on each side of the roadway. On a given weekend, thousands of pedestrians crowd the sidewalks. Outdoor cafes and new hotels are thriving. The pleasant walking conditions prove that parking can be moved back from the roadway, and that business can be allowed to thrive with a proper walking environment.

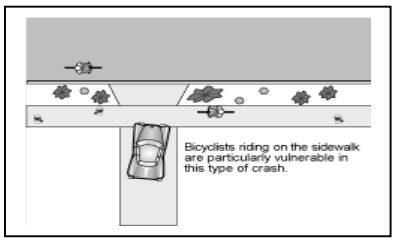
Bicyclists found the new beach-side sidewalks attractive. By creating on street bike lanes from the former wide curb lanes (14 feet), a major portion of bicyclists and in-line skaters moved to the roadway. This emphasizes the need to consider all street users, and was successful on an urban arterial with an ADT in excess of 25,000.

Sidewalk Placement and Components

If all traffic -cars, trucks, bikes and pedestrians- moved at similar speeds, then a wide shared avenue would work. The reality is that each mode needs its own speed. Separation of cars, bikes, and people is essential in most places. The separation pattern requires a car place, a bike place, and a pedestrian place. Trees providing shade and green, street furniture, and buffers must be factored in where appropriate.

How Many Sidewalks Are Needed?

When it comes to funding, the omission of a sidewalk can be a big and costly mistake. Total lack of sidewalks in a place keeps motorists and pedestrians on their toes, and conflicts at a maximum. Children, older adults, and people with disabilities may not be able to move at all. Sidewalks on one street side shows only favoritism and creates conflicts. Equally sized sidewalks (in areas of similar land use on both sides of the street) on both sides of the street provide essential property buffers and complete the essential architecture of the street.



Mixing "trails" and sidewalks on a street places the young biker wanting to ride the "trail" in conflict with the motor vehicle when crossing the street to access the facility. It also exposes the pedestrian on the trail to greater risks with the increase in youth biking by concentrating such use on a single side of the street, not to mention that cyclist/automobile conflicts on trails built next to a street expose both to a much higher incidence of collision and serious injury.

Well-designed bicycle and pedestrian facilities are safe, attractive, convenient and easy to use. It is costly to plan, design and build a facility that is little used, or is used irresponsibly because of poor design. Inadequate facilities discourage users and unnecessary facilities waste money and resources.

Bicycle and pedestrian facilities must be considered at the inception of transportation projects and incorporated into the total design, so that potential conflicts with the safety and level of service for various modes are resolved early on. Bikeways and walkways may be under-designed if they are considered add-on features.

Good design cannot solve all safety problems: enforcement and education are needed to make all road users aware of the presence of others.

SECTION 5. FACILITY TYPES

Bicycles are legally classified as vehicles and are ridden on most public roads in Missouri and Kansas, which are open to bicycle traffic with a few exceptions (interstates). Roadways, which are defined as including the automobile travel lanes to the back edge of the sidewalk, must be designed to allow bicyclists to ride in a manner consistent with the vehicle code.

A bikeway is created when a road has the appropriate design treatment to accommodate bicyclists, based on motor vehicle traffic volumes and speed. The basic design treatments used to accommodate bicycle travel on the road are: shared roadway, shoulder bikeway, or bike lane. Another type of facility is separated from the roadway: multi-use path.

SHARED ROADWAY — On a shared roadway, bicyclists and motorists share the same travel lanes. A motorist will usually have to cross over into the adjacent travel lane to pass a bicyclist. Shared roadways are common on neighborhood streets and on rural roads and highways. There are two treatments that enhance shared roadways for cyclists:

- Wide Outside Lane — Where shoulder bikeways or bike lanes are warranted but cannot be provided due to severe physical constraints, a wide outside lane may be provided to accommodate bicycle travel. A wide lane usually allows an average size motor vehicle to pass a bicyclist without crossing over into the adjacent lane.
- Bicycle Boulevards — A modification of the operation of a local street to function as a through street for bicycles while maintaining local access for automobiles. Traffic calming devices control traffic speeds and discourage through trips by automobiles. Traffic controls limit conflicts between automobiles and bicycles and give priority to through bicycle movement.

SHOULDER BIKEWAY — Paved roadway shoulders on rural roadways provide a suitable area for bicycling, with few conflicts with faster moving motor vehicle traffic. Most rural bicycle travel on the state highway system could be accommodated on shoulder bikeways. AASHTO has supported the concept of shoulders for rural roadways for some time in the areas of safety, capacity, and maintenance.

Safety- highways with paved shoulders have lower accident rates as paved shoulders:

- Provide space to make evasive maneuvers;
- Accommodate driver error;
- Add a recovery area to regain control of a vehicle, as well as lateral clearance to roadside objects such as guardrail, signs and poles (highways require a “clear zone”, and paved shoulders offer the best recoverable surface);
- Provide space for disabled vehicles to stop or drive slowly;
- Provide increased sign distance for through vehicles and for vehicles entering the roadway (*rural*: in cut sections or brushy areas; *urban*: in areas with many sight obstructions);
- Contribute to driving ease and reduced driver strain;
- Reduce passing conflicts between motor vehicles and cyclists and pedestrians;
- Make the crossing pedestrian more visible to motorists; and
- Provide for storm water discharge farther from the travel lanes, reducing hydroplaning, splash and spray to following vehicles, pedestrians and cyclists.

Capacity- highways with paved shoulders can carry more traffic, as paved shoulders:

- Provide more intersection and safe stopping sight distance;
- Allow for easier exiting from travel lanes to side streets and roads (also a safety benefit);
- Provide greater effective turning radius for trucks;
- Provide space for off-tracking of truck’s rear wheels in curved sections;
- Provide space for disabled vehicles, mail delivery and bus stops; and
- Provide space for cyclists to ride at their own pace.

Maintenance- highways with paved shoulders are easier to maintain, as paved shoulders:

- Provide structural support to the pavement;
- Discharge water further from the travel lanes, reducing the undermining of the base and subgrade;
- Provide space for maintenance operations and snow storage;
- Provide space for portable maintenance signs; and
- Facilitate painting of fog lines.

BIKE LANE — A portion of the roadway designated for preferential use by bicyclists. Bike lanes are appropriate on urban arterials and major collectors. They may be appropriate in rural areas where bicycle travel and demand is substantial. Bike lanes must always be well marked to call attention to their preferential use by bicyclists. Many of the benefits of shoulders also apply to bike lanes in urban areas, whether they were created by restriping or by widening the road. Some street enhancements cannot be measured with numbers alone, as they offer values (i.e. trees) that simply make a community better. The following information should be viewed in this context:

For Pedestrians-

- Greater separation from traffic, especially in the absence of on-street parking or a planter strip, increasing comfort and safety. This is important to young children walking, playing or riding their bikes on curbside sidewalks;
- Reduced splash from vehicles passing through puddles (a total elimination of splash where puddles are completely contained within the bike lane);
- An area for people in wheelchairs to walk where there are no sidewalks, or where sidewalks are in poor repair or do not meet ADA standards;
- A space for wheelchair users to turn on and off curb cut ramps away from moving traffic;
- The opportunity to use tighter corner radii, which reduces intersection crossing distance and tends to slow turning vehicles; and
- In dry climates, a reduction in dust raised by passing vehicles, as they drive further from unpaved surfaces.

For Motorists-

- Greater ease and more opportunities to exit from driveways (thanks to improved sight distance);
- Greater effective turning radius at corners and driveways, allowing large vehicles to turn into side streets without off-tracking onto curb;
- A buffer for parked cars, making it easier for motorists to park, enter and exit vehicles safely and efficiently. This requires a wide enough bike lane so bicyclists aren't "doored"; and
- Less wear and tear of the pavement, if bike lanes are restriped by moving travel lanes (heavier vehicles no longer travel in the same, well-worn ruts).

For Other Modes-

- Transit: A place to pull over next to the curb, out of the traffic stream;
- Delivery vehicles (including postal service): A place to stop out of the traffic stream;
- Emergency vehicles: Room to maneuver around stopped traffic, decreasing response time;
- Bicyclists: Greater acceptance of people bicycling on the road, as motorists are reminded that they are not the only roadway users;
- Non-motorized modes: An increase in use, by increasing comfort to both pedestrians and bicyclists (this could leave more space for motorists driving and parking).

For the Community (Livability factors)-

- A traffic calming effect when the bike lanes are striped by narrowing travel lanes;
- Better definition of travel lanes where road is wide (lessens the "sea of asphalt" look); and
- An improved buffer to trees, allowing greater plantings of green canopies, which also has a traffic calming effect.

MULTI-USE OR SHARED-USE PATH (previously called "Bike Path" or “trail”) — A facility separated from motor vehicle traffic by an open space or barrier, either within the roadway right-of-way or within an independent right-of-way. These are typically used by pedestrians, joggers, skaters and bicyclists as two-way facilities. Multi-use paths are appropriate in corridors not well served by the street system (if there are few intersecting roadways), to create short cuts that link destination and origin points, a shortcut between neighborhoods (two cul-de-sac streets), and as elements of a community trail plan along greenways and railroad corridors. They represent limited use applications that would be the exception for design inclusion, not the rule.

According to AASHTO, trails should be thought of as a complementary system of off-road transportation routes for cyclists and pedestrians that serves as a necessary extension to the roadway network. Shared use paths should not be used to preclude on-road bicycle facilities, but rather to supplement a system of on-road bike lanes, wide outside lands, paved shoulders, and bike routes, and sidewalks.

When two-way trails are located immediately adjacent to a roadway, some operational problems are likely to occur. In some cases, paths along highways for short sections are permissible, given an appropriate level of separation between facilities (possibly a curb, wide planter strip and a fence).

Problems with paths located immediately adjacent to roadways are as follows (AASHTO, 1999):

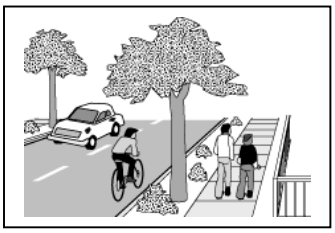
- Unless separated, they require one direction of cycling traffic to ride against motor vehicle traffic, contrary to normal rules of the road.
- When the path ends, cyclists going against traffic will tend to continue to travel on the wrong side of the street. Likewise, cyclists approaching a trail often travel on the wrong side of the street in getting to the path. Wrong-way travel by cyclists is a major cause of bicycle/automobile crashes and should be discouraged at every opportunity.
- At intersections, motorists entering or crossing the roadway often will not notice cyclists approaching from their right, as they are not expecting contra-flow vehicles. Motorists turning to exit the roadway may likewise fail to notice the cyclists. Even cyclists coming from the left often go unnoticed, especially when sight distances are limited.
- Signs posted for roadway users are backwards for contra-flow bike traffic; therefore, these cyclists are unable to read the information without stopping and turning around.
- When the available right-of-way (ROW) is too narrow to accommodate all highway and shared use path features, it may be prudent to consider a reduction of the existing or proposed widths of the various roadway (and bikeway) cross-sectional elements (ie. lane and shoulder widths, etc.--). However, any reduction to less than AASHTO (or other applicable design criteria cited in this document) design criteria must be supported by a documented planning and engineering analysis.
- Many cyclists will use the roadway instead of the shared use path because they have found the roadway to be more convenient, better maintained, or safer. Some motorists, who feel that in all cases cyclists should be on the adjacent path, may harass cyclists using the roadway.
- Although the trail should be given the same priority through intersections as the parallel roadway, motorists falsely expect cyclists to stop or yield at all cross-streets and driveways. Efforts to require or encourage cyclists to yield or stop at each cross-street and driveway are inappropriate and frequently ignored by cyclists.
- Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may block the path crossing.
- Because of the proximity of motor vehicle traffic to opposing cycling traffic, barriers are often necessary to keep motor vehicles out of trails and cyclists out of traffic lanes. These barriers can represent an obstruction to cyclists and motorists, can complicate maintenance of the facility, and can cause other problems as well.

*Note: bikeways are listed in increasing order of complexity, with no implied order of preference.

SECTION 6 ON-STREET FACILITY DESIGN STANDARDS

Shared Roadways

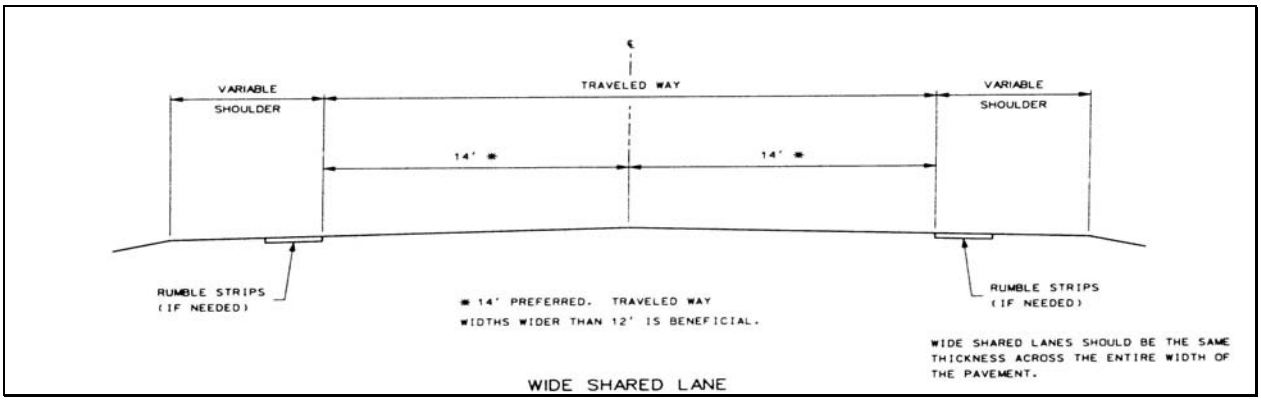
There are no specific bicycle standards for most shared roadways; they are simply the roads as constructed. Shared roadways function well on local streets and minor collectors, and on low-volume rural roads and highways. Mile per mile, shared roadways are the most common bikeway type.



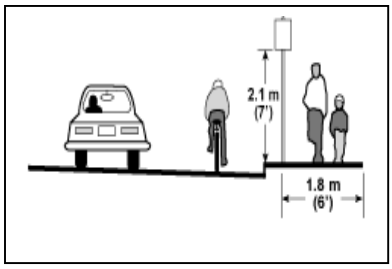
Shared roadways are suitable in urban areas on streets with low speeds - 30 MPH or less - or moderate traffic volumes (12,000 ADT or less, depending on speed and land use).

In rural areas, the suitability of a shared roadway decreases as traffic speeds and volumes increase, especially on roads with poor sight distance. Where bicycle use or demand is potentially high, roads should be widened to include shoulder bikeways where the travel speeds and volumes are high.

Many urban local streets carry excessive traffic volumes at speeds higher than they were designed to carry. These can function as shared roadways if traffic speeds and volumes are reduced. There are many "traffic calming" techniques that can make these streets more amenable to bicycling on the road. The MPO will be developing a traffic calming policy in the near future to provide guidance in this area.



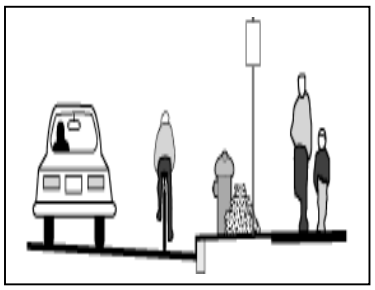
Wide Curb Lanes



A wide curb lane (bike friendly lanes) may be provided where there is inadequate width to provide the required bike lanes or shoulder bikeways. This may occur on retrofit projects where there are severe physical constraints, and all other options have been pursued, such as

removing parking or narrowing travel lanes. Wide curb lanes are not particularly attractive to most cyclists, they simply allow a motor vehicle to pass cyclists within a travel lane.

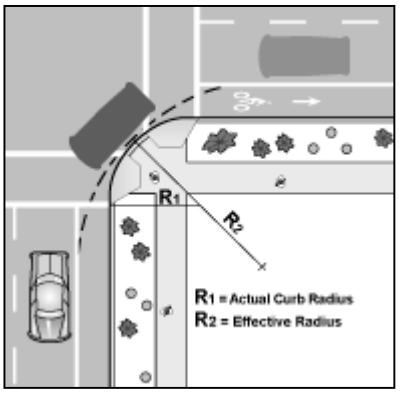
To be effective, a wide lane must be at least 4.2 m (14 ft) wide, but less than 4.8 m (16 ft). Usable width is normally measured from curb face to the center of the lane stripe, but adjustments need to be made for drainage grates, parking and the ridge between the pavement and gutter. Widths greater than 4.8 m (16 ft) encourage the undesirable operation of two motor vehicles in one lane. In this situation, a bike lane or shoulder bikeway should be striped.



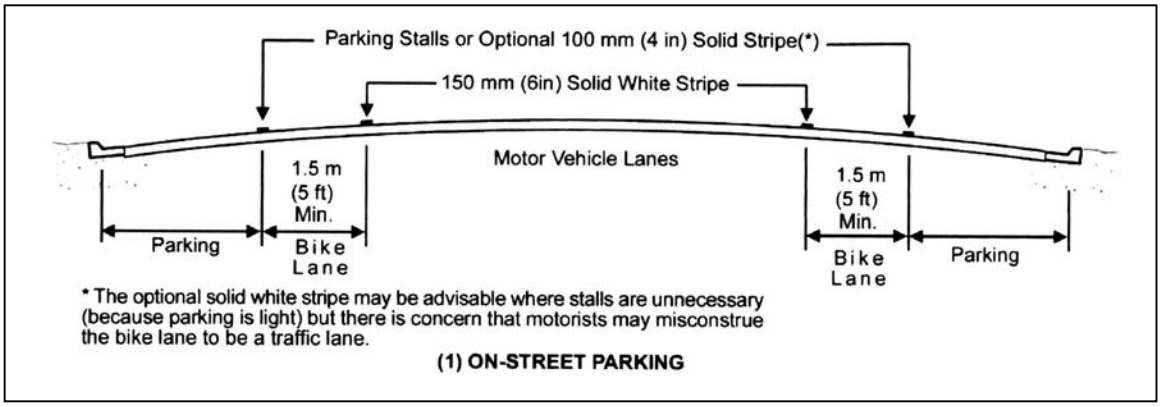
Bike Lanes

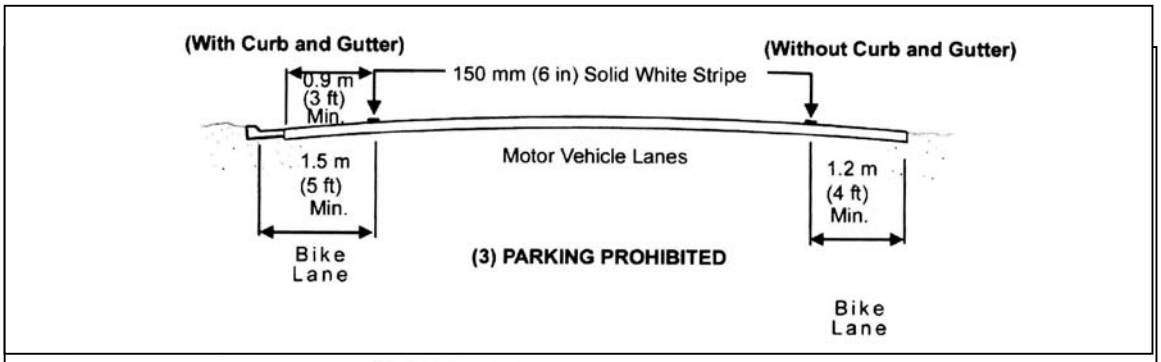
Bike lanes are advantageous in certain applications because by providing cyclists with their own space on the road, bike lanes improve access to destinations and commute options. Bike lanes on arterials:

- Establish the correct position of bicyclists on the roadway;
- Reduce bicycle/pedestrian conflicts as fewer cyclists ride on sidewalks;
- Provide bicyclists a space to travel at their own speed next to motorists;
- Increase the effective turning radius for right turns at intersections;
- Guide bicyclists through intersections;
- Provide additional pedestrian buffer from adjacent automobile traffic;
- Allow bicyclists to pass motor vehicles backed up at intersections (a bike lane is a legal travel lane); and
- Send a message to motorists that bicyclists have a right to the roadway.



Depending upon several design factors outlined in AASHTO in greater detail, the following typical sections should be applied in instances where bike lanes are being considered, given certain variables that are site-driven:



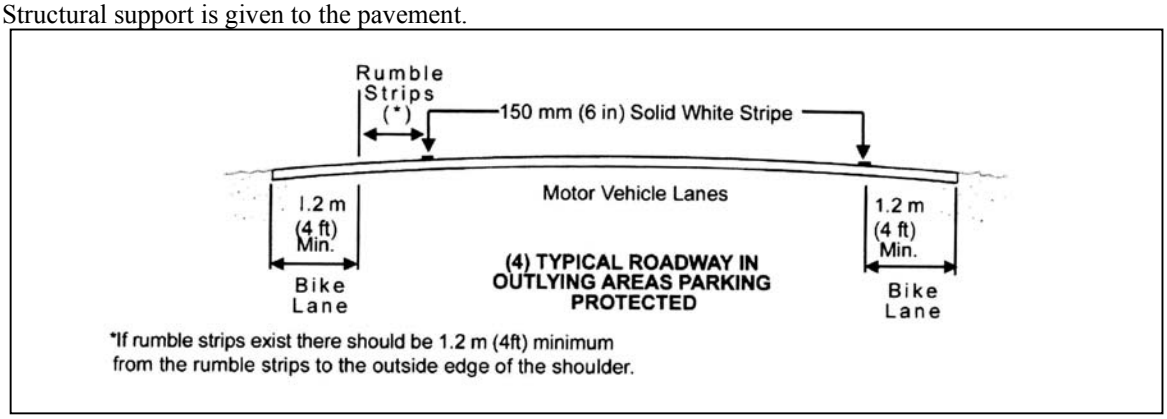


(2) PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL

Shoulder Bikeways

Paved shoulders are provided on rural highways for a variety of safety, operational and maintenance reasons:

- Space is provided for motorists to stop out of traffic in case of mechanical difficulty, a flat tire or other emergency;
- Space is provided to escape potential crashes;
- Sight distance is improved in cut sections;
- Highway capacity is improved;
- Space is provided for maintenance operations such as snow removal and storage;
- Lateral clearance is provided for signs and guardrail;
- Storm water can be discharged farther from the pavement; and
- Structural support is given to the pavement.



Width Standards

In general, the shoulder widths recommended for rural highways in the MoDot Highway Design Guide serve bicyclists well, when constructed. The following table should be used when determining roadway shoulder widths:

	ADT under 250	ADT 250-400	ADT 400-DHV* 100	DHV 100-200	DHV 200-400	DHV over 400
Rural Arterials	1.2 m (4 ft)	1.2 m (4 ft)	1.8 m (6 ft)	1.8 m (6 ft)	2.4 m (8 ft)	2.4 m (8 ft)
Rural Collectors	0.6 m (2 ft)	0.6 m (2 ft)	1.2 m (4 ft)	1.8 m (6 ft)	2.4 m (8 ft)	2.4 m (8 ft)
Rural Local Route	0.6 m (2 ft)	0.6 m (2 ft)	1.2 m (4 ft)	1.8 m (6 ft)	1.8 m (6 ft)	2.4 m (8 ft)

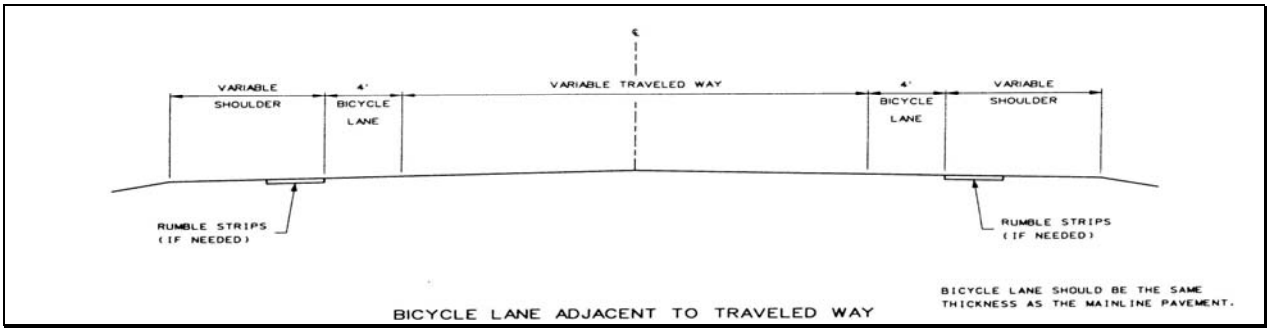
*DHV (Design Hour Volume) is the expected traffic volume in the peak design hour (usually at commuter times); usually about 10% of ADT in urban areas, higher on rural highways with high recreational use.

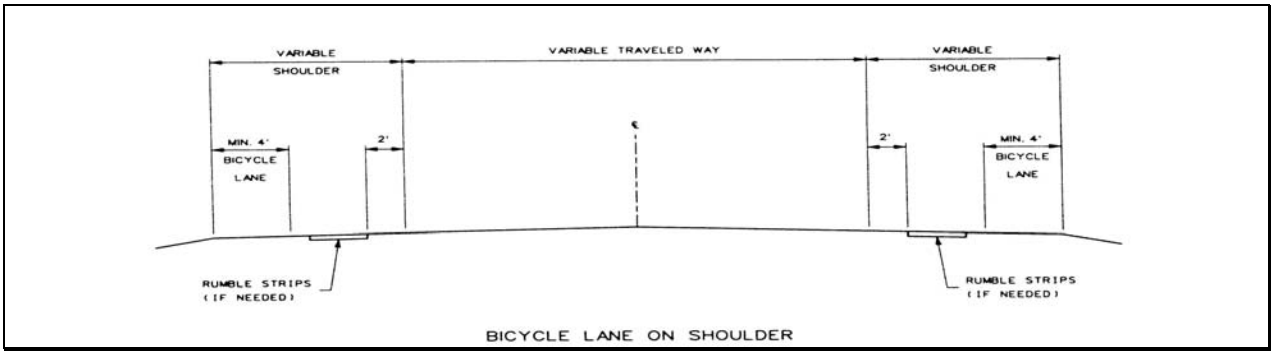
When providing shoulders for bicycle use, a width of 1.8 m (6 ft) is recommended. This allows a cyclist to ride far enough from the edge of pavement to avoid debris, yet far enough from passing vehicles to avoid conflicts. If there are physical width limitations, a minimum 1.2 m (4-ft) shoulder may be used. Shoulders against a curb face, guardrail or other roadside barriers must have a 1.5 m (5-ft) minimum width or 1.2 m (4 ft) from the longitudinal joint between a monolithic curb and gutter and the edge of travel lane.

On steep grades, it is desirable to maintain a 1.8 m (6-ft), (min. 1.5 m [5-ft]) shoulder, as cyclists need more space for maneuvering.

Many rural roads are 8.4 m (28 ft) wide, with fog lines striped at 3.3 m (11 ft) from centerline. The remaining 0.9 m (3 ft) should not be considered a shoulder bikeway (min. width 1.2 m {4 ft}); these are still considered shared roadways, as most cyclists will ride on or near the fog line.

The following typical sections illustrate the standards discussed herein:





SECTION 7. SIDEWALKS

Sidewalks are a very important component of the roadway network and of the roadway itself. As the public way is constructed and maintained to provide safe and efficient circulation for automobiles and bicycles, so too should the needs of the pedestrian be considered and accommodated.

To quote from AASHTO, 1999:

> *Utilizing or providing a sidewalk as a shared use path is unsatisfactory for a variety of reasons. Sidewalks are typically designed for pedestrian speeds and maneuverability and are not safe for higher speed bicycle use. Conflicts are common between pedestrians traveling at low speeds (exiting stores, parked cars, etc.) and bicyclists, as are conflicts with fixed object (e.g., parking meters, utility poles, sign posts, bus benches, trees, fire hydrants, mail boxes, etc.) Walkers, joggers, skateboarders and roller skaters can, and often do change their speed and direction almost instantaneously, leaving bicyclists insufficient reaction time to avoid collisions.*

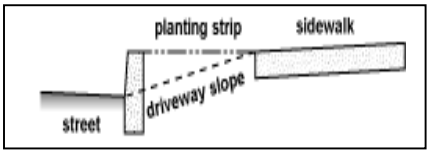
Sidewalks, then, are provided to serve pedestrians. This might range from the resident walking from the home to a neighbor's house, to a child walking to a friend's house a few blocks away. Individuals may walk, jog, or skate to reach their destination, but this is the type of use intended to operate on the facility. Users groups may further be subcategorized to include the same elements for persons with disabilities. Design efforts should focus upon these collective uses and the requirements necessary to support the same.

Width

The width of sidewalks not only affects pedestrian usability, but also determine the types of access and other pedestrian elements that can be installed. For example, a 60-inch sidewalk is wide enough to accommodate pedestrian traffic in a residential area, but a much wider sidewalk would be necessary to include amenities such as street furniture or newspaper stands in a retail area.

Design width is defined as the width specification the sidewalk was intended to meet; it extends from the curb or planting strip to any buildings or landscaping that form the opposite borders of the sidewalk. Minimum clearance width is defined as the narrowest point on a sidewalk. An inaccessible minimum clearance width is created when obstacles such as utility poles protrude into the sidewalk and reduce the design width. A reduction in the design width could also create a minimum clearance width challenge.

Although most guidelines require sidewalk design widths to be at least 60 inches wide, larger design widths can accommodate more pedestrians and improve ease of access. The AASHTO Green Book, the Oregon Department of Transportation, the Institute of Transportation Engineers, and other guidelines recommend wider design widths in areas with high volumes of pedestrians. The sidewalk width often depends on the type of street and the adjacent landuse. In general, residential streets have narrower sidewalks than commercial streets.

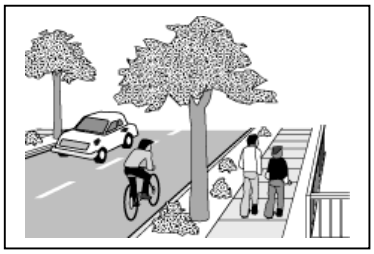


Sidewalks should lie in a continuous plane with a minimum of surface warping. Nonplanar surfaces are frequently found at driveway crossing flares and curb ramps without landings. Rapidly changing cross-slopes can cause one leg of a walker to lose contact with the ground, or cause walking pedestrians to stumble or fall. AASHTO sets the maximum cross-slopes at not to exceed 1.5%, but current ADA guidance sets the maximum at 2%. To meet ADA, a maximum of 2% is the recommended cross-slope for sidewalks, although the AASHTO standard would be more desirable if possible.

The width of the sidewalk is also affected by pedestrian travel tendencies. Pedestrians tend to travel in the center of sidewalks to separate themselves from the rush of traffic and avoid street furniture, vertical

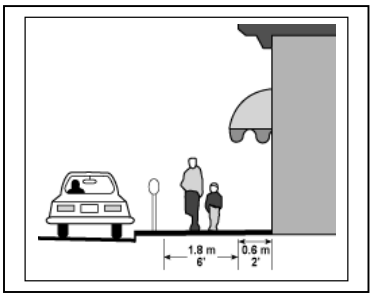
obstructions, and other pedestrians entering and exiting buildings. Pedestrians avoid the edge of the sidewalk close to the street because it often contains utility poles, bus shelters, parking meters, sign poles, and other street furniture.

Pedestrians also avoid traveling in the 0.610 (24 inches) of the sidewalk close to buildings to avoid retaining walls, street furniture, and fences. The sidewalk area that pedestrians tend to avoid is referred to as the **shy distance,** a term that is applied to both cyclist and pedestrian tendency to shy away from perceived obstacles or "threats". Taking into account the shy distance, only the center six feet of a ten-foot sidewalk is used by pedestrians for travel. Thus, the effective width of a sidewalk, not the design width, constitutes the sidewalk area needed to accommodate anticipated levels of pedestrian traffic.



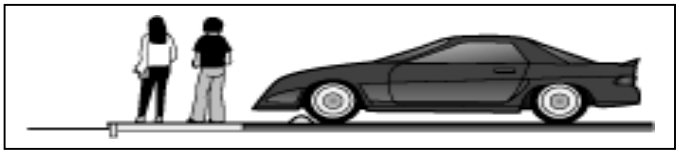
In general, the same notion that is used to categorize the hierarchy of streets and roadways can be applied to sidewalks. In a functional classification system, there is a recognition that certain types of streets operate differently and serve different purposes. Factors that impact functional class for automobiles would include land use, destinations, linkages, volume of traffic, and vehicle type. Sidewalks should use the same approach except that the design treatment should be included in the analysis of accommodating all three classes of cyclists and all four classes of pedestrians, and would examine traffic volumes in a dual fashion: automobile speed and volume on the adjacent roadway and expected/anticipated type and volume of facility traffic. The concept is that higher volume bicycle/pedestrian facilities would mimic the roadways they border because travel characteristics tend to be similar in nature and route chosen.

For general guidance, most residential areas require a minimum 5 foot sidewalk, with a wide planter strip (wide enough to make it feasible to plant trees and maintain grass without planting trees too close to both sidewalk and street in a narrow strip). In certain residential areas, where sidewalks link trails, link schools, or connect to nearby high destination areas such as a movie theater, wider sidewalks are required with a minimum of 6 feet and a maximum of 8 feet.



Commercial areas should include a minimum of an 8 foot walk with a maximum to be determined by examining the adjacent roadway characteristics and anticipated sidewalk treatments (benches, newspaper stands, soda machines, etc.) that a business may propose. Given that most commercial interests seek a high volume of customers, it is reasonable to assume that sidewalks serving such locations will serve a greater number of users, and should be designed to do so. Providing a scant 3 foot wider section of pavement than would be provided in a residential area is not consistent with the design principles provided in this document and referenced design guidelines; however, given that commercial endeavors range from retail, to professional services, to wholesale, to a combination of uses in-between, flexibility is here provided by setting only a minimum width and allowing the designer the opportunity to propose the appropriate treatment for the particular application of these guidelines.

Dependent upon the commercial development type, and its proposed parking uses adjacent to a sidewalk, it is important to recognize that instances such as the automobile overhang seriously impair the capacity and safety of the facility. In such instances, wider walks will be required to preserve the functional capacity and safety of the design element.



Not withstanding the preceding information, sidewalks shall generally conform to the following approach in an urban environment as minimum widths:

- Sidewalks along Local Streets – 5'
- Sidewalks along Collector Streets – 5'
- Sidewalks along Arterial Streets – 6'

In instances where parcel development is planned for a corridor in which a trail is planned as a link between certain corridors or a continuation of the system proper, a 10' sidewalk shall be required, per the design criteria set forth for trails in this document. Such an example is strictly limited to corridors indicated in the most current Urban Trail System Map as trail locations.

The exception to this standard may be the conservation design subdivision. Pedestrian accommodation must be made, but it may be counter-productive to mandate sidewalks on either side of the roadway along the entire extent of the same, given the nature of this development approach and in lieu of other treatments discussed previously in this document. Given this statement, the developer must still analyze the appropriate method for use inclusion and propose the same as a component of the subdivision review process. The Director of the Department of Public Works & Transportation, or the appropriate authority in a given jurisdiction for a subject parcel outside the City of St. Joseph, must approve deviations from the standard (which such an exception would constitute).

ADA

Passing space is defined as a section of sidewalk wide enough to allow two users to pass one another or travel abreast. The passing space provided should also be designed to allow one wheelchair user to turn in a complete circle.

The issue of passing space or usable space is really not limited to ADA, but to functionality. Hearkening to a favorite saying by Dan Burden, "4 foot walks are for lovers". In this comment, Mr. Burden points to the fact that two normal adults find it difficult to comfortably walk next to each other on a four foot walk. One of the pedestrians is forced to walk off the sidewalk, or place his arm around the companion for a closeness that will allow both room on the pavement to walk. A wider surface would not only make the walk more disability friendly, but would make the facility more inviting to, and usable by, the remaining population.

Passing space interval is the distance between passing spaces when/where a sidewalk width is too narrow for a prolonged distance because of a narrow design width or continuous obstacles. Section 4.3.4 of ADAAG states that "accessible routes with less than 60 inches of clear width must provide passing spaces at least 60 inches wide at reasonable intervals not exceeding 200 feet. If turning or maneuvering is necessary, a turning space of 60 inches x 60 inches should be provided", ADAAG, 1991.

In jurisdictions where narrow sidewalks are condoned, additional attention will have to be given to the turnarounds. Typical driveway sections will have to be altered such that the cross-slopes and vertical clearances fall within ADA guidelines for use as turning spaces. Walks that are constructed to a width of 60 inches or greater would not require the inclusion of turning spaces, as the entire design width would be adequate to comply with the needs of persons with disabilities.

Per AASHTO and other design guides, it is important to note that the closer in proximity a sidewalk is to the driving lanes of the automobile, the more narrow the clearance width becomes. Thus, sidewalks that are constructed at the edge of the street curb are required to be wider than the same sidewalk, in the same neighborhood, on the same street - with a planter strip – to maintain a safe and adequate clearance width. What saves one money in bricks and mortar will cost one more in developable space and vice versa.

Vertical Clearance

Vertical clearance is defined as the minimum unobstructed vertical passage space required along a sidewalk. Vertical clearance is often limited by obstacles such as building overhangs, tree branches, signs, and awnings. The minimum vertical clearance shall be 80" of unobstructed vertical passage space.

The ADAAG specifies that if the vertical clearance of an area next to a circulation route is less than 80", elements that project into the circulation space must be protected by a barrier to warn people who are visually disabled or blind.

Changes in Level

Changes in level is defined as vertical height transitions between adjacent surfaces or along the surface of a path. In the sidewalk environment, curbs without curb ramps, cracks, and dislocations in the surface material are common examples of changes in level. Changes in vertical height transitions may also occur at expansion joints between elements such as curb ramps, gutters, and between sidewalk panels.

Federal accessibility standards permit changes in level less than .25" high to be vertical, but require changes in level between .25" and .50" to have a maximum bevel of fifty percent. A ramp is required for changes in level that exceed .50".

SECTION 8 PAVEMENT DESIGN

Many existing gravel shoulders have sufficient width and base to support shoulder bikeways. Minor excavation and the addition of 75-100 mm (3-4") of asphaltic concrete is often enough to provide shoulder bikeways. It is best to widen shoulders in conjunction with pavement overlays for several reasons:

- The top lift of asphalt adds structural strength;
- The final lift provides a smooth, seamless joint;
- The cost is less, as greater quantities of materials will be purchased; and
- Traffic is disrupted only once for both operations.

When shoulders are provided as part of new road construction, the pavement structural design should be the same as that of the roadway.

On shoulder widening projects, there may be some opportunities to reduce costs by building to a lesser thickness. 50-100 mm (2-4") of asphalt and 50-75 mm (2-3") of aggregate over existing roadway shoulders may be adequate if the following conditions are met:

- There are no planned widening projects for the road section in the foreseeable future;
- The existing shoulder area and roadbed are stable and there is adequate drainage or adequate drainage can be provided without major excavation and grading work;
- The existing travel lanes have adequate width and are in stable condition;
- The horizontal curvature is not excessive, so that the wheels of large vehicles do not track onto the shoulder area (on roads that have generally good horizontal alignment, it may be feasible to build only the inside of curves to full depth); and
- The existing and projected ADT and heavy truck traffic is not considered excessive (e.g. under 10%).

The thickness of pavement and base material will depend upon site conditions, and engineering judgment should be used. If there are short sections where the travel lanes must be reconstructed or widened, these areas should be constructed to normal full-depth standards.

The Joint between the Shoulders and the Existing Roadway

The following techniques should be used to add paved shoulders to roadways where no overlay project is scheduled:

1. Saw Cut: A saw-cut 0.3 m (1 ft.) inside the existing edge of pavement provides the opportunity to construct a good tight joint. This eliminates a ragged joint at the edge of the existing pavement.
2. Feathering: "Feathering" the new asphalt onto the existing pavement can work if a fine mix is used and the feather does not extend across the area traveled by bicyclists.
3. Grinder: Where there is already some shoulder width and thickness available, a pavement grinder can be used to make a clean cut at the edge of travel lane, grade the existing asphalt to the right depth and cast aside the grindings in one operation, with these advantages:

- Less of the existing pavement is wasted;
- The existing asphalt acts as a base;
- There will not be a full-depth joint between the travel lane and the shoulder; and
- The grindings can be recycled as base for the widened portion.

New asphalt can then be laid across the entire width of the shoulder bikeway with no seams.

Intersections

Intersections are the bane of designers of roadway systems. A juncture of roadways represent the “choke” point where facility automobile capacity (and related elements referred to as “level of service” (LOS)) is greatly reduced if not well designed. Safety is also paramount at intersections, because the very function of a street congruence involves turning movements and where vehicles turn - vehicles may also crash.

Traditional intersection design has focused upon safely moving traffic at as high a rate a speed as possible to maintain the capacity of the roadway. If intersections are not highly efficient, the impact to the roadway is significant, often involving the need for additional lanes or other treatments.

An elemental component of a high volume intersection is the right turn lane, which allows traffic to move through an intersection (to the right) without transitioning through the signal. Again, the traditional design approach focused only upon the minimum geometry required to move traffic, not factoring in the human element introduced inside the vehicle (the driver) and outside the vehicle (the pedestrian).

The result was a design the forces the driver of a vehicle to turn one's head to the left at a very sharp angle. Such a physical maneuver is difficult at best for the mature driver, which has been a leading cause of accidents at such a location. The driver simply can't see the oncoming vehicle and either collides into or is collided by the same vehicle.

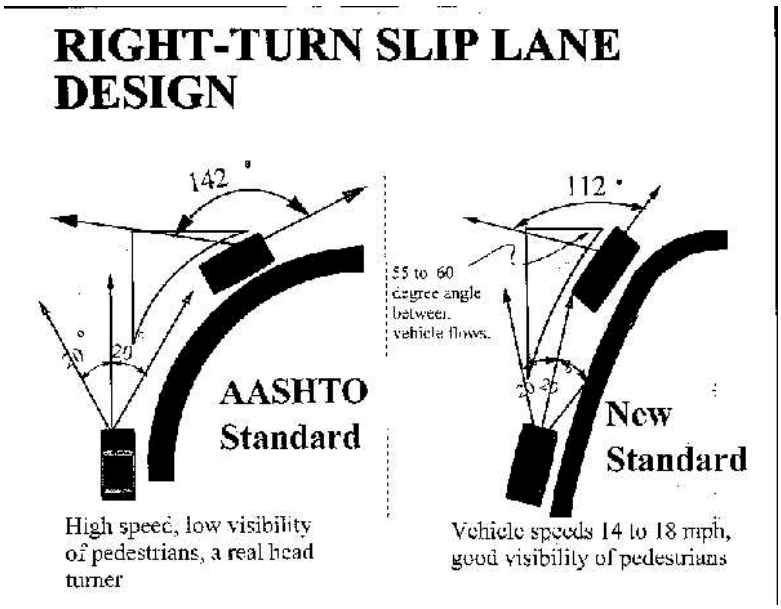
The angle of the turn also makes it difficult for a driver to appropriately recognize the pedestrian attempting to cross the right turn lane. While a driver is straining to identify oncoming vehicles, the pedestrian is unable to see the same driver because the geometry of the turn does not factor in the pedestrian line of sight as it relates to travel speed. For example, it would do a pedestrian little good to see a vehicle coming from 20 yards away, because at a given travel speed there would be insufficient reaction time for either the driver or pedestrian avoid conflict.

With an alternative design, drivers are not forced to strain left and pedestrians are placed in a direct line of sight such that they can be identified before the natural reaction to look for oncoming traffic veers away one's attention. Pedestrians are also able to see an automobile sooner and, because of the decreased travel speed, are provided more reaction time to avoid conflict.

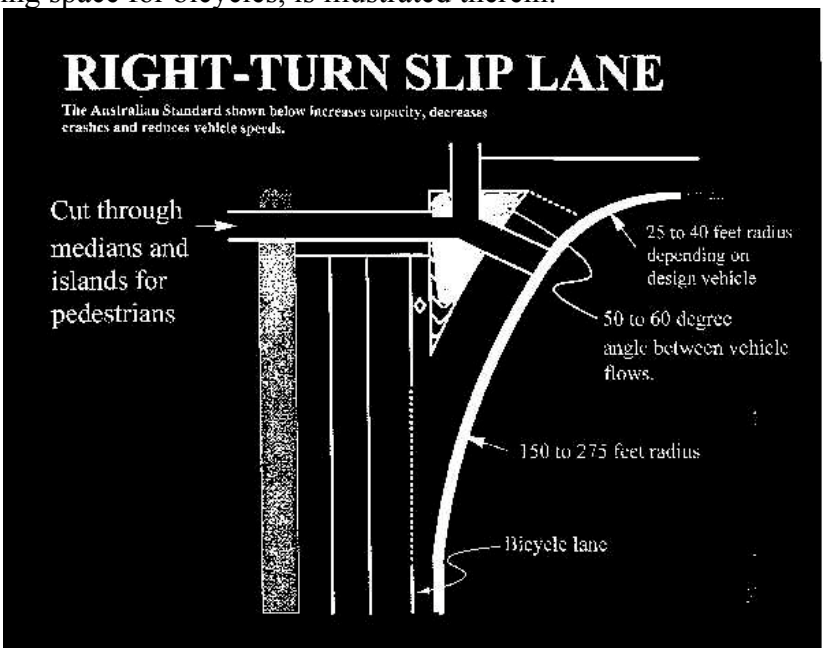
Quoting the AASHTO Green Book, Chapter 3 – Elements of Design, from the subsection concerning Minimum Radius for Turning Speed, on page 192, it states "While it is desirable and often feasible to design for turning vehicles at higher speeds, it is often necessary for safety and economy to user lower turning design speeds at most at-grade intersections". Because AASHTO design is primarily aimed at rural highway or interstate design, this statement is important because it implies a different approach should be chosen in different situations. Urban environments often involve different treatments than the more "typical" design, requiring consideration of uses not traditionally considered.

In the same section of AASHTO, on page 440 of Intersection Design, comes the statement that "At street intersections in residential areas and areas where there are heavy pedestrian movements, the minimum radius of curb return where curbs are used or the outside edge of pavement where curbs are not used should be 5m. A minimum radius of 8m is desirable."

Given the flexibility provided under AASHTO and the reality of human behavior in the natural environment, the following drawing illustrates the standard adopted for right turn lanes that add an increased level of safety for the driver and pedestrian:



Another intersection design variation is one transplanted from Australia that is commonly used throughout the nation. The principle concepts of slowing vehicle travel speeds for the right turning movement and protecting pedestrian access on a multi-lane facility, while providing space for bicycles, is illustrated therein:



Gravel Driveways and Approaches

Wherever a highway is constructed, widened or overlaid, all gravel driveways and approaches should be paved back 4.5 m (15 ft) to prevent loose gravel from spilling onto the shoulders.

Bike Lanes

Bike lanes are provided on urban arterial and major collector streets. Bike lanes may also be provided on rural roadways near urban areas, where there is high potential bicycle use.

Bike lanes are generally not recommended on rural highways with posted speeds of 90 km/h (55 MPH): at channelized intersections, the speeds are too high to place a through bike lane to the left of right-turning vehicles. Shoulder bikeways, striped with a 100 mm (4") fog line, are the appropriate facility for these roads.

Bike lanes are one-way facilities that carry bicycle traffic in the same direction as adjacent motor-vehicle traffic; bike lanes should always be provided on both sides of a two-way street.

Well-designed urban arterials should have paved shoulders. Bike lanes are created by using a 200 mm (8") stripe and stencils. Motorists are prohibited from using bike lanes for driving and parking, but may use them for emergency avoidance maneuvers or breakdowns.

Width Standards

The standard width of a bike lane is 1.8 m (6 ft), as measured from the center of stripe to the curb or edge of pavement. This width enables cyclists to ride far enough from the curb to avoid debris and drainage grates, yet far enough from passing vehicles to avoid conflicts. By riding away from the curb, cyclists are more visible to motorists than when hugging the curb.

The minimum bike lane width is 1.2 m (4 ft) on open shoulders and 1.5 m (5 ft) from the face of a curb, guardrail or parked cars. A clear riding zone of 1.2 m (4 ft) is desirable if there is a longitudinal joint between asphalt pavement and the gutter section. On roadways with flat grades, it may be preferable to integrate the bike lane and gutter to avoid a longitudinal joint in the bike lane.

Bike lanes wider than 1.8 m (6 ft) may be desirable in areas of very high use, on high-speed facilities where wider shoulders are warranted, or where they are shared with pedestrians. Care must be taken so they are not mistaken for a motor vehicle lane or parking area, with adequate marking or signing.

A bike lane must always be marked with pavement stencils and a 200 mm (8") wide stripe. This width increases the visual separation of a motor vehicle lane and a bike lane.

If parking is permitted, the bike lane must be placed between parking and the travel lane, and have a minimum width of 1.5 m (5 ft).

Bike Lanes on One-way Streets

Bike lanes on one-way streets should be on the right side of the roadway, except where a bike lane on the left decreases the number of conflicts (e.g., those caused by heavy bus traffic or dual right-turn lanes), if cyclists can safely and conveniently return to the right.

Practices to Be Avoided

National experience in design has occurred over 20 years with accrued experience in designing bikeways. This has led to improvements in the learning curve indicating positive alternatives and some practices that have proven to be poor ones.

Sidewalk Bikeways

Some early bikeways used sidewalks for both pedestrians and bicyclists. While in rare instances this type of facility may be necessary, or desirable for use by small children, in most cases it should be avoided.

Sidewalks are not suited for cycling for several reasons:

- Cyclists face conflicts with pedestrians;
- There may be conflicts with utility poles, sign posts, benches, etc.;

- Bicyclists face conflicts at driveways, alleys and intersections: a cyclist on a sidewalk is generally not visible to motorists and emerges unexpectedly. This is especially true of cyclists who ride opposing adjacent motor vehicle traffic: drivers do not expect a vehicle coming from this direction; and
- Bicyclists are put into awkward situations at intersections where they cannot safely act like a vehicle but are not in the pedestrian flow either, which creates confusion for other road users.

Cyclists are safer when they are allowed to function as roadway vehicle operators, rather than as pedestrians.

Where constraints do not allow full-width walkways and bikeways, solutions should be sought to accommodate both modes (e.g. narrowing travel lanes or reducing on-street parking). In some urban situations, preference may be given to accommodating pedestrians. Sidewalks should not be signed for bicycle use - the choice should be left to the users.

Extruded Curbs

These create an undesirable condition when used to separate motor vehicles from cyclists: either one may hit the curb and lose control, with the motor vehicle crossing onto the bikeway or the cyclist falling onto the roadway. At night, the curbs cast shadows on the lane, reducing the bicyclist's visibility of the surface. Extruded curbs make bikeways difficult to maintain and tend to collect debris. They are often hit by motor vehicles, causing them to break up and scatter loose pieces onto the surface.

Reflectors & Raised Pavement Markers

These can deflect a bicycle wheel, causing the cyclist to lose control. If pavement markers are needed for motorists, they should be installed on the motorist's side of the stripe, and have a beveled front edge.

Two-Way Bike Lane

This creates a dangerous condition for bicyclists. It encourages illegal riding against traffic, causing several problems:

- At intersections and driveways, wrong-way riders approach from a direction where they are not visible to motorists;
- Bicyclists closest to the motor vehicle lane have opposing motor traffic on one side and opposing bicycle traffic on the other; and
- Bicyclists are put into awkward positions when transitioning back to standard bikeways.

If constraints allow widening on only one side of the road, the centerline stripe may be shifted to allow for adequate travel lanes and bike lanes.

Continuous Right-Turn Lanes

This configuration is difficult for cyclists. Riding on the right puts them in conflict with right-turning cars, but riding on the left puts them in conflict with cars merging into and out of the right-turn lane. The best solution is to eliminate the continuous right-turn lane, consolidate accesses and create well-defined intersections.

Other Design Considerations

Drainage Grates

Care must be taken to ensure that drainage grates are bicycle-safe. If not, a bicycle wheel may fall into the slots of the grate causing the cyclist to fall. Replacing existing or welding thin metal straps across the grate perpendicular to the direction of travel is required as a component of new work or reconstruction. These should be checked periodically to ensure that the straps remain in place.

*Note: grates with bars perpendicular to the roadway must not be placed at curb cuts, as wheelchairs could get caught in the slot.

The most effective way to avoid drainage-grate problems is to eliminate them entirely with the use of inlets in the curb face. If a street-surface grate is required for drainage, care must be taken to ensure that the grate is flush with the road surface.

Inlets should be raised after a pavement overlay to within 6 mm (1/4") of the new surface. If this is not possible or practical, the pavement must taper into drainage inlets so they do not cause an abrupt edge at the inlet.

Traffic Control Devices

At intersections, cyclist and pedestrian traffic should be considered in the timing of the traffic signal cycle, as well as the traffic detection device (i.e. push button actuators for pedestrians).

Normally, a cyclist can cross an intersection under the same signal phasing arrangement as motor vehicles; however, on multi-lane streets special consideration should be given to ensure that short clearance intervals are not used. If necessary, an all-red clearance interval may be used.

To check the clearance interval, a cyclist's speed of 10 mph (16 km/h) and a perception/reaction/braking time of 2.5 seconds should be used. Where programmed visibility signal heads are used, they should be checked to ensure that they are visible to cyclists who are properly positioned on the road.

The Manual on Uniform Traffic Control Devices Guidelines (MUTCD) should be consulted for guidance on signage and pavement markings.

Railroad Crossings

Special care must be taken wherever a bikeway intersects railroad tracks. The most important improvements for bicyclists are smoothness, angle of crossing and flange opening.

Smoothness

Concrete performs best under wet conditions and, when laid with precision, provides a smooth ride. Rubberized crossings provide a durable, smooth crossing, though they tend to become slippery when wet. If asphalt pavement is used, it must be maintained in order to prevent a ridge buildup next to the rails. Timber crossings wear down rapidly and are slippery when wet.

Angle of Crossing

The risk is kept to a minimum where the bikeway crosses the tracks at a 90° angle. If the skew angle is less than 45°, special attention should be given to the bikeway alignment to improve the angle of approach, preferably to 60° or greater, so cyclists can avoid catching their wheels in the flange and losing their balance.

Flange Opening

The open flange area between the rail and the roadway surface can cause problems for cyclists, since it can catch a bicycle wheel, causing the rider to fall. Flange width must be kept to a minimum.
*Note: The combination of smoothness, angle and flange opening create conditions that affect cyclists. By improving smoothness and flange opening, the angle becomes less critical.

Sidewalk Ramps on Bridges

Such treatments on bridges can help cyclists if the bridge sidewalks are wide enough for bicycle uses (minimum 5 feet). They should be provided where motor vehicle traffic volumes and speeds are high, the bridge is fairly long and the outside traffic lanes or shoulders on the bridge are narrow. Where bicyclists are allowed to use bridge sidewalks, the sidewalk railing should be 1.4 m (4.5 ft) high.

Rumble Strips

Rumble strips are provided to alert motorists that they are wandering off the travel lanes onto the shoulder. They are most common on long sections of straight freeways in rural settings, but are also used on sections of two-lane undivided highways. Early designs placed bumps across the entire width of the shoulder, which is very uncomfortable for cyclists.

A newer rumble strip design is more bicycle-friendly: 400 mm (16") grooves are cut into the shoulder, 150 mm (6") from the fog line. On a 2.4 m (8 ft) shoulder, this leaves 1.8 m (6 ft) of usable shoulder for bicyclists.

Other Innovative Designs

These concepts are presented as information to arrive at new solutions to common problems.

Bicycle Boulevards

The bicycle boulevard is a refinement of the shared roadway concept: the operation of a local street is modified to function as a through street for bicycles while maintaining local access for automobiles. Traffic calming devices reduce traffic speeds and through trips. Traffic controls limit conflicts between motorists and bicyclists and give priority to through bicycle movement.

Advantages of Bicycle Boulevards:

- Opportunity - traditional street grids offer many miles of local streets that can be converted to bicycle boulevards;
- Low cost - major costs are for traffic control and traffic calming devices;
- Traffic calming techniques are increasingly favored by residents who want slower traffic on neighborhood streets;
- Bicycle travel on local streets is usually compatible with local land uses;
- Bicycle boulevards may attract new or inexperienced cyclists who do not feel comfortable on arterials and prefer to ride on lower traffic streets; and
- Bicycle boulevards can improve conditions for pedestrians, with reduced traffic and improved crossings.

Disadvantages of Bicycle Boulevards:

- They are often located on streets that do not provide direct access to commercial land uses and other destinations; some cyclists may have to negotiate a hostile street environment to complete a portion of their trip;
- If improperly implemented, they can cause traffic diversion onto other streets;
- Failure to provide arterial crossings can result in unsafe conditions for bicyclists; and
- Traffic signals may be expensive or unacceptable for the traffic conditions.

Successful bicycle boulevard implementation requires careful planning with residents and businesses to avoid unacceptable impacts.

Elements of a Bicycle Boulevard:

- Selecting a direct and continuous street, rather than a circuitous route that winds through neighborhoods.
- Bike boulevards work best on a street grid system;
- Turning stop signs towards intersecting streets, so bicyclists can ride with few interruptions;
- Placing motor vehicle traffic diverters at key intersections to reduce traffic volumes (the diverters must be designed to allow through bicycle movement);
- Placing traffic-calming devices on streets to lower traffic speeds;
- Placing directional signs to route cyclists to key destinations, to guide cyclists through difficult situations, and to alert motorists of the presence of bicyclists; and

- Providing protection where the boulevard crosses high-volume arterials with:
    1. Signals, where a traffic study has shown that a signal will be safe and effective; to ensure that bicyclists can activate the signal, signal loops should be installed where bicyclists ride, supplemented with a push button that won't require dismounting; or
    2. Median refuges, with gaps wide enough to allow bicyclists to pass through (min. 2.4 m [8 ft]); the median should be wide enough to provide a refuge (min. 3 m [10 ft]). The design should allow bicyclists to see the travel lanes they must cross.

Raised Bike Lanes

Normally, bike lanes are an integral portion of the roadway surface and are delineated from motor vehicle lanes with painted stripes. Though most bicyclists ride on these facilities with comfort, others prefer more positive separation, but separated paths are not practical in most urban settings.

Raised bike lanes incorporate the convenience of riding on the street with the psychological separation of a barrier, with these advantages:

- A mountable curb allows cyclists to enter or leave the lane as needed for turning or overtaking;
- Motorists know they are straying from the travel lanes when they feel the slight bump created by the mountable curb; and
- Novice bicyclists are more likely to ride in the bike lane, leaving the sidewalk for pedestrians.

An effective design provides a gentle slope, with no lip, so a bicycle tire is not caught during crossing maneuvers. Using concrete curbs in an asphalt roadway increases the visibility of the bike lane stripe. The raised bike lane is dropped prior to intersections, where the roadway surfacing is uniform.

The disadvantage of raised bike lanes is the greater costs of construction: the travel lanes and bike lanes must be paved separately and a narrow paving machine is required for paving the bike lane.

The additional costs are mitigated by reduced long-term maintenance costs:

- The bike lane portion receives less wear and tear than the travel lanes;
- The bike lane accumulates less debris, requiring less frequent sweeping; and
- The bike lane stripe doesn't need frequent repainting.

*Note: on roads with parking, the bike lane should be placed between the travel lanes and parked cars, elevating the parking lane.

Contra-Flow Bike Lanes

Contra-flow bike lanes on a one-way street are not usually recommended. They may encourage cyclists to ride against traffic, which is contrary to the rules of the road and a leading cause of bicycle/motor vehicle crashes.

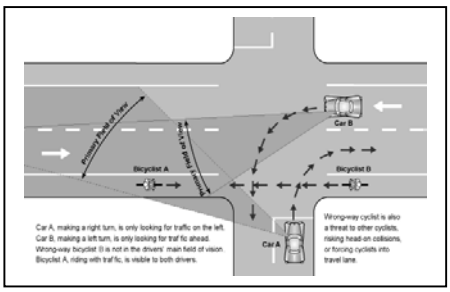
There are, however, special circumstances when this design may be advantageous:

- A contra-flow bike lane provides a substantial savings in out-of-direction travel;
- The contra-flow bike lane provides direct access to high-use destinations;
- Improved safety because of reduced conflicts on the longer route;
- There are few intersecting driveways, alleys or streets on the side of the contra-flow lane;
- Bicyclists can safely and conveniently re-enter the traffic stream at either end of the section;
- A substantial number of cyclists are already using the street; and
- There is sufficient street width to accommodate a bike lane.

A contra-flow bike lane may also be appropriate on a one-way residential street recently converted from a two-way street (especially where this change was made to calm traffic).

For a contra-flow bike lane to function well, these special features should be incorporated into the design:

- The contra-flow bike lane must be placed on the right side of the street (to motorists' left) and must be separated from on-coming traffic by a double yellow line. This indicates that the bicyclists are riding on the street legally, in a dedicated travel lane.
- Any intersecting alleys, major driveways and streets must have signs indicating to motorists that they should expect two-way bicycle traffic.
- Existing traffic signals should be fitted with special signals for bicyclists; this can be achieved with either loop detectors or push-buttons (these should be easily reached by bicyclists without having to dismount).



*NOTE: Under no circumstances should a contra-flow bike lane be installed on a two-way street, even where the travel lanes are separated with a raised median.

Diagonal Parking

Diagonal parking causes conflicts with bicycle travel as drivers backing out have poor visibility of oncoming cyclists and parked vehicles obscure other vehicles backing out. These factors require cyclists to ride close to the center of a travel lane, which is intimidating to inexperienced riders.

Where possible on one-way streets, diagonal parking should be limited to the left side, even if the street has no bike lane; on one-way streets with bike lanes, the bike lane should placed adjacent to parallel parking (preferably on the right).

Bike lanes are not usually placed next to diagonal parking. However, should diagonal parking be required on a street planned for bike lanes, the following recommendations can help decrease potential conflicts:

- The parking bays must be long enough to accommodate most vehicles;
- A 200 mm (8") stripe should separate the parking area from the bike lane; and
- Enforcement may be needed to cite or remove vehicles encroaching on the bike lane.

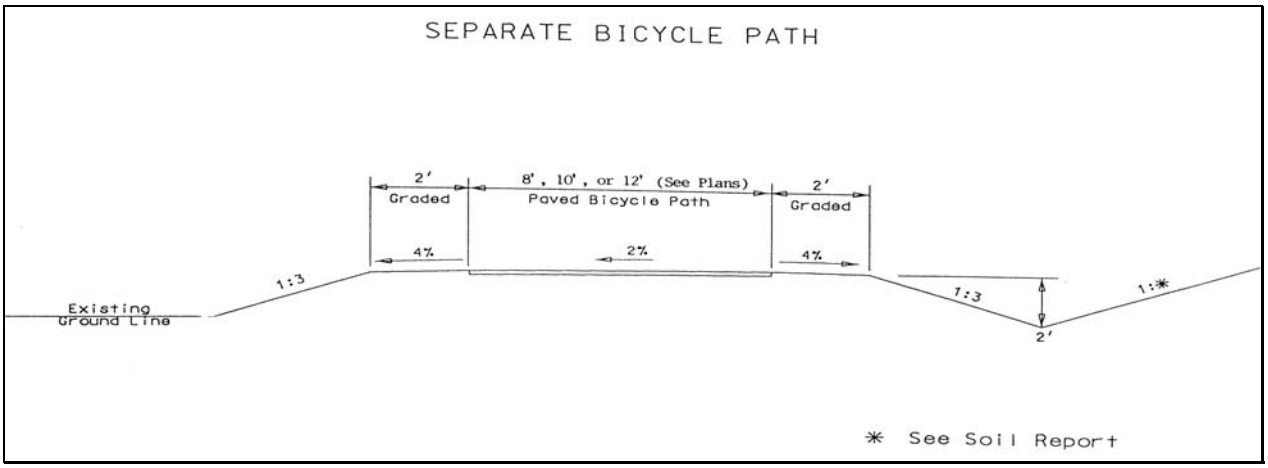
Bike Lanes & Bus Lanes

In most instances, bicycles and buses can share the available road space. On routes heavily traveled by both bicyclists and buses, separation can reduce conflicts (stopped buses hinder bicycle movement and slower moving bicycles hinder moving buses).

Separate bus lanes and bike lanes should be considered, with the bus lane at the curbside, to reduces conflicts between passengers and bicyclists. Buses will be passing bicyclists on the right, but the fewer merging and turning movements reduce overall conflicts.

SECTION 9 BICYCLE TRAIL/PATH

The typical AASHTO section for the trail is as illustrated below. The facility type would only be applied in green spaces (along or near a parkway system), former railroad right-of-way corridors, and other isolated applications.



Rare exceptions would include only the construction of a trail on one side of a street that was heavily developed, where topographic challenges existed, or where right-of-way availability was severely limited. The criteria under which exceptions or variances are available in this instance should be even more stringently applied before allowing "trail" use in areas other than those described in the preceding paragraph, per the guidance provided earlier in this document. Even in such an isolated case, the safety problems caused by such a deployment are significant and should be strongly discouraged, as the benefits may only slightly outweigh the negatives.

There is certainly no operational conflict between the linkage of a trail system to a more traditional sidewalk and shared roadway facilities, as long as appropriate signage is deployed to inform the user of the transition. In fact, trail systems are ideally used (outside greenspaces, etc.) to link traditional systems to one another, if the extension of traditional facilities is not possible.

The Urban Trail Network

The St. Joseph Metropolitan Area has one of the model trail programs in the Midwest. It is both thorough and comprehensive in its approach. Initial phases sought to develop modal facilities along the Parkway System (a greenway) on a north-south axis, while later phases have focused upon the adaptive re-use of former railway corridors on an east-west axis.

The locations of the trails themselves are consistent with national design guidance for trail deployment in that they have not been constructed in areas with prevalent conflict points involving driveways, intersections, and at-grade crossings. Although the majority of the trail is grade separated, the infrequent street crossings are at-grade, though the most are on low volume streets.

In a major departure from the Urban Trail Masterplan, this document views the relationship of the trail system to varied facility types on streets as important and fundamental. This is an significant point because, lacking such a proviso, one would assume that where a trail system begins it must be contiguous typical section throughout.

However, because of the safety and operational hazards resultant from constructing trails areas other than in greenways, etc.-, discussed several times previously in this document, facilities appropriate to and for the adjacent landuse have to be accommodated. In such a case, a trail would represent a link between different systems, not a replacement for the same.

From a systematic approach, a "link" is a part of the overall network of facilities designed to provide citizens an option of riding one's bike, walking, or driving the automobile. In certain areas that are appropriate for trail or shared path construction, a typical trail section should be constructed that is continuous throughout. It may connect to systems that are more traditional, i.e. streets with sidewalks on both sides, streets with wide lanes, or streets with bike lanes; allowing all users the ability to walk from a home or business to access the facility in front of their location and travel to the closest trail connection, or vise versa. Neighborhoods that lie along the Parkway or former Chicago and Rock Island Railroad are good examples of this concept, making trails an integral part of the whole, but not a replacement for poor planning.

Future Trail Sections

The St. Joseph area has made significant inroads in planning, designing, and constructing components of its trail system. Over the years since the vision of greenway amenities was introduced, many phases of the trail have been designed by the City of St. Joseph and Country Club Village. However, many components of the main north/south axis remain, as well as decisions about where to continue on an east/west basis.

Following is a discussion of segments included in the original vision of the trails masterplan, but not completed at this time:

- Southwest Parkway – 22nd Street South to Mansfield Road: This link, if constructed, would connect completed phases of work that terminate at 22nd Street and begins again at Mansfield Road and extends thence to Hyde Park. This section passes through a very picturesque section of the Parkway System, but is plagued with severe topographic challenges that would not be cost-effective to overcome. In addition, cultural resource restrictions would make it less than desirable to pursue. Fig. 5.2

  Instead, alternative linkage methods should be pursued over time to enhance the sharing of this section of the parkway for walkers and bikers. This would likely incorporate lane widening or the construction of shoulders where possible. Signage urging drivers to "share the road" should be erected in the short term as an educational/safety awareness effort.

- Northeast Parkway: This is a segment of trail that would reinforce existing walking patterns evident from a circle traveled along Ashland, down the Corby section of the trail, and back to Northeast Parkway. The topographic challenges are significant, but can be overcome. Linkages are more moderate than other possible routes.
- Chicago and Northwestern Corridor – Maple Leaf Parkway to Northside Complex/Northwest Parkway Trail: Although the ownership of this corridor is still within the hands of the Union Pacific, the segment is fairly attractive. It provides linkages of neighborhoods along St. Joseph Avenue to connections with the trail itself and recreational facilities near Krug Park. The grade is generally flat and even, with few obstructions. The St. Joseph Parks Department already maintains a significant portion of the same as it lies near the parkway system and enhances it as additional greenway space.

- Chicago and Northwestern Corridor – Northside Complex to County Line Road: This segment would be a continuation of the previous segment. Right of way is a greater challenge because the corridor was abandoned and property would have to be obtained from numerous property owners. It is attractive because it would link neighborhoods to the north that are functionally disconnected from the bicycle/pedestrian network and provides an important connection to Country Club Village's section of trail along the same corridor that begins at County Line Road.

- Chicago and Northwestern Corridor – John Glenn Road to Savannah: This segment would represent a series of phases in Andrew County that would connect to the north end of the first phase of Country Club Village's system and extend to Savannah. As the route itself is principally rural in nature, it is recommended that this corridor be initially developed to a standard similar to that of the Katey Trail. The Katey Trail utilizes an aggregate surface that is suitable for walking in localized areas, but recognizes that the intensity of use is less than that of similar trails within urban areas. With less intense use, and a corresponding focus upon bicycles, an aggregate surface would be appropriate.

  As land-use along the trail transitions from rural to more urban uses, existing segments of the trail should be upgraded to a more permanent surface such as asphalt or concrete. However, constructing an urban section at this time, in this area, would not be a prudent expenditure of funds.

- Riverfront – Blacksnake Creek south to Lake Contrary/U.S. 59 Highway: Although a corridor that would be difficult to maneuver, obvious connections from the Riverfront Trail (Blacksnake Creek north to Broadway) and from the Lake Contrary area are attractive anchors. Additionally, opening up large sections of the Missouri River viewshed for a public use is reason enough for development of a trail section through this general alignment.

- U.S. 59 Highway – City limits to Rt. 45 & Amelia Earhart Bridge over the Missouri River: This segment falls largely outside the metropolitan area, but warrants strategic inclusion because of plans moving forward in Platte County and Atchison, Kansas, and their possible connection to planning initiatives proposed and underway in the St. Joseph MPO. Specifically, Platte County will be coordinating with the Missouri Department of Transportation (MoDot) in the future to add or widen shoulders on Route 45 to the Platte County line. Interestingly, this would terminate very near Lewis & Clark (Sugar) Lake.

  On the Kansas side, the Kansas Department of Transportation (K-Dot) is coordinating with MoDot to replace the existing bridge on U.S. 59 over the Missouri River. Depending upon the final location chosen, it is possible that MoDot will have to reconstruct U.S. 59, from Route 45 to the new bridge. As a component of that work, wide shoulders could easily be constructed that would accommodate bikers, as long as accommodations are made on the bridge structure itself.

  Technically, this specific corridor should probably not be listed in the "trail" category, as many of the connections could be easily designed and included as a component of the roadway typical section. However, Buchanan County may want to consider construction of a traditional trail along the abandoned railroad right-of-way that is located on the west side of U.S. 59, from Route 45 to the north.

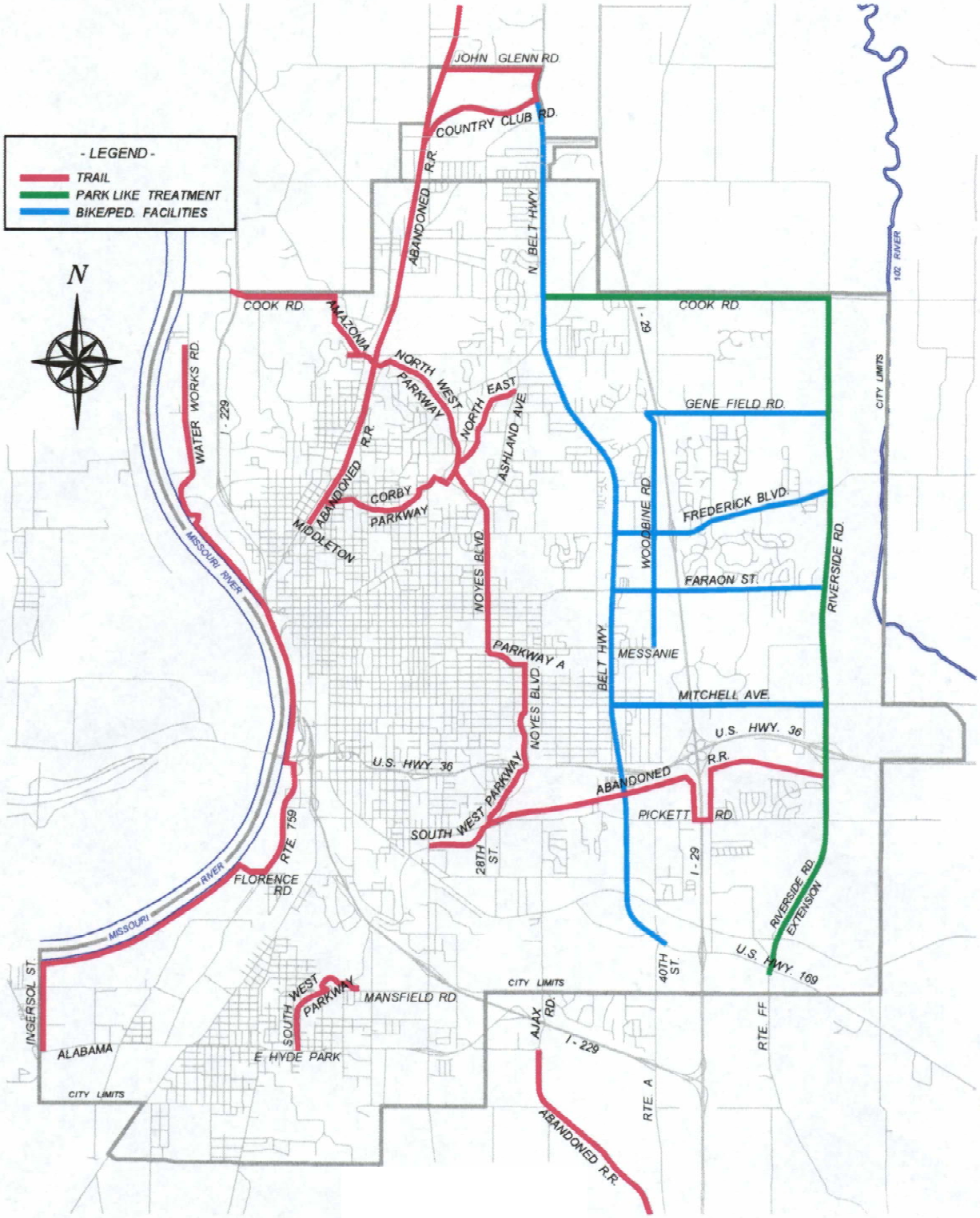
Ideally, this would connect Sugar Lake to Platte County's work along Route 45, as well as on-road facilities constructed on the new section of U.S. 59 west from Route 45 to Atchison. Because of the combination of facilities types, this section will is being discussed in this section of the document, but will likewise be illustrated as a combination of possible facilities. Such a combination would represent the ideal mix of trails functioning in a supportive way to adjacent facilities. The surface of a possible trail section in this area would be aggregate.

- Metropolitan Area Connectors – Railroad corridors: There are several abandoned former railroad corridors leading from the St. Joseph metropolitan to the Kansas City metropolitan area. By name would be included the former Chicago and Rock Island Corridor and the former Inter-Urban corridor.

Corridors of this type represent major opportunities for interconnection between large population centers, but because they tend to cross multiple jurisdictional boundaries, it is difficult for a single local entity to step forward as the lead and have a reasonable opportunity for success.

Regional corridor preservation may appropriately represent an unfilled role for a state government, such as the Missouri Department of Transportation or the Missouri Department of Natural Resources. Certainly, it is clear that larger initiatives such as inter-metropolitan connections represent an issue of state-wide interest that may justify state agency involvement.

ST. JOSEPH AREA
BICYCLE AND PEDESTRIAN MASTERPLAN



SECTION 10 SUMMARY

Good design does more than provide a facility for people already bicycling or walking, it encourages greater use of non-motorized transportation. Examples of facilities that encourage use are:

Bike lanes: By providing cyclists with their own space on the road, bike lanes improve access to destinations and commute options. Bike lanes on arterials:

- Establish the correct position of bicyclists on the roadway;
- Reduce bicycle/pedestrian conflicts as fewer cyclists ride on sidewalks;
- Provide bicyclists a space to travel at their own speed next to motorists;
- Guide bicyclists through intersections;
- Allow bicyclists to pass motor vehicles backed up at intersections (a bike lane is a legal travel lane); and
- Send a message to motorists that bicyclists have a right to the roadway.

Planting Strips: Sidewalks separated from the roadway with a planting strip create a pleasant environment for pedestrians. Besides creating a buffer from the noise and splash of moving vehicles, planting strips provide:

- Room for street furniture such as signs, utility and signal poles, mailboxes, parking meters, fire hydrants, etc.;
- An opportunity for aesthetic enhancements such as landscaping and shade-producing trees, increasing the appeal of a roadway and pedestrians' sense of comfort; and
- A better environment for wheelchair users, as sidewalks can be kept at a constant grade without dipping at every driveway.

Bicyclists & Pedestrians: Similarities & Differences

Many early bikeway designs assumed that bicyclists resemble pedestrians in their behavior. This led to undesirable situations: bicyclists are under-served by inadequate facilities, pedestrians resent bicyclists in their space, and motorists are confused by bicyclists entering and leaving the traffic stream in unpredictable ways.

Only under special circumstances should designs allow bicyclists and pedestrians to share the same space, e.g. on multi-use paths.

The modes are similar in three ways:

- Location: Bicycle and pedestrian facilities, though separate from each other, are found at the roadway edge and often allocated insufficient space for their needs. This puts them close to the right-of-way line and in conflict with other demands such as parking, utility poles and signs. This creates competition for this valuable space.
- Exposure: Pedestrians and bicyclists are exposed to the elements and are more vulnerable than motorists.
- Behavior: Pedestrians and bicyclists can be of any age and no license is required. Their actions and reactions change with age and are sometimes unpredictable.

Bicyclist Behavior

Bicycle riders are legitimate road users. They are, however, slower, less visible and more vulnerable than motorists. They need special treatment on busy, high-speed roads and at complex intersections. In congested urban areas, bicyclists can often proceed faster than motorists if well designed facilities are provided.

Bicyclists have certain unique characteristics: they are operating vehicles, yet they are exposed to the elements and use their own power; they don't like to interrupt their momentum; they are vulnerable in crashes; they must constantly maintain their balance; and they can interact socially with other bicyclists and pedestrians.

Well-designed bicycle facilities guide cyclists of various skill levels to ride on the roadway in a safe manner that conforms to the vehicle code. This is in the same direction as traffic, usually in a position 1 to 1.2 m (3 to 4 ft) from the edge of the roadway or parked cars, to avoid debris,
drainage grates and other potential hazards. Bikeways should allow cyclists to proceed through intersections in a manner that is as direct, predictable and safe as possible.

Pedestrian Behavior

Pedestrians prefer greater separation from traffic and are slower than bicyclists. They need extra time for crossing roadways, special consideration at intersections and traffic signals, and other improvements to enhance the walking environment.

Pedestrians are the most vulnerable of roadway users, as they are exposed to the weather and are often not visible to motorists. They are also the least tolerant of out-of-direction travel, and will often take short cuts where there is no convenient or direct facility. Pedestrian facilities must be designed to meet or exceed the requirements of the ADAAG.

Some design details are important for their contribution to safety (e.g. pedestrian signals and illumination), some because they make walking more convenient (e.g. paths that provide short-cuts), and others because they make the walking experience more pleasant and minimize the sensory impact of adjacent motor vehicles (e.g. planting strips).

Standard Bikeway & Walkway Design

To establish primary design practices, this document has adopted by reference the American Association of State Highway and Transportation Officials' (AASHTO) standards. Most related highway design standards are contained in the "Highway Design Manual," . AASHTO also publishes the "Guide for the Development of Bicycle Facilities." However, the standards hierarchy outlined on page 14, section 4 shall prevail in all cases.

This document has set forth several design standards, most notably for intersections, that are not covered by AASHTO.

Traffic control devices must conform to the "Manual on Uniform Traffic Control Devices" (MUTCD). All bikeway signing and striping plans should be reviewed by the appropriate staff designee for each jurisdiction.

Standards & Minimums

Standards are developed to create conditions for users that are safe and comfortable under optimum conditions. Whenever possible and appropriate, facilities should be built to standard.

There are situations where a standard cannot be maintained due to geometric, environmental or other constraints, or may not be appropriate, due to the nature of the surroundings or users. In these circumstances, a design using dimensions less than the standard may be acceptable; however, a facility should not be built to less than minimum standards.

There is always a range between the standard and the minimum, so intermediate values may be used. For example, the standard width for a sidewalk in a commercial area is 8 feet, with a minimum of 6 feet; sidewalks may also be 7 feet or 6 ½ feet wide, depending on circumstances.

Other Innovative Designs

There are many innovative designs that facilitate bicycling and walking that are not yet found in existing design manuals. Some designs enhance the roadway environment for bicyclists and pedestrians, such as contra-flow bike lanes, while others lessen the negative impacts of designs aimed at improving motor-vehicle flow, such as dual right-turn lanes.

As the state of the practice is evolving in these areas, new and innovative design alternatives are encouraged for evaluation and deployment. However, the term "innovative designs" shall not be defined as a deviation from the philosophical direction set forth in this document that focuses upon coordinated design principles for all modes of transportation.

Design Quick Reference Guide

General Roadway Improvements

Drainage Grates	Do not use parallel-bar grate Advance pavement marking	
Clearance Interval	Bicycle speed of 10 MPH with 2.5 sec. Braking time	
Signage	2' minimum–12' maximum	Lateral placement
	5' minimum	Height

Sidewalks

Width	5' minimum (standard) 8' maximum	Local & Collector in Residential Zone
Width	5' minimum 6' standard 12' maximum	Collectors in Retail Zone*
Width	6' minimum 8' standard 12' maximum	Arterials in Residential & Retail Zone*
Width Exemption	4' if 60" turnaround every 200' or less – 2% maximum cross-slope	Residential Zone on Local Street Only
Cross-Slope	1.5% standard 2% maximum	
Planter Strips	4' minimum 6' standard 14' maximum	Space available from back of curb to front edge of walk for landscaping
Vertical Clearance	80" minimum	
Passing space	60" x 60" @ 1.5% cross-slope	
Changes in level	.25" maximum	Vertical Deviation
	50% maximum bevel	Changes between .25" & .50"
	Changes over .50"	Ramp Required
Shy Distance	24"	

*See text for variables effecting pavement width.

Designated Bicycle Routes

General Signing	"Bike Route" signs	Don't over proliferate on system

Shared Roadways

Right Lane Width	12' minimum (local only)* 14' standard	

	16’ maximum	
Curb & Gutter.....	Counted in usable lane width measured from front face of curb	
Deployment Factors	12,000 ADT or less 35 MPH or less	
Functional Classes..... * Residential Zone only	Local – Collector	

Bike Lanes

Lane Width.....	4’ minimum 5’ standard 6’ maximum	
Facility Type (urban).....	With Curb & Gutter section With on-street parking..... With shoulder	See typical sections
Facility Type (rural)	4’ minimum 6’ standard..... 8’ maximum	Adjacent to Travel Way & Bike Lane on Shoulder
Functional Classes	Collector – Arterial	See text for striping

Shared Use Paths (Trails)

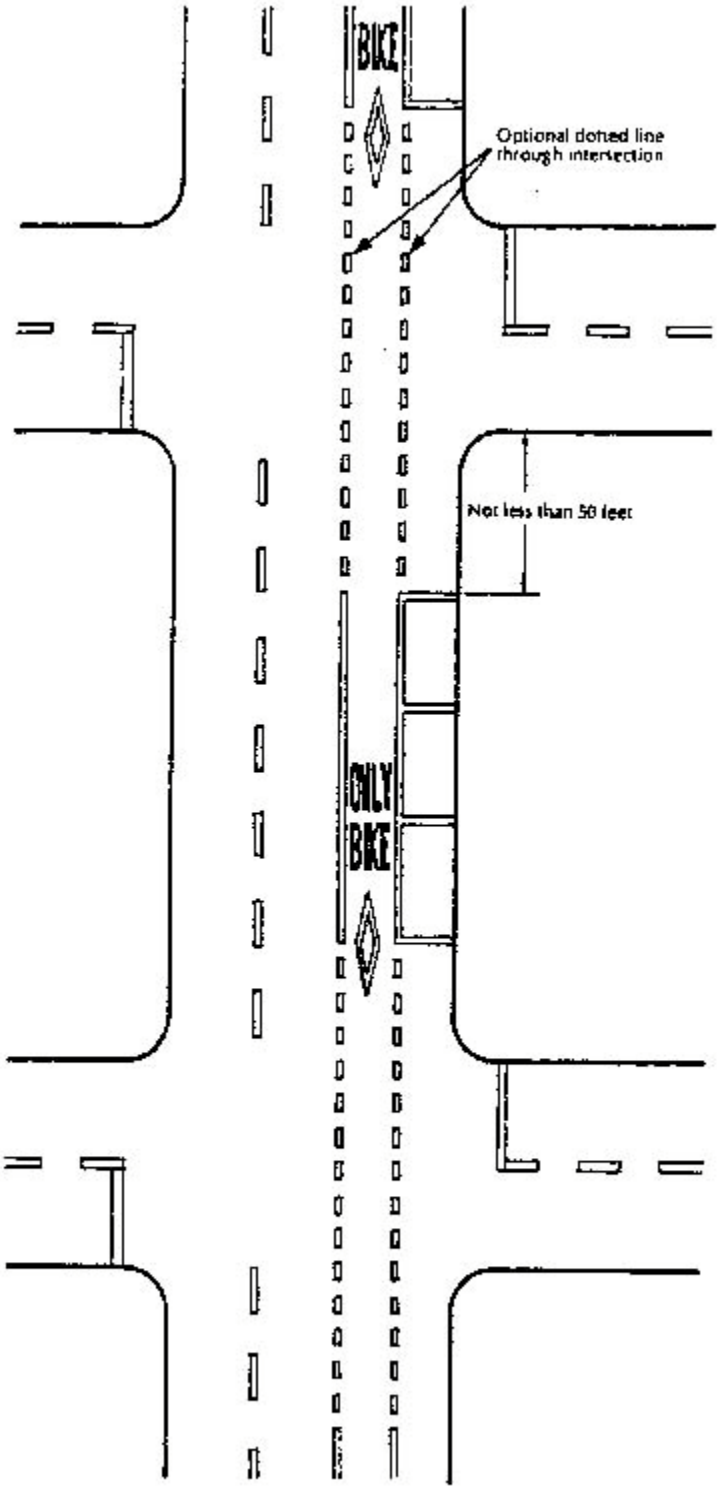
Width.....	8’ minimum 10’ standard 12’ maximum	
Clearances	2’ minimum..... 3’ minimum..... 8’ minimum – 10’ standard.....	Graded Shoulder Area From trees, poles, etc.--- Vertical Clearance
Grades.....	5% maximum (standard)..... 2% minimum (standard).....	Longitudinal Grade Cross-Slope
Grade Variations	5-6%..... 7%..... 8%..... 9%..... 10%..... 11%.....	For up to 800’ For up to 400’ For up to 300’ For up to 200’ For up to 100’ For up to 50’
Design Speed.....	20 MPH minimum (standard) ..... 30 MPH if grade >4%.....	100-200 ADT >300 ADT
Curves.....	95’ minimum..... 260’ ..... 2% minimum – 5% maximum	Radius @ 25 MPH Radius @ 30 MPH Superelevation
Lighting	.5 – 2 footcandles	

Railings.....	4.5’ high – attach at height of 3.5’	With smooth rub rails
Loadings.....	10,000 – 12,000 lbs.	Design load
Clear Width	Same as approach width + 2’ each side	
Fore Slope	1:3	

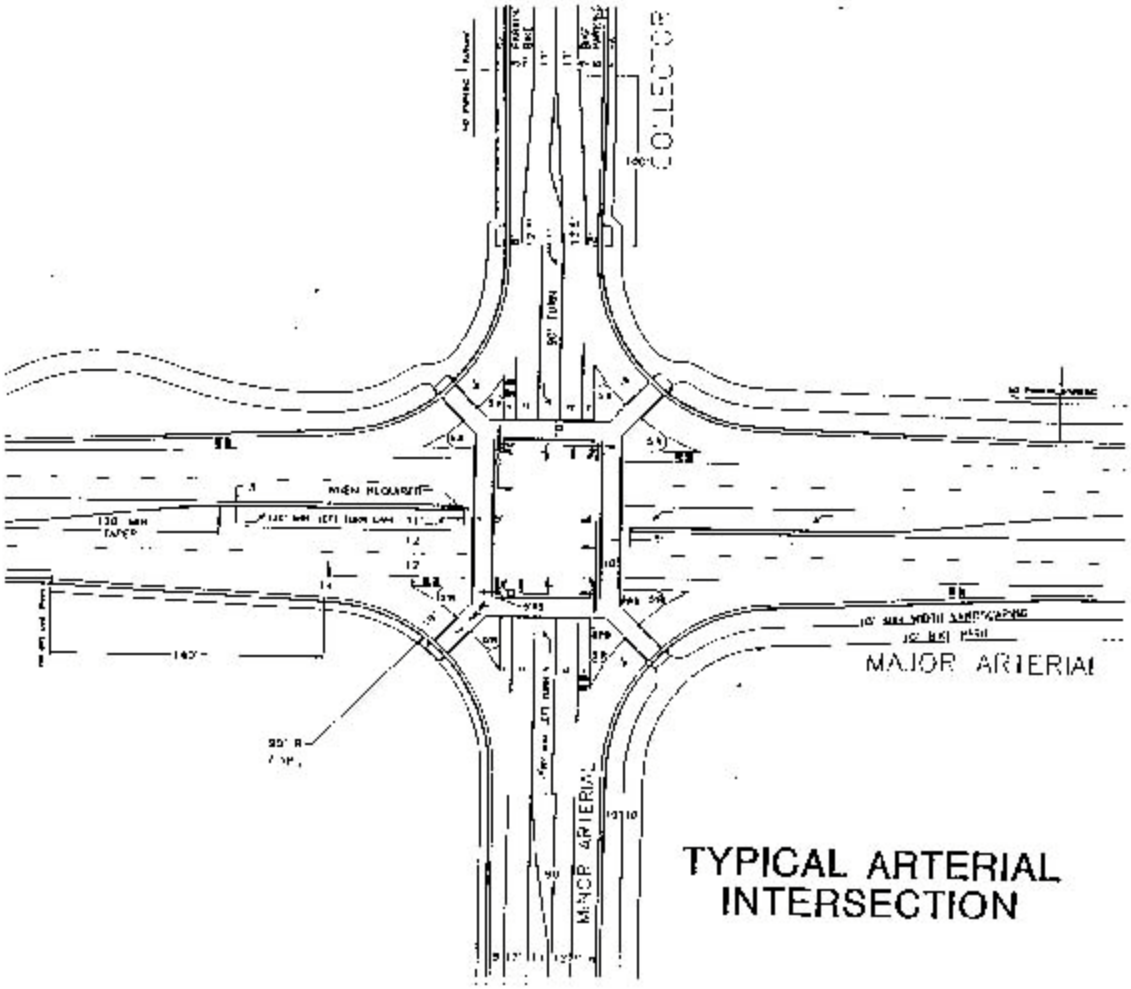
Pavement Markings & Signage (Regulatory)

Crosswalk markings	Use diagonal or longitudinal lines for added visibility	
Signalized crossings	100+ per 4-hour period	Minimum Pedestrian volume
	190+ per 1-hour period	Variation on above minimum
Vehicular warning signs.....	750’ before crossing.....	Bike Xing signs – rural
	250’ before crossing.....	Bike Xing signs – urban
Entrance Bollards	5’ minimum between posts	Entrance bollards
	5’ minimum path width.....	Split Path
Center striping gap ratio	4” yellow line, as needed	Shared path markings
	3’ line with 9’ gap	Shared path markings
User separation striping.....	4” white line.....	Shared path markings
Symbols/Word messages.....	Per MUTCD guidelines.....	Longitudinal placement
Regulatory signs.....	Per MUTCD guidelines.....	Longitudinal placement
Hazard warning signs.....	50’ minimum before hazard.....	Longitudinal placement
RR Xing signs	315’ before RR Xing.....	Longitudinal placement

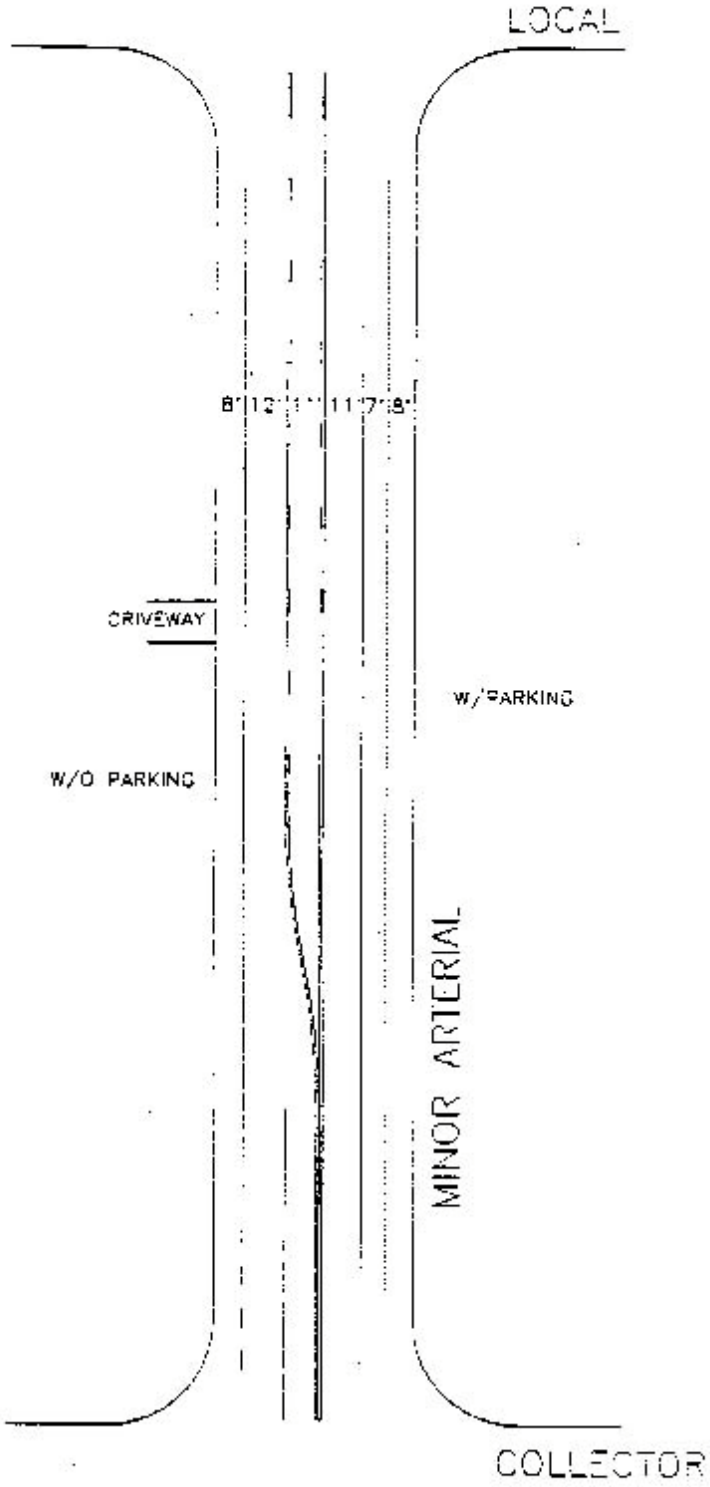
Summary Design Sections
&
Signage Variations



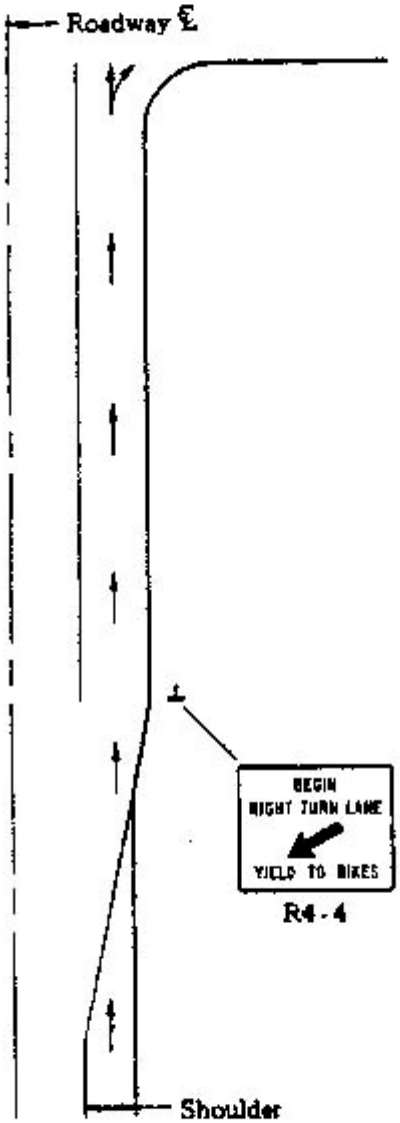
TYPICAL PAVEMENT MARKINGS - DESIGNATED BICYCLE LANE, TWO-WAY TRAFFIC WITH PARKING AND LOW RIGHT-TURN VOLUME



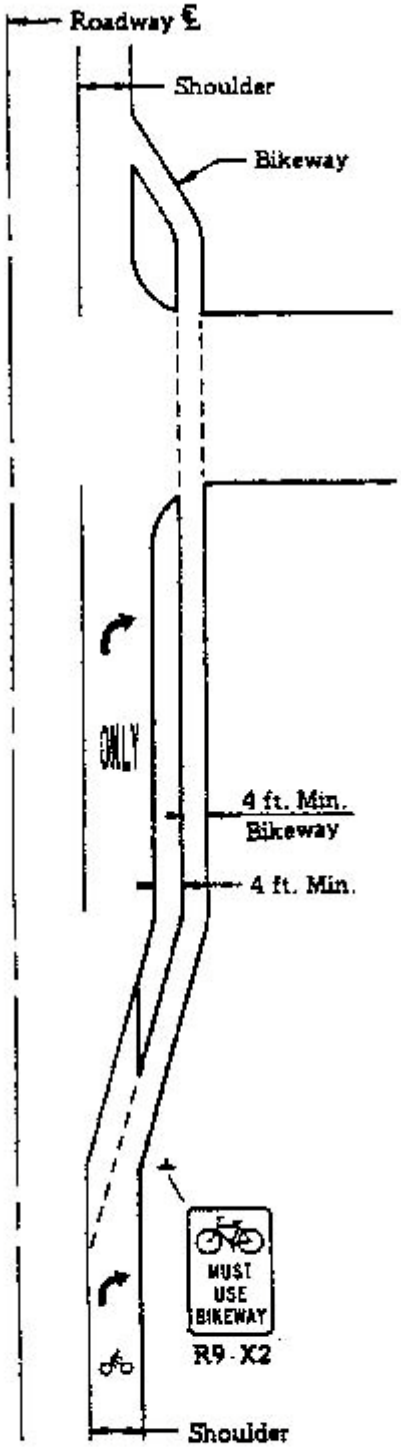
TYPICAL ARTERIAL INTERSECTION



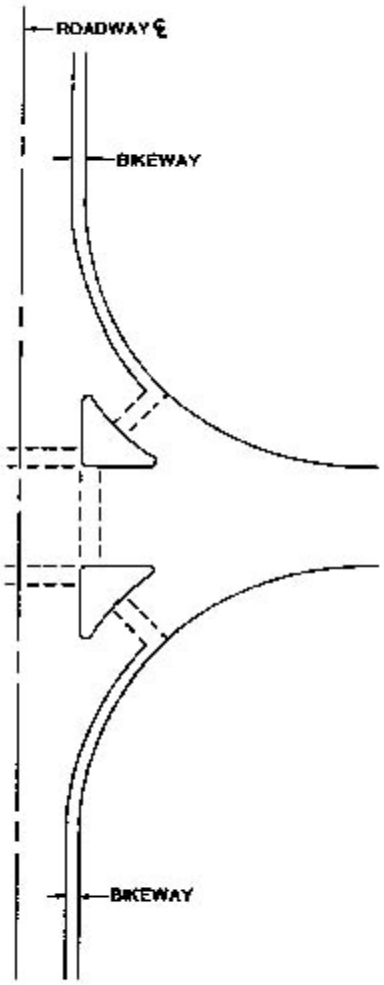
MINOR ARTERIAL
BIKE LANES AND TWO
WAY LEFT TURN LANE



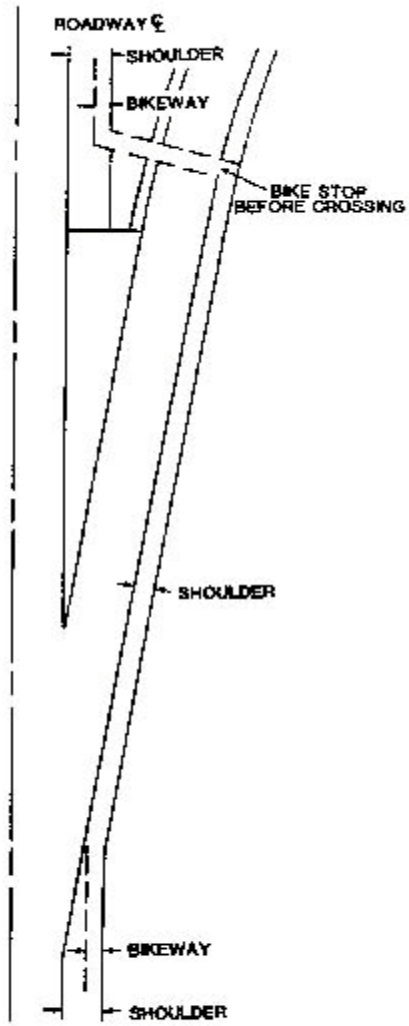
LOW VOLUME RIGHT TURN LANE



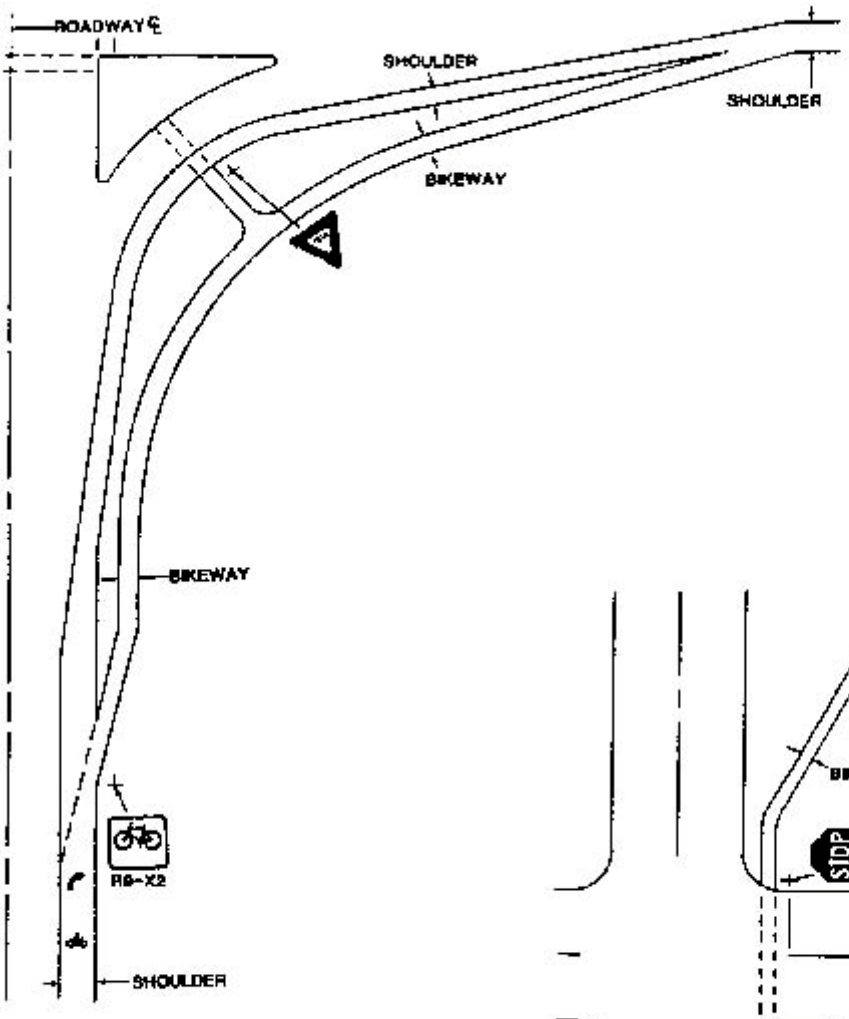
HIGH VOLUME RIGHT TURN LANE



LOW SPEED – LOW VOLUME TREATMENT

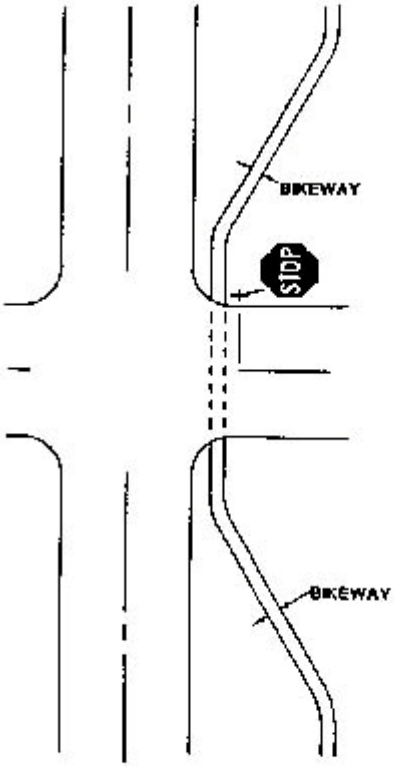


HIGH SPEED – LOW VOLUME BIKEWAY TREATMENT

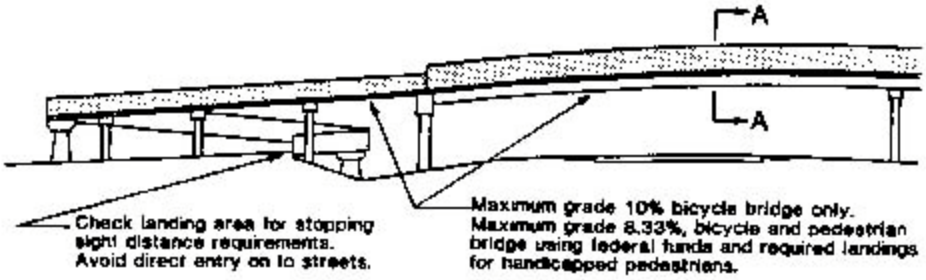


HIGH SPEED – HIGH VOLUME
ON ROAD TO OFF ROAD TREATMENT

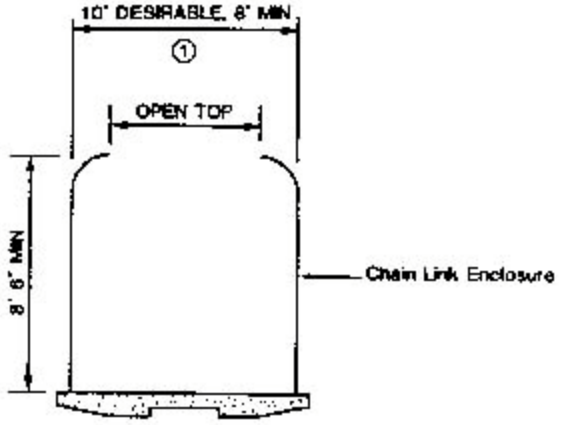
Figure 12



OFFSET BIKEWAYS
INTERSECTION TREATMENT



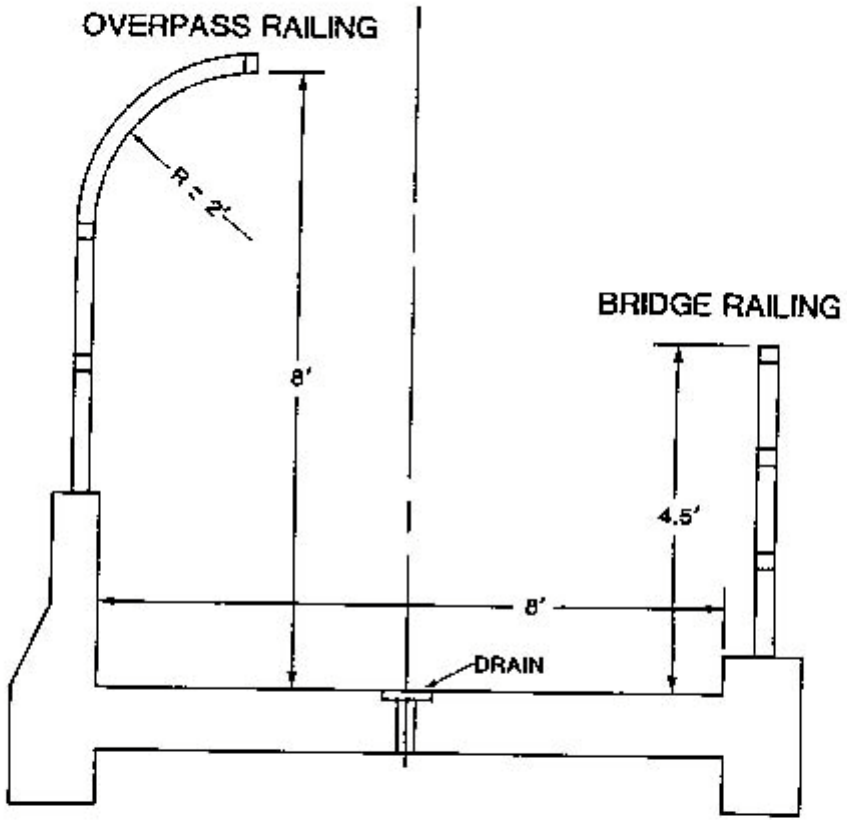
HALF ELEVATION



SECTION A–A

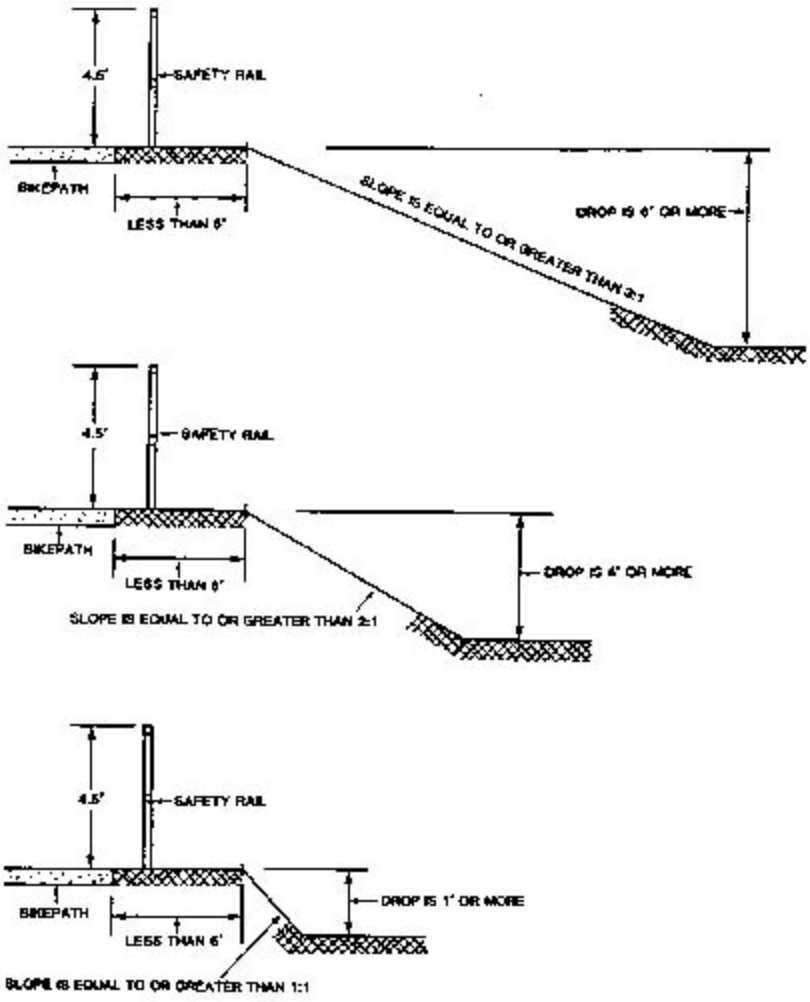
1 In areas where it is not economically feasable to separate the pedestrian and bicyclists on the bridge, it is recommended that an 8 foot minimum clear zone be utilized for a width. In areas where more than occasional encounters between groups of pedestrians and cyclists can be anticipated, provision of facilities wider than the above minimum is desirable.

SEPARATE BIKEWAY BRIDGE

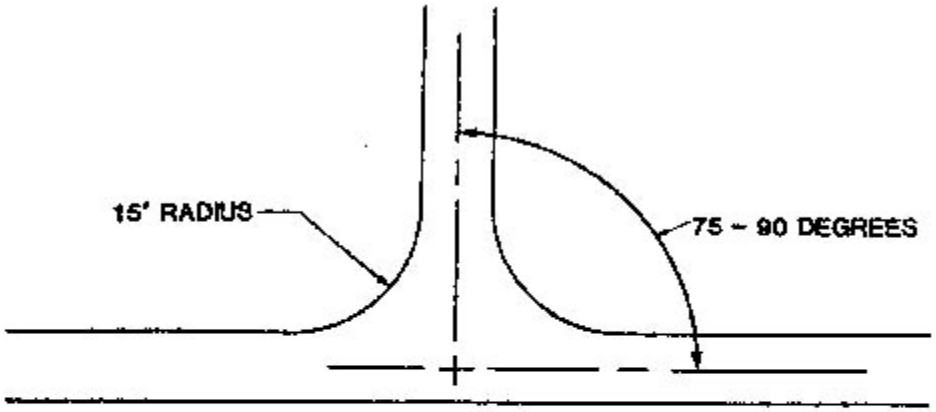


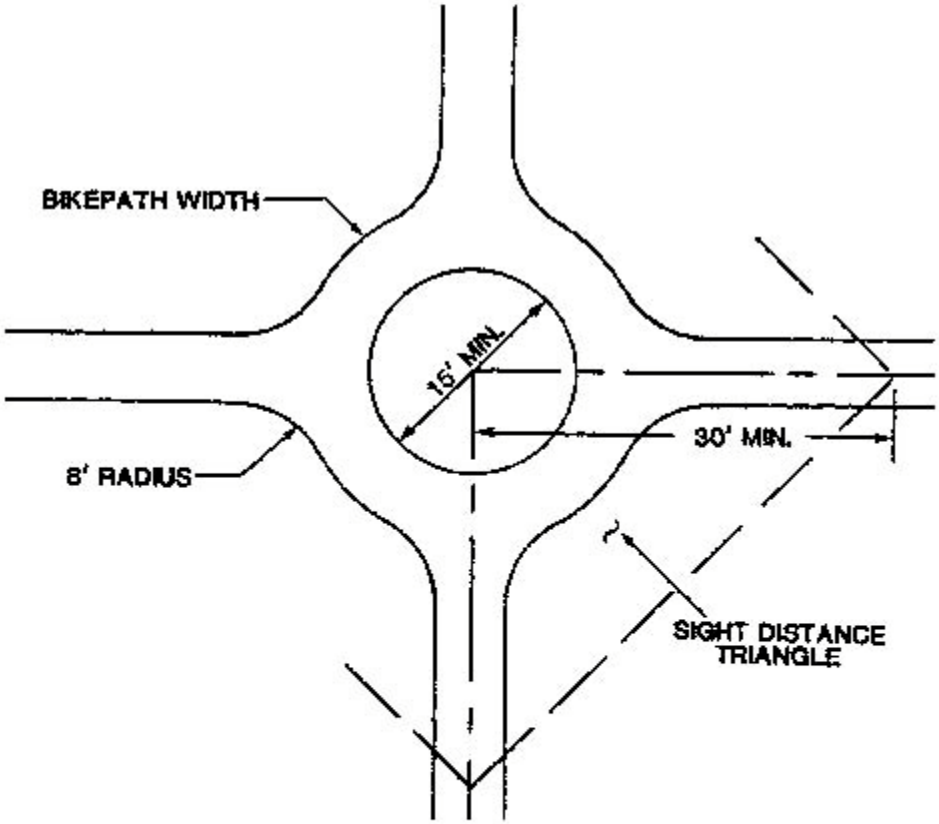
BIKEPATH OVERPASS OR BRIDGE

BIKEPATH SAFETY RAILS ALONG SIDE SLOPES

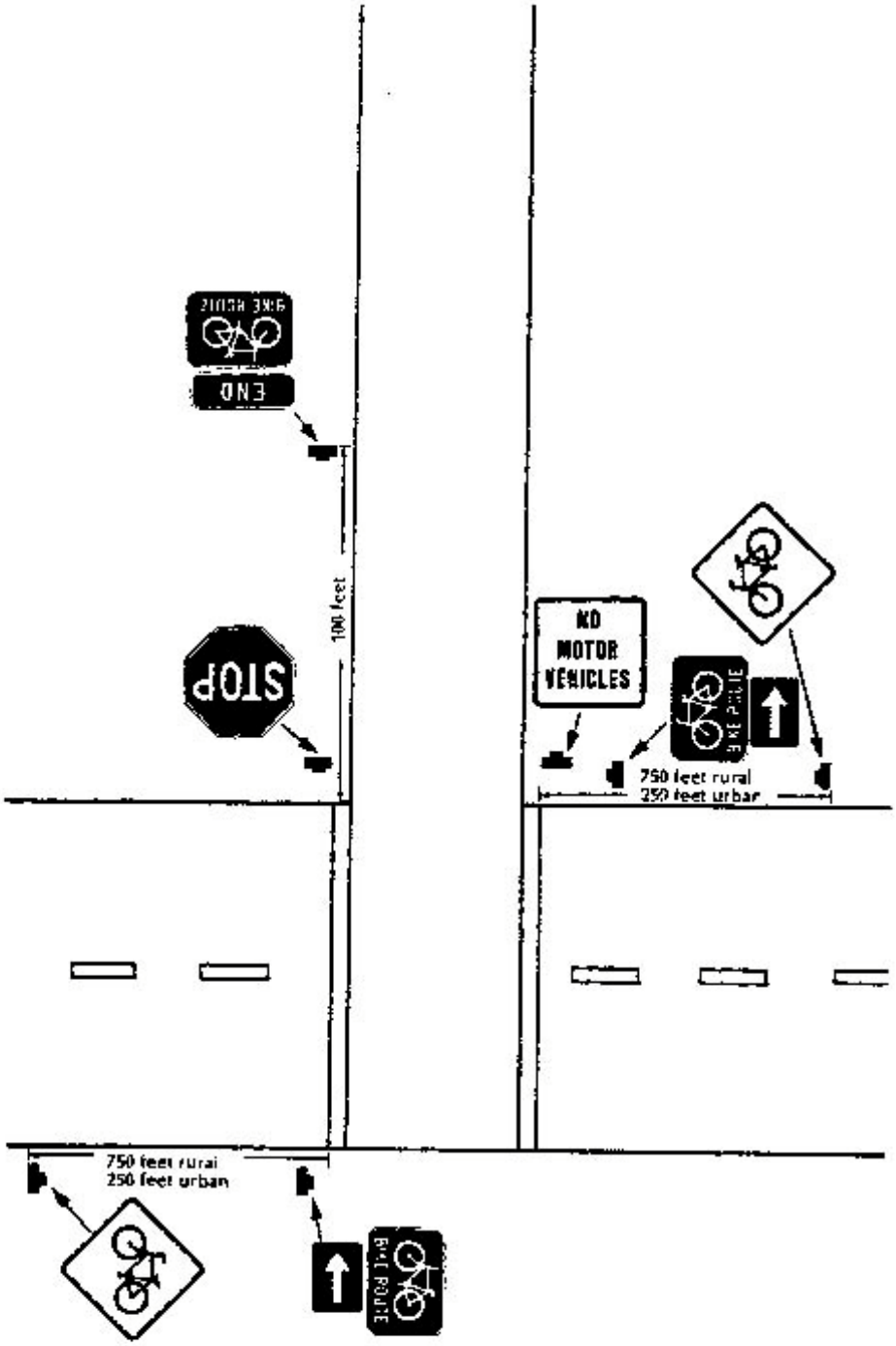


SAFETY RAIL IS NEEDED WHERE THE CONDITIONS
WILL EXCEED THE ABOVE DEPICTED LIMITS



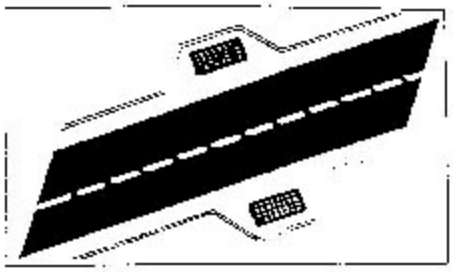


BIKEPATH INTERSECTIONS



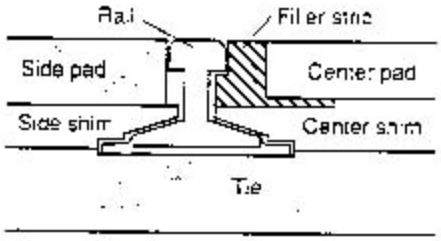
TYPICAL SIGNING FOR BEGINNING AND ENDING OF BICYCLE TRAIL

Bike Compatible Drainage Grate Placement



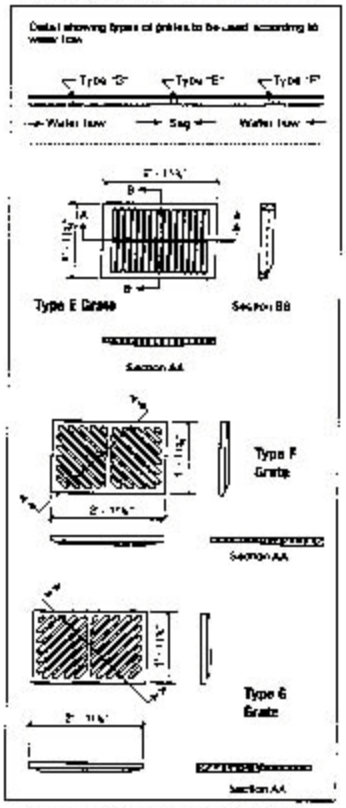
Source: NEW JERSEY BICYCLE COMPATIBLE ROADWAYS

Cross-Section of Rubberized Railroad Crossing with Flangeway Filler Strip; for Low-Speed Angle Crossings



Source: NORTH CAROLINA PLANNING AND DESIGN GUIDELINES

. Bicycle-Safe Drainage Grates Approved by NCDOT



Source: NORTH CAROLINA PLANNING AND DESIGN GUIDELINES

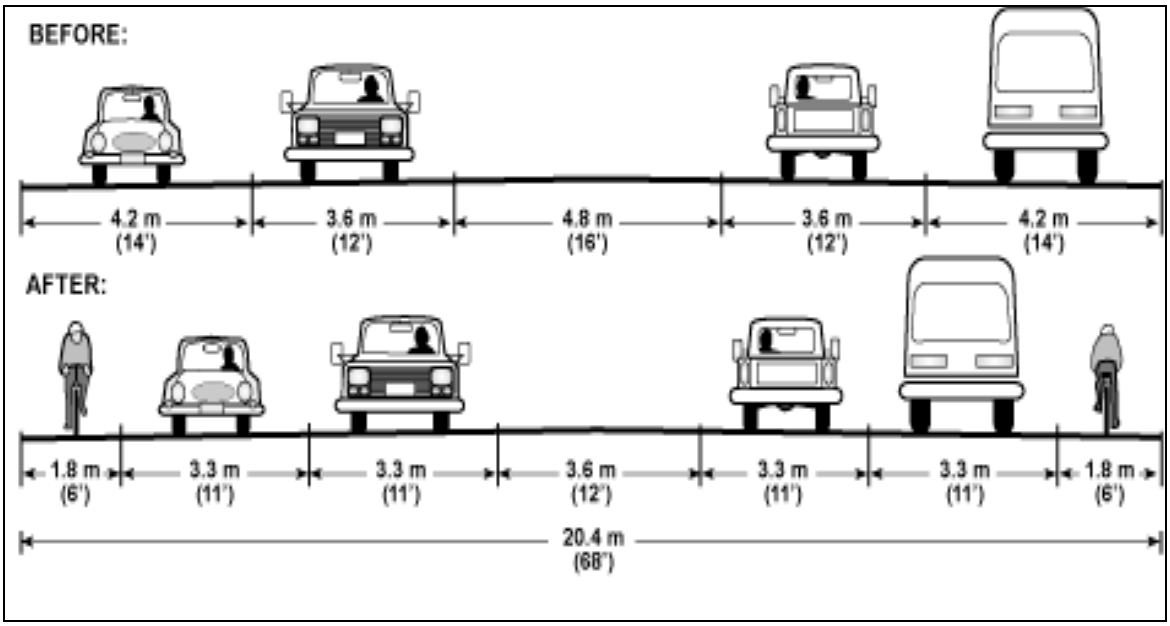
Urban Lane Design Widths

The lane widths depicted in this graphic in the "before" category are consistent with the typical AASHTO standard. AASHTO is a design approach that is geared more toward the rural climate or interstate system where the adjacent

land uses and other modal accommodations are not common. In the effort to improve safety and increase capacity, at a higher rate of speed than is typical in the urban environment, lane widths are traditionally optimized.

However, the documented and uncontested reality is that wider lane widths in the urban environment encourage greater speed. When this phenomenon is factored with the operational characteristics of the typical urban roadway (i.e. turning movements to and from business/retail centers) safety suffers. Therefore, although it would appear that a wider lane would be more safe than a narrower lane, the fact is that travel speed is lower on a narrow lane and such facilities typically operate at a much more favorable rate of safety.

Certainly, the notion of narrower road lanes is impacted by many factors and can be taken to extremes. Additionally, narrower lanes in all cases is not necessarily the treatment for all facilities, just as wider lane widths are not appropriate in all cases. The point is that applying rural design standards to an urban environment may actually result in enforcing the very operational outcomes a project may be designed to overcome. If the principal goals for facilities in the majority of urban area roadways are safety (for automobiles, cyclists, and pedestrians), capacity, reasonable travel speeds, and efficiency, then design options utilizing approaches other than the rural model should be deployed. The following illustration highlights possible options, before and after, within the same right-of-way width:



Signage Variations
The following sign variations provide guide that are less confusing to the driving public and B&P user, who consistently confuse the modal direction of purpose. Additionally, most MUTCD derived signs are oriented toward the bicycle, which leaves the pedestrian in the lurch. These variations are very successful in solving the related problems of non-specific signage and have been MUTCD approved variations by other States in such applications.

SOURCES

This document relies heavily upon the philosophies and source materials contained within this section:

A Policy on Geometric Design of Highways and Streets, 2001. American Association of State Highway and Transportation Officials (AASHTO).

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Manual on Uniform Traffic Control Devices, 1998. Federal Highway Administration.

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Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas, Transportation Research Board.

Street Design Guidelines for Healthy Neighborhoods, 1999. Center for Livable Communities.

The Planning, Design, Maintenance & Safety of Bikeways and Walkways, 1999. Oregon Department of Transportation.

Urban Trail Masterplan for the City of St. Joseph, 1995. Bucher, Willis & Ratliff.