



Creating Bicycle Transportation Networks: *A Guidebook*

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16. Abstract (Limit: 200 words) This guide presents a practical planning model for bicycle transportation in cities, suburbs and small towns. It focuses on the use of networks of specialized bicycle facilities and bicycle friendly zones to support and promote the use of bicycles for transportation. The potential of using bicycle roadway networks in relationship to land use is discussed in terms of using them to make a civic contribution to the form of the city beyond transportation function. A model classification system for bicycle facilities is presented that is similar to the "functional classification of streets" for motor vehicle roadways. Bicycle Expressways, Bicycle Boulevards and Bicycle Byways are introduced and discussed as specific types of bicycle roadways. Detailed planning parameters are recommended for assembling the different types of bicycle facilities into integrated systems to support bicycle use for utilitarian transportation. Planning guidelines for bicycle friendly zones are presented, along with a step-by-step process that describes how communities can plan for bicycle transportation. Planning and design considerations that are important to the success of a bicycle transportation system are also discussed. These considerations include the needs of cyclists, skill levels, personal safety issues, system legibility and traffic calming techniques. This guidebook is intended for use by professional planners, designers and engineers, neighborhood groups, bicycle advocates and community decision makers.			
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Creating Bicycle Transportation Networks: A Guidebook

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1. Introduction

Sets of streets should be planned and designed to form “mini-systems” that provide a network transportation function for bicycles in any size urban area – large or small.

This guide presents a practical planning model for bicycle transportation in cities, suburbs and small towns. The basic approach used in the model recognizes that interconnected sets of streets form transportation networks, and that localized networks link to form a larger, more powerful network of urban transportation facilities. In other words, *sets of streets should be planned and designed to form “mini-systems” that provide a network transportation function for bicycles in any size urban area — large or small.*

The planning model presented here emphasizes *scale* in the urban setting. A characteristic of communities is that the physical environment is composed of things that are different sizes — that is, “of different scales.” This influences the way in which the parts of urban transportation networks are planned and designed. Scale should always be considered in every phase of any planning, design and engineering endeavor.

Another focus of the model is *the contribution of roadway systems to cities and communities*. Two general areas of contribution are outlined. *The civic contribution* focuses on how transportation systems can positively impact cities, by effecting their structure and their form. *The transportation contribution* provides a community service with networks of roadways that allow people to travel about the community, beyond their immediate homeground.

This guidebook uses the terms “urban” and “city” in a generic sense, *without* a connotation of community size. This means the information it contains is fully applicable to smaller towns and suburbs. The terminology of “city” and “urban” are used to express a broad notion of any kind of community with a sufficient density of land use and population to foster the gathering of people in a general area of community.¹

The guide focuses on “utilitarian” bicycle transportation as opposed to recreational bicycle systems. A utilitarian bicycle trip is any trip that is made for purposes other than the enjoyment of the trip itself. For example, a bicycle trip to the movies is a utilitarian trip, even though the purpose of the trip is the enjoyment of the film. In contrast, a recreational trip is a trip for the purpose of enjoying the scenery, the physical exercise, or the weather while cycling. Utilitarian trips comprise most of the travel today, regardless of the mode of transportation.²

The approach to envisioning, planning and designing networks of urban bicycle roadways presented in this book was developed at The Landscape Studies Center of The Department of Landscape Architecture at the University of Minnesota with research funding from the Center for Transportation Studies and the Minnesota Department of Transportation.

This guidebook intended for use by professional planners, designers and engineers, neighborhood groups, bicycle advocates and community decision makers. It is organized as follows:

- **Chapter 2 describes the power of bicycle roadway networks to improve the shape of cities.** The potential of using urban bicycle roadway networks in relationship to land use is discussed in terms of using them to make a civic contribution to the city beyond simply transportation function.
- **Chapter 3 describes the structure and characteristics of the bicycle facilities.** It introduces the types of bicycle roadways and how they work, including their relationship to motor vehicles, transit and other transportation modes. It includes details of the parameters that should be used to establish networks of bicycle facilities in bicycle friendly zones.
- **Chapter 4 describes how communities can plan for bicycle transportation.** This chapter provides a step-by-step planning process, but discusses other pertinent topics. These topics include community transportation policy, community involvement and effectiveness in fulfilling the requirements and the spirit of national transportation policy as articulated in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).
- **Chapter 5 describes planning and design considerations that are important to the success of a bicycle system.** They are provided to help inform the planning, design, implementation decision-making.

Though the guidebook addresses bicycle transportation, many of the topics are pertinent to the planning and design of motorized modes of transportation as well. Specifically, the topics of scale, the context of the urban cityscape, modal priority and the civic contribution of transportation systems apply to all roadway planning efforts, regardless of mode.

2. Transportation & Community: A Broader Picture

Transportation infrastructure can make a powerful and positive contribution to the shaping of civic structure and form

In recent years, the bicycle has received increasing recognition as a viable and realistic transportation option for many trips in urban areas. The bicycle provides individuals with a flexible, personal mode of transportation. It is also practical because it can provide competitive trip travel times for most of the trips we make every day in urban areas. These aspects of bicycle travel are clearly established and are discussed in Section 4.1. However, bicycle transportation systems and transportation infrastructure investment in general, can also make a powerful and positive contribution to the shaping of civic structure and form. It is this contribution that is the focus of this chapter.

Physically, the *structure* of the city can be viewed as that which is constructed. The city is composed of massings of buildings, plants and the topography of the land — including the spaces between these masses. The spaces in-between are typically used for some type of transportation. These spaces link together to form a larger network that, at once, gives form to urban structural masses and provides movement between them. The particular way in which the structural masses and the spaces in-between are arranged provide a visual and functional organization that knits the city into a single entity.

The physical *form* of the city can be described as the *shape that the physical arrangement of the city takes*. The organization provides a visual framework for understanding and using the city. The quality of city life is directly dependent upon how well the physical form of the city supports the positive activities in the daily lives of those who dwell and work in the city. Therefore, the location, size and shape of transportation networks are extremely important contributors to the form of urban areas and to the quality of life they support.



Figure 2-1.
The location, size and shape of transportation networks directly contribute to the form and structure of urban areas.

To understand how the establishment of bicycle transportation systems can make a positive contribution to city form and structure, it is helpful to have a language about structure. Such a language was developed by Michael Robinson, a lecturer and research fellow in the Department of Landscape Architecture at the University of Minnesota. He provided a framework for thinking about the physical and spatial factors that give structure to cities as civic entities. The framework includes three aspects:

Urban transportation networks play a dual role in the structure of community:

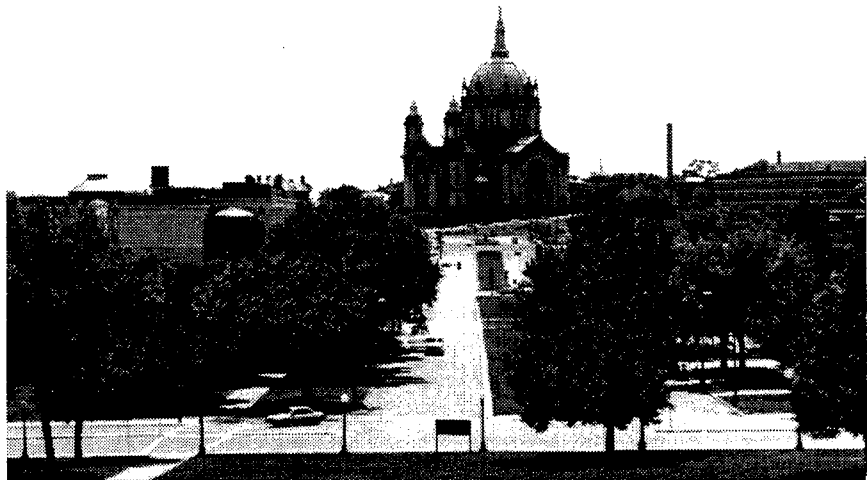
- They contribute to the civic infrastructure, giving support to public access and mobility
- They contribute to the civic superstructure, giving order to social and cultural institutions.

- The *substructure* of community is the land itself. It includes the surface form of the land and ecological and geological structure and function, including that which lies below the surface of the terrain.
- The civic *infrastructure* provides the support systems for communities and includes public utilities, property boundaries and transportation systems.
- The *superstructure* of community is “the civic architecture and anchoring institutions that order and focus our social and cultural activities.”³ The superstructure includes government buildings (libraries, schools, town halls, post offices, etc.), parks and other cultural institutions aimed as public purposes (e.g., performing arts halls, museums).

According to this view, transportation networks are clearly an investment in the civic infrastructure, giving support to public access and mobility. However, transportation systems also directly impact the civic architecture and the anchoring institutions that order and focus human

Figure 2-2.
Physical and spatial factors that give structure and form to cities include aspects of:

- The substructure of community,
- The civic infrastructure and
- The superstructure of community.



“The question should not be what kind of transportation system do we want but what kind of city do we want.”⁴

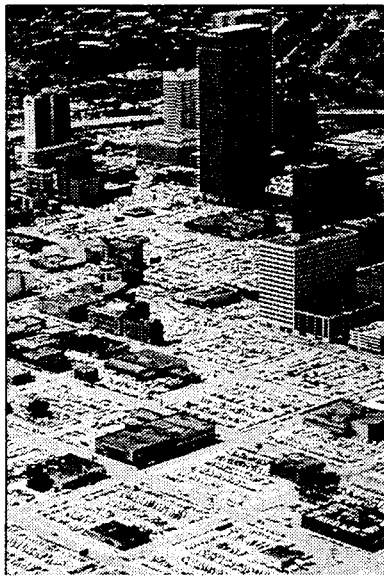


Figure 2-3.

Roadway transportation systems can enhance or detract from city structure and form — and they play a *dual* role in the structure of community:

They provide a *transportation service* and they contribute to the *form, function, and coherence of the civic spaces of the community.*

Figure 2-4.

activity in the city. The network of roadways surrounding civic institutions and, particularly streets directly adjacent to these areas of community focus, are integral to the degree of success with which the institutions and their civic architecture fulfill their roles as civic superstructure.

Roadways can be consciously planned to reinforce and give a coherent order to the elements of superstructure and substructure of a city. They can be organized to foster and direct the growth of a visually and functionally coherent pattern. They can be organized to respond to the local substructure and to the needs of humans and human activity, yielding a positive contribution to overall city form and structure.

They can also be planned without regard to these issues. Ignoring the civic contribution of any transportation investment produces an urban form in which the physical components of the superstructure are visually and functionally estranged from each other — linked only by accident because of the completeness of the urban transportation network.

Transportation networks developed without regard for their civic contribution produce no unity of existing civic architecture: They will also fail to give direction to future capital investments in civic structures and spaces that could lead to a greater civic unity. It is in this way that contributions to civic structure and form are left to accident. Tremendous opportunity for civic benefit is lost simply by viewing the establishment of a transportation infrastructure as a transportation benefit.

In summary, roadway transportation systems can enhance or detract from city structure and form — and they play a *dual* role in the structure of community: they provide a *transportation service* and they contribute to the *form, function, and coherence of the civic spaces of the community.*



All the benefits of social and cultural interaction enabled by community take place within the physical spaces the city provides.

This is particularly true of streets which can provide dynamic urban settings as conduits for travel and places for human interaction.

The organization of civic spaces to make coherent, civil cities is a timeless idea. The structure and form of cities have historically influenced the quality of life in them.

The purpose of cities, from ancient times to present, has been to foster the congregation of people and the interaction of individuals and groups of individuals. Most people enjoy and benefit from interactions with other people. The family and groupings of families fulfill many of the requirements for personal and familial interaction. However, the larger community — the city — provides the setting and the opportunity for interactions with larger groups — for meeting and interacting with people that are not members of the family or the family group.

The human settlement is the setting for the development of changes in all arenas of human social and cultural activity. Society and culture — along with more specific areas of human interest including trade, politics, government, economics, religion, art, science and technology — are created, developed and benefitted in the settings that cities have provided. Cities, and the interactions they foster, allow both the individual and society to create and move to new frontiers through meeting and interacting with other people — whether individually or in groups.⁵

All the benefits of social and cultural interaction enabled by community take place within the physical spaces the city provides. This is particularly true of streets which can provide dynamic urban settings as conduits for travel and places for human interaction.

Figure 2-5.

Those who plan, design and engineer streets and transportation systems must have an understanding of the civic contribution of roadways and roadway systems.

Streets, as conduits for travel and places to congregate, provide settings within which human activity should occur and community purpose — a sense of community — can be played out.



Good civic structure and good civic form, planned carefully to work together, endow the city with meaning and value for both the individual and the community.



Figure 2-6.
The form that city streets take and the form that roadway networks project, directly and powerfully influence the development of a sense of identity about the city.

The quality of the urban roadway network and its component parts is critical to the formation of a positive community image and identity.

The *physical structure of the city* was described earlier as that which is constructed — including the massings of buildings, plants and topography and the spaces between these masses. *Civic structure* can be described as 'that which holds' the commonly shared social and cultural aspects of community — *the commonwealth*. As such, civic structure supports community by providing the city with organization and order.

The *form of the city* was described earlier as *the shape that the physical arrangement of the city takes*. By extension, *civic form* can be seen as 'that which gives identity' to a city. This identification is a mind's-eye summation of the city, built up through a combination of experience, memory and human interaction with the physical form and structure of the city. The extent to which each structure and space in the city adds to a memorable whole affects the quality of that identity.

Good civic structure and good civic form, planned carefully to work together, endow the city with meaning and value for both the individual and the community — reasons why people live in community with one another and why people choose to live in one community over another. Good civic structure and form support community and the individual's experience of community. In vibrant and vital communities, individual and community purpose, satisfaction, and accomplishment flourish, and are recognized as valued outcomes of civic investment.

As components of the city's physical structure, community roadways provide the primary connective tissue of the city. They are the chief means by which we come to form an image of how the city is organized and an overall impression of the city as a whole. The spatial arrangement of roadway networks and the character of the component roadways contribute significantly to civic form, and by extension, civic identity. This means the form that city streets take and the form that roadway networks project, directly and powerfully influence the development of a sense of identity about the city. Because of this, the *quality* of the urban roadway network and its component parts is critical to the formation of a positive community image and identity.

Historically, roadway systems and their component roadways have profoundly influenced community structure and form. Streets (and the necessary land area for vehicle parking) typically use a large portion of the total land area of cities, especially in the twentieth century.⁶ The ubiquitous network of streets place them literally at everyone's door. Streets have historically provided the public space for meeting others, and engaging in commerce and entertainment and, they provide the backdrop for everything that is constructed in the city.

Therefore, streets provide a significant *context* within which other city structure is built and within which the daily activities of city life are carried out. Streets, as conduits for travel *and* places to congregate, provide settings within which human activity should occur and community purpose — a sense of community — can be played out.

Bicycle systems can directly contribute to the humanization of civic streets and spaces by giving a coherent order to the street at a human, rather than automotive scale.

Travel at a human scale demands an environment that is human in nature, as well as a mixed land use that is readily accessible and able to fulfill the daily and weekly needs of all people in the area.

All social and cultural interaction takes place within the structure that the city provides. It is important that the design of physical spaces in this structural setting seeks to:

- Connect and organize the community,
- Support the individual as community member and participant,
- Bind and support the common interest,
- Give structure and form to the placement of civic institutions and places.

The establishment of bicycle transportation networks provides the opportunity to redirect or reinforce civic structure and form. Since the bicycle is close in scale to the human being, bicycle systems can impart a more *human scale* to urban roadway systems. Bicycle systems can directly contribute to the humanization of civic streets and spaces by giving a coherent order to the street at a human, rather than automotive scale. Therefore, bicycle systems and their component facilities also have the potential for influencing the *quality* of community structure and form, creating high quality, visually coherent, constructed spaces for movement and human activity.

Since bicycle systems impart a more human-scaled form and structure to the urban setting, bicycle transportation planning allows communities to consciously use the bicycle network and its component facilities to reinforce and reformulate *land use* at a more human scale that serves the mixed needs of people. Travel at the human scale demands an environment that is human in nature, as well as a mixed land use that is readily accessible and able to fulfill the daily and weekly needs of all people in the area.

Figure 2-7.

As components of the city's physical structure, community roadways provide the primary connective tissue of the city.

The spatial arrangement of roadway networks and the character of the component roadways contribute significantly to civic form, and by extension, to civic identity.



Transportation systems and their component roadways contribute to civic structure and provide transportation services at different *scales*, influencing *the city, the community, and the near-neighborhood*. Likewise, bicycle facilities are provided at these same scales of transportation service and civic contribution as seen in the illustrations below.

Figure 2-8.

At the scale of the city, *bicycle expressways* provide a district-to-district service. Networks of bicycle expressways form a connective tissue for areas of city-wide importance.

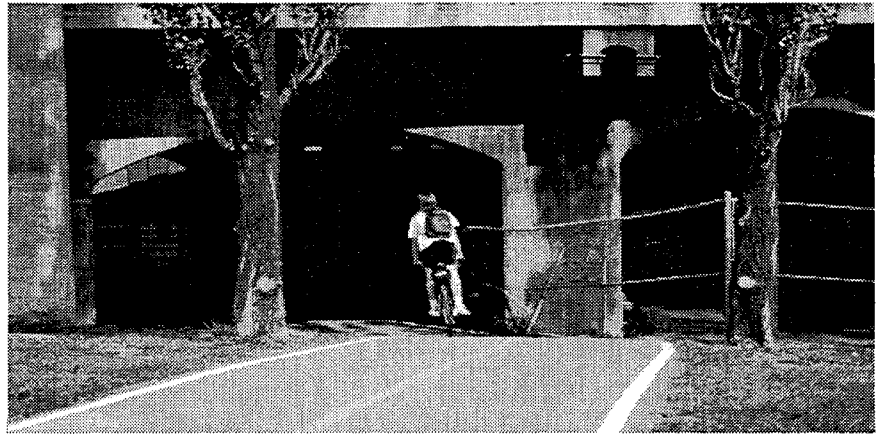


Figure 2-9.

At the scale of community, *bicycle boulevards* provide a neighborhood-to-neighborhood service and access to places in the community.

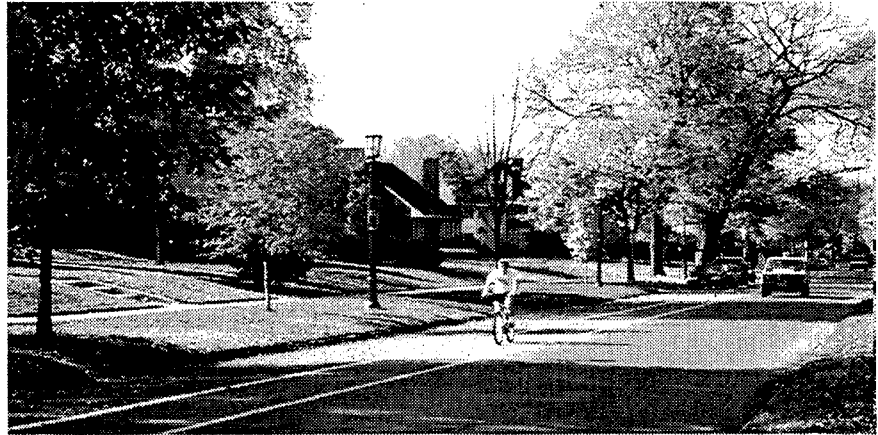


Figure 2-10.

At the scale of the near-neighborhood, *bicycle byways* provide a neighborhood local service and access to place.



Planning bicycle networks offers communities the opportunity to build new urban transportation systems that enhance existing community superstructure without demolishing existing civic infrastructure.



Figure 2-11.
By systematically supporting non-motorized modes of transport, we can foster bicycling and walking for short-range trips and bolster transit use for longer trips with attractive bicycle and pedestrian intermodal options

The importance of the design of physical spaces becomes more apparent when one looks at the city structure that has evolved. Today, our community structure has often been characterized as sprawling in dedication to the automobile. It was shaped by an overwhelming emphasis on efficiently moving motor vehicles through the community, even at the expense of many other important aspects of civic structure. More than any time in the last fifty years, it is important to review and examine the structure of our cities.

The ISTEA era encouraged communities to reduce the use of automobiles and rethink the quality of life in urban areas (see Appendix A). There is a need to re-establish a vision of the kind of civic structure we want today and for the future. As we redirect our transportation thinking, it is doubly important that attention to civic structure and form plays a central role in the planning and design of urban roadway transportation systems.

In the last fifty years, overwhelming attention to the movement of automobiles led us to an automobile-scaled civic form and structure. The resulting urban spaces are comfortable for moving autos around. They are also superhuman spaces that are usually not comfortable for walking or cycling. Increase in the use of more human-scaled modes of travel provides opportunity to regain a more coherent and human-scaled civic form and structure for our cities.

Planning bicycle networks offers communities the opportunity to build new urban transportation systems that enhance existing community superstructure without demolishing existing civic infrastructure. Trip travel data show that people continue to carry out most of their activities within biking range of home (see section 4.4.) Because of this, we can organize our transportation base by restructuring what we have. Many new bicycle facilities in an urban bicycle transportation network will use existing urban streets. New bicycle roadway facilities are the most cost-effective way of providing an efficient urban transportation service, when compared with all other vehicular systems. In addition, all bicycle infrastructure will use an economy of urban space, in comparison to the overall spatial needs for urban transportation.

By systematically supporting non-motorized modes of transport, we can foster bicycling and walking for short-range trips and bolster transit use for longer trips with attractive bicycle and pedestrian intermodal options. To adequately accommodate bicycle transportation, planners and decision makers must provide bicycle networks at all scales of transportation service and civic contribution: at the scale of the city, the community and the near-neighborhood. Different types of facilities, representing each scale, must be constructed to ensure that the needs of people as transportation consumers can be met using the bicycle as a preferred and chosen mode of transportation.

3. Bicycle Facility Types

This chapter describes planning guidelines for different types of bicycle facilities and introduces the bicycle friendly zone as a means of implementing viable networks for bicycle transportation.

In order to develop plans for bicycle transportation in urbanized areas, it is important to have a systematic way of thinking about how to do it. This chapter introduces ideas for using different types of bicycle facilities as components for building systems of bicycle networks. The component facilities — *bicycle expressways*, *bicycle boulevards*, *bicycle byways* and *bicycle access facilities* are introduced, defined and discussed in terms of how they can be configured with one another to make interconnected space for bicycle transportation in urban areas.

This chapter introduces the *bicycle friendly zone* as a means of implementing viable networks for bicycle transportation in urban areas. With this approach, an area of the city is designated a bicycle friendly zone and then carefully blanketed with the different types of facilities.

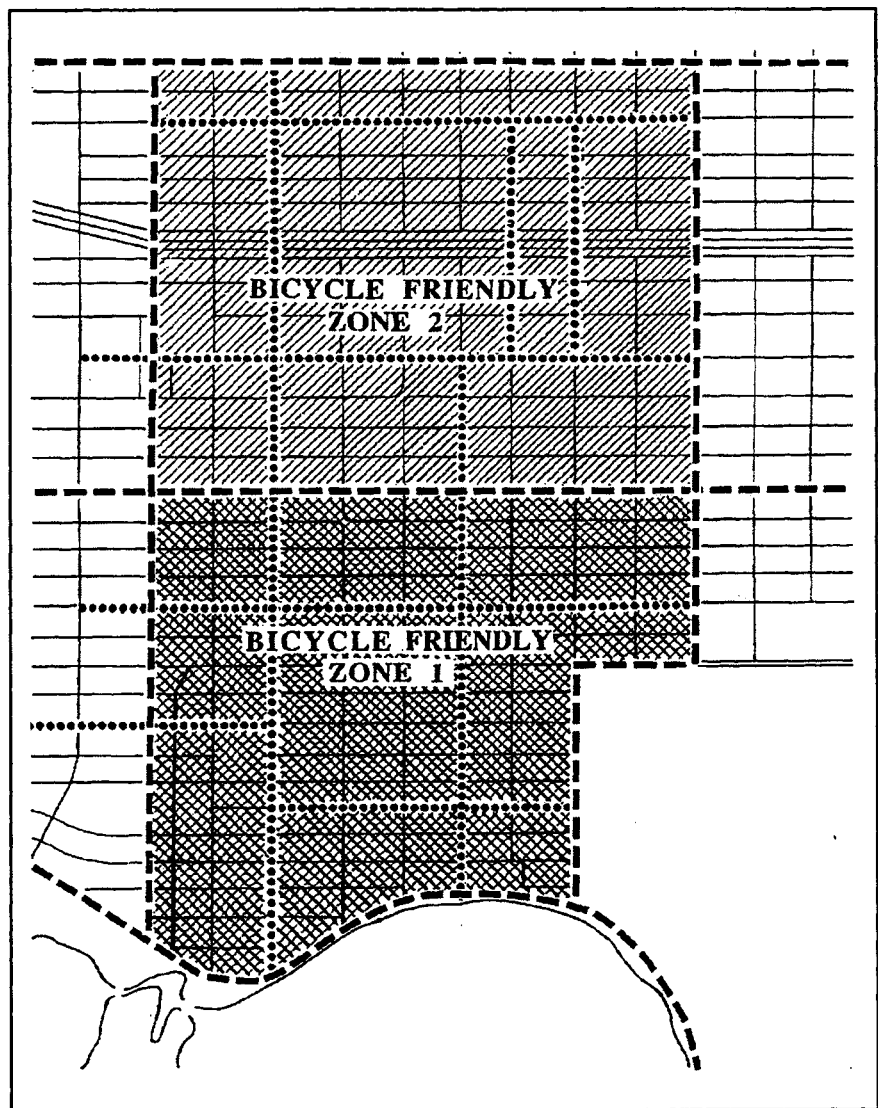


Figure 3-1. Bicycle networks must function as true systems of travel, providing all types of movement, access and connectivity.

This figure shows the connectivity of two neighboring bicycle friendly zones and their integration with the city.

If bicycle friendly zones and bicycle facilities are developed using the guidelines recommended in this chapter, the resulting bicycle network will provide transportation function and should promote and direct expansion of the system into adjacent areas.

If bicycle friendly zones and bicycle facilities are developed using the guidelines recommended in this chapter, the resulting bicycle network will provide transportation function and should promote and direct expansion of the system into adjacent areas. By thinking in terms of networks of the different component facilities working together, it is possible to reorganize our streets to establish large quantities of bicycle space with limited funds.

This chapter presents specifications for bicycle networks as systems of travel that deliver trip travel times, competitive with the automobile for most urban trips. Other guidelines address convenience, safety and access to places in the community for the cyclist. The chapter is organized into these sections:

- Section 3.1. provides a description of the component facilities from which bicycle networks are constructed.
- Section 3.2. discusses facility design guidelines in terms of motor vehicle facility speed (functional classification) and size (ADT) and bicycle facility type (summarized in Table 3-1),
- Section 3.3. describes planning guidelines for the different types of bicycle facilities (summarized in Table 3-2).

Planning Principles

The information about bicycle networks presented here should be considered guidelines, not requirements. Departures from these guidelines may be necessary due to local conditions and should be guided by these principles which were helpful in developing this guidebook:

1. All roads, except interstate highways, are legal for bicycle use in Minnesota. The guidelines seek to provide systems of safe and supportive space for bicycle transportation by enhancing roads and organizing improvements for bicycle use in the public right-of-way.
2. If all traffic can be slowed to approximately the same speed, then the same space can be shared by all modes of travel. If not, then separate space should be provided for each mode.
3. The planning of bicycle facilities should respond to context and local conditions, including land use, land use density, existing road patterns and physical features of the surrounding area.
4. Bicycles have a major competitive advantage over motor vehicles because of their human scale and their maneuverability: they can get the traveler closer to the door of a destination. Bicycle facility development must respond and cater to these advantages, whenever possible.

3.1. Components

Experience in bicycle transportation planning in the U.S. and abroad reveals that in order for a system to be effective and used to any appreciable degree, it must be a complete system, blanketing an area with bicycle facilities.

Because a large proportion of our daily trips are made within cycling distance from home (2 miles or less),⁷ an important goal for a successful bicycle transportation system is to attract people who are not currently using the bicycle as transportation. To do this, communities must meet all of the transportation needs of these potential users. Experience in bicycle transportation planning in the U.S. and abroad reveals that in order for a system to be effective and used to any appreciable degree, it must be a complete system. This means blanketing an area with bicycle transportation facilities.

The area to be blanketed, the bicycle friendly zone, is a portion of the urbanized area designated as the focus for establishing a complete network of bicycle facilities (see section 4.4.). Bicycle friendly zones should contain all of the types of component facilities required for a good bicycle transportation roadway network. These component facilities are *bicycle boulevards*, *bicycle byways* and *bicycle access facilities*. The bicycle friendly zone may also contain a portion or a segment of a *bicycle expressway*, which connects the zone to other zones and destinations in distant part of the city. These facilities are fully defined and discussed in section 3.3.

Within the bicycle friendly zone, facilities should be established in a coordinated way to address the transportation needs of the people living or working within the area. The series of figures that follow show how a bicycle friendly zone relates to the larger city, as well as photographs of what each type of facility might look like.

Figure 3-2.
Bicycle friendly zones can provide a well-used and effective system for bicycle transportation. A bicycle friendly zone should provide all types of bicycle facilities and access by bicycle to all destinations within the zone. Transit or bicycle travel options to the bicycle friendly zone are equally important for people who must travel to the zone, but live outside of it.



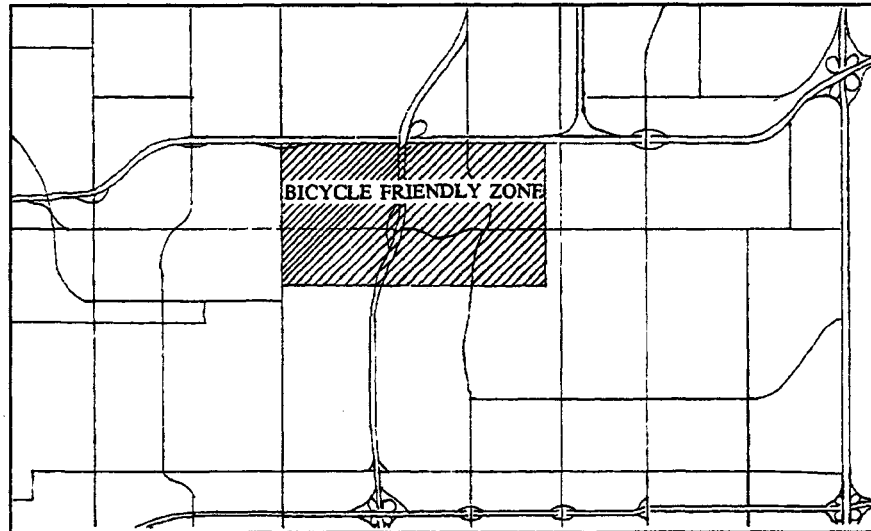


Figure 3-3.
A bicycle friendly zone shown within the context of the city.

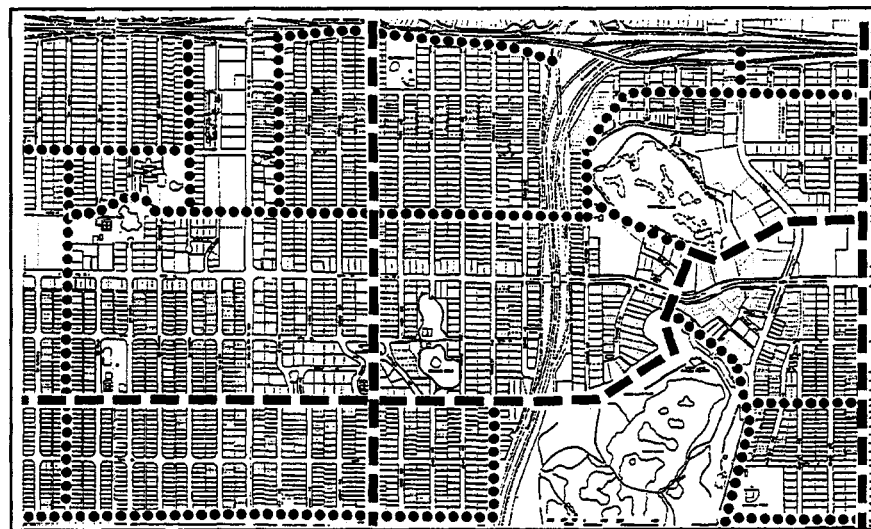


Figure 3-4.
The bicycle friendly zone showing bicycle boulevards and bicycle expressways. Bicycle byways are represented by the local streets.



Figure 3-5.
Networks of bicycle expressways provide high-speed connections across the city. Bicycle expressways are the most non-stop and directly continuous of all bicycle facilities. They should provide at least two exclusive lanes in each direction.

Bicycle expressways are fed traffic by other bicycle facilities. Exit and entrance facilities are recommended, as necessary, so that through movement on the expressway is not disrupted.

Figure 3-6.
Networks of bicycle boulevards provide moderate-speed connections across the city and in bicycle friendly zones. Bicycle boulevards can connect with bicycle expressways, bicycle byways and bicycle access facilities.

Bicycle boulevards will commonly be located on city streets where the cyclist can achieve a moderate degree of travel continuity (1/4 - 1/2 mile between stops).



Figure 3-7.
Networks of bicycle byways provide connections to larger bicycle facilities and to abutting land uses. Bicycle byways are slow speed facilities, where the cyclist can expect frequent stops.

Bicycle byways are usually found on local streets and include alleys and bicycle shortcuts. Cyclists commonly share the street with motor vehicles and other, non-motorized transport in a mixed-use condition.

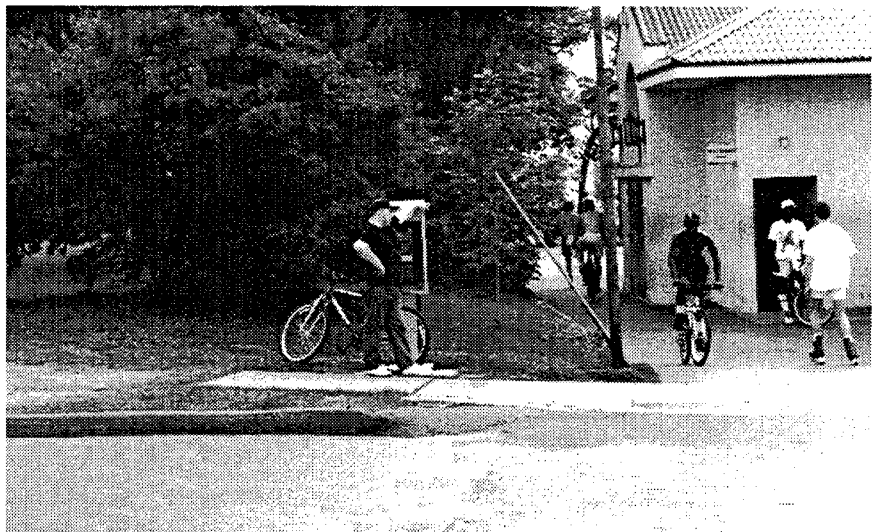


Figure 3-8.
Bicycle access facilities support the completion of trips by providing a connection from the roadway to the door of the destination. They include:

- Ample bicycle parking near the door of the destination
 - Transition facilities that provide a clear, safe path from the public right-of-way to the bicycle parking facilities.



3.2. Separation Recommendations

The facility separation guidelines presented here describe optimum facility design that should be pursued for each type of bicycle facility in terms of the volume and speed of motor vehicles sharing the same corridor.

When bicycles and motor vehicles share roadway space, the operating requirements of bicycles must be taken into account in the planning and design of new facilities. Studies have shown that the volume and speed of motor vehicles are the primary factors affecting the safety and 'rideability' of bicycles. However, sound planning and design can remove unsafe and undesirable cycling conditions.

Table 3-1 summarizes basic design specifications for corridor facilities. It uses the standard functional classification of streets to describe the range of motor vehicle speeds found on each street type and describes additional speed requirements that must be met. The table expresses volume of motor vehicle traffic in terms of Average Daily Traffic Counts (ADT) which are usually available from community public works departments.

The drawings in this section describe the design guidelines described in Table 3-1.



Figure 3-9.
Well-designed bicycle facilities can successfully separate bicycle traffic from other uses in the street to create a safe operating environment for cyclists and an attractive street space for everyone.

Physical separation is accomplished with:

- Barrier separation
- Distance separation
- Grade separation

Figure 3-10.
Barrier separations physically and spatially separate the bicycle's space with continuous vertical barriers or a series of vertical objects, such as trees, posts, and street furniture.



Figure 3-11.
Distance separations place enough horizontal distance between the bicycle facility and the motor vehicle to significantly reduce the danger of vehicle encroachment on bicycle space.

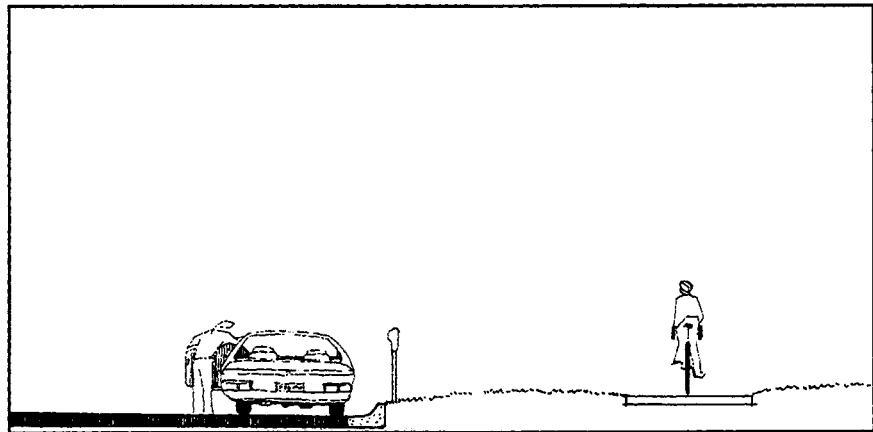


Figure 3-12.
Grade separation specifies the use of a vertical separation where the level of the bicycle facility is higher than that of the motor vehicle.

In urban areas, curbs are usually used to accomplish this kind of separation, where bicycle space is raised slightly above motor vehicle space.

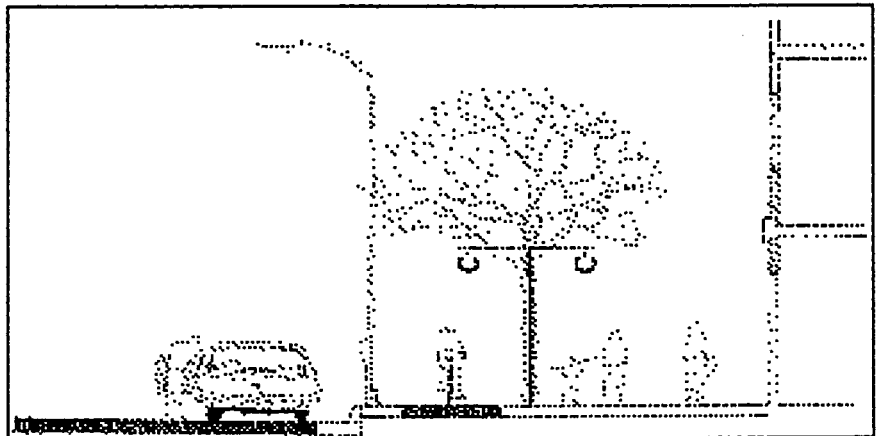


Figure 3-13.
A curb is used to provide a physical, grade separation of motor vehicle and bicycle traffic.

The raised bicycle facility is visually spatially defined by this vertical separation.

The curb will also act as a protective barrier for minor motor vehicle movements that might encroach on the bicycle's space.

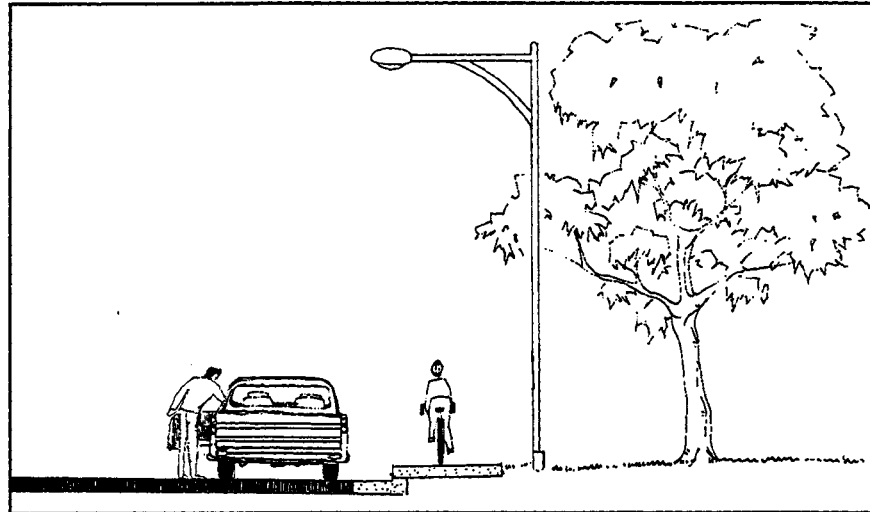
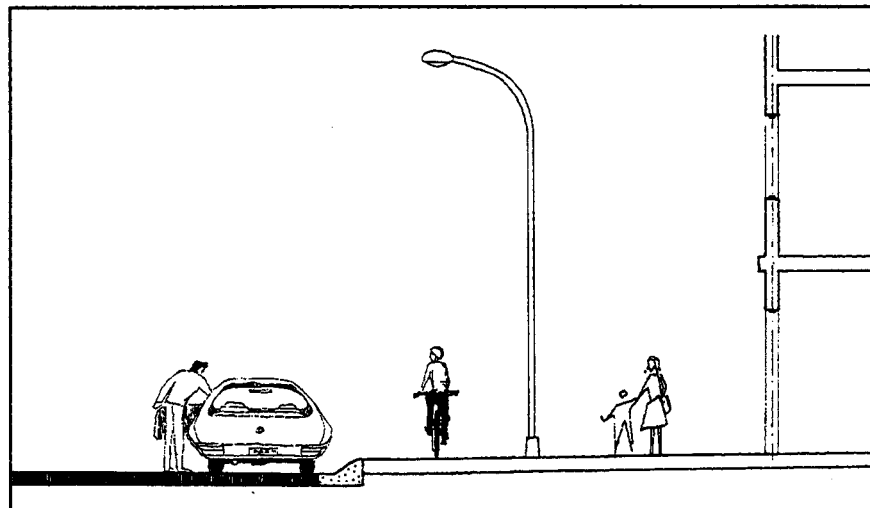


Figure 3-14.
Grade separation using roll curbs are effective in busy areas where space is at a premium and where various incidental uses of the bicycle's space are necessary.

Note how the space between the bicycle and pedestrian facilities is marked with barrier separators (lighting, street furniture, etc.).

The roll curb allows motor vehicles to temporarily use the bicycle space for drop-offs and deliveries. The barrier separators, in turn, allow the cyclist to pass temporarily parked motor vehicles by using the pedestrian space.



Demarked space identifies a continuous space or lane by clearly marking it for bicycle use only. Marking may be accomplished by striping, by painting the bicycle space a solid color, or by using a contrasting surface material for the different lanes (e.g., concrete and asphalt). A contrasting surface material can also be used to "line" or separate bicycle space from pedestrian or motor vehicle space (e.g., a row of bricks, flush with the pavement). All approaches should be supplemented with signage identifying the bicycle facility and should be consistent throughout the city.

Figure 3-15.
The simplest and quickest method of demarking space can be accomplished with striping.

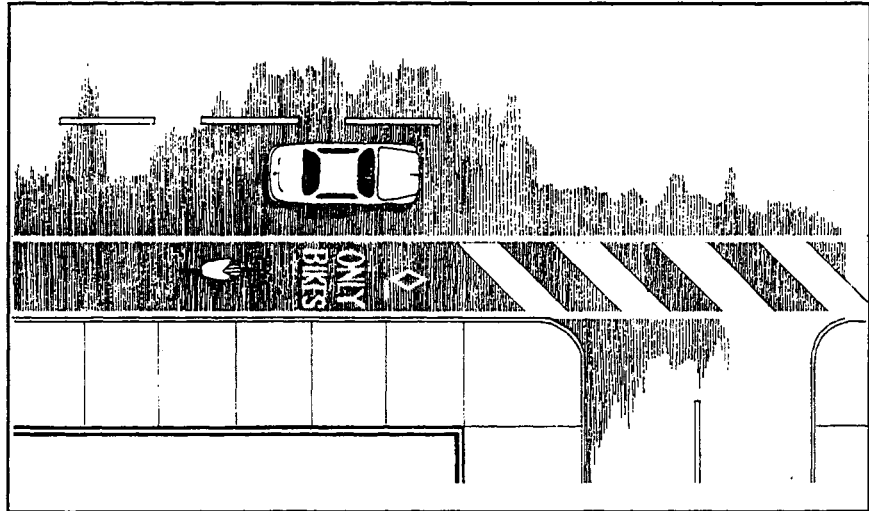


Figure 3-16.
Contrasting paving materials for the street, bicycle facility and pedestrian spaces are an effective means of demarking the roadway area into three zones of use.

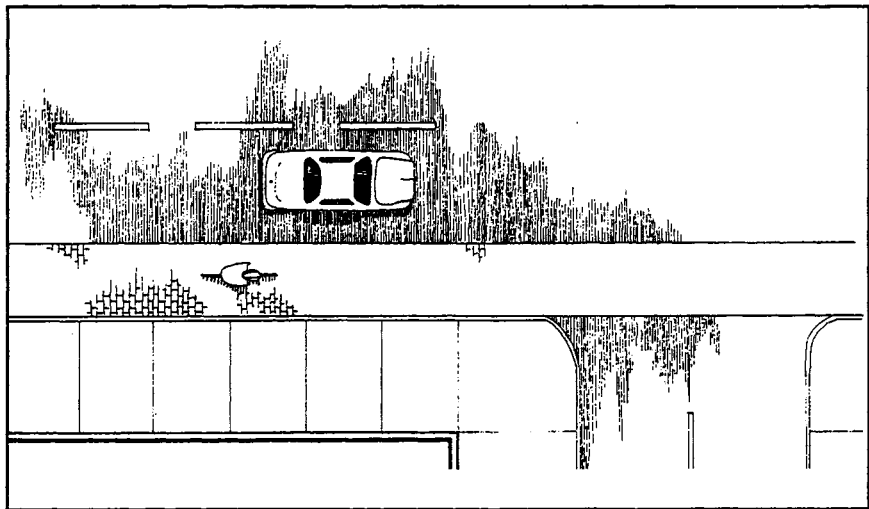
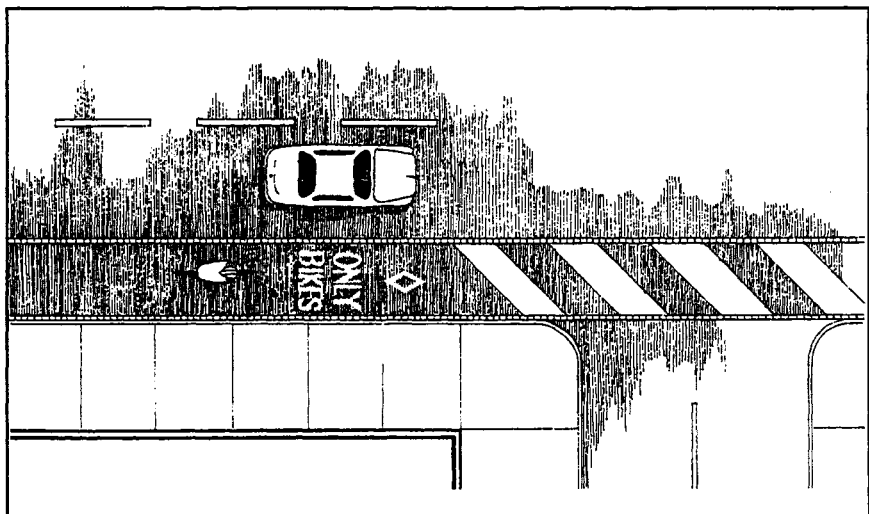


Figure 3-17.
Contrasting paving materials can be used to “line” or separate bicycle space from motor vehicle or pedestrian space. Contrasting materials act as visual and tactile cues for demarking zones of use on the street.

Note, surface materials that provide tactile cues must be used with caution, so that cyclists do not slip or fall when they encounter the surface.



The term *shared space* means that the right hand lane in each direction is set aside and posted at 16 kph (10-12 mph). *Both* bicycles and motor vehicle share travel in the set-aside, slow lane. Shared space must not be used where motor vehicle traffic in the faster lanes exceeds 10,000 ADT OR 48 kph (30 mph). Shared space should be well signed and preferably used in conjunction with some kind of demarked space.

The term *mixed space* means that motor vehicle traffic and bicycles use the same driving space, at very low speeds that are equal to and comfortable for bicycle operation (< 19 kph (< 12 mph)).

Figure 3-18.
Bicycles and motor vehicles share a slow-moving right lane 16-19 kph (10-12 mph) on streets designated for shared space. Shared space must *not* be used where motor vehicle traffic in the through traffic lanes exceeds 10,000 ADT or 48 kph (30 mph).

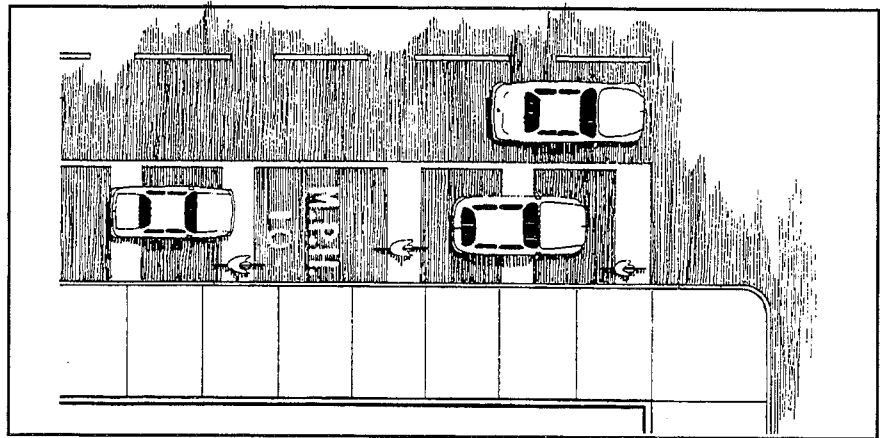


Figure 3-19.
In mixed space, bicycles and motor vehicles use the same driving space. The operating speed of the entire street should not be higher than 19 kph (12 mph).



Figure 3-20.
In mixed space, traffic calming techniques are effective for making it physically impossible for motor vehicles (and bicycles) to travel at faster speeds.



Table 3-1. SEPARATION GUIDELINES FOR BICYCLE FACILITIES

Speed and Space Relationships to Parallel Motor Vehicle Movement by Street Class	Bicycle Expressways	Bicycle Boulevards	Bicycle Byways	Bicycle Access Facilities
Principal Arterial Street (limited access highway, freeway)	Minimum: Barrier or distance separation Preferred: Large distance separation	Minimum: Barrier or distance separation Preferred: Large distance separation	Minimum: Barrier or distance separation Preferred: Very large distance separation	Minimum: Transition facility from bicycle boulevard or byway parking. Bikes limited to <5 mph (<3 mph). Bicycle parking at
Minor Arterial Street (over 3000 ADT)	Minimum: Barrier or distance separation	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space	Minimum: Transition facility from bicycle boulevard or byway parking. Bikes limited to <5 mph (<3 mph). Bicycle parking at
High Volume Collector Street (1500 - 3000 ADT)	Preferred: Barrier, distance, or grade separation	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space	Minimum: Transition facility from bicycle boulevard or byway parking. Bikes limited to <5 mph (<3 mph). Bicycle parking at
Low Volume Collector Street (1000 - 2000 ADT)	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space for motor vehicle operating speeds to 32 kph (20 mph)	Preferred: Barrier, distance, or grade separation Satisfactory: Demarked space or shared space	Minimum: Transition facility from bicycle boulevard or byway parking. Bikes limited to <5 mph (<3 mph). Bicycle parking at door.
High Volume Local Street (350 - 1200 ADT)	Bicycle expressway should not be located here	Preferred: Traffic calmed street using mixed space approach, or demarked space Satisfactory: Shared space for motor vehicle operating speeds to 32 kph (20 mph)	Preferred: Traffic calmed street using mixed space approach, or demarked space Satisfactory: Shared space for motor vehicle operating speeds to 32 kph (20 mph)	Minimum: Demarked space mixed space with pedestrians bikes at <5 kph (<3 mph). Bicycle parking at door.
Low Volume Local Street (up to 500 ADT)	Bicycle expressway should not be located here	Bicycle boulevard should not be located here	Preferred: Traffic calmed street using mixed space approach, or demarked space Satisfactory: Shared space for motor vehicle operating speeds to 32 kph (20 mph)	Minimum: Demarked space mixed space with pedestrians bikes at <5 kph (<3 mph). Bicycle parking at door.

DEFINITIONS

Mixed Space. The same driving space is used by motor vehicles and bicycles, traveling at very low speeds, equal to and comfortable for bicycle operation, <19 kph (<12 mph). Traffic calming techniques should be used where necessary to make it physically impossible for motor vehicles and bicycles to travel at faster speeds.

Demarked Space. A continuous space or lane clearly marked for bicycle use only, with striping, contrasting materials, paving or painting the full bike lane surface a contrasting color. All approaches should be supplemented with signage identifying the bicycle facility.

Distance Separation. A horizontal (distance) separation of the bicycle facility and motor vehicle space.

Shared Space. The right hand lane in each direction is set aside and posted a 12 mph. Both bicycles and motor vehicles share travel in the set aside lane. Must not be used where motor vehicle traffic in the through traffic exceeds 10,000 ADT or 30 mph.

Grade Separation. Vertical separation where the level of the bicycle facility is higher than that of the motor vehicle. In urban areas, curbs are usually used to accomplish this kind of separation, where bicycle space is raised slightly above motor vehicle space.

Barrier Separation. A physical and spatial separation of the bicycle's space and street furniture.

3.3. Planning Guidelines

This chapter presents the planning parameters for the component facilities of bicycle networks. These parameters help planners assemble networks that deliver satisfactory trip travel times, intermodal options, safe cycling facilities, and access to places in the community.

The information presented in this section is summarized in Table 3.2. Each table entry is fully defined and discussed in the text following Table 3.2. Parameters in Table 3.2. are defined as follows:

- **Basic Characteristics**
- **Transportation Function**
- **Place Connections**
- **Spacing of Facilities**

A shorthand description of each type of facility.

The basic transportation purpose of the facility in terms of degree of movement and access.

The kinds of places that are connected by the facility in terms of size; e.g., community or city-wide focal points or neighborhood and local destinations.

The recommended spacing of each type of facility according to the density of development.

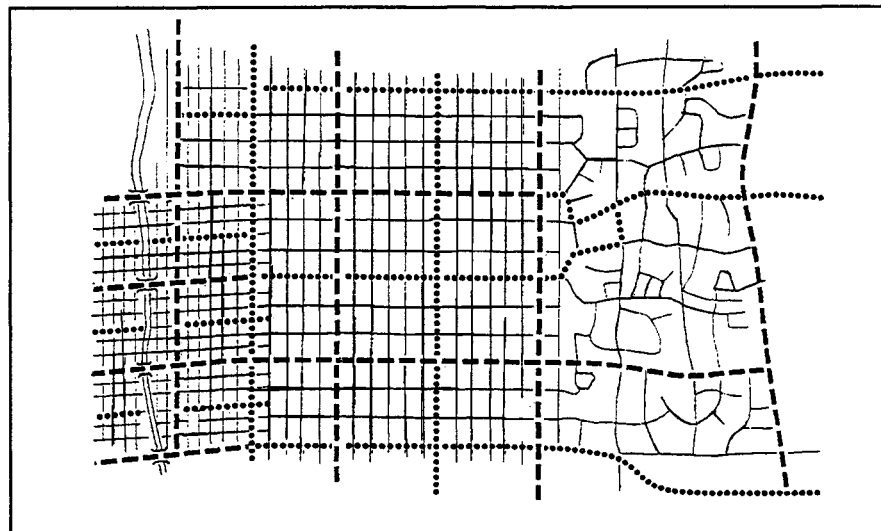
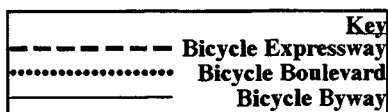
Two subcategories are identified: one gives recommendations for fully developed areas (central cities and first ring suburbs) and the other gives recommendations for developing areas (second and third ring suburbs, and beyond). When planning each type of bicycle facility, the denser the development, the closer the facilities should be spaced.

Implementation strategies, lack of funding, and urban conditions may make it difficult to observe the recommended spacing of facilities. However, bicycle boulevards and bicycle expressways can work in concert to create an efficient network system. A bicycle boulevard can be used to complete part of a longer expressway trip for cyclists. That is, bicycle boulevards can be used to “fill in” for a bicycle expressway as

Figure 3-21.

In densely developed areas, with 2.4 dwelling unit per hectare (6 dwelling units per acre) or more, bicycle facilities should be spaced according to the closest requirements for spacing (see Table 3-2).

In developing areas, with a lower density of development, bicycle facilities can be spaced farther apart.



long as *the spacing between these bicycle boulevards does not exceed the recommended spacing for bicycle boulevards*. In other words, bicycle boulevards should not “fill in” the bicycle expressway network at the spacing recommended for bicycle expressways.

A major function of bicycle expressways is to provide a high degree of travel continuity, with fewer stops than other facilities. However the stopping requirements that dense, urban land use and urban traffic demand will make it impossible to maintain the level of travel continuity that expressways provide. Under these conditions, the bicycle expressway must, necessarily, be replaced with bicycle boulevard facilities.

• **Continuity of Movement**

The degree to which the facility provides the cyclist with a continuous, stop-free trip. Facilities where the primary transportation function is movement should provide a high degree of continuity. Facilities where the primary transportation function is access will not have a high degree of continuity, but will have a larger number of places that the cyclist can directly access; that is, a high level of connectivity.

• **Operation**

The level of operating continuity that the cyclist is expected to achieve on each type of facility. Expressed in terms of operating speed and frequency of stops because fewer stops enable higher operating speeds.

• **Spacing of Facility Exits and Entrances**

The maximum spacing of exits and entrances to the facility. Required when facilities are physically separated from other roadways or from destinations, and exit and entrance points must be planned and designed.

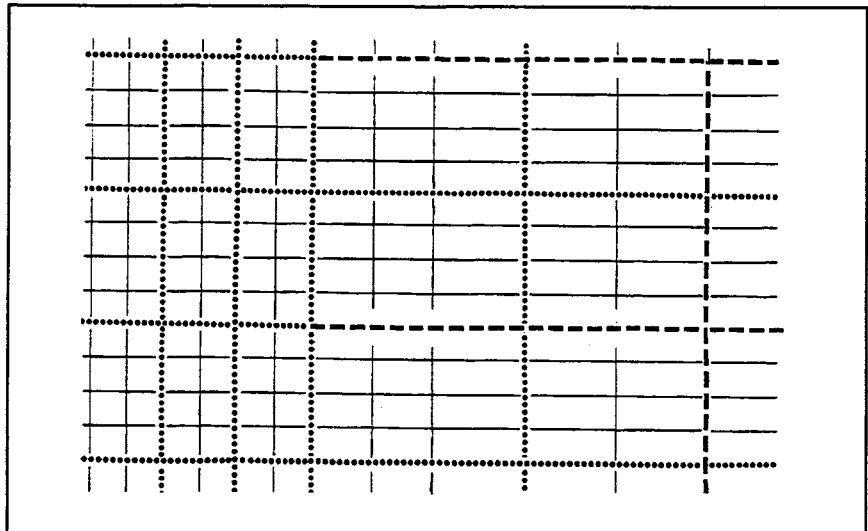
• **Connections to Local Streets**

The degree to which access is provided to the local street (bicycle byway) system.

Figure 3-22.

In some urban areas, the density of land use and roadway traffic make it impossible to observe the recommended spacing of stops needed to deliver the high degree of movement continuity supplied by bicycle expressways. In these situations, bicycle boulevards can be used to continue the expressway network. If this is done, the spacing requirements for bicycle boulevards – as opposed to those for bicycle expressways – must be used.

Key	
-----	Bicycle Expressway
.....	Bicycle Boulevard
_____	Bicycle Byway



- **Access to Destination Entrances**

- **Minimum Facility Segment Length**

- **Target Trip Length**

- **Multi-Modal Use of Space with other non-motorized modes**

The degree to which access is provided to distinct destinations, as determined by the degree to which the cyclist can arrive at the doors of specific places and use good bicycle parking facilities there.

Minimum segment length to be implemented for the facility to be useful.

Expected average trip length for those using the facility.

The probability that either the bicycle facility or the facility's corridor right-of-way could be used by other non-motorized modes, such as pedestrians, in-line skaters, wheelchair users, or child cyclists.

An important aspect of the planning and design of bicycle facilities includes consideration of other roadway users. The sharing of the roadway with motor vehicles is apparent, but the sharing of roadway space designed for bicycle use with other, non-motorized vehicles and pedestrians may be less obvious. The heavy use of bicycle facilities by other non-motorized modes can make the facility inconvenient or non-

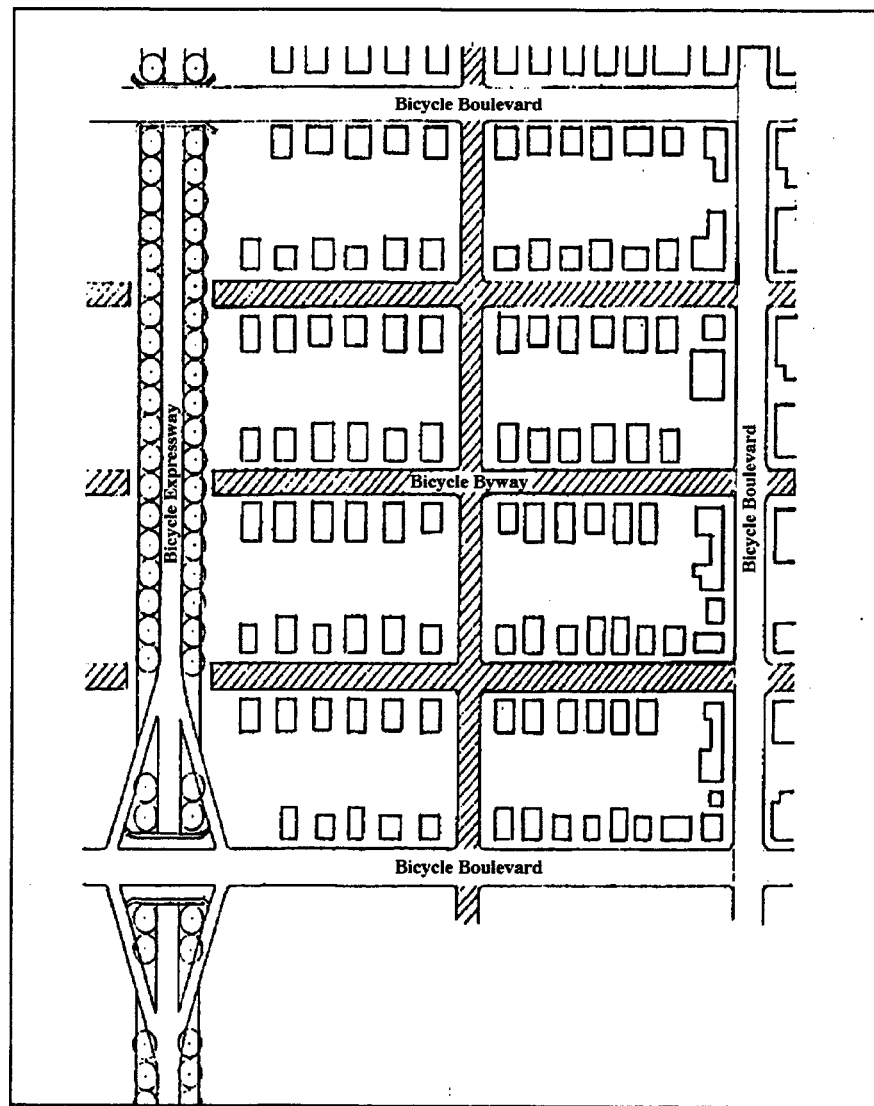


Figure 3-23.

Facilities where the primary transportation function is movement should provide a high degree of travel continuity.

Facilities where the primary transportation function is access will not have a high degree of continuity, but will have a larger number of places that the cyclist can directly access — that is, a high level of connectivity.

Figure 3-24.
An important aspect in the planning and design of bicycle facilities includes consideration of other potential users of the facility.

It is important for planners and designers to determine the attractiveness of their proposed facilities for other, non-motorized users.

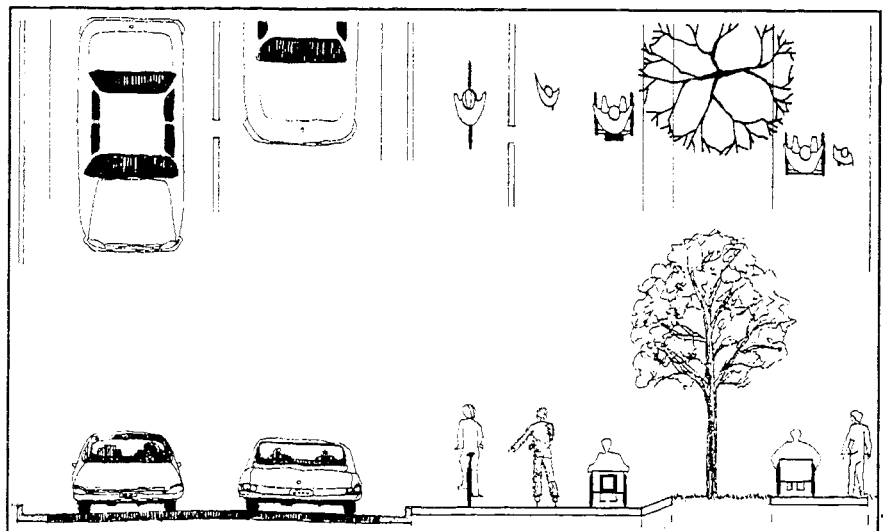
If other use is anticipated (including recreational cycling uses), then the facility *must* be designed to accommodate the other uses.



functional for commuting cyclists and hazardous for all. It is important to examine the bicycle transportation plan, and its context within the city, to determine the attractiveness of proposed facilities for other, non-motorized users. If other use is anticipated (including recreational cycling uses), then the facility *must* be designed to accommodate these other uses.

Depending on their location and land-use, some types of bicycle corridors might be ideal for intentionally providing transportation facilities for other types of users. For example, a senior citizen's housing complex or an apartment complex for the handicapped might be located along a corridor reserved for a bicycle boulevard that serves a major shopping center. The provision of facilities for wheelchairs, tri-wheel cycles, bicycles and pedestrians might serve a larger population of the city, making more people independently mobile. With the increases in these populations in the coming years, corridors designated for bicycle use may provide other transportation and civic opportunities for cities, as long as they are well-planned and well-designed for this kind of non-motorized, multi-modal use.

Figure 3-25.
Bicycle boulevard space where use by other non-motorized modes was anticipated. The corridor was designed to not only accommodate commuting cyclists, but to also allow slower moving cyclists, including children; in-line skaters; motorized and non-motorized wheelchairs; and pedestrians to safely use the corridor. In this multi-modal corridor for non-motorized modes, the motor vehicle should be made a guest using traffic calming features.



- **Service/Linkage to Transit Stops**

Bicycle systems are the most successful when they provide options for linking with transit. Likewise, transit is most successful when people have direct and easy bicycle access to transit stops and stations. Therefore, plans for bicycle networks and the designs of specific facilities should always include cycle friendly access to transit as a high priority.

Connections from a bicycle facility to a transit stop are accomplished by locating bicycle facilities next to existing and proposed transit stops or within a short cycling distance from them (0.8 km or 1/2 mi). In some cases, it may be necessary to provide special exit and entrance facilities from the bicycle facility to the transit stop.

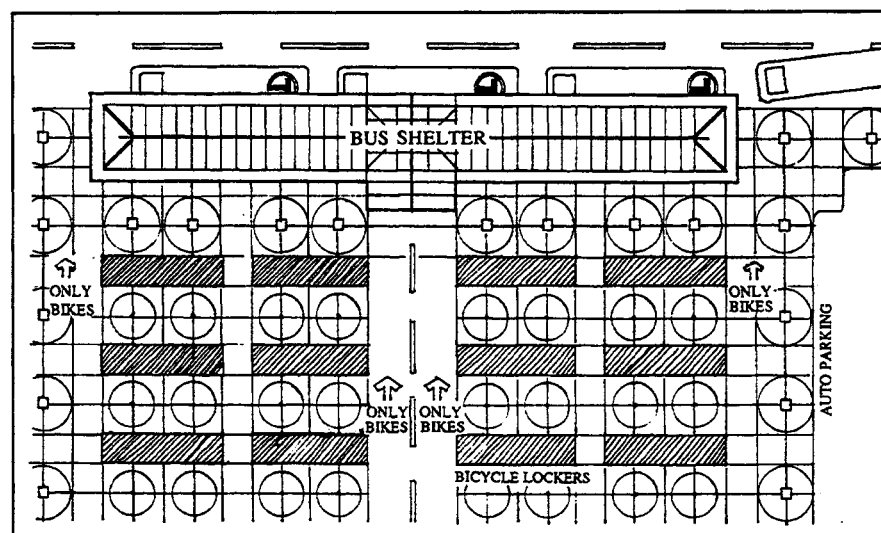
To open discussion on the relationship of the specific characteristics of a community's bicycle and transit systems, and the relationship of both to land use in the community, planners should ask: "How long would a person be willing to cycle to connect with each kind of transit option?"

- **Volume**

The relative number of cyclists that can be expected to use a facility during periods of average use on a typical (warm weather) day. This category gives a relative idea of how large a facility might need to be.

In general, bicycle planners have had to design for relatively low volumes of bicycle riders in the past. However, as bicycle transportation becomes a more viable option for many people, volumes can increase beyond what has been a "typical" target volume. The size of a facility

Figure 3-26.
Bicycle expressways and bicycle boulevards should always provide convenient, comfortable and direct connections to transit stops.



depends not only on growing numbers of cyclists, but also on surrounding land use, and the size and types of destinations that the facility serves.

Note, too that facility type is not necessarily a predictor of volume. For example on campus bicycle routes at a large university may be typed as bicycle byways for a number of reasons such as required operating speed and number of stops along the route. However, these byways could be high-volume facilities and should be designed to anticipate high volumes of users.

- **Maintenance and Repair**

Maintenance and repair guidelines for each type of facility are expressed in terms of snow removal and pavement maintenance standards in use for motor vehicle streets. Maintenance standards and schedule are always required for every implemented bicycle facility.

Poor maintenance can be the cause of accidents and unsatisfactory trip travel times. A poorly maintained bicycle facility may cause cyclists to use facilities that are not designed for additional bicycle use (e.g., a bicycle byway being used instead of a bicycle boulevard or expressway).

- **Skill of User**

A shorthand description of the skill levels of different kinds of cyclists that can be expected to use the facility. (Section 5.1. describes the different kinds of users of a bicycle transportation system in detail).

In general, less-skilled users will tend to use facilities with less traffic; in particular, facilities with less motor vehicle traffic interaction. Therefore, bicycle expressways and some kinds of bicycle byways will attract less-skilled users. Bicycle expressways are required to be separated from motor vehicle traffic and bicycle byways located on local, residential streets will often also have low volumes of motor vehicle traffic for most of the day. However, many bicycle boulevards and some bicycle byways are the types of facilities that will be located in the same roadway space with heavy motor vehicle traffic.

The designer must take potential conflicts between skilled and unskilled cyclists into account in the design of the facility. Where space permits, all heavily used facilities should provide both slow and fast moving lanes. Communities should be prepared to enforce traffic laws on facilities that have a large number of low and high skilled users.

- **Personal Safety Issues**

The relative number of personal safety issues needing consideration in the planning and design of bicycle facilities. Personal safety (as opposed to physical safety) refers to the safety of the cyclist from personal attack. This is a critical urban design issue and requires careful attention. Section 5.1 discusses personal safety and bicycle facilities in more detail.

Table 3-2. Planning Guidelines for Bicycle Facilities (Part 1 of 2)

Parameter (See Definitions)	Bicycle Expressways	Bicycle Boulevards	Bicycle Byways	Bicycle Access Facilities
Basic Characteristics	Maximum distance Highest speed Least interruption Physical Separation Minimum of 2 lanes in each direction required High priority	Maximum connectivity to metro activities May need low speed & high speed facilities Highly dependent on land use High/medium priority	Usually on local streets, alleys, bicycle shortcuts Sometimes on busy arterials Traffic calming techniques Pedestrian has highest priority: Motor Vehicle usually has lowest priority	Provide superior parking accessibility for bicyclist Provide transition facilities to avoid conflicts with motor vehicles or pedestrians Separate access facilities for dense traffic Otherwise, same as for bicycle byways
Transportation Function	Movement Primary	Movement and Access Equal	Access Primary Movement Secondary	Access Primary from byways or boulevards As necessary, includes transition facilities from roadway to parking to avoid motor vehicle and pedestrian conflicts
Place Connections	Community-sized focal points: shopping, commercial, employment and entertainment centers, secondary schools, colleges	Neighborhood-sized focal points: shopping, employment and entertainment centers, elementary and secondary schools, colleges, libraries	Individual buildings, homes or open spaces	From byways and boulevards to the front doors of places of business, employment or residence
Spacing of Facilities Fully Developed Areas (Central Cities & 1st Ring Suburbs) (Notes 1 & 2)	0.8 km to 3 km (1/2 to 2 mi)	0.8 km to 1.5 km (1/2 to 1 mi)	Shared with motor vehicles and integrated with local street system Alleys, shortcuts	Parking at destination entrances. Minimally, parking within 100 m (300 ft) of the door.
Spacing of Facilities Developing Areas (2nd & 3rd Ring Suburbs) (Notes 1 & 2)	0.8 km to 5 km (1/2 to 3 mi)	0.8 km to 2.5 km (1/2 to 1 1/2 mi)	Shared with motor vehicles and integrated with local street system Alleys, shortcuts	At every destination. Minimally, within 1 block from the roadway & 1 block from the destination
Continuity of Movement	High	Medium	Low	Very Low
Operation	Average operating speed is 32 kph (20 mph) or more Bikes required to stop no more frequently than every 0.8-1.6 km (1/2 - 1 mi)	Average operating speed is 24-32 kph (15-20 mph) Bikes required to stop no more frequently than every 0.4 -0.8 km (1/4 - 1/2 mi)	Average operating speed is 8-24 kph (5-15 mph) Stops as frequently as every 100-400 m (1/16 mi, a short block - 1/4 mi)	Average operating speed less than 8 kph (5 mph) to be compatible with pedestrian traffic.

Table 3-2. Planning Guidelines for Bicycle Facilities (Part 2 of 2)

Parameter (See Definitions)	Bicycle Expressways	Bicycle Boulevards	Bicycle Byways	Bicycle Access Facilities
Spacing of Facility Exits & Entrances (Notes 1 & 2)	Developed areas: 0.4 km (1/4 mi) Developing areas: Up to 0.8 km (1/2 mi)	Developed areas: 0.2 km (1/8 mi) Developing areas: Up to 0.8 km (1/2 mi)	Every intersection with streets, bicycle byways, parking lots and driveways	As needed to provide access to the door
Connections to Local Streets	Low / Medium	High	Bicycle byway is typically the local street	Low --> Very High Depends on Land Use
Access to Destination Entrances	Not Recommended	Medium	High	Very High
Minimum Facility Segment Length	3.2 km (2 mi)	1.6 km (1 mi)	Same as community local motor vehicle street standard	Adequate number of bicycle parking spaces adjacent to the front door of every destination
Target Trip Length (Note 1)	Trips > 3.2 km (2 mi) at least 1.6 km (1 mi) of travel on the bicycle expressway	Trips > 1.6 km (1 mi) at least 0.8 km (1/2 mi) of travel on the bicycle boulevard	Typically, 0.4 km - 1.6 km (1/4 to 1 mi)	Typically, < 200 m (1/8 mi) Trip end portions from right-of-way to the destination Includes parking lots & Very Common
Multi-Modal Use of Space with other, non-motorized modes (Note 3)	Rare --> Common High-speed, bicycle-only lane required in multi-modal situations	Rare --> Common Bicycle-only lane required in multi-modal situations	Very common	Network makes linkage automatic
Service/Linkage to Express Route Transit Stops	High Priority	High Priority	Network makes linkage automatic	Network makes linkage automatic
Volume (Notes 2 & 3)	Medium	High	Low --> Very High	Low --> Very High
Maintenance Requirements Standards & Schedule Required	High Snow removal standard is the same as minor arterial street standard Pavement maintenance is higher than minor arterial standard.	High Snow removal standard is the same as minor arterial street standard Pavement maintenance is the same as minor arterial standard	Low Snow removal standard is the same as local street standard. Pavement maintenance is higher than local street standard.	Low --> High Depends on location and traffic activity
Skill of User	Low --> High Many	Medium --> High Many	Low --> High Many	Low --> High Many
Personal Safety Issues	Especially if facilities are isolated from urban activity	Depends on location and level of street activity	Depends on location and level of street activity	Depends on location and level of street activity

1) 10-12 blocks = 1 mi

2) Depends on density of development, land use, traffic densities, the patterning of streets and other local conditions.
A fully developed area generally has more than 6 dwelling units per acre, a developing area has 1-3 dwelling units per acre.

3) Depends on the density of development and the degree to which the facility provides safe and convenient transportation.

Bicycle Expressways

- **Basic Characteristics**
- **Transportation Function**
- **Place Connections**

The purpose of bicycle expressways is to move cyclists the longest distances across metropolitan areas in the most time-efficient manner. Bicycle expressways are maximum distance facilities. They allow cyclists to achieve the highest cycling speeds and complete their trips with the least amount of interruption.

The number, quality and length of the facilities comprising a community's bicycle expressway network provide the means for the bicycle to compete with the automobile where trip travel times are concerned. Expressway networks should connect major employment, retail, commercial, industrial, residential and entertainment destinations in the city. Well-planned bicycle expressways should be located near other, medium scaled attractions, as well.

Because of their ability to provide competitive trip travel times with the automobile, bicycle expressway networks and roadways should receive a high priority in the modal prioritization process described in section 4.2.

Because of their function and high priority, it is recommended that all bicycle expressways be physically separated from motor vehicle and pedestrian traffic. Physical separation from other traffic requires either a vertical or horizontal spatial separation, as described in section 3.2.

A minimum configuration for a bicycle expressway must include at least one physically separated, high-speed, bicycle-only lane in either direction.

- **Multi-Modal Use of Space with other non-motorized modes**

Though bicycle expressways are high speed facilities, their ability to connect major attractions in the city may attract cyclists who do not have the skills to travel at high speeds. In addition, portions of expressways will usually provide some district-level or neighborhood-to-neighborhood connectivity. Their ability to connect these attractions with separation from motorized traffic, may also attract children on

Figure 3-27.

Bicycle expressways move cyclists the longest distances across metropolitan areas in the most efficient manner. Bicycle expressways are maximum distance facilities, allowing cyclists to achieve the highest cycling speeds and complete their trips with few interruptions.



bicycles, as well as other modes such as in-line skate, moped, tri-wheel, pedestrian, and wheelchair traffic.

For these reasons, it is highly recommended that expressway facilities provide *at least two* lanes for each direction of travel in the corridor. One lane can be used for higher speed travel and passing, and the other for slower moving traffic. This accommodates users with different skill levels and those who use more than 1.5 meters (5 feet) of space (e.g., tri-wheel vehicles, in-line skates, passing cyclists). This, however, is also a minimum configuration. For bicycle expressways that attract a sizeable volume and variety of user types, additional lanes should be when densities of use are expected to be high.

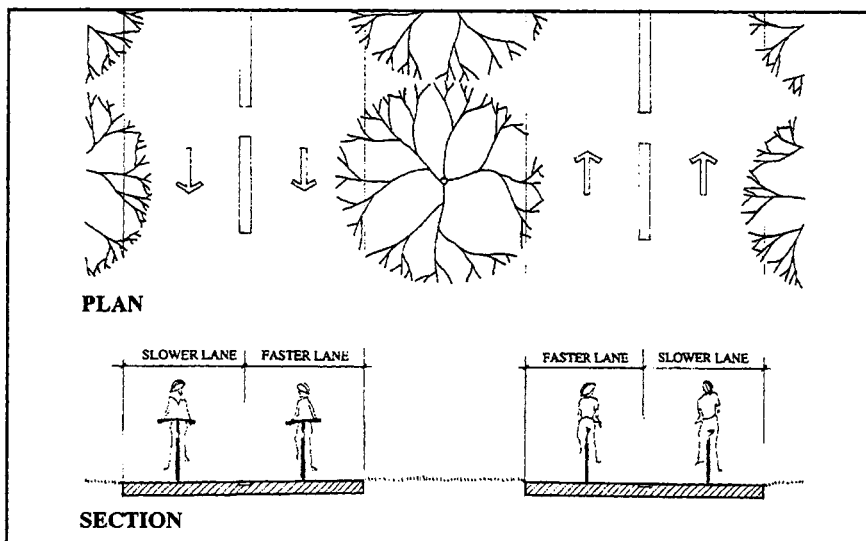
• Spacing of Facilities

The recommended spacing between bicycle expressways is 0.8 - 4.8 km (1/2 - 3 mi), depending on the density of development. However, bicycle expressways should ideally be spaced no more than 1.6 km (1 mi) apart in a rough grid form. This makes a high speed facility no more than 0.8 km (1/2 mi) away from any place in the community. A 3.2 km (2 mi) spacing between expressways is the maximum that is recommended in fully developed areas of 2.4 dwelling units per hectare (6 dwelling units per acre) or more. A wider spacing, up to 4.8 km (3 mi), can be used in less dense areas. Where feasible, corridors that run diagonally to a gridded urban pattern should be used for bicycle expressways in order to provide the most direct routes to major attractions.

In general, the denser the level of development, the closer the spacing of facilities. A closer spacing of facilities makes the bicycle system more convenient and, thus, attractive as transportation for larger numbers of people. A closer spacing of expressways also serves to reduce traffic density and traffic conflicts on each individual expressway in the network.

Figure 3-28.
A minimum configuration for a bicycle expressway must include one physically separated, high-speed, bicycle-only lane in either direction.

For bicycle expressways that attract a sizeable volume and variety of user types, additional lanes should be added when densities of use are expected to be high.



Implementation strategies, lack of funding and urban conditions may sometimes make it difficult or impossible to observe the recommended spacing of expressways. In such cases, bicycle boulevards and bicycle expressways can be used together to provide the linkages needed to create an efficient network system. Bicycle boulevards can be used to “fill in” for a bicycle expressway as long as *the combined spacing between bicycle expressways and bicycle boulevards does not exceed the recommended spacing for bicycle boulevards.*

- **Spacing of Facility Entrances & Exits**

The spacing of entrances and exits to bicycle expressways should be 0.4 km ($\frac{1}{4}$ mi) or less in fully developed areas and may be spaced as far as 0.8 km ($\frac{1}{2}$ mi) in developing areas. In some locations, specially designed entrance and exit access facilities must be constructed. This will occur when the facility is physically separated from other roadways, located in areas such as abandoned rail corridors or designed with strong horizontal or vertical separation barriers.

- **Continuity of Movement**
 - **Operation**

Bicycle expressways must achieve a very high degree of travel continuity. This means expressways should be designed to accommodate a 32 kph (20 mph) average operating speed and that they be as stop-free as possible. Bicyclists should be required to stop no more frequently than every 0.8 - 1.6 km ($\frac{1}{2}$ - 1 mi).

Network routes should also be configured to insure the most direct route to the various attractions served by the facility. To ensure maximum continuity of travel, intersection treatments should require the least amount of stopping for through traffic on the expressway. In many cases, more than one expressway lane might be necessary to allow for smooth exit and entrance to the expressway.

The spacing of stops is often the limiting factor in designating a facility an expressway. For example, it is often impossible to maintain the high degree of travel continuity required by bicycle expressways

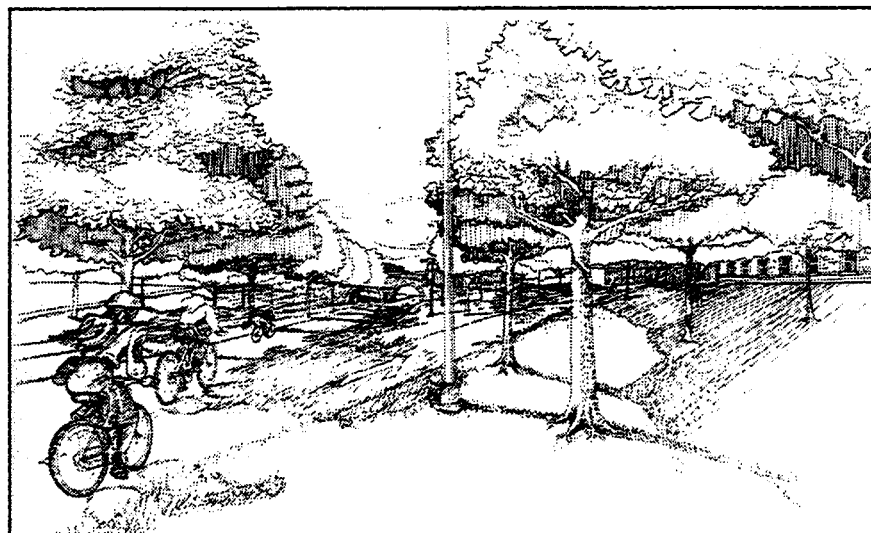


Figure 3-29. Specially constructed exit and entrance facilities are needed when the bicycle expressway is physically separated from other roadways or when strong horizontal or vertical barriers make access to and from the expressway impossible.

- **Connections to Local Streets**

- **Access to Destination Entrances**

when they are located in downtown areas. This is due to the frequent stops required in these busy, multi-modal locations. For these stretches, such a facility would have to be designated a bicycle boulevard or even, a bicycle byway, depending on the spacing of stops.

Though bicycle expressways provide connectivity across the longest distances, they usually connect fewer *numbers* of destinations than bicycle boulevards or bicycle byways. For example, some bicycle expressways could have their own dedicated corridor along former urban railways. Such expressways may provide connectivity to fewer numbers of discrete places than bicycle boulevards or byways which are located on city streets.

A bicycle expressway must maintain its high degree of travel continuity by maintaining the recommended spacing of stops for the cyclist moving on the expressway. Therefore, access to local streets

Figure 3-30.
A hypothetical bicycle friendly zone in the context of the surrounding urban area.

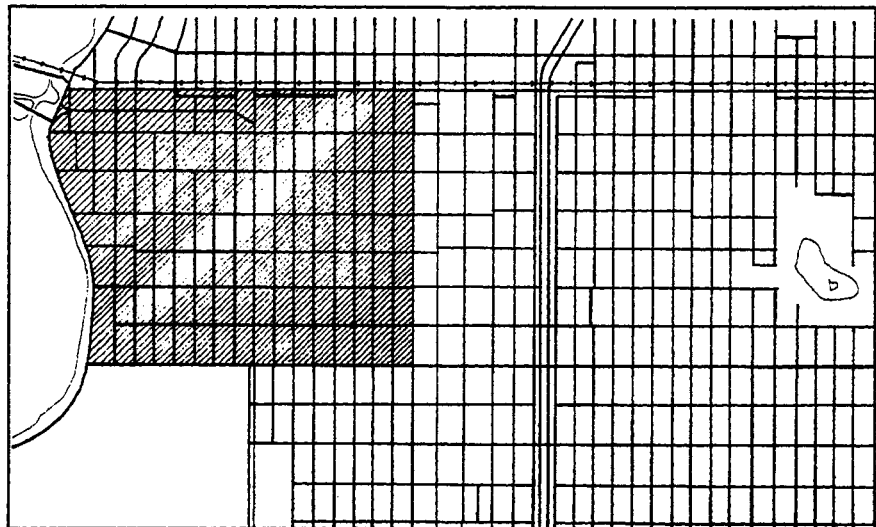
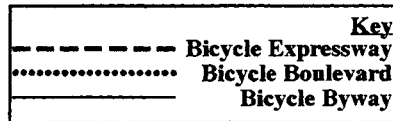
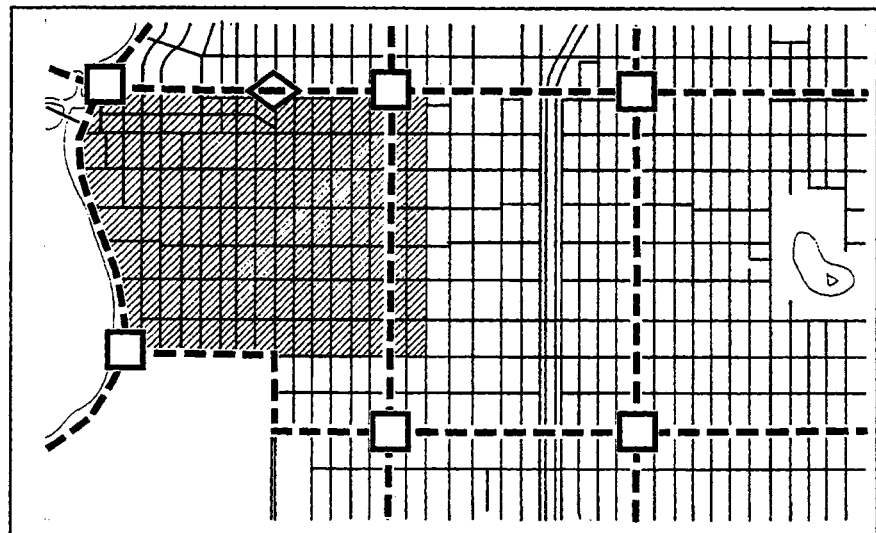
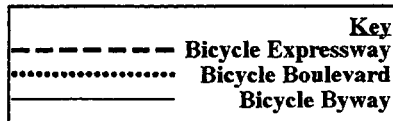


Figure 3-31.
An example of bicycle expressways in relation to the bicycle friendly zone.

When local streets (bicycle byways) intersect bicycle expressways, traffic on the local street must stop or yield, similar to local street intersections with arterial streets.



from expressways could be at a relatively low to medium degree of frequency, depending on the location of the facility and how it is designed.

In existing cities, bicycle expressways that are placed in former railway corridors could have a relatively limited number of access points to local streets. Others located on community streets dedicated to their use and local motor vehicle traffic or on city parkways could have more access to and from local streets. When local streets (bicycle byways) intersect bicycle expressways, traffic on the local street must stop or yield, similar to local street intersections with arterial streets. Expressways designed in new communities should have a dedicated corridor, so that designers can provide good access to local streets and still retain the expressway's requirement for uninterrupted through movement.

Direct access to the doors of places in the community would significantly degrade the continuity and efficiency of travel on express-

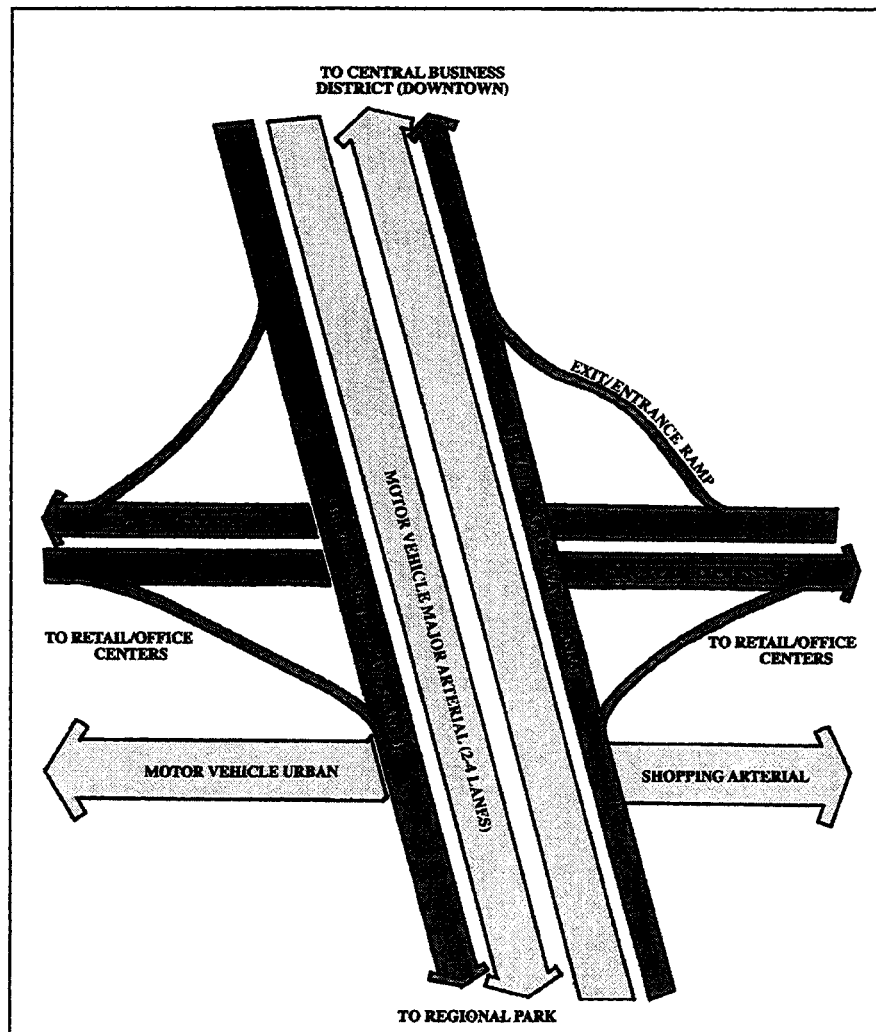


Figure 3-32.

The intersection of two, well-planned bicycle expressways that provide a high degree of continuity and a high number of direct connections to major destinations in the city.

- **Minimum Facility Segment Length**
- **Target Trip Length**
 - **Volume**
- **Maintenance and Repair**

ways. Such access is not recommended from bicycle expressways.

Bicycle expressways connect the most destinations that are the most remote from each other. To provide useful transportation service to cyclists, they should be no less than 3.2 km (2 mi) in length and depending on the size of the urban area could serve destinations that are 8 km (5 mi) or more apart.

Experience in European cities that accommodate bicycle transportation has shown that the bulk of bicycle trips are around 3.2 km (2 mi) in length, and the medium-sized facilities (bicycle boulevards) carry the greatest volumes of cyclists. This supports the trip distance and trip travel time statistics for the United States, described in section 4.1. The average trip length expected on bicycle expressways is 3.2 km (2 mi) with 1.6 km (1 mi) on the bicycle expressway.

The volume statistics from Europe do not mean however, that some bicycle expressways, particularly sections of well-placed expressways will not receive heavy volumes of traffic. Expressways that connect destinations of high attraction could receive volumes of cyclists equal to those of medium-sized facilities and should be planned accordingly. (Also see “Multi-Modal Sharing of Space with Other, Non-Motorized Modes,” above.)

Bicycle expressways must have their own maintenance and repair standards and schedules. The pavement maintenance standard must be higher than the standard for minor arterial streets.

In addition, bicycle expressways should be open year-round and they must receive high priority for snow and ice removal. Their snow removal standard should be the same as for minor arterial streets. On facilities that parallel motor vehicle facilities, snow from the street must not be stored on the bicycle expressway.

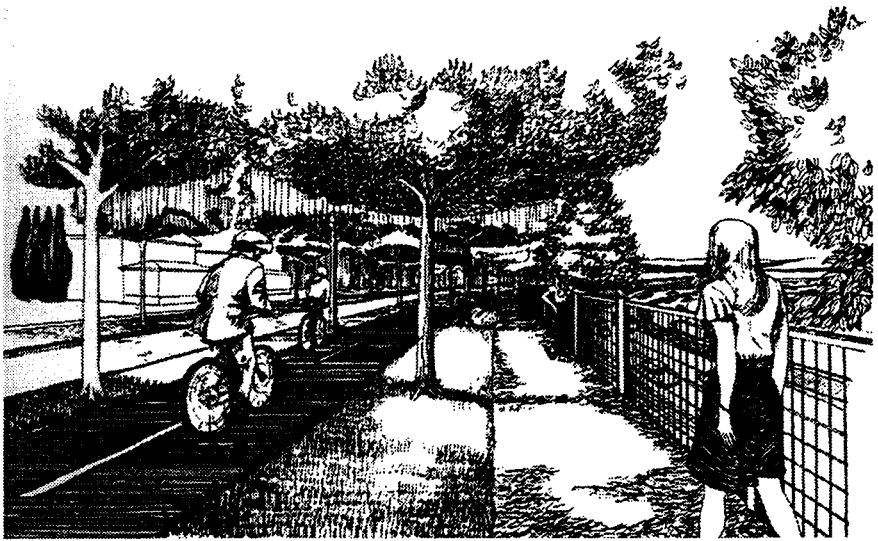


Figure 3-33.
A bicycle expressway through a residential area of the city following along the top of the bank for the abutting, depressed urban interstate highway

- **Service/Linkage to Transit Stops**

Access to high speed or express route transit stops should be given high priority in the planning of expressway routes and the design of expressway facilities. Because of their relative fast pace and high degree of travel continuity for the cyclist, access to local route transit stops can receive a medium priority on bicycle expressways.

In general, designers should provide orderly exit and entrance facilities between transit stops and expressways. This is particularly true if the transit stop is directly adjacent to the expressway or when the spacing of transit connections is more frequent than the recommended minimum 1 mile spacing of stops for cyclists using bicycle expressways.

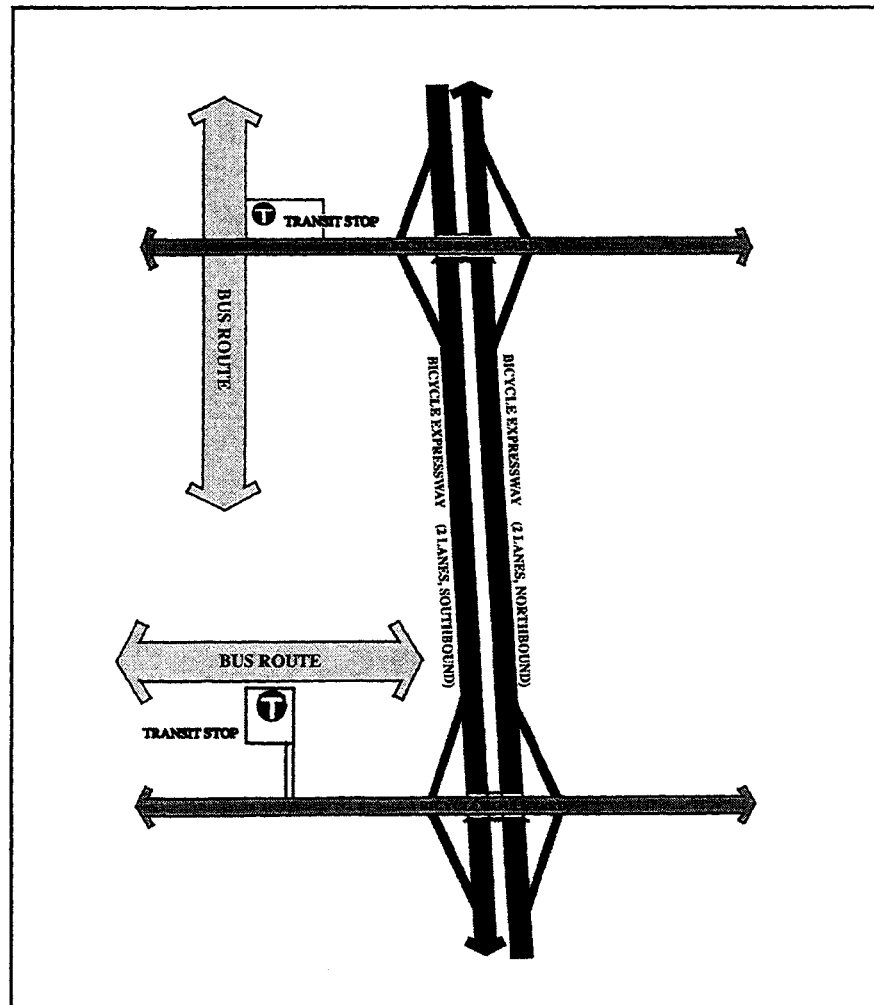


Figure 3-34.

A schematic placement of bicycle expressways in relation to major urban transit stops and transit routes. Note the connection to transit from bicycle expressways via bicycle boulevards. Major transit stops should have abundant bicycle parking.

Bicycle Boulevards

- **Basic Characteristics**
- **Transportation Function**
- **Place Connections**

Bicycle boulevards are intended to provide a high degree of connectivity within and between neighborhoods and districts of an urban area. Bicycle boulevards provide this connectivity at a smaller scale and a lower speed than the bicycle expressway.

Well-planned bicycle boulevards should connect the entire city in networks of boulevards. Bicycle boulevards should provide a web of connections between neighborhood and district attractions in the city. Major city-wide attractions are not exclusively in the realm of the bicycle expressway and should also be included in the networks of bicycle boulevards. Thus, cyclists who are not conveniently serviced by the bicycle expressway system can cross the city and access all places in the city using networks of bicycle boulevards.

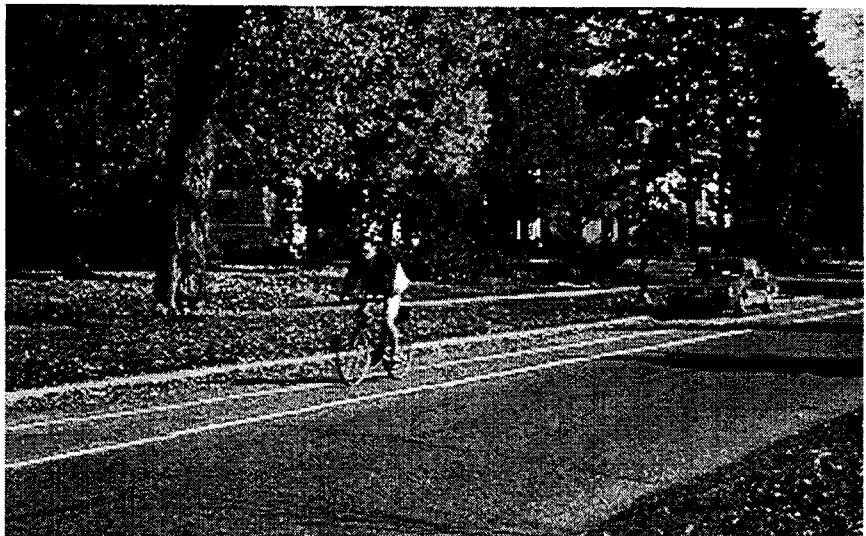
Because of their ability to provide connectivity to all places in an urban area, bicycle boulevards should receive a medium or high priority in the modal prioritization process described in section 4.2. The priority of each bicycle boulevard will depend on its location, its expected volume, and the diversity of users that the bicycle boulevard serves.

Bicycle boulevards provide maximum connectivity to metropolitan activity but should retain a medium degree of travel continuity. They will provide most of the cycling transportation function in the city — for those trips that are 0.8 - 3.2 km ($1/2$ - 2 mi) from home (see section 4.1).

All multi-modal bicycle boulevards must have a minimum of one lane dedicated to bicycle use for each direction of bicycle travel.

Figure 3-35.
Bicycle boulevards provide a high degree of connectivity within and between neighborhoods and districts in an urban area. Well-planned systems of bicycle boulevards should connect the entire city in networks of bicycle boulevards.

Thus, cyclists who are not conveniently serviced by the bicycle expressway system can cross the city and access all places in the city using the bicycle boulevard system.



- **Multi-Modal Use of Space with other non-motorized modes**

- **Spacing of Facilities**

In some cases, the high degree of connectivity that bicycle boulevards offer at a lower speed, together with its smaller contextual scale may attract high volumes of users, thereby necessitating the establishment of more than one dedicated lane on the boulevard.

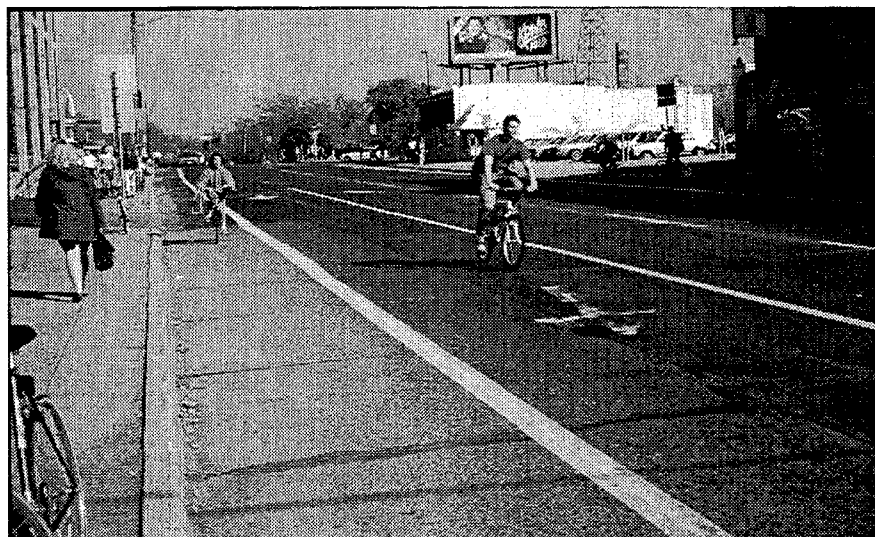
A bicycle boulevard will often be part of a city street or will be a street dedicated to the bicycle boulevard. Because of this, the design of the corridor and the intersections of the bicycle boulevard will need to respond to the specific context of the neighborhood, the street, and motorized and non-motorized traffic conditions.

The ability of bicycle boulevards to provide the maximum connectivity to community destinations may attract cyclists with varying skills, as well as children on bicycles and other modes such as in-line skates, moped, tri-wheel, wheelchair, and pedestrian traffic. Planners and designers must anticipate the kinds of use that bicycle boulevards will receive. This will largely depend on the location of the facility, the land use surrounding it, the major and minor urban destinations it serves, and anticipated volumes. It may even be necessary to provide more than two lanes and designations of lane use for each lane (e.g., bicycle, in-line skate, pedestrian).

The recommended spacing between bicycle boulevards is 0.8 - 2.4 km ($1/2$ - $1\frac{1}{2}$ mi), depending on the density of development. However, bicycle boulevards should ideally be spaced no more than 0.8 km ($1/2$ mi) apart. This makes a high speed facility no more than 0.4 km ($1/4$ mi) away from any place in the community. A 1.6 km (1 mi) spacing between bicycle boulevards is the maximum that is recommended in fully developed areas of 2.4 dwelling units per hectare (6 dwelling units per acre) or more. A wider spacing, up to 2.4 km ($1\frac{1}{2}$ mi), can be used in less dense areas.

Figure 3-36.

All multi-modal bicycle boulevards must have a minimum of one lane dedicated to bicycle use for each direction of bicycle travel. The high degree of connectivity that bicycle boulevards offer at a lower speed and a smaller contextual scale may also necessitate the establishment of more than one dedicated lane on the boulevard.



The spacing of entrances and exits to bicycle expressways should be 0.2 km ($1/8$ mi) or less in fully developed areas and may be as far as 0.8 km ($1/2$ mi) in developing areas. This should not be difficult to provide since most bicycle boulevards will be placed on existing streets.

In general, the denser the level of development, the closer the spacing of facilities. A closer spacing of bicycle boulevards makes the bicycle system more convenient and more attractive as transportation for larger numbers of less skilled and less experienced bicycle riders. A closer spacing could help to encourage the non-cycling public to use the bicycle as transportation and will also reduce traffic density and traffic conflicts on individual boulevards in the network.

Implementation strategies, lack of funding and urban conditions may sometimes make it difficult or impossible to observe the recommended spacing of facilities. In such cases, bicycle boulevards and bicycle expressways can work in concert to create an efficient network system, as discussed previously under Bicycle Expressways. Bicycle boulevards can be used to “fill in” for a bicycle expressway as long as *the combined spacing of bicycle expressways and bicycle boulevards does not exceed the recommended spacing for bicycle boulevards*. Designers of bicycle boulevards should anticipate the impact of their use in lieu of a higher speed facility and should plan and design the boulevard accordingly.

- **Spacing of Facility Entrances & Exits**

The spacing of entrances and exits to bicycle boulevards should be 0.2 km ($1/8$ mi) or less in fully developed areas and may be as far as 0.8 km ($1/2$ mi) in developing areas. This should not be difficult to provide since most bicycle boulevards will be placed on existing streets.



Figure 3-37. Entrance and exit to bicycle boulevards will often be made from bicycle byways; that is, the local street system. Designers should anticipate conflicts with this kind of access and design the bicycle boulevard accordingly.

- **Continuity of Movement**
- **Operation**

Bicycle boulevards should provide a medium degree of travel continuity. This means that boulevards should be designed to accommodate a 16 - 24 kph (10 - 15 mph) average operating speed and that they be planned so that cyclists are required to stop no more frequently than every 0.4 - 0.8 km (1/4 - 1/2 mi).

Network routes should be configured to insure the most direct route possible to the various land use attractions served by the boulevards. However, interruption of travel can be tolerated to a degree, depending on the land use that the facility serves. For example, a bicycle boulevard routed through a small to medium-size retail area may accommodate a number of stops.

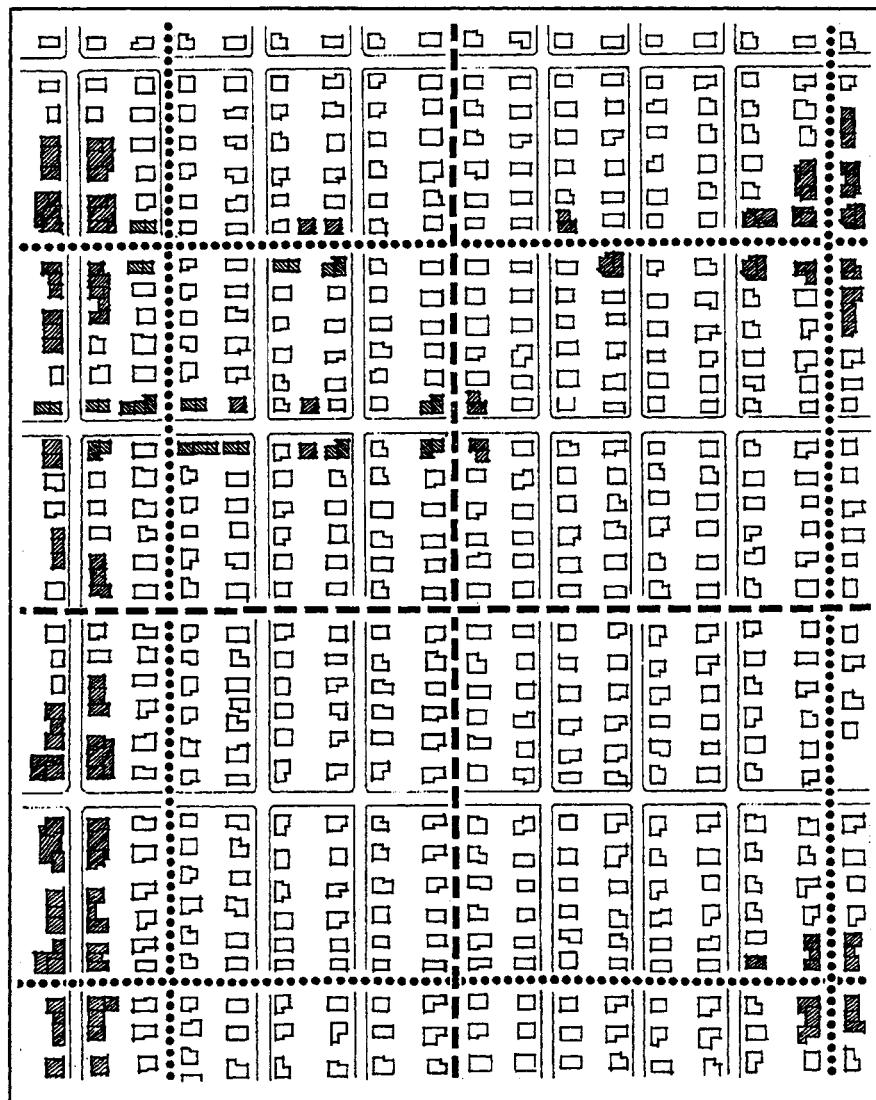


Figure 3-38.

A well-planned system of bicycle boulevards that allows a medium level of travel continuity and place connections throughout a bicycle friendly zone.

Key	
-----	Bicycle Expressway
.....	Bicycle Boulevard
————	Bicycle Byway
▧	Residential
▩	Commercial

• **Connections to Local Streets**

Bicycle boulevards connect a larger *number* of places than do bicycle expressways, though the the average trip lengths they serve may not be as great. Even though individual segments of the boulevard network may not cover distances as great as expressway segments, a well-planned network of bicycle boulevards should connect the major destinations of the entire city.

Because of their high degree of connectivity to places in the community, bicycle boulevards should provide a high degree of access to local streets. This should not be difficult since most bicycle boulevards will be placed on existing community streets. In new developments, planners and designers should provide this kind of access so that bicycle boulevards are convenient to every neighborhood or district attraction.

Figure 3-39.
The bicycle friendly zone showing an arrangement of bicycle boulevards.

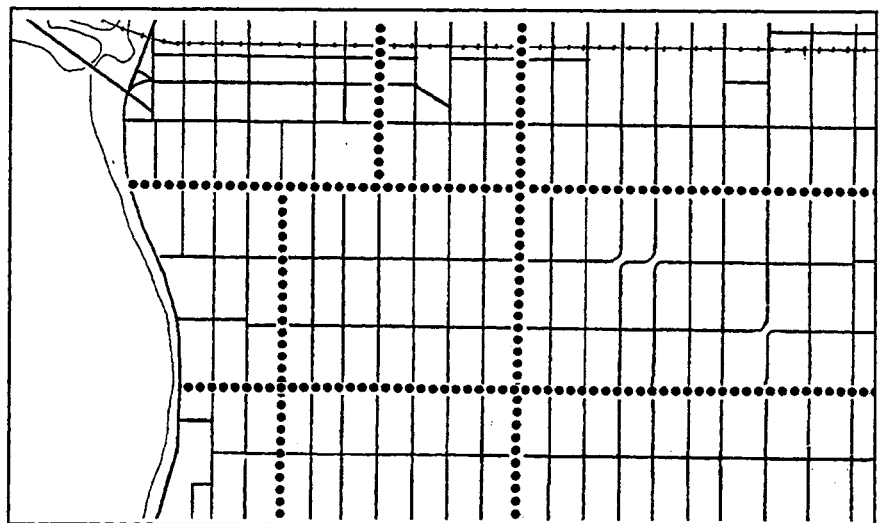
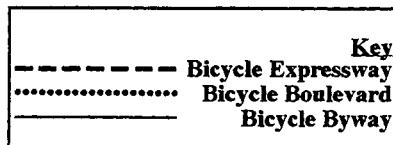
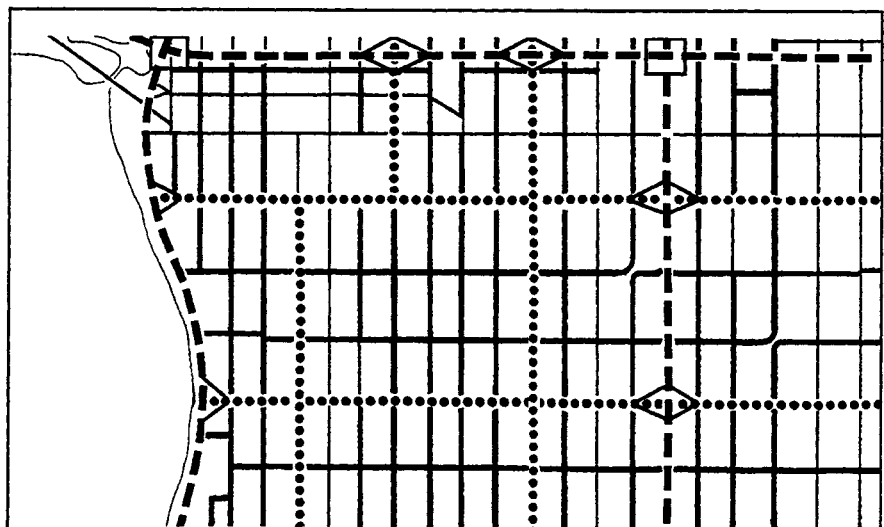
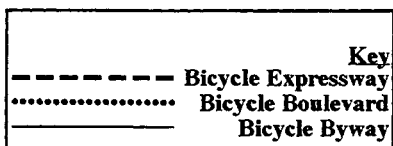


Figure 3-40.
The bicycle friendly zone showing the bicycle boulevards in combination with the bicycle expressways. The combination begins to form an interactive network of specialized facilities to support bicycle transportation. Notice the connections to local streets (bicycle byways) and to bicycle expressways



- **Access to Destination Entrances**

Direct access to the doors of places in the community is not recommended where bicycle boulevards directly pass by community destinations, access to these destinations should be accommodated using bicycle transition facilities (see bicycle access facilities). In medium and heavy traffic, access to destination entrances should be accommodated in a controlled and safe manner.

- **Minimum Facility Segment Length**
- **Target Trip Length**

Bicycle boulevards connect community destinations and should be routed through and between neighborhoods and districts of the city. To provide any community transportation service at all, they should be no less than 1.6 km (1 mi) in length. It is expected that the average trip length on bicycle boulevards will be trips greater than 1.6 km (1 mi), with at least 0.8 km (¹/₂ mi) on the boulevard.

- **Volume**

Because of their connectivity to many place destinations, bicycle boulevards will probably carry the highest volumes of bicycle traffic in the city. It is the bicycle boulevard that will carry most of the shorter trips which make up the bulk of daily travel. Experience in European cities which accommodate bicycle transportation has also shown that the bulk of bicycle trips are around 3.2 km (2 mi) in length and it is the medium-sized facilities that carry the greatest volumes of cyclists.

It is important that planners and designers anticipate these volumes and create multiple lanes where necessary. If space does not permit multiple lanes, the widest recommended lane width (according to state or local standards) should be used. The multi-modal, non-motorized use of the facilities should also be anticipated (see “Multi-Modal Use of Space with Other, Non-Motorized Modes,” above).

- **Maintenance and Repair**

Because of the high number of places they connect and the volumes of travellers they serve, bicycle boulevards should receive the same high degree of year-round maintenance as the bicycle expressway.

In severe winter climate conditions, many cyclists will curtail their bicycle use to destinations nearer to home. Therefore, if a trade-off is necessary between maintaining a network of bicycle boulevards or the expressway network in winter, communities may choose to maintain the boulevards in order to provide a high degree of connectivity.

Since bicycle boulevards are often located on the street, planners and designers in snowy climates should ensure that there is room for snow storage in the right-of-way so that the bicycle facility is not used for this purpose.

Bicycle boulevards must have their own maintenance and repair standards and schedules. The pavement maintenance and the snow removal standards should be the same as the standard for minor arterial streets.

- **Service/Linkage to Transit Stops**

Access to high speed or express route transit stops should be given high priority in the planning of boulevard routes and the design of boulevard facilities. Because of their high degree of community connectivity, bicycle boulevards should also provide connections to all transit route stops. With their 800 meter (1/2 mile) spacing interval and their relatively high degree of travel continuity, bicycle boulevards will provide the most attractive intermodal transit option to the most people. Planners should anticipate and accommodate heavy use of intermodal transit connections on bicycle boulevards.

Designers should anticipate the exit and entrance requirements between transit stops and bicycle boulevards. This is particularly true when the transit stop is directly adjacent to the boulevard or when the bicycle boulevard has a high volume of use. Note, since bicycle facilities are usually located in or near the same roadway space as transit facilities and transit stops, extreme care must be taken in designing both to avoid conflicts between transit vehicles, bicycles and transit passengers. Additional care must be taken to provide safe and convenient access to transit stops from bicycle boulevards located on busy arterial streets.

Figure 3-41.

The integration of bicycle networks and transit systems significantly strengthens each.

The provision of transit in conjunction with bicycle transportation should be a high priority in community transportation planning.

Planners and designers should make access and parking at transit facilities more convenient for cyclists, than motorists.

At this medium-size stop, more cyclists have convenient access than motorists.



Bicycle Byways

- **Basic Characteristics**
- **Transportation Function**
 - **Place Connections**
- **Multi-Modal Use of Space with other non-motorized modes**

Bicycle byways are intended to provide a high degree of access and connectivity within the neighborhood. In most cases, bicycle byways are shared roadways and will be the existing local (mostly residential) streets and alleys. They also include bicycle shortcuts through spaces that cannot accommodate motor vehicles.

Local streets are multi-modal, multi-use streets. Byways connect the residence to low volume neighborhood attractions and provide the connective fabric to and from bicycle boulevards and expressways. In most cases, the bicycle byway will initially be achieved by redesignating the function of local streets as bicycle byways, with any physical modifications being achieved incrementally over time.

The major attribute of bicycle byways is their location on streets where a number of people, including children, could be present, and where a wide variety of activities take place. Any mode of personal transportation can be found using this roadway space. In streets like these, motor vehicles should have the lowest priority of use. The pedestrian, or the individual — particularly children — must have the highest priority. In between, other human-scaled, non-motorized modes, such as the bicycle, find their priority.

Note also, the bicycle facilities on some urban retail arterial streets will be bicycle byways. Traffic conditions on these busy streets necessarily put the bicycle travel on them in the category where operating speeds and frequency of stops are within the range defined for bicycle byways. Planners and designers should therefore be prepared to provide other features of the bicycle byway on these kinds of facilities.

Today, the local street network is composed of corridors that do not clearly articulate their use as multiple-use places in the neighborhood. Today's local streets are usually streamlined and wide — roads that should be used for many purposes. However, in most newer devel-

Figure 3-42.

Bicycle byways provide a high degree of access and connectivity within the neighborhood. They are usually located on existing local streets and alleys and include bicycle shortcuts through spaces that cannot accommodate motor vehicles.

Bicycle byways provide:

- **Connections from the residence to low volume neighborhood attractions.**
- **The connective fabric between bicycle boulevards and bicycle expressways.**
- **Bicycle travel on busy retail arterial streets.**



opments, and on many busy urban retail arterials, the streets are so wide, they are often abandoned to nearly exclusive use by the car, — becoming movement conduits in practice. Wide streets that are home to many different kinds of human activity are often dangerous because it is possible for motor vehicles to use the roadbed at inappropriately high speeds.

At its core, the bicycle byway embraces the second principle that was set forth at the beginning of this chapter: *if all traffic can be slowed to approximately the same speed in the same space, then the space can be shared by all traffic.*

According to AASHTO, the proportion of service for the local street should be predominantly for access to land, not mobility.⁸ In performing such access, motor vehicles maneuver to park or to enter

Figure 3-43.
A schematic representation of the bicycle friendly zone showing an arrangement of bicycle byways.

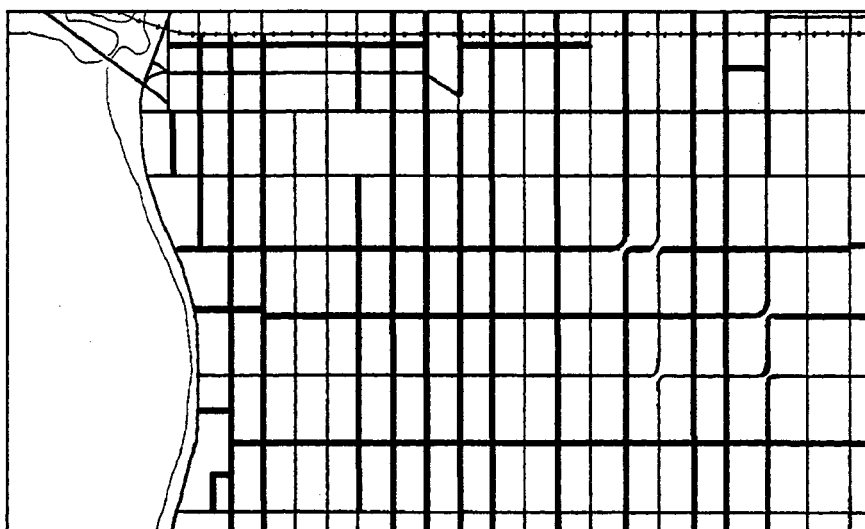
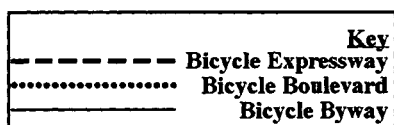
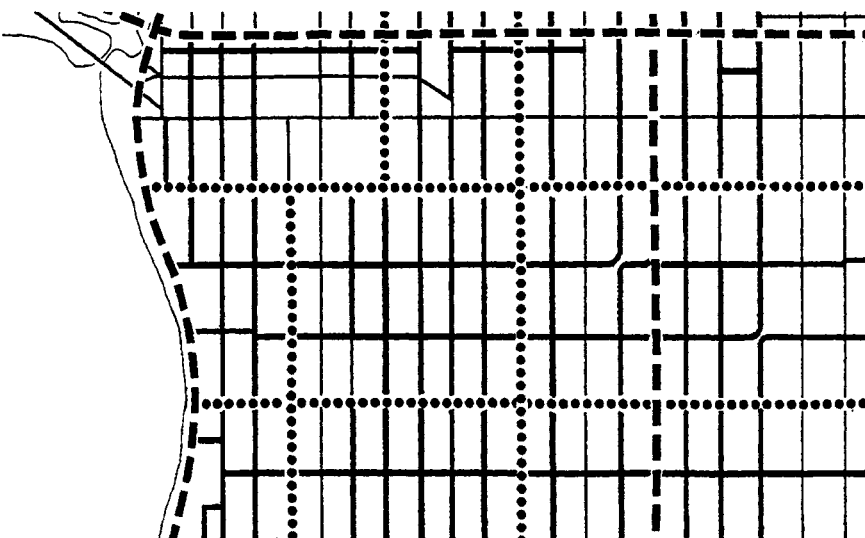
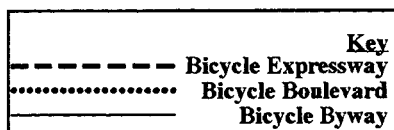


Figure 3-44.
The bicycle friendly zone showing bicycle byways added to the bicycle boulevard and expressway network. The combination completes the interactive network of specialized facilities for bicycle transportation.



driveways, not only interrupting through movement but also crossing pedestrian paths. Bicycles need to do this too — at lower speeds than the through speeds found on bicycle boulevards and expressways.

The lowest common denominator of speed on the local street is the pedestrian. The idea of the bicycle byway is to slow down traffic to create compatibility among pedestrians, bicycles and motor vehicles in a place where the focus is slow-speed maneuvering for access. The idea of a bicycle byway *is not* to achieve sustained speeds of travel for efficient through movement.

By using the principle of slowing all modes to create shared-space bicycle byways on local streets, it is possible to create the bulk of the miles of bicycle facilities in a bicycle friendly zone with minimal initial expense. Initial designation can be made by means of policy and reinforced by signage. Additional improvements can then be made over time with an orderly budgeting, funding and construction process. By this means, local streets would become shared neighborhood places for people to go *to*, rather than conduits for vehicles to go *through*.

While signs, policy and paint will set space aside for bicycle byways, additional physical changes will make the street more habitable for all users and inspire pride of place in the residents and business owners in the neighborhood. Many of these improvements fall into the category of traffic calming techniques (see section 5.2).

In Europe, traffic calming techniques are used to design and engineer the local street to restore its traditional status as a place for people to meet. The physical design of these streets makes it impossible for the motorist and the cyclist to speed. Designers and decision-makers should seriously consider using traffic calming techniques to reinforce the designation and signage of local streets as shared-space, bicycle byways.

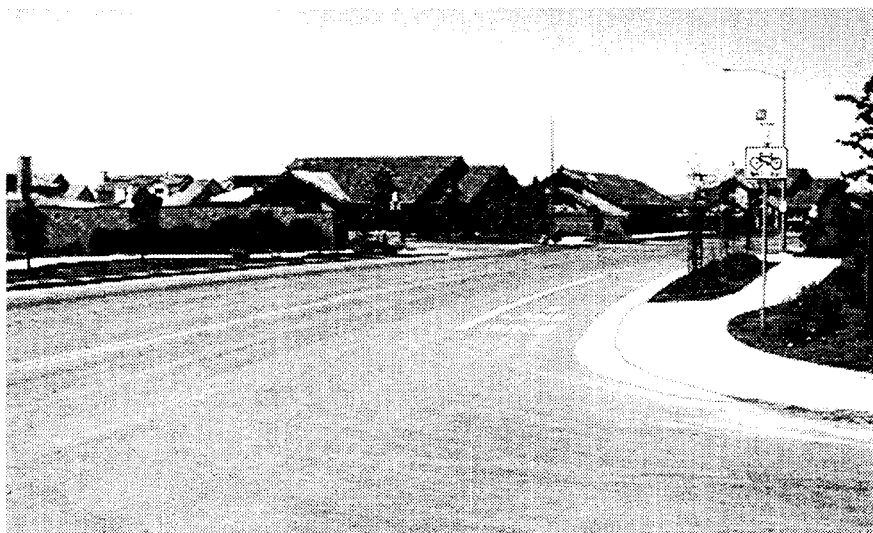


Figure 3-45.

A suburban street.

Notice the relative amounts of space allocated for motor vehicles, bicycles and pedestrians.

The design of the street is prohibitive of multi-use activities on a daily basis and designers have even walled the residences off from this street.

To encourage better bicycle byways, some designs for traffic calmed local streets provide special, small scale bicycle facilities. However, the facilities are designed to defer to other non-transportation use of the street. The “brush stroke” used in their design is so light, that it is difficult to describe them with the term “facilities” — they are bicycle byways through the near neighborhood.

Traffic calming techniques should also be used on busy urban arterials where bicycle byways are located. The techniques should be used to demarcate space in a physical way, to promote the traffic compatibility of all modes and to slow motor vehicles and bicycles, as necessary.

Though there are numerous techniques for designing traffic calmed streets, their specific design must respond to the use and the context of the street. Traffic calming design relies on the ingenuity and the imagination of the designer, the engineer and neighborhood residents who will usually, at some point, also participate in the design process. Section 5.2 describes the basic principles that are used in traffic calming and shows some illustrative examples of traffic calmed streets that respond to the context and ambience of the street.

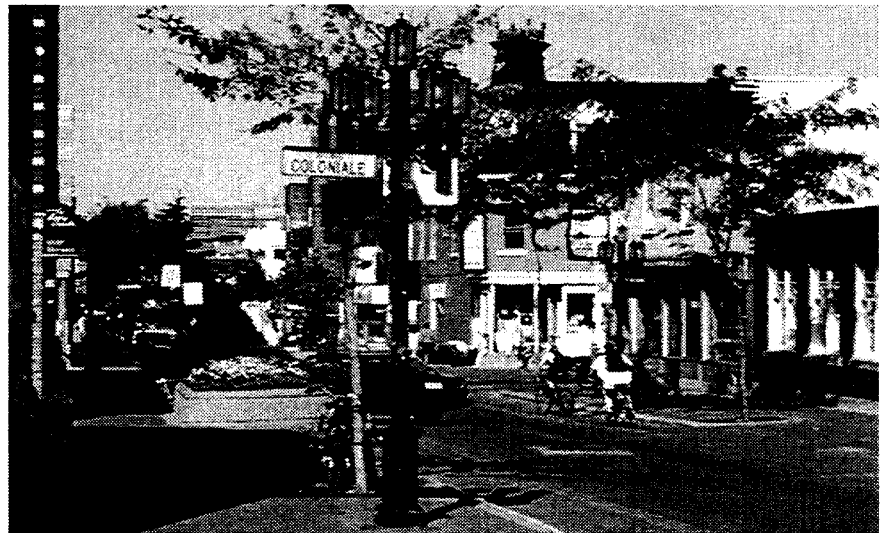
Since bicycle byways are located on multi-use streets, their degree of sharing of the roadway space with others — people and vehicles — is very high. Many bicycle byways on local streets will be host to cyclists of an extreme range of skills — from the most-skilled cyclist to the physically impaired cyclist or the child learning to ride a bike.

Bicycle byways should be designed to only permit a slow speed of bicycle travel and to promote traffic compatibility of pedestrians, bicycles and motor vehicles.

Figure 3-46.

A bicycle byway through a neighborhood retail node in Montreal, Canada.

Traffic calming techniques are used to reduce motor vehicle speeds to those of the bicycle and pedestrian. The entire street is designed to permit multi-modal access and multi-use activities at a human scale.



- **Continuity of Movement**

Continuity of travel on bicycle byways is extremely low. Byways are primarily for access and arrival, not through movement. The frequency of stops or interruptions can be high, though the directness of byway routes can be very attractive because byways comprise the finest grained fabric of city streets.

- **Operation**

The average operating speed on a bicycle byway is low — in the range of 8 - 24 kph (5 - 15 mph). On byways with a high degree of activity, bicyclists should be expected to behave as pedestrians, traveling at pedestrian speeds of approximately 8 kph (5 mph). The design of the street and the bicycle byway will directly influence the behavior of cyclists and motorists and should only permit slower pedestrian-compatible speeds, where desired.

The purpose of bicycle byways is to provide access and movement through the near-neighborhood. In most urban areas, bicycle byways on which there are no stops for 400 m ($\frac{1}{4}$ mi) would be functioning at a level higher than the byway. In dense urban areas, bicyclists could be expected to stop every 100 m ($\frac{1}{16}$ mi) on a bicycle byway. However, in outlying and suburban areas where density is low, the spacing of stops on bicycle byways may be more than 400 m ($\frac{1}{4}$ mi).

Even though bicyclists on byways will usually encounter stops or slow downs within a 2 block distance, some byways could provide a slow, through movement for approximately 2 blocks. This again, depends on location and use of the street.

- **Connections to Local Streets**

- **Access to Destination Entrances**

- **Target Trip Length**

Because of their location on local streets, bicycle byways connect a very high number of places, though their running distances can be very short. Bicycle byways also connect bicycle boulevards and expressways to all destinations. Direct access to the doors of residences and other places in the near-neighborhood is the norm.

The average expected trip length on a bicycle byway is 0.4 - 1.6 km ($\frac{1}{4}$ - 1 mile). However, bicycle byways form the finest grained connective fabric of the city because they coincide with every local street. Therefore, cyclists could travel great distances using only bicycle byways. In a given area, the total miles of bicycle byways should exceed the combined total miles of bicycle expressways and boulevards.

Figure 3-47.

Traffic calming techniques are effective on bicycle byways to slow the speed of cyclists and motorists, indicating their deference to the role of the street as a place in the near-neighborhood.

To encourage better bicycle byways, some designs for traffic-calmed streets provide special, small scale bicycle facilities.

However, the facilities are designed to defer to other non-transportation use of the street.



• **Volume**

Traffic volumes and the general use of the local street is highly dependent on a variety of contextual factors including land-use; time of day; the age, habits and whims of the residents of the near-neighborhood. Traffic volumes and the general use of busy urban arterials are often always high.

The volume of bicycle use on local streets depends on the location of the street. For example, byways may be only used by the people living along the street. But, if the street is located on a convenient route to an attraction in the near-neighborhood (e.g., neighborhood stores) or to a nearby bicycle boulevard or expressway, the volume of use could be relatively high when compared with other byways in the area. The volume of cyclists on urban retail or commercial arterials could be very high.

• **Maintenance and Repair**

Designers of bicycle byways should anticipate the volume of bicycle traffic on the byway and use traffic calming techniques to modify cyclist (and motorist) behavior to accommodate all uses on the street.

Bicycle byways are highly integrated with the local streets on which they are found. Pavement standards for the byway itself should be equal to or higher than standards of the local street. Standards and schedule for snow and ice removal, may coincide with those for the local street.

Likewise, pavement, maintenance and snow and ice removal standards for bicycle byways on busy urban arterials should be the same as for the arterial. Since these kinds of bicycle byways are located on the street, planners and designers in snowy climates should ensure that there is room for snow storage in the right-of-way so that the bicycle space is not used for this purpose.

• **Service/Linkage to Transit Stops**

Because of their high degree of connectivity to residences in the near-neighborhood, the byway system will automatically provide a high degree of bicycle access to transit stops. Note, since bicycle facilities are usually located in or near the same roadway space as transit facilities and transit stops, extreme care must be taken in designing both to avoid conflicts between transit vehicles, bicycles and transit passengers. Additional care must be taken to provide safe and convenient access to transit stops from bicycle byways located on busy arterial streets.



Figure 3-48.
Bicycle byways may not look very different from traditional local streets.

Bicycle Access Facilities

- **Basic Characteristics**
- **Transportation Function**
 - **Place Connections**
- **Multi-Modal Use of Space**
with other non-motorized modes

Bicycle access facilities aid the cyclist in moving comfortably, conveniently, and safely between bicycle expressways, boulevards or byways and the entrances (or doors) of their destinations. There are two kinds of bicycle access facilities:

- Bicycle parking facilities, and
- Transition facilities that provide a clear, safe path from the roadway to the bicycle parking facilities.

Transition facilities are designed and engineered to prevent conflicts between cyclists and motor vehicles or pedestrians on the trip segment between the roadway and the bicycle parking facilities. Transition facilities are not always required. However, planners, designers and

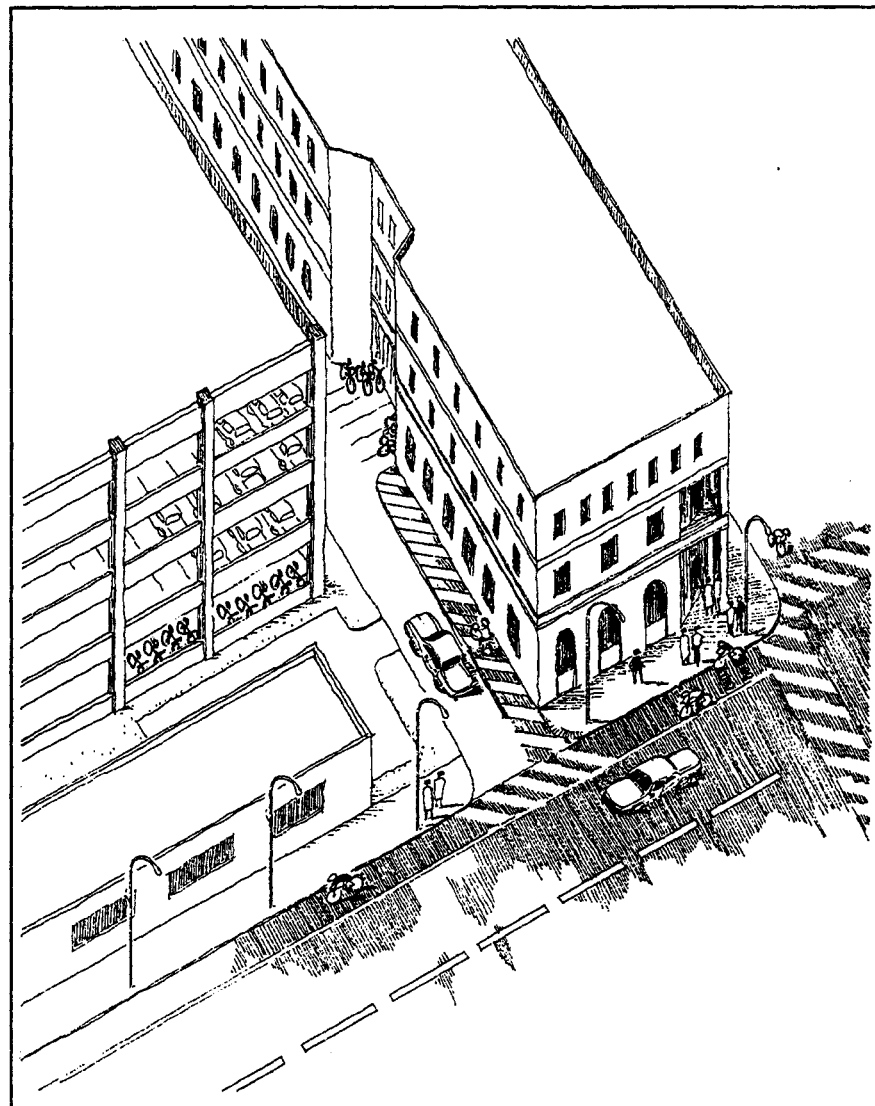


Figure 3-49.

There are two kinds of bicycle access facilities:

- **Parking facilities**
- **Transition facilities that are designed and engineered to prevent conflicts between cyclists and motor vehicles or pedestrians.**

All bicycle access facilities should defer to the use of the space by pedestrians.

communities should be prepared to provide them when they are necessary.

The potential for conflict depends on the context within which the bicycle access operates and the amount or degree of pedestrian and motor vehicle conflict at the parking facility. Designers should anticipate potential conflicts, avoiding them with traffic calming techniques, signage and adequate space.

All bicycle access facilities should defer to the use of the space by pedestrians.

In streets where there is heavy pedestrian or heavy motor vehicle traffic, designers and engineers should provide a means by which cyclists can move from the bicycle roadway to the parking area in an orderly fashion that ensures the safety of pedestrians and cyclists. Because of their proximity to the door, bicycle access facilities will often coincide with pedestrian space on the street and should, therefore, always be designed at a pedestrian scale. While travelling to a parking facility across pedestrian space, cyclists should be expected to behave as pedestrians. The design of the transition space should suggest and control this kind of behavior on the part of cyclists.

Cyclists should also not be obligated to stop, walk or abruptly turn their bicycles in the bicycle roadway in order to reach their destinations. As with bicycle byways, whenever there is a potential for accident due to modal conflicts at bicycle access facilities, traffic calming techniques should receive primary consideration as the solution to the problem.

Bicycle parking facilities will often share their space with others. In some parking situations, bicycles may share their space with motor vehicles, as well as pedestrians. Bicycle transition facilities may also be required when a portion of a parking ramp is allocated for bicycle



Figure 3-50.

To encourage bicycle transportation, the entrances of destinations in the community should be made more accessible to the bicycle than they are for the motor vehicle. Therefore, plenty of bicycle parking should be provided near the entrances of *all* places in the community.

parking. The design of the ramp may need alterations to safely guide cyclists to their parking area. The parking lots of large shopping facilities may also require transition facilities between the roadway and the bicycle parking area to comfortably and safely accommodate cyclists within the large expanse of parking allocated to automobiles.

Bicycle access facilities must always include parking facilities as near to the door as possible. To encourage bicycle transportation, the entrances of destinations in the community should be made more accessible to the bicycle than they are for the motor vehicle. Therefore, plenty of bicycle parking should be provided near the entrances of *all* places in the community. Lack of an adequate number of parking spaces will definitely reduce the numbers of people who will use the bicycle as transportation. If there is no place to park the vehicle at the end of the

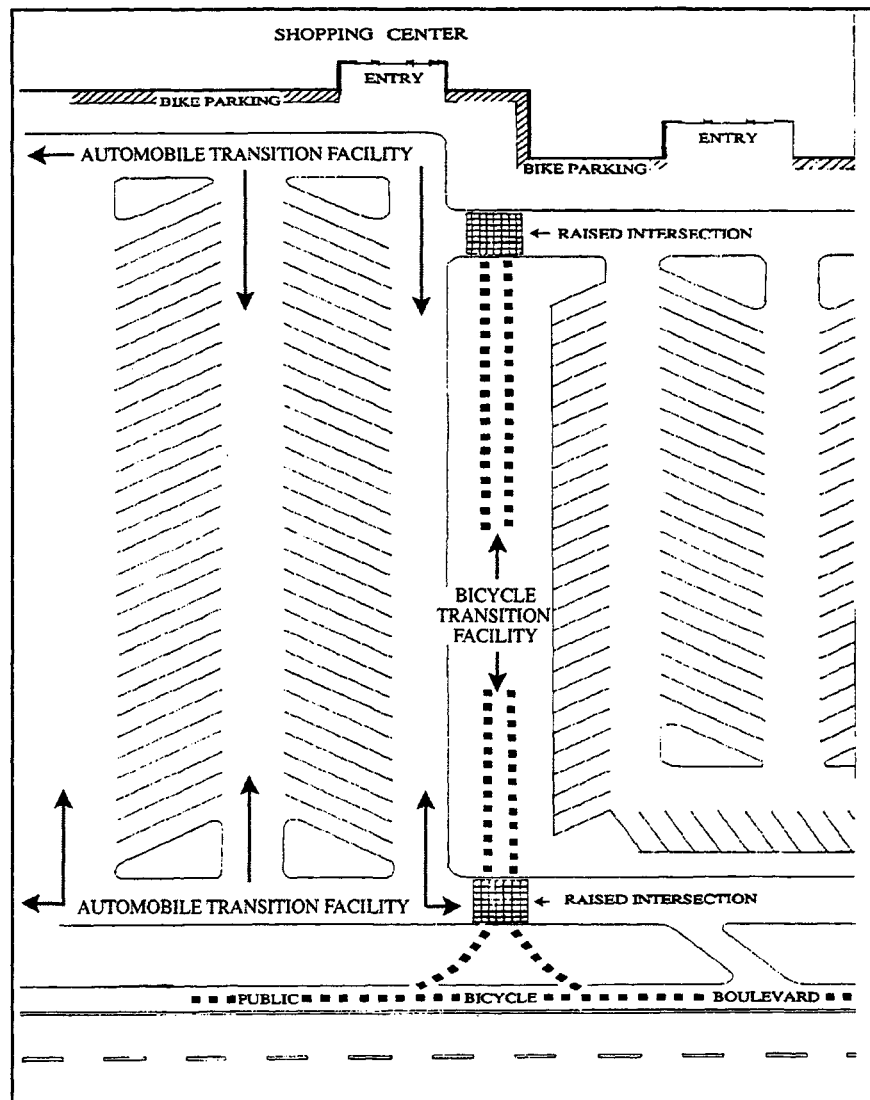


Figure 3-51.

Bicycle transition facilities are special accommodations that facilitate the transition between the roadway and the door. Transition facilities are often provided for the motor vehicle, the most clear example being found at large shopping malls.

Transition facilities are not always required. However, planners, designers and communities should be prepared to provide them when they are necessary.

This plan shows bicycle access facilities for a portion of a regional shopping center. A private bicycle transition facility brings cyclists from the public bicycle boulevard to the bike parking near the main doors of the shopping center. Note the motor vehicle transition facilities in this example.

trip, the vehicle cannot realistically be used. (An informal estimation of the number of parking spaces provided each motor vehicle in an urban setting is eight. These include parking space in front of the home, on the driveway or near the alley; at work, at the grocery store, at retail shops and so forth. This supply of motor vehicle parking has been primarily achieved outside of the right-of-way through parking requirements mandated by zoning.)

Cities should similarly use their zoning code and development control process to achieve adequate bicycle access facilities. Several cities allow substitution of bicycle parking spaces for up to 10 percent of the motor vehicle parking space requirement mandated in their zoning codes. This provides a considerable incentive for developers and building owners, as one bicycle space takes up less than an eighth of an auto space. Bicycle transition facilities can be similarly required in the zoning controls and enforced through the plan review process in city planning departments.

In many situations in the near-neighborhood, the bicycle byway will provide adequate access to local attractions and separate arrangements for bicycle access to the door (other than parking facilities) are not necessary. This may also be the case on bicycle boulevards or bicycle expressways where pedestrian *and* motor vehicle traffic volumes are low.

The provision of good bicycle parking facilities near the doors of all destinations can also avoid nuisances and even dangers that illegal bicycle parking can cause. Because the bicycle is a maneuverable vehicle, it is possible for bicyclists to usually reach the entrances of their destinations with their bicycle. This maneuverability and flexibility makes parking close to the door always convenient for the cyclist. Many who work in areas where there is inadequate bicycle parking can observe that the lack of parking facilities will cause cyclists to park on parking

Figure 3-52.

A bicycle transition facility through a motor vehicle parking lot allows bicyclists access to the door of the destination in a safe and convenient manner.

Notice how space for the tree planting is accommodated in the motor vehicle parking space, rather than the bicycle transition facility.



meters, fences, trees and on railings used by the physically impaired. Further, bicycles parked in remote areas that are low in pedestrian traffic have a greater exposure to the risk of theft. This is a justified concern for bicyclists and potential bicyclists. Bicycle parking placed near the front door of a destination puts the bicycle under observation by people entering and leaving the building. This reduces the conditions conducive to bicycle theft because criminal activity is easily detected. For all of these reasons, community decision makers are well advised to include provisions for adequate numbers of bicycle parking facilities near the entrances of all destinations in their community.

- **Spacing of Facilities**
 - **Spacing of Facility Entrances & Exits**

Bicycle access should be developed at all destinations in the city. Their spacing is dependent on the spacing of these destinations. In most urban areas, cyclists should find parking facilities within 1 block from their exit point from the roadway. In large parking lots or large public spaces, the distance to parking facilities should be no greater than 2-3 blocks in length.

- **Continuity of Movement**
 - **Operation**

Bicyclists should expect a number of interruptions on bicycle access facilities. The average operating speed on bicycle access facilities should be 8 kph (5 mph) or less to be compatible with pedestrian traffic. The design of bicycle transition facilities should take this into account in controlling the speed and the behavior of bicyclists.

- **Connections to Local Streets**

Depending on location, and street and land use patterns, access to local streets from access facilities could be very high. In some areas of a dense urban grid of streets, access to local streets can be found at each corner. In a suburban community, connectivity between bicycle access facilities and local streets could be very low because the connectivity of local streets in many suburban street patterns (e.g., cul-de-sac and eyebrow street patterns) is very low. If this is the case, bicycle byways, boulevards or expressways that transport bicyclists from local streets to community attractions should be built.

- **Volume**

Volumes of cyclists at bicycle access facilities depends on the context and land use surrounding the space. Community decision-makers should ensure that enough parking is supplied through zoning and the development review process. Bicycle parking counts, using a simple two category system of “parked at provided space” or “parked elsewhere,” (e.g., signs, rails, trees) can be a useful tool for determining if more bicycle parking is needed.

- **Maintenance and Repair**

Depending on their location and intensity of use, bicycle access facilities may require little care beyond standard maintenance for sidewalks and streets. Access facilities that are in continuous use or in high traffic areas will need periodic maintenance to insure that the area is kept free of litter, gravel and debris. All bicycle parking and bicycle transition facilities should be kept free from ice and snow in the winter.

4. Community Planning

In order for the bicycle to effectively capture a significant share of the trips made in urban areas, it is important for communities to enter into a complete and professional transportation planning process. This chapter presents important areas of concern in this process.

- Section 4.1 gives reasons why the bicycle is a viable vehicle for fulfilling many of today's urban transportation needs.

Trip distance and trip travel time data are used to demonstrate why the bicycle is a practical urban transportation choice. The data show how the bicycle can effectively compete with the motor vehicle for a significant number of urban trips.

Next, the bicycle is described as a practical choice for communities to support as a mode of transportation. Goals and requirements placed on communities relating to the environment, energy efficiency and quality of life are discussed in light of urban transportation options.

- Section 4.2 explains why communities should engage in a transportation policy dialogue after deciding to support bicycle transportation. This dialogue is necessary in order for other steps of the planning process, such as modal prioritization, to move forward.
- Section 4.3 discusses how the population of the community can become involved and supportive of bicycle transportation.
- Section 4.4 describes how the network of bicycle facilities can be planned and implemented. This section describes how to select bicycle friendly zones and plan the network within the zone, as well as connections to other parts of the community.

4.1. Why the Bicycle Makes Sense

The Bicycle: A Practical Choice for Many Urban Trips

There is a common perception that we travel great distances while carrying out our daily activities. However, national statistics on trip distances show that the bicycle is a feasible and realistic transportation option for many urban trips. Table 4-1⁷ shows the percentage of trips taken within a given distance from home. These are for all trips, including the trip to work.

Nearly 40% of all trips are within 2 miles from home and almost 63% of all trips are within 5 miles. *These distances are well within the ability of the average person on a bicycle.* And, in reality, our daily lives are decidedly local and well-suited to using bicycle transportation.

Table 4-2 shows how long it takes to travel these same trip distances on a bicycle, assuming constant operating speeds at 12 mph, 15 mph and 20 mph.⁹ Given these operating speeds, a 3.2 km (2 mi) trip takes an average of 6 to 10 minutes on a bicycle. An 8 km (5 mi) trip takes 15 to 25 minutes.

Daily Trip Distances

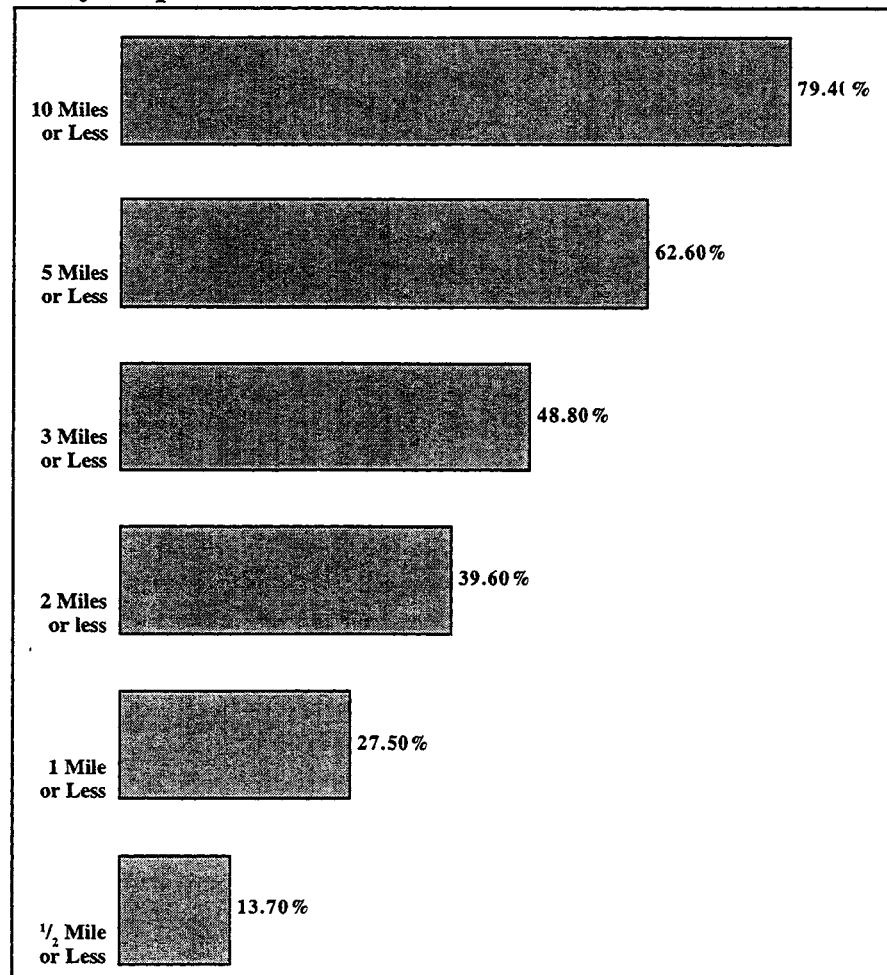


Figure 4-1.

Data from the 1990 census Personal Transportation Survey show daily trip distances for all trips taken.

There has been a perception that we travel great distances while carrying out our daily activities.

In reality, our daily lives are decidedly local and well-suited to using bicycle transportation for many trips.

In terms of trip travel times, the bicycle is a competitive transportation alternative to the automobile. Though motor vehicle congestion in many of our urban areas has significantly increased commuting times by car, the average commute time that people have tolerated for centuries has consistently been 20-30 minutes.¹⁰ From this perspective, the bicycle can deliver satisfactory trip travel times for a significant number of trips, assuming an infrastructure is provided to accommodate the bicycle as transportation.

For trips less than 2 miles, the bicycle can actually be more convenient to use than an automobile. For short trips, parking the vehicle becomes a large part of the total travel time to the door of the destination. The time spent searching for a parking space and walking to the door of the destination may actually take as long or longer than the time spent biking the entire distance (provided there is ample bicycle parking near the door of the destination.)

Bicycle Trip Travel Times

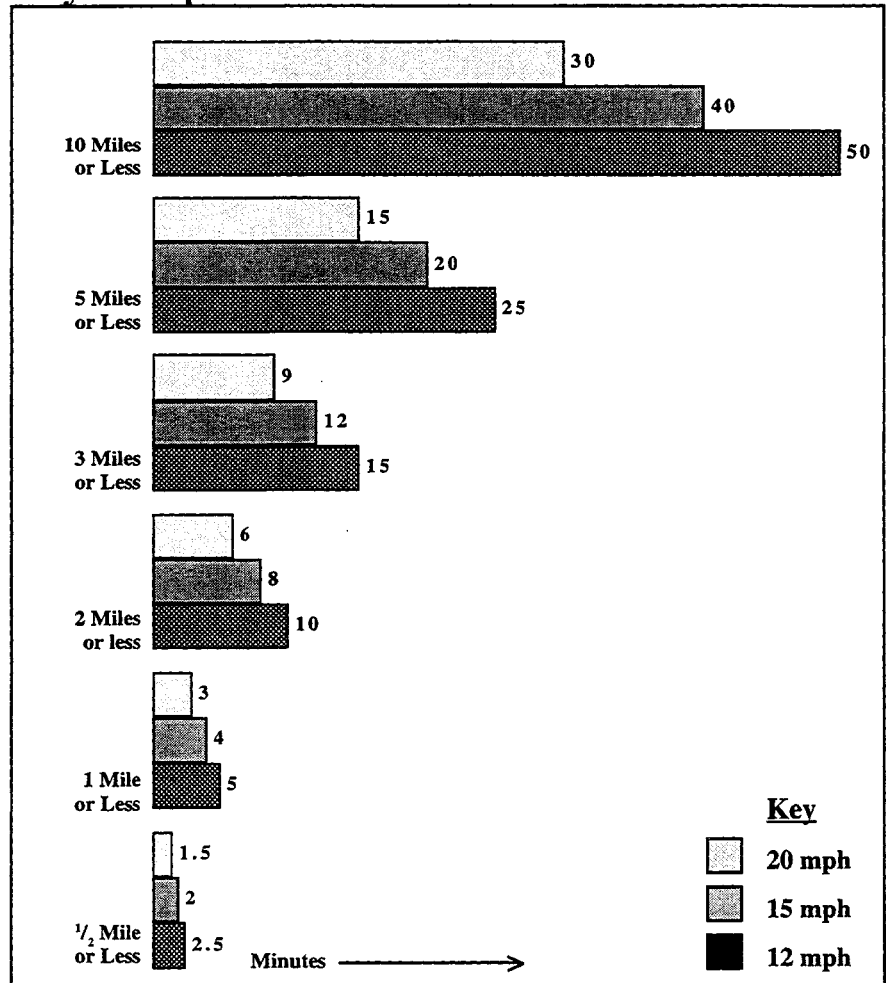


Figure 4-2.
 Bicycle trip travel times for various trip distances, assuming constant operating speeds.
 The bicycle can deliver satisfactory trip travel times for a significant number of trips, thereby providing a viable transportation alternative to the automobile in urban areas.

New Goals for Urban Transportation Systems

All systems are planned and designed according to a set of requirements from a number of sources. The planning and design of a system of bicycle transportation networks must attend to three major categories of requirements.

- The requirements of the users of the system represent the most obvious category of requirements. Bicyclists, as users of an urban transportation network, are discussed in section 5.1.
- Another category of requirements comes from the environment in which the system operates. In the case of urban bicycle systems, this includes the city itself, the roadway network, roadway space, land use, and the surroundings of every street.
- Yet another category of requirements comes from the initiators, or the requestors, of the system. This group describes the purpose of the system; that is, a broader set of reasons that explain why the system is to be built.

These three sources of requirements provide a complete description of all that is required of the system. If a system is properly planned and implemented, the system's requirements are embodied in the system itself — in the functions and the services it provides.

For this reason it is essential that a bicycle transportation system's requirements be fully understood so that the system fulfills its function and its purpose to the greatest possible degree. In the latter part of the 20th century, the federal government has required that local units of government increasingly attend to environmental, energy and quality of life issues in all community planning activities. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) reflected this trend and radically changed the urban transportation mandate for the United States.

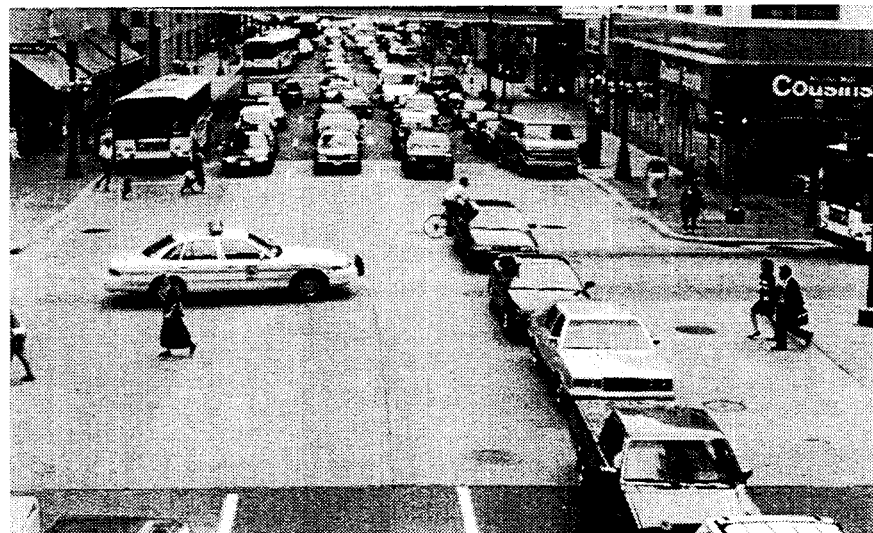


Figure 4-3.
The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) changed the fundamental assumptions and requirements that directed urban transportation planning in the United States for the last 50 years.

ISTEA and the other federal mandates together have changed fundamental assumptions and requirements that directed urban transportation planning up to the latter years of the century . Previous assumptions and requirements for the “highway system” (a pre-ISTEA term used to describe urban street systems) have been modified to include a variety of environmental, energy and community goals.

The bicycle is an essential part of the change that ISTEA mandated and is an implicit part of the change mandated by environmental and community planning legislation.

Analysis of ISTEA’s goals shows that the bicycle should not be merely accommodated — or just included — as a transportation option. It was mandated to be a *primary* option in future surface transportation systems. The list below summarizes the set of new goals and requirements from ISTEA. Note how a requirement for bicycle transportation in the intermodal system is specifically articulated. (The original ISTEA text from which this list is formulated is found in Appendix A.)

ISTEA's stated goals are worded in a such a way that they give rise to a range of opinions about the means by which they should be pursued. They do not tell us the degree to which non-automotive modes should replace automobile transportation and they do not describe the percentage that each mode — auto, transit, bicycle and pedestrian — should claim in the modal mix. They allow room for fresh thinking and encourage debate on these issues.

There are methods for analyzing goals and requirements where opinion and point-of-view do not come into play. One method involves

- Environmental quality
- Economic development, productivity and efficiency
- Energy efficiency
- Modal integration into a unified system
- Efficient maximization of the mobility of people and goods
- More efficient use of existing transportation facilities
- Social benefits relating to quality of life
- Mobility for disabled and disadvantaged groups
- Cost-efficient and timely construction
- Innovative, competitive, efficient, and accountable operations and maintenance
- *Plans and programs shall specifically provide walkways and bicycle transportation facilities.*

Table 4-1.
Summary of goals and requirements from ISTEA

determining the degree to which each mode fulfils each of the stated goals. If framed in this manner, the goals reflect measurable modal characteristics, rather than point-of-view. Research that has quantitatively addressed modal characteristics includes that of Charles L. Wright in his book, *Fast Wheels Slow Traffic: Urban Transport Choice*. He addresses modal characteristics that are similar, if not the same, as many addressed by ISTEA. Table 4-2 describes his analysis.

A comparison of ISTEA's goals (Table 4-1) and The Performance Characteristics of Transportation Modes (Table 4-2) shows a remarkable correspondence throughout. For example, the goal of 'greater energy efficiency' corresponds exactly with the characteristic 'greater energy efficiency.' The characteristic 'greater sustainability of the system' corresponds to the ISTEA goals of 'innovative, competitive, efficient, and accountable operations and maintenance,' 'cost efficient' and 'timely construction.'

In comparing Tables 4-1 and 4-2, it can be seen that bicycle and pedestrian transportation possess characteristics that more successfully and more completely fulfill more of ISTEA's goals than do other modes.

Table 4-2. Performance Characteristics of Transport Modes ¹¹

	<u>Walking</u>	<u>Cycling</u>	<u>Transit</u>	<u>Car</u>
<u>Characteristics Important to Society</u>				
Greater capacity/area	S	S	S	S
Greater energy efficiency	S	S	S	P
Less air pollution	S	S	S	S-I
Less noise	S	S	S-P	P
Better aesthetics	S	S	S-P	I-P
Less vulnerability of system	S	S	P	P
Greater sustainability of system	S	S	I	P
Less public expense	S	S	S-P	I-P
More healthful	S	S	I-P	P
Fewer serious accidents	S-P	I-P	S-I	P
<u>Characteristics Important Primarily to Individuals</u>				
Lower costs to users	S	S	S-I	P
Better personal microenvironment	S	S	P	S
Greater flexibility	S	S	P	S
Higher frequency	S	S	S-P	S
Greater punctuality	S	S	S-P	S
Greater comfort	S-P	S-P	S-P	S
Better orientation	S	S	S-P	S-I
Ease of carrying things	I-P	S-P	S-P	S
Less total travel time	<u>Approximate ranges</u>			
Up to 400 meters (1/4 mile)	S	S	I-P	I
400-1,500 meters (1/4-1 mile)	I-P	S-I	S-P	S-I
Beyond 1,500 meters (Beyond 1 mile)		S-P	S-I	S
Notes: S=Satisfactory or Superior I=Intermediate P=Poor				

In practice, the bicycle can become the ultimate transportation management system in urban areas.

Therefore, a network infrastructure that caters to these modes for fulfilling daily transportation needs comes the closest to fulfilling the spirit and the intent of the ISTEA mandate and other federal legislation that addresses environmental, energy and quality of life issues in urban planning.

The bicycle makes sense in terms of environmental and economic efficiency. The bicycle produces no pollution. It relies on the operator's last meal and stored energy for fuel. The vehicle itself embodies less energy in its manufacturing than does the motor vehicle. In addition, the bicycle's infrastructure costs are minimal compared to the infrastructure costs for the motor vehicle. Since almost 40% of all trips from home are within cycling distance (2 miles or less), the bicycle could capture a major share of urban trips if proper facilities are established to support its use. Bicycle transportation could reduce the pressure for expanding infrastructure required for single occupancy vehicles — an infrastructure that on average consumes one-third of the real estate in our urban areas, as well as large sums of public funds on an increasing basis.

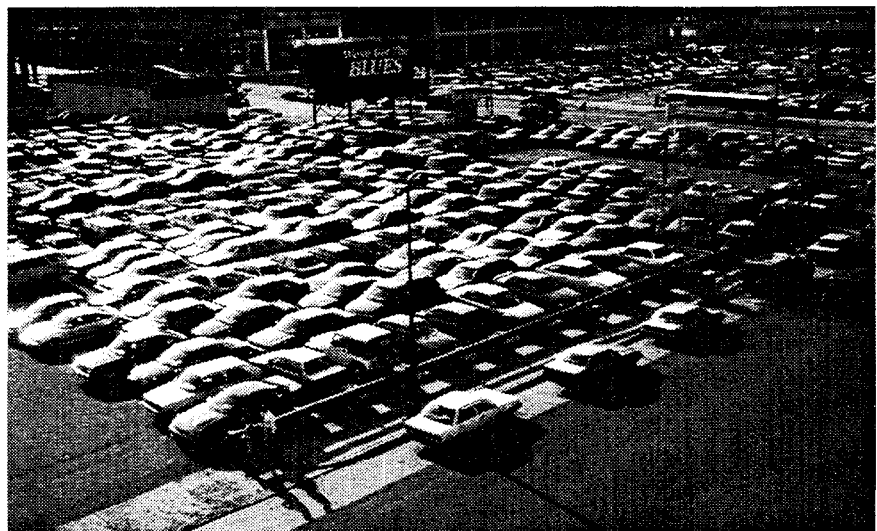
The bicycle becomes an extremely attractive urban transportation option when considered in the light of all of these factors:

- ISTEA's national requirements of environmental and economic efficiency in transportation,
- The bicycle's ability to fulfil these requirements in the most complete and cost-effective manner,
- The bicycle's ability to deliver satisfactory trip travel times for many daily trips, and
- The bicycle's ability to reduce roadway infrastructure needs in urban areas,

In practice, then, the bicycle could become the ultimate tool in ongoing efforts to establish effective transportation management systems in urban areas.

Figure 4-4.
Bicycle transportation could reduce the need for an ever-expanding infrastructure required for single occupancy vehicles — an infrastructure that at a minimum consumes 30% of our urban land, as well as large sums of public funds.

This can be done by making the bicycle a realistic and viable choice, and allowing people to use the bicycle for those trips that are suitable to bicycle transportation.



4.2. Local Transportation Policy

The process of policy making is as important as the policy itself because it affords citizens the opportunity to determine what kind of community they want.

As cities move away from single-mode transportation systems planned solely for the motor vehicle, to multi-modal and intermodal systems, it becomes increasingly important to develop local surface transportation policy to accommodate this change. Goals and priorities for a single-mode system are relatively simple. For multi-modal and intermodal systems, they are considerably more complex.

In addition to cities, it is also beneficial for subsections of the community, such as universities, community business groups, and even neighborhood groups to develop transportation policy at their scale of planning. At a more local scale, policy making need not be as complex as a city-wide effort. For example, a neighborhood group could establish neighborhood policy requiring that new neighborhood development projects support bicycle transportation on all new roads, that bicycle access is supported to all new buildings, that all new buildings install shower facilities, and that all new employers in the neighborhood supply quality bicycle parking (regardless of the age of the building). Since it is established by a consensus of people at a smaller scale of community, local policy can be used to influence decisions at higher levels of planning and development.

The process of policy making is as important as the policy itself because it affords communities an opportunity to examine what kind of city, or what kind of university, business district, industrial park, or neighborhood that they want. Because transportation systems shape the civic structure and form (chapter 2), transportation policy making is an important process for communities at whatever scale of government and influence they represent.

In establishing local transportation policy, communities must examine their values in relation to a number of issues regarding quality of life, civic structure, and the economic and environmental efficiency of their transportation systems. These issues are, in turn, intertwined with complex issues of land use and transportation, and community priorities, in general.

Motor vehicle generated problems of congestion, pollution, urban sprawl, and land use in the late twentieth century increasingly press communities to examine alternatives to the single occupancy vehicle for transportation. In addition, federal legislation has increasingly directed communities to achieve environmental and economic efficiency in general and with their transportation systems, in particular (section 4.1).

Communities must build transportation systems that are efficient in their entirety, rather than transportation systems that provide efficient service to one mode.

There is a quantitative and qualitative difference between the two approaches.

We are now at a time when communities must build transportation systems that are efficient in their entirety, rather than transportation systems that provide efficient service to one mode. There is a quantitative and qualitative difference between these two approaches for transportation planning.

When a primary goal of community transportation is to develop an efficient system, communities are first faced with understanding what kind of modal mix would make their community's transportation system the most efficient. By and large, those modes which are small and human-powered best fulfill requirements for environmental and economic efficiency (section 4.1). When human-powered vehicles are used for daily transportation, their ability to cover large distances is more limited in comparison to motorized vehicles. This is especially true when looking at the larger population of travelers. However, if bicycle transportation is coupled with motorized transport, the transportation system becomes even more efficient.

A community transportation policy should set forth goals that precisely describe the modal split for the system and specific dates when goals will be reached. Modal share and modal split describe the percentage of each mode in the roadway. For example, the 30% mode share for the bicycle that Dutch cities report means that 30% of the person trips (as opposed to person miles) in The Netherlands are by bicycle.

Figure 4-5.

Modal share and modal split describe the percentage of each mode in the roadway.

By and large, those modes which are small and human-powered fulfill requirements for environmental and economic efficiency the best.



Communities that wish to develop an efficient transportation system must develop land use policy with a primary goal of efficiency for the transportation system.

The development of dense, multi-use land use patterns should be encouraged in order to shorten trip distances for the greatest numbers of people.

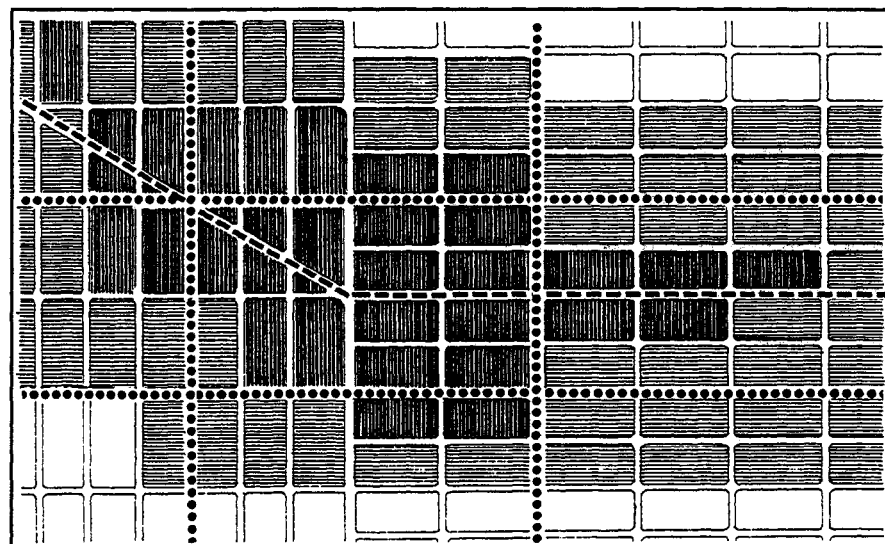
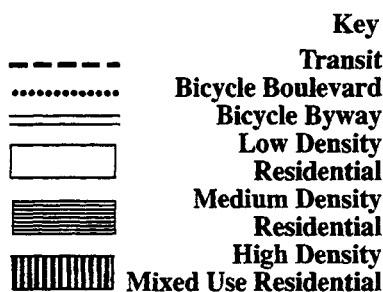
Transportation and land use are closely intertwined concerns — community land use policy will always affect a community’s transportation system. Communities that wish to develop an efficient transportation system must develop land use policy with a primary goal of efficiency for the transportation system. This means that communities should encourage the development of dense, multi-use land use patterns in order to shorten trip distances for the greatest numbers of people. In addition, dense communities give better support to transit.

Where density is impossible or undesirable, intensely varied, multi-use development should still be encouraged. Every resident should be able to accomplish daily and weekly tasks within 3.2 km (2 mi) from home. This would permit most trips in the community to be made by cycling or walking.

Communities should adopt land use policy and develop land use patterns that encourage transit, along with bicycle and pedestrian intermodal options. This should include:

- The development of land use patterns that make transit a convenient option from each residence,
- Consideration of daily and weekly tasks that people must accomplish by developing transit stops as nodes of service and retail activity,
- Preferential parking for bicycles at transit stops.

Figure 4-6. Communities should adopt land use policy and develop land use patterns that encourage transit, along with bicycle and pedestrian intermodal options.



Inherent in the goals for an urban transportation system, are the priorities that the community places on each mode of transport.

Modal prioritization establishes a link between transportation policy and that which is planned, designed, and built.

It is important that the priorities a community places on each mode of transport be explicitly stated in its goals for its urban transportation system. In the inter-modal and multi-modal contexts, planners and engineers will regularly be required to determine which mode is more important (which has the highest priority) in order to complete specific community transportation plans, corridor and intersection designs, and engineering details. It is not possible to make these kinds of decisions in the absence of a prioritization of each mode. Therefore, the prioritization of modes must be an explicit and well-documented step in the formulation of community transportation policy.

Modal prioritization provides an added benefit for ensuring the implementation of both local and national transportation policy. Priority-setting is an activity of judgement and cannot occur outside of the context of values and goals. Community decision-makers, planners and designers can only prioritize networks, roadways, and intersections within the context of the community's values and goals which are at the heart of any kind of public policy. Therefore, the prioritization of modes within the context of public policy is necessary and prioritization establishes a link between policy and that which is planned, designed, and built.

Communities should also consider methods by which they can put muscle into their policy. A policy is only good, or effective, if it is implemented in the real world. For example, it is good policy to state that a 30% bicycle mode share be achieved by the year 2000. However, simply making this statement does not ensure achievement.

Figure 4-7.
This intersection of minor arterial streets in Davis, California shows how bicycles are given equal priority with motor vehicles for making left turns. A left turn bicycle lane has been set aside (with loop detectors). Although not visible in this view, the path of the left-turning bicycles through the intersection has been painted and lined with reflector hubs.



Communities should consider methods by which they can put muscle into their policy.

Policies should explicitly direct actions that make the policy influence reality.

Any policy can be left on the shelf and ignored if it does not include items that ensure that the policy is carried out. An example of a policy statement with muscle comes from Portland, Oregon which wanted to reduce motor vehicle congestion in its downtown area and foster a pedestrian environment.¹² In 1972, the City of Portland introduced policy stating that no new motor vehicle parking would be created in the downtown area. This is an example of a policy statement with muscle. The policy effectively capped the number of motor vehicles using the downtown area. Implementation of an attractive and efficient light rail system and a pedestrian friendly environment followed this policy. Policy statements that simply call for efficient light rail or a beautiful, pedestrian-friendly downtown express good intentions, but need more muscle to become implemented. Policies must explicitly direct actions that make the policy influence reality.

In summary, cities should at a minimum discuss the following in developing their transportation policy:

- The efficiency of their transportation system as whole,
- Land use policy that includes an efficient transportation system as one of its goals,
- Mode share targets to be reached by specific dates,
- Explicit specification of modal priorities for networks, roadways and intersections,
- Policy statements that ensure implementation.



Figure 4-8.
Metropolitan transportation systems should encourage bicycle and transit intermodal options.

4.3. Community Involvement

It is important that urban residents participate in transportation decisions.

They either expressly or intuitively understand the impact of transportation on their communities and their lives.

Citizen involvement in all issues of civic life has become increasingly important to communities of all sizes and the people that live in them. The federal government also recognizes the importance of citizen participation in decisions affecting the local community. Federal legislation in the last 30 years has increasingly required community participation as a requisite for receiving federal funding. Federal transportation mandates are no exception, requiring local participation in transportation decision-making and planning processes.

It is important that urban residents participate in transportation decisions. Urban residents either expressly or intuitively understand the impact of transportation on their communities and their lives. For reasons of achieving consensus on community goals and priorities that affect quality of life and civic structure, urban residents should be active participants in the policy-making, planning and design of the transportation systems that serve and effect their communities.

In some communities, citizen participation in transportation issues is commonly found. Citizen groups dedicated to the promotion of bicycle transportation, a particular mode of transit, or groups opposed to the expansion of freeways are often very active, receiving front page coverage of their activities. It should not be difficult to engage these groups in transportation policy making, decision-making, and planning efforts.

Local, neighborhood participation should also always be a part of transportation planning efforts. Organized neighborhoods can provide the vehicle for this participation. A well-organized group actively engages local residents in a broad spectrum of issues effecting the neighborhood, ranging from physical development of the area to developing, supervising and participating in programs of a social, economic, health, educational and cultural nature.

Transportation will often arise as an issue of general or specific concern in neighborhood meetings. A neighborhood group might recognize and accurately articulate the conditions of major transportation problems affecting their neighborhood or they may issue periodic complaints regarding specific problems such as the safety of children at an intersection. Whatever the scope of the problem that is described, residents can often add information and analysis of neighborhood transportation issues that the professional would be hard pressed to uncover.

Neighborhood residents spend significant amounts of time in their neighborhoods every day of the year. They experience a multitude of traffic conditions and understand on a practical level how the transporta-

tion system works. They understand how the land is really used and what it means in their lives. Because of this knowledge, neighborhood residents can sometimes suggest valuable planning and design solutions that would not occur to the transportation professional.

If communities have no organized neighborhood groups, transportation professionals have other avenues of community outreach. Local business and civic organizations, as well as churches, schools, adult education programs and universities can help gain community involvement. Media campaigns presenting information on local transportation issues and transportation impacts on community can spur the interest of some citizens to become involved in transportation decisions. Public notices located in the classified ad section or on the back page of newspapers are a poor source of information for the general public. These traditional (and legal) means of posting meetings and their subject matter are scanned usually only by professionals and are rarely seen or sought out by most people in the community. In order to gain a grassroots involvement, a more sophisticated media/educational program is needed to arouse the public's interest in transportation issues and to spur their involvement in decision making for their community.

Whatever the means of engagement, the public should be honestly and sincerely included early in the decision making process. Ideally, this inclusion begins when a problem is identified. It should continue until a mutual solution between transportation professionals, public officials and the public can be reached and solidified into a project proposal. It is too often the public's experience that they are consulted after a project has been drawn up and ready for construction. At this point, considerable amounts of effort and money have often been expended. When the public is engaged at this late date, the agencies proposing the project have a larger psychological and economic investment in the project and are less inclined to change it or to consider other solutions or project proposals.

The citizens naturally feel that something is being "shoved down their throats," and they are forced into a reactive position. Because the reaction time that communities are given to respond to project plans is often short, the pursuit of modifications to a proposal is a difficult or impossible choice for the community. The net result can be that the public sees no choice but to stop the project. When this happens, the opportunity is lost to engage citizens as active problem solvers and participants in the planning of a community project. For this reason, the amount of effort expended on involving the public at the beginning

***"Is there a value to having
citizens involved?
You bet there is.
Not only because they'll
bring a common-sense view
to the whole issue but also
because it's their money
and it's just the
right thing to do."***¹³

**Dee Richards
Community Activist against the
construction of a garbage burner
and Dakota County Board
Member**

when problems and solutions are being identified can be very cost-effective. It is certainly more practical than presenting a completed project proposal to the public, having to defend it, and risk ill-considered late changes or outright stoppage of the project in response to public input, protest or resistance.

It is important to use planners experienced in public participation, transportation and community development as participants in the process. These individuals should have well-rounded world views and well-rounded views of transportation. For example, local communities will often be opposed to freeway development and freeway expansion projects on their homeground. In such cases, the transportation professionals must work with the public to find a solution to the traffic problem that has generated the proposal. They must sincerely be open to other solutions.

For successful public participation, it is essential for staff to be assigned to prepare minutes of meetings and any other documentation that the process and its plans produce. Community participants in projects such as these, are volunteers with other jobs, interests and obligations. Involvement in a transportation issue is an extra, volunteer effort by the citizen participants. They need support to make their efforts productive to all involved in the project. Attending the meetings required to reach consensus requires a sizable commitment of time and energy. If agencies do not provide staff support for the public participation process, the entire effort can be undermined because of the work load demanded of the public. Local support for the project could fade, disappear altogether, or turn into an organized opposition.

For their part, transportation officials must approach the process with open minds. They must be open to solutions other than the traditional ones. Likewise, they must consider citizen participation worthwhile and an integral part of the entire process — not a token nod to the community (which often backfires).

When transportation professionals, public officials, and the general public engage in the process of public problem solving, it is critical to promote and maintain an attitude of respect and cooperation. This is not to say that dissent and disagreement should be whitewashed out of the process. However, the consensus that is the desired outcome of the public participation process will never be reached if the relationship is not rooted in respect and cooperation. It is important for all involved to realize that participants might hold different values and goals. Each must be willing to listen to the other and if in disagreement, bring

“They’re the ones who like to do roads and they are the ones saying ‘We looked at everything and the roads truly are wonderful.’ ... The process itself doesn’t have a disinterested party.”¹³

Dore Mead
Community Activist in favor of
light rail transit and opposed to
the expansion of Interstate
Highway 35W in Minneapolis,
and Minneapolis City Council
Member

realistic solutions, backed by logic and sound judgement to the discussion. Unbiased arbiters could be used during the process when an impasse is reached.

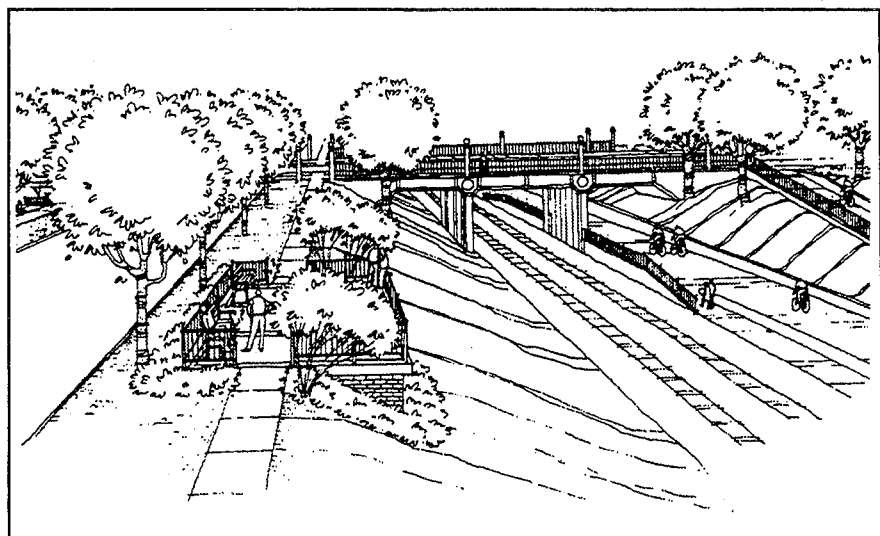
A final ingredient for reaching successful solutions to urban transportation issues is creativity and vision. Most transportation professionals have been trained to be, and in practice, are planners and engineers for motor vehicle systems. The public brings another kind of expertise on motor vehicle systems because they see, experience and use them every day. They also bring an understanding of how motor vehicle systems affect all dimensions of living in their part of the city. In fact, both the citizen and the professional often have experience with no other kind of urban transport. We all need to recognize that there is a tempta-

Figures 4-9 and 4-10.

An abandoned rail corridor is often seen as a clear opportunity for a bicycle expressway. This one cuts across the southside of Minneapolis. For its entire length, a major retail and commercial artery is just one block away from it. From the beginning, bicycle advocates tagged this corridor as ideal for a bicycle expressway.

Begun and managed by bicycle advocates and neighborhood participants, the Midtown Greenway Coalition now has private parties and public officials interested in developing the opportunities offered by the new corridor with its bicycle expressway and green space.

In this case, the development of a major bicycle transportation facility was initiated by local citizen action and is now seen as a project that can help spur other inner city development.



Courtesy: SRF Consulting Group with Close Landscape Architects, Minneapolis, Mn.

tion to see future transportation systems in terms of the familiar ones we use today, blinding us to better alternatives. For example, the best route for a bicycle facility may not be the one that is apparent using today's transportation system under today's traffic conditions. A re-planned, re-designed and re-engineered system of roadways that provides infrastructure for other modes may indicate the selection of another route as the ideal through connection for bicycles.

In a similar vein, though citizens are seasoned users of the motor vehicle system, a seemingly simple and obvious solution to a transportation problem, may in fact be one of the most unsatisfactory solutions. For example, citizens often want to install stop signs at neighborhood intersections to address local traffic problems. Transportation systems are complicated networks and seemingly simple and logical solutions can create problems that are worse than the original conditions. A stop sign could cause traffic to back up the street, creating more dangerous conditions than before. It could cause traffic to be diverted to nearby streets, shifting the problem to the neighbors. If there are other stops at nearby intersections, it could frustrate motorists, causing them to increase their speeds between stop signs or to start running the stop signs.

ISTEA and other federal legislation have added many new considerations — such as the quality of community life — to urban planning processes. This, in turn, almost demands public participation to effectively address the quality of life issues. Therefore, neighborhoods and the general public should be included in urban transportation planning projects. This public involvement will result in a transportation system that more completely and more satisfactorily serves the short and long distance travel needs of neighborhoods and the city as a whole.



Figure 4-11.
Transportation systems are complicated networks and seemingly simple and logical solutions can create problems that are worse than the original conditions.

4.4. Network Planning

Each implementation of the bicycle system should be wildly successful, attracting both current cyclists and new users to the provided facilities.

The Planning Guidelines for Bicycle Facilities (Table 3-2) gives values for the various characteristics of bicycle networks composed of bicycle expressways, boulevards, byways and bicycle access facilities. However, these values are only useful when a network of these facilities is implemented so as to provide meaningful urban transportation function. For example, a community could implement a bicycle transportation system that incorporates all of the spacing, stopping, multi-modal considerations, safety, skill, maintenance, and access requirements for each facility. However, the system could go unused if the network was configured in such a manner that it did not allow people to conveniently go where they needed to go — that is, unless it provided a bona fide transportation service.

Even though communities may eventually want to blanket the entire city with bicycle facilities, implementation constraints make it necessary that a bicycle transportation system be built in phases, selectively blanketing smaller areas in incremental steps.

It is critical that communities accomplish this step-by-step implementation in a fashion that ensures the success of each phase. Ideally, each implementation of the bicycle system should be wildly successful, attracting both current cyclists and new users to the provided facilities. Each phase should generate both media and “windshield recognition” of a facility that is attractive, and convenient — one that is used by many different types of people with different cycling skills. This is necessary to not only ensure the success of the implemented facility, but to ensure continued support and demand for more bicycle transportation.



Figure 4-12.
Bicycle facilities should be planned and designed for many different types of people with different cycling skills.

Therefore, in order for implemented facilities to be successful, communities must also develop an implementation strategy in addition to the overall plan. This strategy must incrementally provide a meaningful transportation service in the growing bicycle network. That is, each implementation phase, however small, must contribute a true milestone of transportation function to the larger network.

Communities should also prepare and execute a “marketing plan” concurrent with the implementation plan. This is essential to simultaneously inform the public of the construction of new routes, build the community’s support of the bicycle as a part of their transportation policy, and market the merits of bicycle transportation.

Also important to the success of the larger endeavor are ongoing measurements and data gathering efforts as each project is added to the network. This will not only provide much needed data on bicycle transportation, but can inform and justify future projects and the planning and implementation of future areas that are bicycle friendly.

This chapter describes how communities can plan a bicycle network system that is effective as transportation and how communities can phase an implementation to ensure success at each phase. The chapter is divided into the following topic areas:

- Bicycle friendly zones,
- Selecting bicycle friendly zones,
- Transportation, land use and bicycle friendly zones,
- Integrating bicycle friendly zones with the city,
- Phased implementation strategy,
- Marketing plan,
- Gathering data.

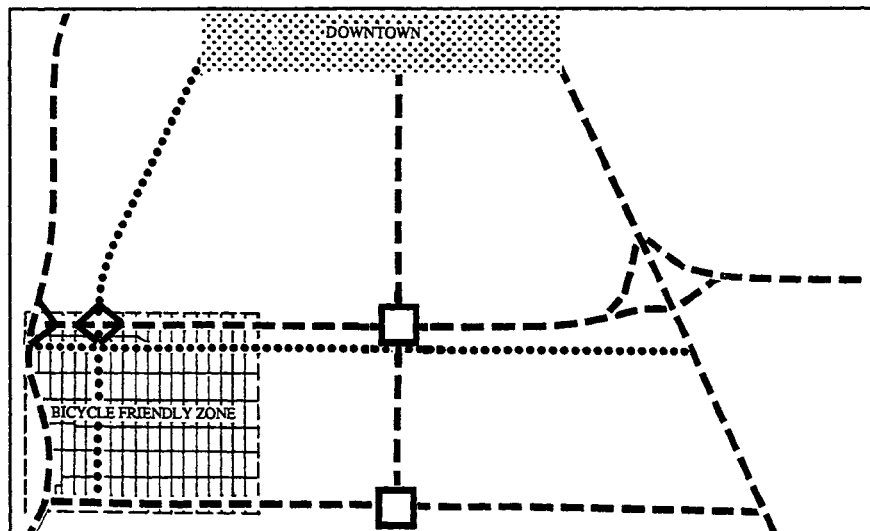


Figure 4-13.
A bicycle friendly zone and its connections to the larger city.

Key
 - - - - - Bicycle Expressway
 Bicycle Boulevard

Bicycle Friendly Zones

Bicycle friendly zones provide a complete bicycle transportation service and include transit and pedestrian options, as well.

The purpose of a bicycle friendly zone is to concentrate a community's resources in one area to produce a system that is effective and attractive as transportation.

Bicycle friendly zones are areas of the city that are blanketed with a complete set of bicycle facilities. It is possible to travel everywhere in these zones on safe, convenient, integrated, and attractive bicycle facilities. Use of automobiles and the presence of automobiles should be diminished to a significant degree in bicycle friendly zones. Ideally, travel by bicycle or foot should be more convenient than travel by automobile. A variety of transit, bicycle, and pedestrian options should be available for travel to and from the bicycle friendly zone.

The purpose of a bicycle friendly zone is to concentrate a community's resources in one area to produce a system that is effective and attractive as transportation. A successfully implemented bicycle friendly zone will "self-advertise" and create demand for more bicycle friendly zones in other areas of the city. Concentrating human and monetary resources in a bicycle friendly zone to produce a strong, complete network is recommended instead of spreading those resources across a metropolitan area and producing a weak system that is of benefit to only a few users.

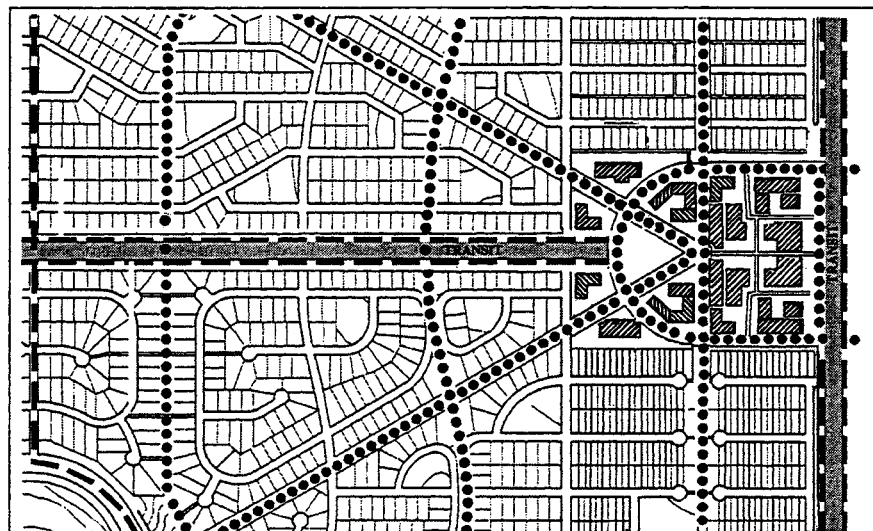
It is essential that bicycle friendly zones serve as integral components of the entire urban transportation network. Because they serve as demonstration projects for generating more demand for bicycle facilities, the selection of the area in which to establish a bicycle friendly zone is critical. The coordination of transportation and land use planning for the bicycle friendly zone and the connections of the bicycle friendly zone to other areas of the city are also critical. The strictest of design standards and planning guidelines as described in Chapter 3 should be applied as well.

Figure 4-14.

In a bicycle friendly zone, bicycle and pedestrian travel should be more convenient than travel by car. A variety of attractive transit, bicycle and pedestrian options should be used for travel to and from the bicycle friendly zone.

The plan at right provides quick and convenient access to the commercial center for these modes and the commercial center is bicycle and pedestrian only.

- Key**
- Bicycle Expressway
 - Bicycle Boulevard
 - ===== Bicycle Byway
 - ===== Transit



Selecting Bicycle Friendly Zones

Communities should select high profile areas for their first bicycle friendly zones.

The area should be patronized by large numbers of people on a daily basis. It should already be one of the major focal points in the community.

When a community initially decides to establish a bicycle transportation system, it is usually more practical to select a single bicycle friendly zone for an initial implementation. Planning and implementation resources will often initially limit communities to the development of a single zone. In larger cities or in large metropolitan areas composed of many municipalities, more than one bicycle friendly zone can be selected, *only if* each zone can be effectively blanketed with a bicycle network.

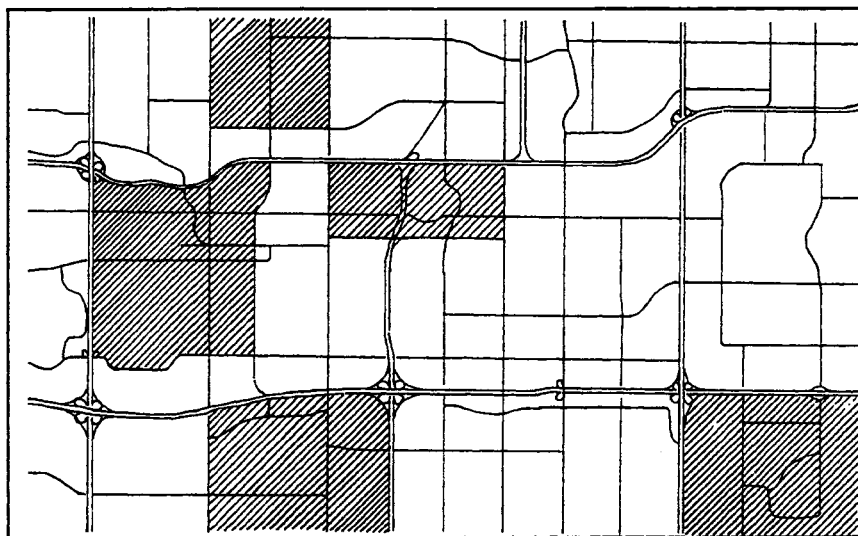
It is more prudent to implement and manage a single zone that can be guaranteed success than to spread out resources and risk the implementation of a bicycle friendly zone that is not successful. An unsuccessful bicycle friendly zone can severely damage the growing image of the bicycle as an attractive means of transportation. Also, a poorly planned and poorly implemented bicycle friendly zone can create other traffic problems of major proportions in the area. This could serve to diminish the reputation of the bicycle.

Communities should select high profile areas for their first bicycle friendly zones. The area should be patronized by large numbers of people on a daily basis. It should already be one of the major focal points in the community. Ideally, the area should already be a focus of community and media attention. It should be an area that is patronized by people who have the inclination and the opportunity to travel by bicycle, given an attractive, safe and accommodating infrastructure. The area should be heavily patronized by large numbers of people who reside within 3.2 km (2 mi) from the bicycle friendly zone. The area should also be patronized by others who typically travel 8 km (5 mi) to the

Figure 4-15.

For their first bicycle friendly zones, communities should select:

- High profile areas that are major focal points of the community
- Areas patronized daily by many people
- Areas patronized by people who have the inclination to travel by bicycle
- Areas heavily patronized by people living less than 3.2 km (2 mi) from the zone
- Areas already well served by transit



zone. The area should also already be well served by existing transit facilities and should have good candidate roadways that can be used as bicycle and intermodal feeder routes.

The size of the bicycle friendly zone should be that for which there are adequate funds to thoroughly blanket it with well constructed bicycle improvements. An effective minimum size would be 1.6 - 3.2 square kilometers (1 - 2 square miles).

Several types of urban areas are potential candidates for the establishment of bicycle friendly zones. Colleges and universities attract large numbers of people who live close by and who would be inclined to use the bicycle as transportation. Central business districts also attract large numbers of people and, depending on the city and its land use patterns, many of these people could live within cycling distance of the downtown area. In suburban areas, large shopping centers, office and industrial parks that attract people from the community, as well as neighboring communities are good candidates. Large and even mid-size medical facilities employ a significant number of people twenty four hours a day. Such a facility, which focuses on health, could provide the nucleus of the bicycle friendly zone. Government facilities also employ large concentrations of workers. In smaller towns, the main street area or newer shopping strips could be good candidates for the bicycle friendly zone. If a handful of businesses provide employment for large segments of the population in a small town, the bicycle friendly zone could be located around these businesses.

The initial determination of candidate areas for bicycle friendly zones provides a springboard for a more in-depth analysis to select the zone from a number of candidate areas, and for determining the boundaries of the final site and the major routes that link the bicycle friendly zone to the rest of the city. Useful urban population data can be obtained from the United States census survey data. These are available to all communities. Universities, employers, medical facilities and sometimes, retail facilities, can provide zip code information for the residences of their employees and patrons. In some cases, even addresses can be obtained. Employee and patron survey data can also be gathered to gain a picture of trip origin and trip destination patterns to, in and around the area. In general, the larger the metropolitan area, and the more complicated the land use and travel patterns, the more information is needed to determine exactly where people are going. In some cases, professional transportation planners should be used to gather this more precise information.

Transportation, Land Use & Bicycle Friendly Zones

The ideal bicycle friendly zone will have a mixed land use incorporating residential, retail, commercial and employment within close proximity to each other.

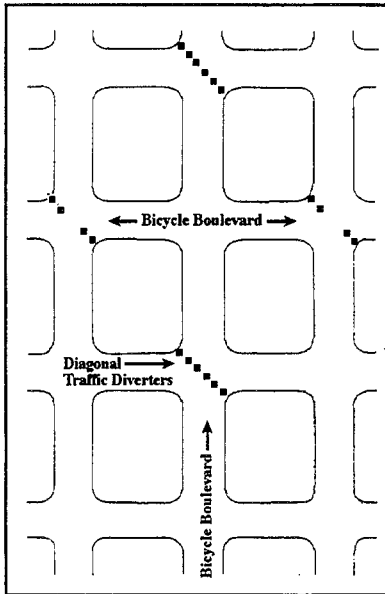
Integral to both the selection and the planning of bicycle friendly zones are transportation and land use patterns. The ideal bicycle friendly zone will have a mixed land use incorporating residential, retail, commercial and employment within close proximity to each other. This would place most daily trips under two miles in the zone. Communities may find it practical to develop a longer term land use plan concurrent with the bicycle transportation plan for the bicycle friendly zone in order to eventually achieve mixed land use patterns that support shorter trips for daily travel needs.

If current land use patterns in a metropolitan area do not support a variety of uses, communities should select areas that display a high residential/employment use, or a high residential/retail use where the retail is representative of daily and weekly shopping needs of the residents. Another approach would be to select a high transit/employment use where transit, in conjunction with bicycle travel could be used by commuters. Medium and large scale transit nodes should always be developed as commercial, service and retail nodes as well.

Figure 4-16.
Bicycle friendly zones should be located in mixed use areas where many daily activities can be accomplished within 3.2 km (2 mi) from home.

In such areas, most destinations can be reached in less than 10 minutes using the bicycle.





Figures 4-17 and 4-18.

This idea for creating bicycle boulevards using traffic calming techniques is used in Palo Alto, California, where 6-8 inch diameter PVC (plastic) pipe is used to create traffic diverters and chokers every 2-4 blocks.

Using this technique, motor vehicle traffic speeds and volumes are calmed to be compatible with bicycle traffic.

The pipe can be broken off easily by emergency vehicles to gain emergency access. Initially, temporary measures are used for a year to test design suitability and plan acceptance before more permanent measures are taken.

Current motor vehicle traffic patterns and the degree to which they can be altered are critical factors to consider in selecting and planning bicycle friendly zones. These factors are particularly critical on minor arterial and collector streets which have heavy motor vehicle traffic and which either provide a singular link in the area's roadway system or serve the shopping needs of many people. Chapter 3 provides guidelines that relate motor vehicle average daily traffic (ADT) counts and motor vehicle speed to the kinds of bicycle facilities that must minimally be implemented to successfully serve bicycle traffic (Table 3-1). If motor vehicle traffic cannot be altered to meet these criteria on any of the bicycle expressways or bicycle boulevards in the bicycle friendly zone, then another area should be selected.

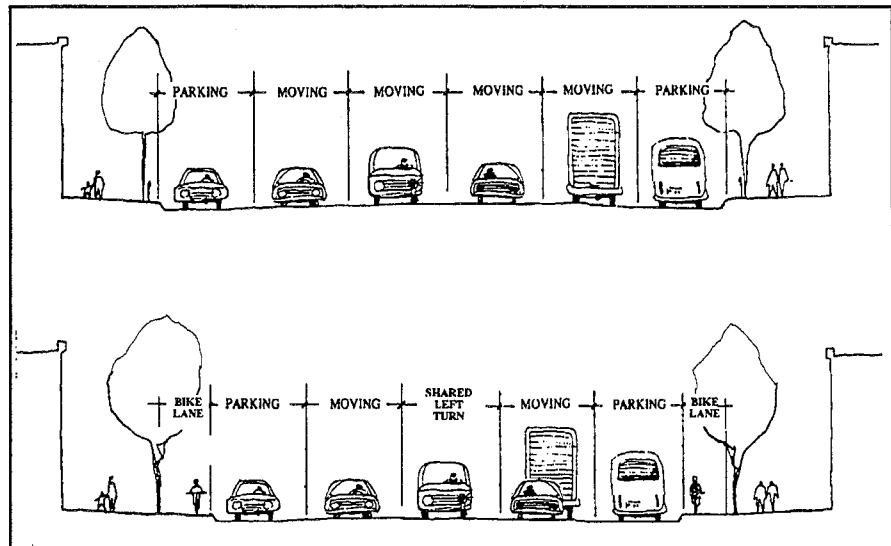


Figure 4-19.

Sections of a major collector street in a retail area. Before and after views show alterations to accommodate bicycles.

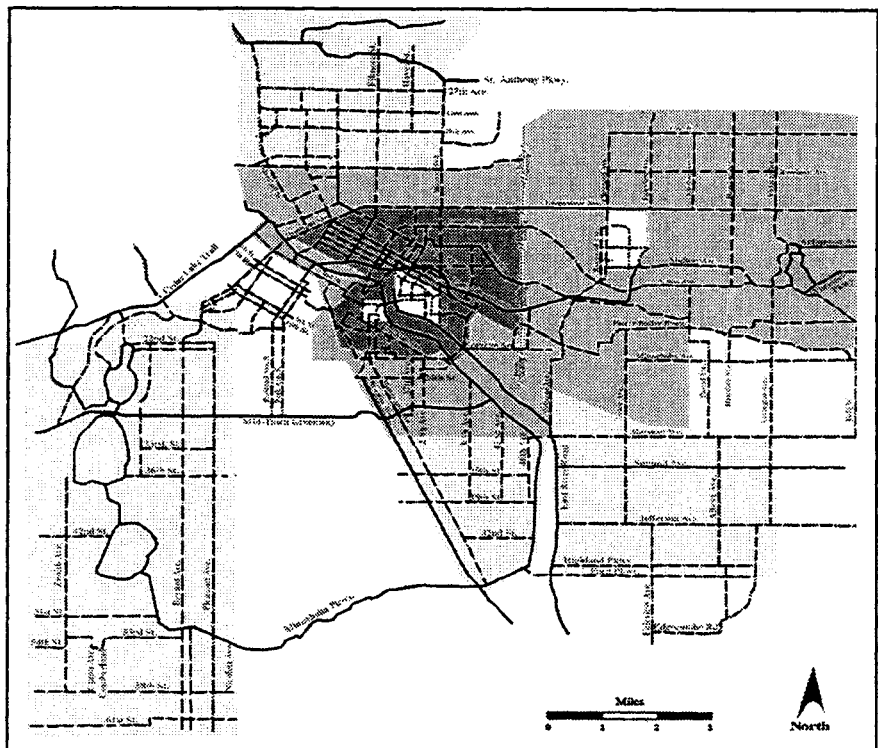
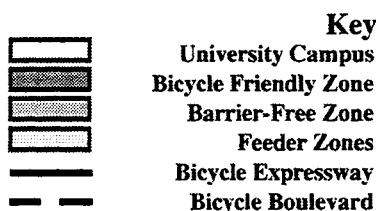
Integrating Bicycle Friendly Zones in the City

It is not sufficient to only provide bicycle service within the bicycle friendly zone.

Bicycle and intermodal feeder routes must be provided to bring people into the area.

There are no urban areas that are entirely self-contained as far as their land use and their transportation needs are concerned. Good candidate areas for bicycle friendly zones not only have dense residential development within and near the zone, but also depend on the transportation system to bring people into the area. Therefore, it is often not sufficient to provide only bicycle service within the bicycle friendly zone. Communities must also provide bicycle and intermodal “feeder routes” that bring people into the area. These can be bicycle expressways, bicycle boulevards and transit. This is also a practical strategic move because well-planned and well-designed routes that bring people into the bicycle friendly zone from outside of its boundaries serve to familiarize more people with bicycle transportation. This, in turn, can create a demand for more bicycle friendly zones in the city. The bicycle feeder routes also provide a structure to direct and guide bicycle infrastructure expansion from the bicycle friendly zone.

Figure 4-20. Communities must plan feeder routes into the bicycle friendly zone to encourage travel by bicycle and transit into the zone from other areas of the city.



Courtesy: University of Minnesota Intermodal Bicycle Transportation Plan

Communities should always consider intermodal options with the bicycle as a part of the system that feeds the bicycle friendly zone.

These options accommodate people who must travel longer distances to reach the area.

If communities implement feeder routes into the bicycle friendly zone, then these routes should be implemented with the same high standards as the bicycle friendly zone. Substandard facilities and missing transportation links undermine bicycle transportation and should not be a part of the bicycle friendly zone. Feeder routes should be planned so they begin forming a larger network of city-wide and district-to-district connections. They should also be planned to be useful for bicycle friendly zones that are targeted for implementation in the future.

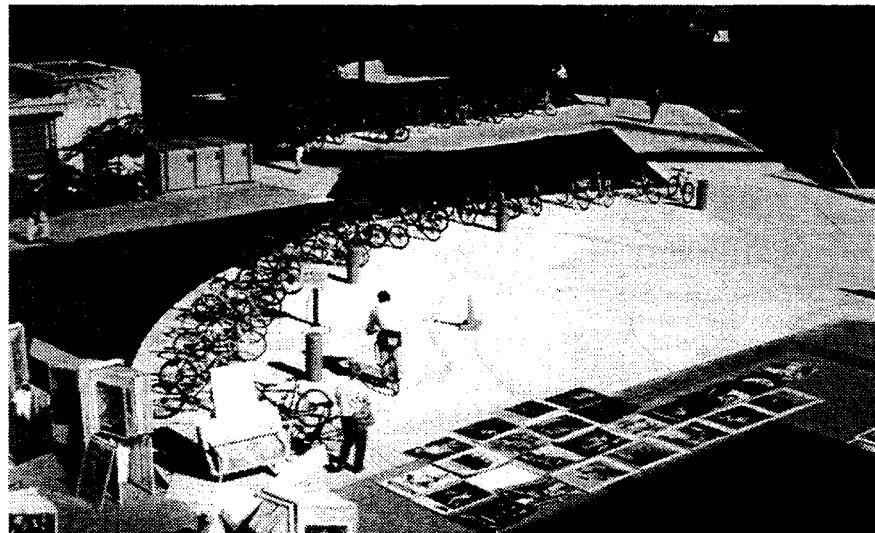
Communities should always consider intermodal options with the bicycle as a part of the system that feeds the bicycle friendly zone. These options accommodate people who must travel longer distances to reach the area.

To support these intermodal options, it should be possible for commuters to take their bicycles on transit vehicles for use at both ends of the transit link. Another way to support the bicycle-transit option, is to provide secure and safe bicycle parking at transit stops. Using both methods allows commuters to use their bicycles to reach the transit stop from home and ride to their destination after their transit ride. This is effective in areas where automobile parking is expensive or difficult to find or where bicycle transportation is quicker and more convenient than any other mode at either end of the transit trip. This means that ample parking facilities should be provided at origin *and* destination transit stops.

Figure 4-21.

If secure and safe bicycle parking is available at transit stops, bicycles can be used by commuters to reach the transit stop from home or after they reach their destination. Often, commuters may find using one bicycle to reach the transit stop near home *and* using another bicycle at their destination, a desirable transportation alternative.

Convenient hoop parking is provided on the student union plaza at this transit node on the University of Minnesota campus, (only 25% of the total parking is shown). Bicycle lockers can be seen in the background.



Phased Implementation Strategy

It is important that the phased implementation of the bicycle system demonstrate success at each development phase.






A phased implementation strategy is a critical piece of the entire plan.

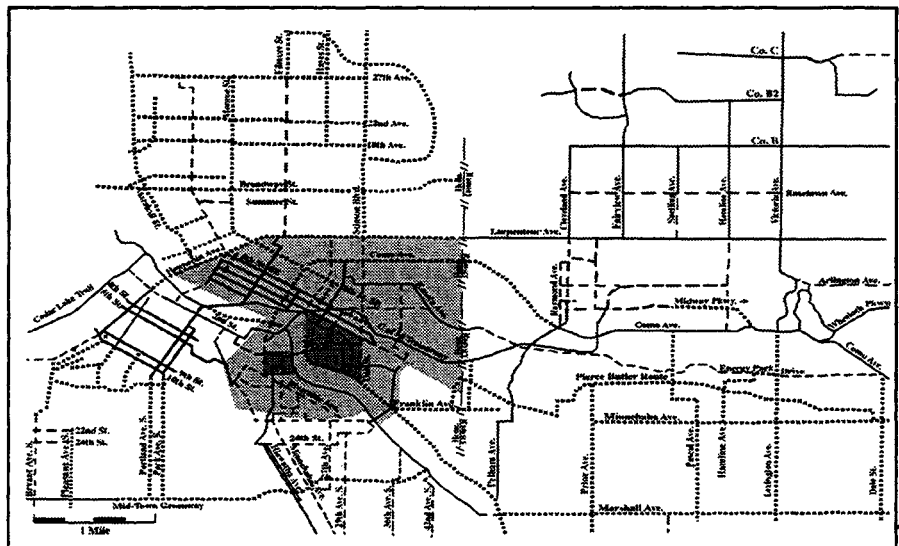
It will rarely be possible for communities to implement an entire bicycle transportation plan all at once, even in small, self-contained bicycle friendly zones. Even with adequate funding resources, it will often not be physically feasible to construct an entire zone along with its feeder routes in one phase of development. Since bicycle transportation systems are in their infancy in the United States, it is very important that the phased implementation of each bicycle facility and each bicycle sub-system demonstrate success at each phase. Any facilities added to a system should be well-used and visible.

A phased implementation strategy, therefore, becomes a critical piece of the entire plan. In addition to the benefits derived from a well-formulated implementation strategy, communities also have a clear understanding of how to proceed after the planning phase is complete. With an implementation strategy in hand, community decision makers and neighborhood advocates can point to specific projects that should be built and the bicycle plan carries less risk of being shelved along with many other plans of the past.

Determining the phased order of implementation depends on the specific details of each site and corridor, on roadway patterns, land use patterns, traffic conditions, and trip origin and destination data. A basic rule to follow in determining which projects should be implemented first is that each phase — each combination of projects — should return “more bang for the buck” than any other combination of projects. This easy rule becomes more complicated in practice where the relationships of land use, transportation and local conditions must be taken into account.

Figure 4-22.
Map showing a proposed bicycle friendly zone with existing and funded routes, planned routes and recommended additions to the system.

- Key**
-  University Campus
 -  Bicycle Friendly Zone
 -  Existing/Funded Routes
 -  Planned Routes
 -  Recommended Additions



Courtesy: University of Minnesota Intermodal Bicycle Transportation Plan

Initial phases of implementation should significantly alter the transportation infrastructure of the bicycle friendly zone.

Initial phases should include four major strategic moves. Taken together, these efforts should significantly alter the supporting transportation infrastructure of the bicycle friendly zone. All four of these strategies must proceed together to ensure the success of the bicycle system.

- **Bicycle infrastructure.** The initial phases should begin to blanket the bicycle friendly zone with bicycle boulevards and bicycle byways that will receive the heaviest use. Short feeder routes, preferably bicycle expressways, should also be built from concentrations of residences or other retail and commercial nodes nearby. The initial phases must begin to establish bicycle access facilities and parking everywhere.
- **Transit infrastructure.** A transit plan should also begin its operation in cooperation with the bicycle plan to provide attractive transportation options to former automobile users.

Figure 4-23.

In an initial phase, striping is used to test traffic flow and other traffic conditions for two streets in a bicycle friendly zone.

The streets have been restructured to accommodate bicycle traffic.

The larger street was previously configured with one parking lane and four traffic lanes. It has been restructured to provide two bicycle lanes — one in each direction, a parking lane, two through traffic lanes and a shared left turn only lane. Lanes on the intersecting side street have been narrowed to accommodate bicycle lanes.

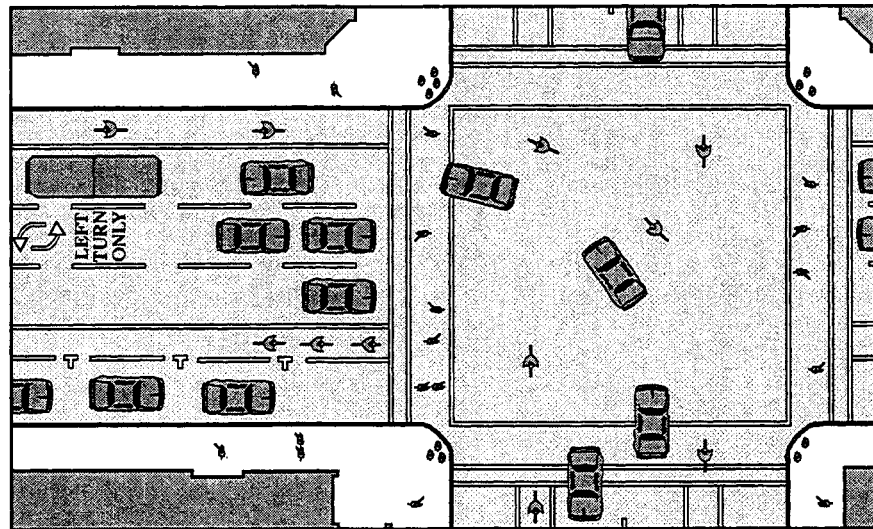
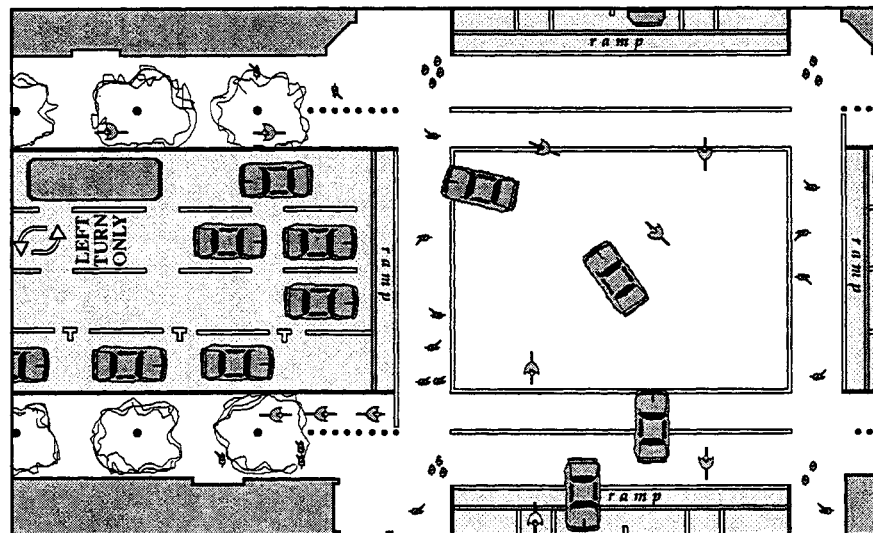


Figure 4-24.

After testing the new corridor configuration with striping, permanent changes provide more safety for cyclists and give priority to cyclists and pedestrians in the intersection.

The bike lane pavement is raised to the level of the sidewalk and a new curb is constructed. Bicycle space and pedestrian space are defined with trees, light fixtures, bollards and other street furniture. The raised intersection makes the bicycle and pedestrian space continuous and the motor vehicle space broken or discontinuous, giving priority to cyclists and pedestrians.



All four of these strategies must proceed together to ensure the success of the bicycle system

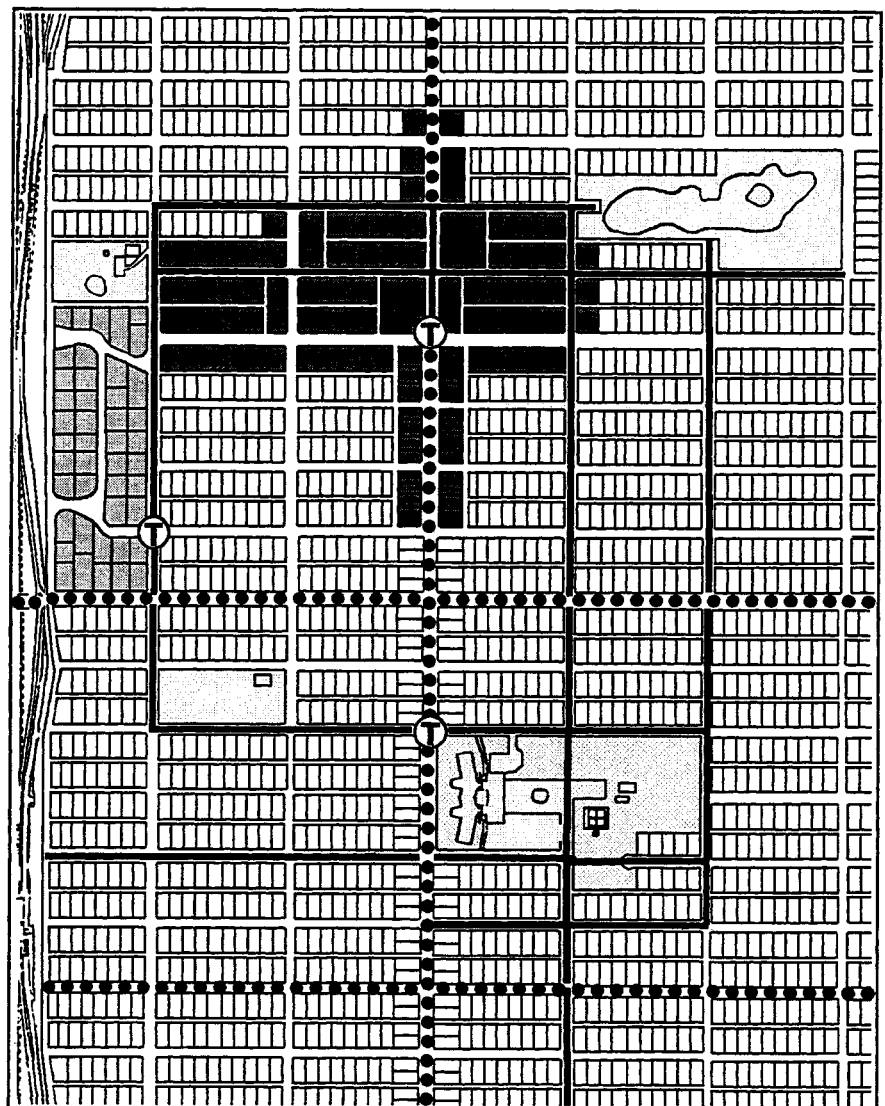
- **Reduced automobile infrastructure.** Initial phases must also begin to implement a plan that results in reduced automobile use in the bicycle friendly zone with a combination of parking regulations, traffic calming techniques or other public or private transportation policy and incentive programs.
- **Signage.** In addition to standard informational and warning signage required for bicycle facilities, all bicycle byways should be designated and signed in the initial phases. Implemented bicycle boulevards and expressways should be marked and labeled with roadside signs. Roadside signs should also welcome travelers to the bicycle friendly zone. (See Marketing Plan).

Figure 4-25.

Initial projects in the bicycle friendly zone create a comprehensive network that makes circulation by bicycle throughout the zone easy, safe and convenient. Employment, retail, commercial, recreational and educational places are connected with bicycle facilities. Inexpensive, temporary techniques, including traffic calming techniques, provide an overall structure that is tested for performance, effectiveness and acceptance during the initial phases.

Initial phases also significantly enhance bicycle and transit access to the area by extending or establishing new bicycle and transit feeder routes. In this example, value-added transit nodes are also developed near the commercial center, the industrial park and the school. All areas of the zone are connected by bicycle byways to encourage new bicycle users.

- Key**
- Bicycle Expressway
 - Bicycle Boulevard
 - Bicycle Byway
 - Commercial
 - ▨ Light Industrial
 - ▩ Schools and Parks
 - Residential
 - ⊕ Developed Transit Node



Later phases extend and refine the system.

Later phases of the implementation extend and refine the system.

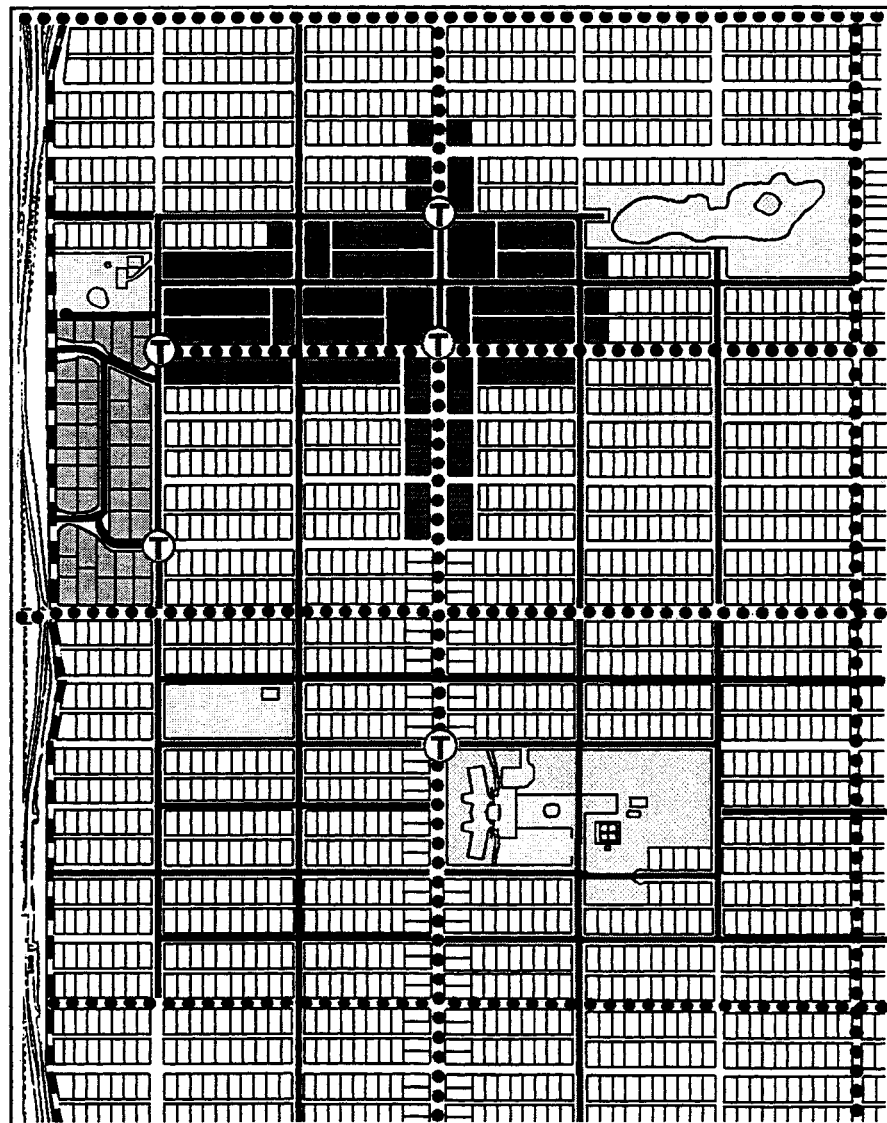
- Bicycle infrastructure. Later phases should continue building the bicycle boulevard network within the zone.
- Bicycle facilities. The designs of bicycle byways, intersections and bicycle access facilities should be fine tuned so that bicycle travel within the zone is convenient and safe. In the later phases, it is important to focus on the details of conflict between cyclists, pedestrians, and motor vehicles.

Figure 4-26.

Later projects extend and refine the bicycle system. Bicycle boulevards and byways form a finely grained network throughout the zone. In this example, care is taken to make all streets around the school bicycle friendly for children. Permanent traffic calming elements are installed in the test locations established in the first projects. Exit and entrance facilities from the new bicycle expressway on the edge of the bicycle friendly zone are at frequent intervals to provide convenient access to all parts of the zone.

Additional care has been taken to increase bicycle and transit travel to employment, retail and recreational centers by improving the convenience of the system to bicycle and transit users. Incentive programs provide more encouragement for travellers to use these modes.

Zoning and land use policies are adjusted to promote bicycle, transit and pedestrian modes of transportation to, from and around the area.



-
- Access to all destinations. Bicycle parking and transition facilities that enhance the access of cyclists to all destinations in the area should be vigorously pursued.
 - Network of feeder routes. Additional feeder routes should be implemented to serve secondary concentrations of patrons. Existing feeder routes should be strategically extended to serve more users travelling to the bicycle friendly zone and to serve other areas that could be bicycle friendly zones in the future.

Communities must be prepared to support the full maintenance plan at each phase of the implementation. If it is not possible to fully maintain a facility, the project should be postponed until later phases. This includes regular maintenance (gravel and litter removal, and facility repair) and seasonal maintenance (quick and frequent snow and ice removal). Recommended maintenance levels are described in chapter 3 for each component facility.

Since an incentive to daily bicycle travel is the ability to perform errands on route between home and the destination, every phase should include at least one project that significantly improves the parking facilities in the bicycle friendly zone and at destinations along the feeder routes. As the phased implementation proceeds, the provision of parking facilities should become finer grained, until upon completion of the plan, facilities are provided at the doors of all destinations. Planners should keep in mind that bicycle parking must also blanket the bicycle friendly zone, much as auto parking blankets our cities now. It should be at least equal to that provided for automobiles.

Some phases may contain projects that do not implement a new route, but provide missing links in the current system. This usually involves overcoming some existing barrier to the smooth and safe flow of bicycle travel. When a significant number of projects of this nature must be pursued, and particularly when a phase is solely composed of projects like this, the marketing plan should include provisions to present the merits of each to the public.

Marketing Plan

Though a well-selected and well-designed bicycle friendly zone with attractive and visible feeder routes will provide good windshield advertising, a more organized effort for providing information and education to the public is important for attracting larger numbers of cyclists.

Another effort which benefits the implementation of a bicycle system is the marketing of the system to the general public. Even though a well-selected and well-designed bicycle friendly zone with attractive and visible feeder routes will provide good windshield advertising, a more organized effort for providing information and education to the public is important for attracting larger numbers of cyclists.

Media coverage can additionally serve to educate the public about the merits of bicycle transportation, about bicycle and motor vehicle safety and behavior, and the purpose and the operation of the bicycle friendly zone and its bicycle and transit feeder routes. Media coverage and promotional materials can also advertise and market the system to people not currently using the bicycle as transportation. Though the maxim, "Build it and they will come" has applied to many well-planned bicycle projects in the past, a new maxim, "Publicize it and they will come" also holds true for many services and attractions in urban areas. This kind of advertising is important public education about the use and nature of bicycle facilities in urban areas.

As is the case with facilities for the motor vehicle, the beginning and completion of each implementation phase should be reported in the news media. Additional media updates should also be provided during the construction of lengthy projects. Ground breaking and ribbon cutting ceremonies are commonly held to recognize and celebrate the construction of significant public works projects and these events should include the construction of bicycle system projects, as well. All media coverage and special events should be attended by elected officials, community leaders and the general public.

Figure 4-27.

"Bicycle Trail Blazers Open New Route to Downtown"
from *Seward Profile*, June 1993.

A front page article announcing the opening of a new urban bicycle bridge over an interstate highway.

The photo of the ribbon-cutting ceremony for this county project includes the County Commissioner for the area, County Bicycle Advisory Board members, the State Bicycle Coordinator, and bicycle advocates.



Courtesy: *Seward Profile*, A Publication of the Seward Neighborhood Group, Minneapolis, Mn.

Media coverage can also educate the public about:

- **The merits of bicycle transportation**
- **Bicycle and motor vehicle safety and behavior**
 - **The purpose and the operation of the bicycle friendly zone, its bicycle and transit feeder routes.**

Maps should always be a part of the media coverage and all promotional, informational and educational materials that are provided to the public. Communities should be prepared to produce maps of the system that are readily available at various places in the city and in the bicycle friendly zone at little or no cost.

Visitors should be welcomed to bicycle friendly zones by attractive signs that include the name of the zone. All bicycle signage should be standardized across a metropolitan area, if not the state. Signage should be easy to read and readily recognizable under heavy traffic conditions.

In order to market the system to people who are not presently using the bicycle, media coverage and marketing materials should include images of people carrying out the ordinary tasks of daily life. Images of cyclists that reinforce the image of cyclist-as-racer should be avoided. People of all ages should be pictured wearing everyday clothing for work or shopping. With their bicycles, they should be pictured carrying objects associated with everyday life, such as purses, briefcases, bags of groceries, or children on their way to day care. Rather than reinforcing the image of the bicycle as a vehicle for sport and recreation only, these kinds of images will serve to promote the bicycle as a viable option to serve the utilitarian transportation needs of many people.

Figure 4-28.

In order to market the system to people who are not presently using the bicycle, media coverage and marketing materials should include images of people carrying out the ordinary tasks of daily life.



Gathering Data

Measuring the success or the failure of the bicycle system is as important as the implementation strategy, the marketing plan, the network plan and the design of each facility. At a minimum, the following information should be recorded for all parts of the system:

- Bicycle traffic counts,
- Bicycle parking counts (both legally and illegally parked),
- Pedestrian and motor vehicles accidents with bicycles.

These data will provide much needed information to later stages of the plan regarding the effectiveness of route selection, corridor and intersection design, and the adequacy of parking facilities. They will identify routes and problem areas that need to be addressed and amended in later phases of implementation and they will provide data for obtaining support and funding for future projects. If traffic counts and parking data are carefully gathered, they can add to the community's trip origin and destination data. These minimum measurements will also aid in the selection and the planning of future bicycle friendly zones.

Additional information of great benefit includes:

- Motor vehicle and motor vehicle passenger counts in the bicycle friendly zone,
- Transit trips to and from the bicycle friendly zone,
- Bike and transit trips to the bicycle friendly zone,
- Pedestrian trips to and from the bicycle friendly zone,
- Bike trip origin and destination information by land use type,
- Other data that the community desires; e.g., the effectiveness of a particular design, the effectiveness of signage, the effectiveness of the maintenance schedule, the effectiveness of the marketing plan, reactions to the neighborhood and public participation process, reactions to the community's transportation policy and so forth.

Because there is little data on bicycle transportation at this time, any data that a community collects benefits the community's plans and the transportation and planning professions in general. All gathered information should be made public, not only for purposes of publicizing success, but for informing the bicycle planning process and promoting bicycle transportation in general.

4.5. Planning Checklist

Why the Bicycle Makes Sense

- Almost 40% of all trips taken in the U.S. are less than 3.2 km (2 mi) from home. Almost 63% are less than 8 km (5 mi).
- A 3.2 km (2 mi) bicycle trip takes 8-10 minutes of uninterrupted, or stop-free travel, at speeds between 19-24 kph (12-15 mph). An 8 km (5 mi) trip takes 20-25 minutes.
- The average commute time has historically been 20-30 minutes.
- The bicycle can deliver satisfactory trip travel times for a significant number of trips, assuming an infrastructure is provided to accommodate the bicycle as transportation.
- The bicycle (and the pedestrian) more successfully, completely and cost-effectively fulfill goals of environmental, energy and economic efficiency than other modes.

Community Transportation Policy

- Formulate transportation policy that guides transportation, land use, and development decisions.
- Examine what kind of city, or what kind of university, business district, industrial park or neighborhood the community wants.
- In accordance with the ISTEA mandate, build transportation systems that are efficient in their entirety, including energy efficiency, rather than transportation systems that provide efficient service to one mode.
- Set goals that precisely describe the modal split for the planned system and specific dates when objectives will be reached.
- Develop land use policy with a primary goal of efficiency for the transportation system.
- Explicitly designate priorities for each mode that uses the roadway system.
- Put muscle into policy to ensure that it is implemented. Explicitly direct actions that make the policy influence reality.

Community Involvement

- ISTEA requires local participation in transportation decisions. Involve the public through:
 - Citizen groups
 - Bicycle advocacy groups
 - Neighborhood groups
 - Local business and civic organizations
 - Schools
 - Adult education programs
 - Colleges and universities
 - Media campaigns
 - Educational campaigns

**Community Involvement
(continued)**

- Include the public early in the decision making process
- Use planners experienced in public participation, transportation and community development as key participants in the process
- Assign staff to prepare minutes of meetings and other documentation that the process and its plans produce
- Develop and maintain open minds and a group attitude of creativity in transportation problem solving
- Be open to solutions other than traditional ones.

**Network Planning
Characteristics of Good
Bicycle Friendly Zones**

- Area blanketed with a complete set of bicycle facilities
- Presence of automobile movement diminished
- A variety of bicycle, pedestrian, and transit options available for travel to, from, and within the zone
- Resources concentrated in one area to provide an effective and successful system
- Provides “windshield” advertising for bicycle transportation
- Generates demand for more bicycle transportation

**Selecting
Bicycle Friendly Zones**

- Select a single zone, or a handful of zones
- Select zone *only if* it can be effectively blanketed with a bicycle network
- Select high profile areas
- Select areas patronized by large numbers of people on a daily basis
- Select areas where people currently travel by bicycle *and* areas where people have the inclination to bicycle
- Select areas where people have the opportunity to travel by bicycle (less than two miles from residential concentrations)
- Select areas serviced well by existing transit facilities
- Potential candidates:
 - Universities and colleges
 - Central business districts
 - Medical and government facilities
 - Shopping centers
 - Business districts
 - Industrial parks and large industrial employers

Transportation, Land Use and Bicycle Friendly Zones

- Gather in-depth information to finalize selection of the bicycle friendly zone and information on major routes linking the zone to other areas of the city
- Promote and develop areas of mixed land use
- Achieve patterns that support shorter trips for daily travel. Provide residential, retail, commercial and employment within 3.2 km (two mi) of each other
- Initiate new land use plan concurrent with the bicycle plan
- When mixed land use patterns are not present or supportable, select:
 - Areas with high residential/employment use
 - Areas with high residential/retail use, where the retail serves daily and weekly shopping needs
 - Areas with high transit/employment use
- Develop transit nodes with mixed commercial/retail and residential uses
- Adhere to standards that reflect Average Daily Traffic Counts (ADTs) and motor vehicle speeds (Table 3-1) when planning bicycle facilities

Integrating Bicycle Friendly Zones with the City

- Provide feeder routes -- bicycle expressways, bicycle boulevards and transit -- to and from the zone
- Implement feeder routes with the same high standards as the bicycle friendly zone
- Plan feeder routes to form a larger network of city-wide and district-to-district connections
- Plan feeder routes to be useful to future bicycle friendly zones
- Plan high visibility feeder routes to:
 - Familiarize people with bicycle transportation
 - Create a demand for more bicycle friendly zones
- Provide transit and transit/bicycle options
- Provide bicycle parking at origin and destination transit stops

Phased Implementation Strategy

- A phased implementation strategy is always necessary to accommodate the funding limits and physical limits of construction.
- Provide understanding of how to proceed and identify a sequence of specific projects to be built

Phased Implementation Strategy (continued)

- With each phase, add facilities that:
 - Are well-used and have high visibility,
 - Demonstrably improve the capabilities of the system
- Get “the most bang for the buck” with each phase
- Initial phases — Make basic alterations to transportation infrastructure of the bicycle friendly zone:
 - Construct bicycle boulevards that will receive the heaviest traffic; short feeder routes from nearby residential, commercial and retail areas; parking and bicycle transition facilities
 - Reduce automobile use in the zone with parking regulations, traffic calming techniques, policy or incentive programs
 - Implement transit plans to provide alternatives to former automobile users
 - Designate and sign bicycle byways
 - Install signs that identify the bicycle friendly zone
- Later phases — Extend and refine the system:
 - Continue building the boulevard network within the zone
 - Fine tune the designs of all facilities
 - Make travel by bicycle everywhere within the zone convenient and safe
 - Focus on the finer details of motor vehicle, bicycle and pedestrian conflicts
 - Provide additional bicycle parking and bicycle transition facilities; enhance the access of cyclists to all destinations in the area
 - Add feeder routes to serve secondary concentrations of patrons
 - Extend existing feeder routes to serve more users and to serve other areas that could be future bicycle friendly zones
- Support the full maintenance plan at each phase
- Include at least one project in each phase that significantly improves the parking facilities in the zone and along the feeder routes
- Construct routes that provide access to destinations or other routes; never construct routes that do not terminate at a destination

Marketing Plan

- Use the media and promotional materials to:
 - Educate the public about bicycle transportation
 - Inform the public about the purpose and operation of the bicycle friendly zone

-
- Inform the public about transit and bicycle feeder routes
 - Advertise and market the system
 - Report the beginning and completion of every phase in the media
 - Celebrate ground breaking and ribbon cutting with elected officials, community leaders and the public
 - Provide maps in the media coverage and in promotional materials
 - Mark the boundaries of the bicycle friendly zone with attractive, clear and visible signs
 - Market the system with images of different people using the bicycle for carrying out their daily activities. Avoid a sports-oriented or recreational image, but retain an image that promotes physical health.
 - Market gathered data and share success with the public

Gathering Data

- At a minimum, record the following for all parts of the system:
 - Bicycle traffic counts, (preferably, before and after improvements) within the intended service area, as well as on individual routes
 - Bicycle parking counts
 - Pedestrian and motor vehicles accidents with bicycles
- Additional information can include:
 - Motor vehicle and motor vehicle passenger counts in the bicycle friendly zone
 - Transit trips to and from the bicycle friendly zone
 - Bike and transit trips to the bicycle friendly zone
 - Pedestrian trips to and from the bicycle friendly zone
 - Trip origin and destination information
 - Other data that the community desires
- Use data to:
 - Amend later phases, as necessary
 - Identify problems
 - Plan future bicycle friendly zones and city-wide routes
 - Obtain support and funding for future projects
 - Add to the data and information base for the transportation and planning professions
- Market the system to the public

5. Fundamentals for Planning & Designing Bicycle Facilities

The fundamentals of bicycle transportation planning and design affect the qualitative aspects of bicycle systems in terms of their effectiveness as safe, attractive and convenient systems of transportation.

Everyone involved in efforts to establish and foster bicycle transportation in urban areas should understand the fundamentals of bicycle transportation planning and design. These affect qualitative aspects of the bicycle system in terms of its effectiveness as a safe, attractive and convenient system of transportation. The information presented in this chapter should serve as background information, or as a foundation on which decisions are made at each phase regarding the implementation of planned bicycle facilities.

This chapter presents some user and operating requirements of bicycle transportation systems. The degree to which policy makers and decision makers, bicycle and community advocates, and urban transportation planners, designers and engineers provide an accommodating bicycle transportation infrastructure will be based on the degree to which the requirements described in this chapter are fulfilled. In general, all participants involved should understand:

- The needs of cyclists as transportation consumers,
- The needs of cyclists as transportation users,
- The skill levels of bicyclists,
- The personal safety concerns of cyclists,
- The importance of “legibility” in the multi-modal roadway,
- The importance of the “legibility” of the bicycle system.

Figure 5-1.

Everyone involved in the planning and building of bicycle facilities and bicycle systems must understand the needs of cyclists.

As transportation consumers, cyclists have the same needs as motorists. They should be able to accomplish daily and weekly tasks close to home or on the trip to and from work.



5.1. The Needs of Cyclists As Transportation Consumers

As people who live in the community and participate in the business, social and cultural activities of the community, cyclists are transportation consumers.

They have the same transportation needs as motorists.

Attention to the consumer-oriented features of roadway systems for cyclists will provide the opportunity for more people to more thoroughly use the bicycle in their daily lives.

An essential goal for any bicycle transportation system should be to attract new users to bicycle transportation. According to non-cyclists, a reason for not cycle commuting is that bicycle transportation is not convenient or practical enough for accomplishing the various incidental daily trips in their lives. This section addresses the needs of cyclists as transportation consumers. It describes their needs as people who live in a community and use its businesses, services, institutions and streets.

Looking at the larger picture, this problem concerns land use and urban living patterns that reflect automobile-oriented forms of development. Land use issues of single-use, sprawled living patterns which are only accessible by the motor vehicle are ones that bicycle transportation planners should address and actively engage. However, the more immediate issue of providing access to daily and weekly shopping and service needs can often be handled more quickly and within the context of a bicycle transportation plan.

Bicyclists have the same transportation needs as motorists. As people who live in a community and participate in the business, social and cultural activities of the community, cyclists need to “be where the action is,” just as much as motorists. Cyclists need to get to work, run errands, shop, browse, and attend movies, festivals and sporting events, as do motorists. In addition, with the majority of women and men working today, commuters require the ability to accomplish daily and weekly errands on their way to and from work, and at noon, as well. Often, trips to the day care are also a part of the daily commute to work.

Planning and design attention to the consumer-oriented features of roadway systems for cyclists will provide the opportunity for more people to more thoroughly use the bicycle in their daily lives. However, discussions of the transportation needs of cyclists often do not include discussions of the basic transportation services that are given motorists as members of the community. The result is that unsaid planning assumptions are made regarding the kinds of transportation services and facilities that cyclists should get and the consumer-oriented features of transportation are often overlooked in the planning of bicycle facilities.

If a bicycle system does not provide safe and convenient facilities for accomplishing daily and weekly tasks, the bicycle will be abandoned to the automobile for accomplishing them. Therefore, in order to increase the viability of cycle commuting for larger numbers of people, it is important that planners include the consumer-oriented features of transportation. Plans should always provide access to all areas of daily and weekly importance in the city, and they should provide competitive bicycle trip travel times for getting to these areas over longer distances.

5.2. The Needs of Cyclists As Transportation Users

Bicyclists have basic needs as people who travel using a transportation system.

Bicyclists have basic needs as people who travel using a transportation system. Bicycle literature in the last ten years has summarized cyclist requirements for bicycle systems and bicycle facilities with the words “fast, safe, attractive.” Others have added words, such as “convenient” and “comfortable.”

In 1994, the Bicycle Federation of America described the basic needs of cyclists, as transportation users. They described these as ‘Performance Criteria for Bicycle Networks,’ in a publication prepared for the Federal Highway Administration. Their description provides the following requirements for cyclists, as transportation users.

Performance criteria define the important qualitative and quantitative variables to be considered in determining the desirability and effectiveness of a bicycle facility network. These can include:

- Accessibility** ■ *This is measured by the distance a bicycle facility is from a specified trip origin or destination, the ease by which this distance can be traveled by bicycle, and the extent to which all likely origins and destinations are served.... no residential area or high priority destination (school, shopping center, business center, or park) should be denied reasonable access by bicycle.*
- Directness** ■ *Studies have shown that most bicyclists will not use even the best bicycle facility if it greatly increases the travel distance or trip time over that provided by less desirable alternatives.¹⁴ Therefore, even for [less-skilled] bicyclists, routes should still be reasonably direct. The ratio of directness to comfort/perceived safety involved in this tradeoff will vary depending on the characteristics of the bicycle facility (how desirable is it?), its more direct alternatives (how unpleasant are they?), and the typical user’s needs (in a hurry? , business or pleasure trip?).*
- Continuity** ■ *The proposed network should have as few missing links as possible. If gaps exist, they should not include traffic environments that are unpleasant or threatening to [less-skilled] riders, such as high volume or high-speed motor vehicle traffic with narrow outside lanes.*
- Route Attractiveness** ■ *This can encompass such factors as separation from motor traffic, visual aesthetics, and the real or perceived threat to personal safety along the facility.*

Low Conflict

- *The route should present few conflicts between bicyclists and motor vehicle operators.¹⁵*

In addition to the Performance Criteria for Bicycle Networks from the Bicycle Federation of America, the following should be included as requirements of cyclists, as transportation users.

Quality Facilities

- Quality facilities that insure the physical and personal safety of cyclists, provide a physically legible roadway space to reduce ambiguity and conflict regarding the use of the space by cyclists, other vehicles and pedestrians, and offer smooth, level, well-drained roadways.

Well-Maintained Facilities

- Well-maintained facilities that are free from gravel and debris, receive prompt and complete snow and ice removal, and are regularly remarked and restriped so that the bicycle facility is legible to cyclists and motorists.

Secure, Convenient Parking

- Secure and convenient parking as close to the door as possible — closer than auto parking.

Weather-Protected Facilities

- Weather-protected parking facilities and shelters at intersections where a wait can be greater than 2 minutes.



Figure 5-2.

Studies have shown that most bicyclists will not use even the best bicycle facility if it greatly increases the travel distance or trip time over that provided by less desirable alternatives.

5.3. Skill Levels: The Design Cyclist

When developing a bicycle transportation plan, communities need to recognize that there is a range of cyclist skills that must be accommodated in the bicycle transportation system.

Selecting Roadway Design Treatments to Accommodate Bicycles, a manual produced for the Federal Highway Administration (FHWA) by the Bicycle Federation of America (BFA) and the Center for Applied Research, Inc., describes cyclist needs in terms of skill levels, as follows:

Nearly 100 million people in the United States own bicycles.¹⁶ The Bicycle Federation of America estimates that fewer than 5 percent would qualify as experienced or highly skilled bicyclists. Since the [Federal] policy goal is to accommodate existing bicyclists and encourage increased bicycle use, there will be more novice than advanced bicyclists using the [roadway] system. Therefore, any roadway treatments intended to accommodate bicycle use must address the needs of both experienced and less experienced riders. One solution to this challenge is to develop the concept of a “design cyclist” and adopt a classification system for bicycle users such as the following:

- *Group A – Advanced Bicyclists: These are experienced riders who can operate under most traffic conditions. They comprise the majority of the current users of collector and arterial streets and are best served by the following:*
 - *Direct access to destinations usually via the existing street and highway system.*
 - *The opportunity to operate at maximum speed with minimum delays.*
 - *Sufficient operating space on the roadway or shoulder to reduce the need for either the bicyclist or the motor vehicle operator to change position when passing.*
- *Group B – Basic Bicyclists: These are casual or new adult and teenage riders who are less confident of their ability to operate in traffic without special provisions for bicycles. Some will develop greater skills and progress to the advanced level, but there will always be many millions of basic bicyclists. They prefer:*
 - *Comfortable access to destinations, preferably by a direct route, using either low-speed, low traffic-volume streets or designated bicycle facilities.*

- *Well-defined separation of bicycles and motor vehicles on arterial and collector streets (bike lanes or shoulders) or separate bike paths.*
- *Group C – Children: These are pre-teen riders whose roadway use is initially monitored by parents. Eventually they are accorded independent access to the system. They and their parents prefer the following:*
 - *Access to key destinations surrounding residential areas, including schools, recreation facilities, shopping, or other residential areas.*
 - *Residential streets with low motor vehicle speed limits and volumes.*
 - *Well-defined separation of bicycles and motor vehicles on arterial and collector streets or separate bike paths.*

While other distinctions can be added, these lists support combining groups B and C bicyclists in most situations. Therefore, a “design cyclist” concept is proposed that recognizes two broad classes of bicyclists: group A riders and group B/C riders.¹⁵

Figure 5-3.

Group A – Advanced cyclists are experienced riders who can operate under most traffic conditions.

Group B/C – Basic cyclists and children are less confident or able to operated in traffic without special provisions for bicycles.



Design Approach according to Skill Level

The FHWA and the BFA recommendations support the facility separation guidelines in section 3.2. ('minimizing speed differentials between bicycles and motor vehicles') and the need for systems of bicycle byways ('side-street bicycle routes'), boulevards and expressways ('separate bike paths') for group B/C bicyclists. They say:

Generally, group A bicyclists will be best served by designing all roadways to accommodate shared use by bicycles and motor vehicles. This can be accomplished by:

- *Establishing and enforcing speed limits to minimize speed differentials between bicycles and motor vehicles on neighborhood streets and/or by implementing "traffic calming" strategies.*
- *Providing wide outside lanes on collector and arterial streets built with an "urban section" (i.e., with curb and gutter).*
- *Providing usable shoulders on highways built with a "rural section" (i.e., no curb and gutter).*

Generally, group B/C bicyclists will be best served by a network of neighborhood streets and designated bicycle facilities which can be provided by:

- *Ensuring neighborhood streets have low speed limits through effective speed enforcement or controls and/or by implementing "traffic calming" strategies.*
- *Providing a network of designated bicycle facilities (e.g., bike lanes, separate bike paths, or side-street bicycle routes) through the key travel corridors typically served by arterial and collector streets.*
- *Providing usable roadway shoulders on rural highways.*

The FHWA and BFA report continues by recommending that "Group A riders will be best served by making every street 'bicycle friendly.' ... Group B/C riders will be best served by identifying key travel corridors (typically served by arterial and collector streets) and by providing designated bicycle facilities on selected routes through these corridors."¹⁵

The following planning guidelines are recommended as additions to the recommended design approaches according to skill levels.

- Physical separation of cyclists and motorists may be necessary on large, busy urban streets to provide bicycle access to the retail and service destinations on them.

Section 5.1 described how cyclists, as transportation consumers, have the same needs as motorists. Since traffic volumes on major urban retail streets will often be uncomfortable or unsafe for many, striping or a wider curb lane may not suffice for 95% of the cycling population — Group B/C riders, or even Group A riders.

Additional Planning Guidelines for Responding to Skill Level

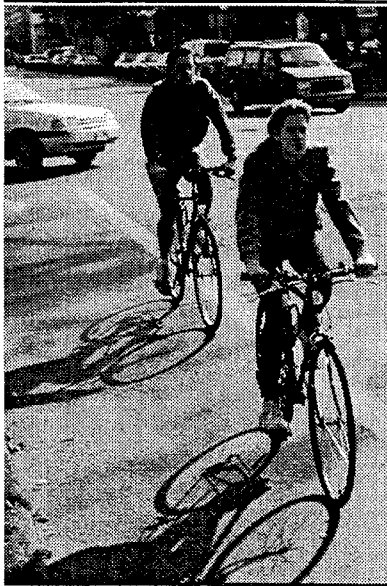
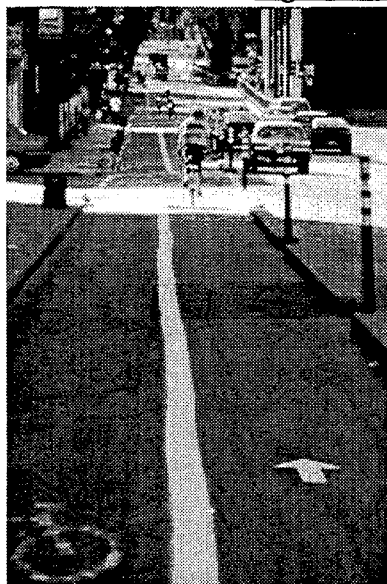


Figure 5-4.

Group A and Group B/C riders, like motorists, all have the same needs as transportation consumers. Since traffic volumes on major urban retail streets will often be uncomfortable or unsafe for many, striping or a wider curb lane may not suffice for 95% of the cycling population — Group B/C riders, or even Group A riders. Therefore, physical separation of cyclists and motorists may be necessary on larger urban streets to provide bicycle access to their destinations. This one-way street in Montreal provides physically separated bicycle travel in both directions. Turns at intersections are made "pedestrian-style."

Figure 5-5.



Section 3.2. noted how bicycle facilities on busy urban streets will often be classified as bicycle byways because of the operating speeds and the number of stops that busy urban streets necessitate. If the kind of traffic on these types of streets warrants the byway classification, then all of the recommended techniques for planning and designing bicycle byways (including traffic calming) should be used as necessary on this application of bicycle byway.

- Where the bicycle facilities on busy commercial arterials are bicycle byways, it would be ideal to designate and implement a bicycle boulevard or expressway within a few blocks of the arterial, so that commuting cyclists (particularly Group A riders) can make better time.

Commuting cyclists prefer routes that have few stops since stopping interrupts the vehicle's forward movement and, unlike stops for the motorist, requires physical exertion on the part of the cyclist to regain traveling speed. Stop-free routes are particularly important to Group A cyclists who often travel longer distances than Group B/C cyclists and who sometimes use the bicycle as their only mode of personal transportation. The use of the existing street system adapted with wider curb lanes can mean that frequent stops are required of the cyclist, unless the cyclist chooses to ignore stop lights and stop signs. A carefully designed, designated bicycle boulevard or expressway can cut down the number of stops for all cyclists, regardless of skill level.

- The probability of large volumes of potential cyclists indicate the need for facilities that are carefully sized for high volume use (also see the 'volume' planning parameter in section 3.3).

If cycling is well accommodated as a transportation option, the numbers of cyclists could grow such that striped or signed bike lanes or wide curb lanes do not serve volumes of cyclists in a convenient, comfortable, or safe manner. Such conditions can occur around universities, in bicycle friendly zones or other heavily used areas of the community.

The kinds of facilities recommended here indicate there is a need for a measure of security and convenience that is provided by a "separate facility." The common notion that separated facilities are provided with a grassy strip separating cyclists from motorized traffic does not apply in many urban areas where space in the corridor of the street is at a premium. Other techniques can be used to physically separate cyclists from motorized traffic including elevated space, barrier separation using trees or street furniture (e.g., parking meters, bollards and parked cars), separation using pavement texture or color, and the separation of bicycle boulevards and expressways from busy arterials with bicycle byways or bicycle local access facilities on the arterial itself.

5.4. Personal Safety & Bicycle Transportation

The planning and design of bicycle transportation systems must always attend to the personal safety of the cyclist, otherwise facilities may go unused.

The major guideline for planning and designing personally safe bicycle facilities is that the bicyclist must be visible to others at all times during the trip.

Whereas the term “physical safety” refers to the safety of the cyclist from accidents in the roadway, the term “personal safety,” refers to the safety of the cyclist from personal attack. Unlike the motorist who is sheathed in the protective metal cover of the motor vehicle, cyclists operate their vehicles with no protective covering. In fact, cyclists are usually more vulnerable during an attack than pedestrians. A pedestrian is on foot and can more quickly escape on foot. During an attack, a cyclist can often become entangled in the bicycle or injured in a fall from it, and therefore be significantly disabled during an attack.

The planning and design of bicycle transportation systems must always attend to the personal safety of the cyclist, otherwise facilities may go unused. In recent years, the incidence of personal attack on bicycle facilities has grown. All bicycle facility planners and designers must take positive action to reverse this trend. An increase in the number of attacks on cyclists could generally discourage the use of the bicycle as a transportation option and the growing interest in bicycle transportation could suffer significant setbacks because of threats to personal safety.

Urban residents receive sound advice when they are warned by safety experts that concealed areas are dangerous and should not be entered or used. Transportation professionals should also heed this advice in the planning and design of bicycle facilities. *The major guideline for planning and designing personally safe bicycle facilities is that the bicyclist must be visible to others at all times during the trip.*

Routes that pass through isolated areas can be extremely dangerous as far as the personal safety of the cyclist is concerned. These include routes through woodlands and other isolated park areas; routes on streets with a low level of public activity; routes on some abandoned urban rail corridors, particularly those that are below the grade level of the street; and routes that have tunnels along their way.

Though isolated routes can often meet many of the most important requirements of cyclists for direct, stop-free, traffic-free, and pollution-free routes through beautiful surroundings, they could also be perceived by many to be unsafe and unsuitable for transportation or recreation. It is a challenge to the profession to select and design routes that fulfill these requirements *and* provide a high degree of personal safety as well.

When designing for safety, Views from the torso and higher and views mid-calf and lower are important.

The maxim “to see and be seen” applies when designing for personal safety in the roadway. Vegetation, topography and physical structure that conceal the cyclist from the view of others is dangerous. Likewise, if these landscape elements are placed too close to a bicycle facility, an attacker can be concealed.

When designing for safety, *views from the torso and higher, and views mid-calf and lower are important.*

Minimally, the view from approximately 1-3 meters (3-10 feet) above the ground should be unobstructed so that the cyclist can view the surrounding area and so that others can see the cyclist. If there are taller buildings surrounding the route, then a clear view higher than 3 meters (10 feet) should be maintained so that cyclists are visible from the windows of surrounding buildings.

Views at the ground level should also be unobstructed. Views mid-calf and downward are important if an attack occurs so that others can see the attack occurring and obtain help. A row of small shrubs no taller than 0.5 meters (1½ feet) or a row of trees will provide this measure of safety — a row of 1 meter (3 foot) shrubs will not. The view mid-calf and downward is also important when concealment is under consideration. A common mistake when designing for safety is to construct a solid wall that meets the pavement. Such an arrangement can hide a potential attacker. If the wall was visually permeable or rested on legs, the attacker could be seen hiding.

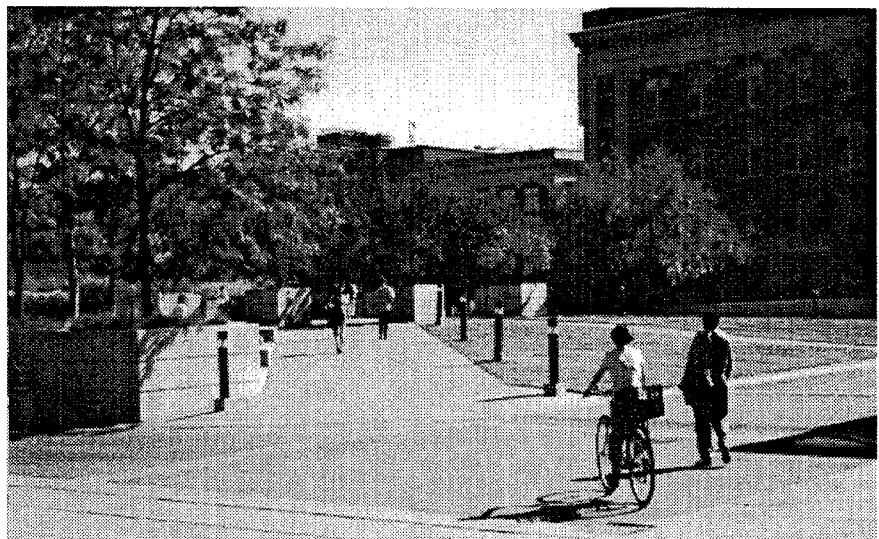


Figure 5-6.
The maxim “to see and be seen” applies when designing for personal safety in the roadway. Activity on this mixed-use facility is easily viewed both at ground level and from above.

It is equally critical that cyclists are able to “see and be seen” at bicycle parking facilities. It is common to see bicycle parking facilities placed in out-of-the way spaces created by the nooks and crannies of the urban architecture or in spaces between buildings. Though this may be a practical use of oddly shaped or unused urban space, these spaces can potentially create a dangerous setting for the cyclist while parking. As far as personal safety is concerned, it is advisable to provide bicycle parking facilities near the entrances of buildings, or along busy streets. This practice can doubly benefit bicycle transportation because it also allows the cyclist more convenient access to the doors of destinations in the city than the motorist and because it makes cycling a more visible part of the urban scene.

Lighting is another tool of the bicycle facility designer when designing for personal safety. Vegetation should not hide light that is cast onto the bicycle roadway. Lighting that is placed below the canopy of trees not only fully lights the bicycle roadway, but can provide an intimate, urban ambience as well.

A useful characteristic of lighting is that light casts shadows. Well-positioned lights can cast shadows that either discourage attacks or which can be used as a warning of a potential attack. It is a common urban experience that lights behind a pedestrian not only cast the pedestrian’s shadow on the pavement ahead, but also the shadow of

Figure 5-7.

It is important that cyclists are able to “see and be seen” at bicycle parking facilities.

For reasons of personal safety, bicycle parking should be provided near busy entrances to buildings or along busy streets.

This practice can doubly benefit bicycle transportation because it also allows the cyclist more convenient access to the doors of destinations than the motorist.



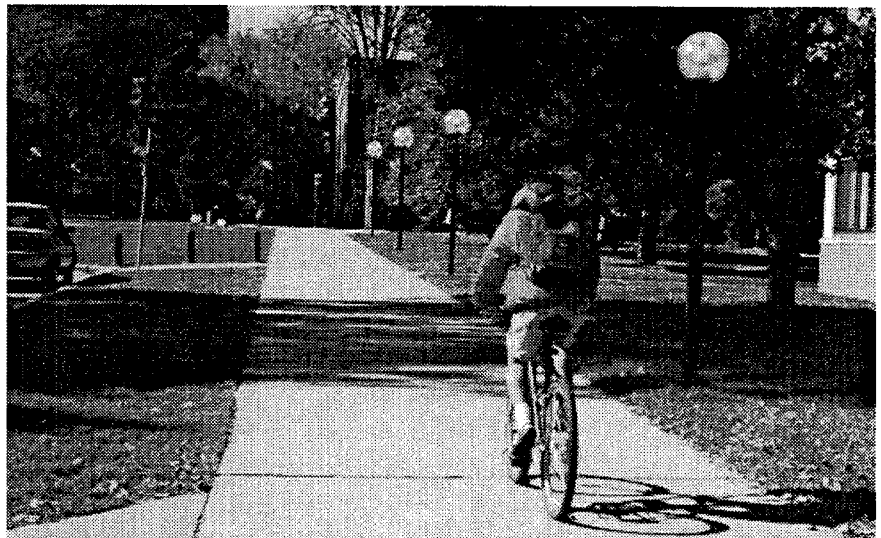
anyone behind the pedestrian. Under these conditions, the pedestrian need only watch the sidewalk in front in order to see if someone is approaching from behind. This technique of casting shadows can be manipulated by designers of bicycle facilities to make concealment at night more difficult, so that the shadow of a hiding attacker would be cast either onto the path of the facility or to other places in the area so that others could see the shadow.

Even though lighting can help make many nighttime situations safer, designers must be cautioned and should understand that lighting is *not* a panacea for problems of personal safety at night on bicycle facilities. It is important to remember that if a person cannot be seen by others at night, then no amount of lighting will make them less vulnerable to a nighttime attack.

All bicycle facilities are potentially dangerous if they are isolated from the activity of the city. Bicycle byways located on local streets could be dangerous if the street is not an active street. However, it is bicycle expressways with their requirement for separation from motor vehicle traffic that run the risk of being planned and designed without proper concern for personal safety. The same can be true of some bicycle boulevards on dedicated streets. Regardless of the project, it is important to plan and design for personal safety, just as much as for physical safety on bicycle facilities.

Figure 5-8.
Lighting placed below the canopy
of trees fully lights the bicycle
roadway and can provide an
intimate ambience as well.

However, if a cyclist cannot be
seen by others at night, then no
amount of lighting will make
them less vulnerable.



5.2. System Legibility

There are two types of legibility:

Legible roadways physically indicate how the roadway should be used.

Legible networks enhance wayfinding through the city.

The less mental integration required to understand the network or use of the roadway, the more legibility there is.

What is a legible network of roadways? There are two types of legibility. First, each type of roadway within a network should be self-descriptive of its use. The visual and spatial cues of the roadway's design should clearly show users how the roadway is to be used. Second, the network should be a coherent and clearly logical network, enhancing wayfinding in the city. The network's own logic should describe how it takes its users from point A to point B.

The system of roadways designed for the automobile represents a legible transportation system. The system is visually and conceptually clear, or logical, both to the users and the planners of the system. There is an immediate understanding of how the system works. For the user, this largely represents wayfinding — understanding how to get from one place to another. For the planner, it means that plans and designs for additions or amendments to the roadway network are readily formulated, understood and evaluated. Most importantly, the motorist immediately understands how to use each roadway in the system by understanding the type of space the roadway represents. The most obvious and important spatial cue that is given by the motor vehicle's roadway is how fast the motorist can proceed with safety.

When planning and designing for legibility, *the less mental integration required to understand the network or use of the roadway, the more legibility there is*. In other words, if a sign is all that identifies a facility as a "bike route," then that facility is not legible within the roadway space. A legible facility is one where the use of the roadway space is articulated with a design that physically permits or prohibits specific behavior. Table 5-1 summarizes principles that should be remembered when planning and designing for legibility.

Consistency is important when symbolic means of representation must indicate use of the roadway or the network because *the less mental integration required to understand and interpret visual or verbal cues, the more legibility there is*. When used, signage and striping should be consistent throughout the system so that the cyclist, the motorist and the pedestrian need not mentally re-interpret new symbols. Signage should be in frontal view of all roadway users so that motorists and cyclists alike need not search the sides of the roadway for instruction (yet another instance of mental interpretation and integration).

The bicycle's smaller scale makes legibility a factor in the planning and design process. The bicycle's network of facilities and its space in the roadway are not as obvious as are the facilities and networks for larger scaled vehicles, like the motor vehicle. They are not as readily grasped by the mind or by the eye. Making bicycle facilities legible to cyclists, motorists and pedestrians is a planning and design challenge. If it is a challenge well-met, then the legibility of the bicycle system can serve as self-advertisement of the system to non-cyclists.

Design Principles for Roadway Legibility

The safety, convenience and character of bicycle roadway space are major factors in the success of a facility. Many people do not use the bicycle as transportation because conflicts or proximity to motor vehicle traffic make it too dangerous, too “nerve-wracking,” or too unpleasant an undertaking on a daily basis. These real and perceived roadway deterrents should be removed in order for bicycle transportation to be successful in gaining new, regular “customers.”

To ensure that these deterrents are successfully removed, *bicycle space should be articulated with a legible demarcation of the bicycle travel corridor.* This suggests a general hierarchy of preferred design articulation for roadways:

- 1.) The most effective way of providing a legible demarcation of a travel corridor is with a physical articulation of the roadway space that presents a clear path for moving through it.
- 2.) If a physical articulation is not possible, a symbolic means of articulation (e.g., striping) should be used.
- 3.) As a last resort, verbal descriptions of roadway use (signs) should only be provided to warn users of dangers that could not be resolved physically or symbolically.

The following are design principles that enhance roadway legibility. Also see the Facility Separation Guidelines, Table 3-1., section 3-2.

Spatial Definition

The spatial definition of roadway space is accomplished with a *physical* separation of the bicyclist’s space from the rest of the roadway.

Physical separation is accomplished with either horizontal or elevated space, or with barrier separation using landscape elements such as vegetation or structure to define the bounding surfaces of the space.

DESIGN PRINCIPLES FOR ROADWAY LEGIBILITY

Table 5-1.
 Legible roadways are those that require the least amount of “think-time” to integrate a mental picture of an entire scene and how it should be navigated.
 Legible roadways show how the roadway should be used.
 The roadway is less legible when its use is described by visual or verbal means.

<i>Mental Integration Required</i>	<i>Design Conveyance</i>	
	<i>Type</i>	<i>Example</i>
<i>Least</i>	Physical Spatial	Physical Separation
	Symbolic Visual	Striping
<i>Most</i>	Symbolic Verbal	Signage

Spatial definition in the roadway creates tangibly separate spaces for each type of roadway user. The integration of landscape elements should be used in conjunction with a horizontal or vertical separation to achieve maximum effectiveness in the spatial definition of traffic space. For the cyclist, a spatially separate space from motor vehicle (and pedestrian) traffic makes the space safer, more comfortable and more convenient to use as transportation space.

**Spatial Definition:
Horizontal Separation**

Horizontal separation is achieved by placing lateral distance between the bicycle space and any other traffic space. The more distance that is introduced in the horizontal separation, the safer the space. However, spaces that are too distant from each other could compromise the personal safety of the cyclist or the pedestrian.

Horizontal separation can also be accomplished by dedicating a street to bicycle use. This is usually accomplished using a local, residential street that cyclists share with residents and local traffic on the street. Traffic calming techniques are often used for permitting local and bicycle through-traffic and discouraging all other through traffic.

**Spatial Definition:
Vertical Separation**

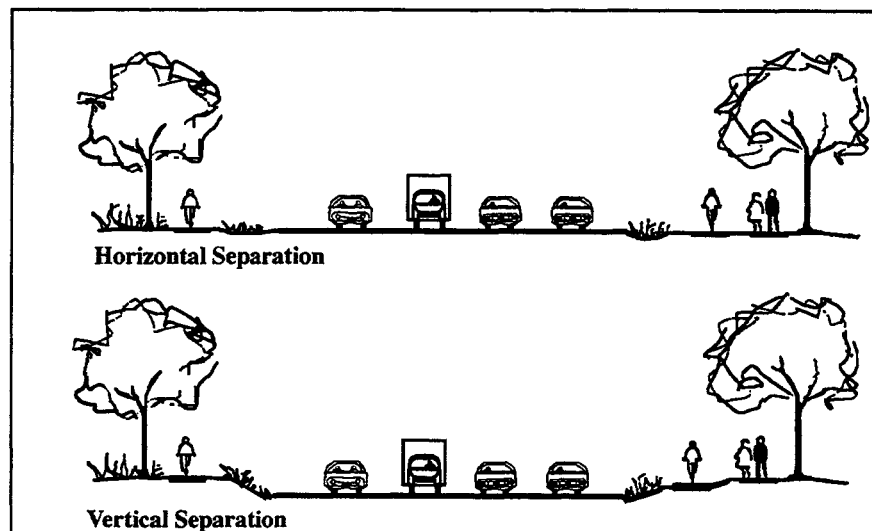
Vertical separation is accomplished with designs that provide a separation in grade; that is the cyclist's roadway is lower or preferably, higher than that of the adjacent motor vehicle or pedestrian space. In urban areas, vertical separation is an effective technique for creating bicycle space when the amount of space in the roadway is limited. Vertical separation is of particular use for indicating modal priority in intersections. Raised intersections are discussed later in this chapter, under traffic calming techniques.

A vertical separation that raises the bicycle higher than the motor vehicle is preferred for safety reasons. A bicycle facility that is lower than the motor vehicle roadway places the cyclist at risk because a minor

Figure 5-9.

Horizontal separation provides safe space by placing lateral distance between the bicycle space and any other traffic space. Horizontal separation can also be accomplished by dedicating a street to bicycle use.

A vertical separation that puts the bicycle roadbed higher than the motor vehicle adds a measure of safety for the cyclist. In areas where there is room, the bicycle roadbed can be raised alongside the motor vehicle roadway. In urban areas, the higher position for the bicycle is more practically accomplished by using a curb.



Spatial Definition: Landscape Elements

error on the part of the motorist could cause the motor vehicle to “fall” into the cyclist’s space.

Elements of the landscape can define the cyclist’s space. Landscape elements introduce vegetation or structure between the different roadway spaces and include planted strips, structure (low fences or walls, bollards, parked cars), or street furniture (light posts, parking meters, mailboxes, sitting walls, benches, planters). Further, a sensitive use of the various elements of the landscape can provide a psychological separation of the cyclist or the pedestrian from motor vehicle traffic.

Landscape elements that provide open space between each element (e.g., street furniture, trees) serve to not only define the cyclist’s space, but are useful for permitting users of the roadway to temporarily use the space of other users. For example, if these kinds of vertical landscape elements were used, a cyclist would be able to pass an ambulance parked in a bicycle facility by temporarily using the pedestrian space.

Visual and Tactile Techniques

Visual and tactile techniques make the bicyclist’s space even more legible when they are used in conjunction with spatial separation. Such techniques greatly reduce the amount of mental integration required to identify the extent, limits and function of bicycle space.

Visual techniques

Some visual techniques are preferred over others. Successful application of visual spacemaking techniques include:

- Defining the enclosing surfaces for the entire space, and making them visually apparent,
- Providing an immediate visual differentiation of the space from other spaces,
- Maintaining a visual presence in the roadway.

Figure 5-10.

Landscape elements using vegetation, structure or “street furniture” can be used to define different spaces in the roadway.

Here, street furniture is used to separate pedestrians and cyclists along a narrow street space in Germany. All spaces are further emphasized with different textured and colored surfaces. The bicycle space is red brick and the sidewalk is light gray concrete squares. Note how the bicyclists’ space is raised with an inclined gutter of darker gray stone.



Courtesy: *The FHWA Study Tour for Pedestrian and Bicyclist Safety in England, Germany and The Netherlands.*
The U.S. Department of Transportation and the Federal Highway Administration

Pavement Coloring

Pavement coloring in the bicycle facility makes a visual “floor” more vivid in the cyclist’s space. Pavement coloring is successfully used in Europe where a reddish brick color is often used to define the cyclist’s space along the roadway corridor. Pavement coloring is especially useful at intersections where cyclists, motorists and pedestrians can determine at a glance in which space each is to travel while in the intersection.

Striping

Areas that are only outlined by striping require more mental effort to integrate into a clear, simple understanding of area shapes than areas filled with color or texture. Filled areas read as easily grasped figures. Outlined shapes require the viewer to visually search the perimeter, mentally integrate it into a form and fill the form to see the figure of the area. This takes more time and mental effort when the traveler is rapidly processing the surrounding environment and its changing conditions, and making decisions based on this process.

Pavement striping with a white line should be used when it is not possible to spatially define the cyclist’s roadway by any other means. Under some conditions, the white line that marks the edge of the bicycle space can be difficult to differentiate from other white lines on the pavement. It is easier for a bicycle stripe, than a colored band of pavement, to become visually lost among other lines that are used to present on-pavement roadway signage and mark the edges of motor vehicle lanes, pedestrian crosswalks and railroad crossings.

Striping, and pavement coloring to a lesser extent, are symbolic means of spacemaking, particularly at intersections. These two techniques do not physically support or prohibit behavior. They require interpretation by all roadway users. Therefore, their application should be consistent throughout an urban area, and preferably nationally and

Figure 5-11.

The historic Stone Arch Bridge is a bicycle and pedestrian-only bridge in Minneapolis where different textures and colors are used to delineate space. Exposed concrete aggregate is used for the sidewalks and asphalt is used for the bicycle space. The center line of the bicycle space is defined by a french drain. All spaces are delineated with white concrete separator strips.

Note how the pedestrian viewing area on the left is protected by a raised curb and a low fence that run its length.



internationally. Standards developed by AASHTO and FHWA should be used when bicycle lanes are striped along corridors and particularly at intersections where there are conflicts between modes during turning and through-travel operations.

Tactile Techniques

Tactile techniques present a change in texture of the pavement surface. Thus, differently textured spaces provide a tactile warning to the different users of multi-modal roadways that they are wandering out of their space. Different textures on the “floor” of the roadway also provide a visual means of differentiating the space.

The application of different textured surfaces should not present a danger or inconvenience to the cyclist or other roadway users, particularly physically disabled users. Therefore, texturing must be carefully chosen and applied. Often, instead of texturing the entire space, a textured strip can be used to demarcate space, like striping. In this way the texture provides a warning to the cyclist, motorist or pedestrian that each is crossing into a different space. When using texture, it is very important to consider the condition of the texture under all weather conditions as well as the ability of the texture to withstand use.

Verbal Techniques: Signage

Verbal techniques require the most mental integration for users to understand how the roadway should be used. The only verbal technique used in the roadway is the sign. Signs that explain how the roadway is to be used should be kept to a minimum and should only be used when physical, visual or tactile techniques cannot explain the message. Roadway corridors that require a sign to explain *how* the space is to be used are confusing and do not provide a spatial or visual definition of the space. This is less true of intersections where signs may be necessary to explain complicated crossings, though, again, designers should always strive for intersection designs that require the least amount of signage.

Figure 5-12.
Verbal techniques, or signs, require the most mental integration for understanding how the roadway should be used. Non-verbal, space-making techniques, should be employed instead.

In this seasonal tourist town signs at every corner warn bicyclists, skateboarders and inline skaters to stay off the sidewalk, yet there is no roadway space defined for the many people using these modes.



Traffic Calming Techniques

This section describes the principles of traffic calming and the basic techniques that are used to implement it. Traffic calming is used in places where communities want to more stringently control the use of the motor vehicle to make its use more compatible non-motorized modes of transportation and with the social function of street spaces. Typically, the kinds of spaces treated with traffic calming measures include residential streets, commercial and retail districts, crossings of motorized and non-motorized modes, and bicycle access facilities. Communities and individuals who are interested in applying traffic calming techniques are encouraged to study the variety of examples from Europe where traffic calming has been widely and successfully applied.

Traffic calming aims to control the unfettered forward movement of the motor vehicle using techniques that make it physically impossible for the motorist to proceed in an unrestrained fashion.

Traffic calming involves physical change to the layout or plan of the street. Therefore, as is the case with bicycle transportation in general, traffic calming almost always requires a decision on the part of the community to introduce it as a means for community change or as a solution to traffic problems. The introduction of traffic calming measures alters the transportation function of the street and its civic contribution as well.

Traffic calming techniques are important tools for planners and designers of bicycle transportation facilities when the objective is to control motor vehicle speed and movement at levels where the same space can be shared by bicycles, or by bicycles and pedestrians.

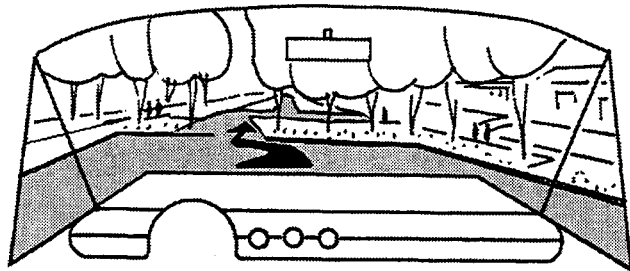
Figure 5-13.
“A traffic sign indicating the recommended driving speed ... does not induce motorists to drive any slower. The road is ... wide and long. Local authorities and motorists are both responsible for fast driving.”¹⁷



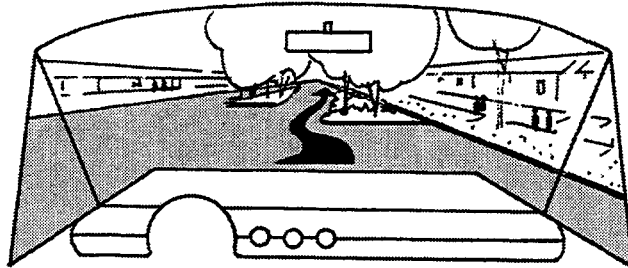
Recent research has shown that long visual length and wide pavement widths significantly contribute to increases in the speed of motor vehicles. Traffic-calming is used to modify such conditions by introducing combinations of: forced turns, chokers, median barriers, diagonal diverters, culs-de-sac and raised intersections.

Figure 5-14.
Traffic calming slows motor vehicle traffic by:

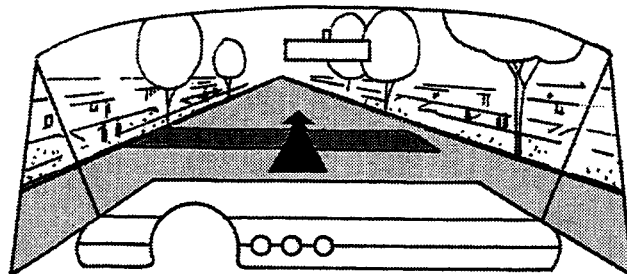
- Making the motorist perform turning movements



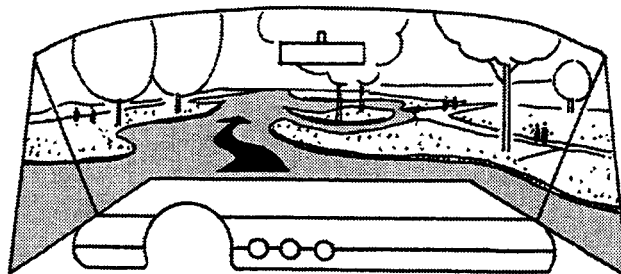
- Forcing the motor vehicle to travel through narrow spaces



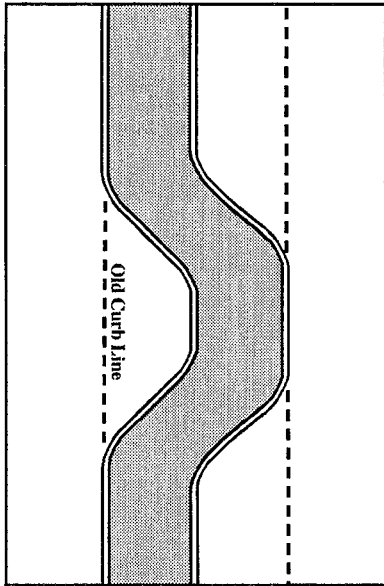
- Introducing spatial discontinuity in the roadway for the motor vehicle and spatial continuity for the bicycle or pedestrian



- Visually breaking up the space or introducing visual barriers to the motorist



**Traffic Calming Techniques:
Forced Turns**

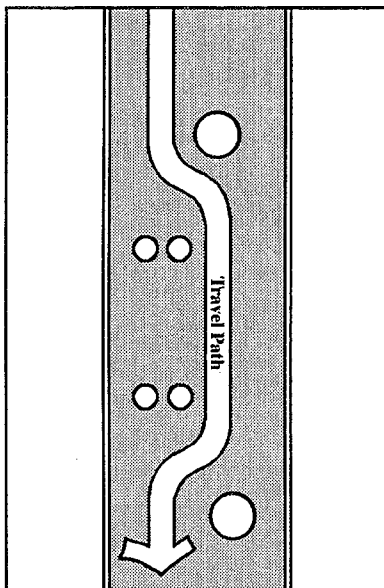


Figures 5-15 and 5-16.
Traffic calming measures that force turning movements can shorten the visual length of the street for the motorist and narrow the motor vehicle's pavement.

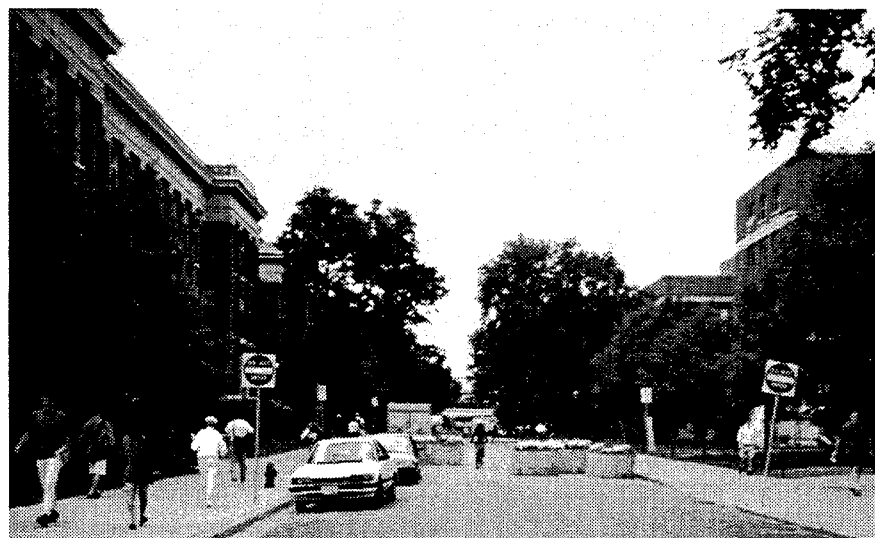
Forced turns slow traffic by physically requiring the motorist to make a turning movement. Forced turns must be accomplished by physical means, so that it is not possible for the motorist to compromise the intent of the traffic calming measure.

There are a number of ways to force turning movements. Some of them require change to the course of the street, others require minimal change. Posts, street lights and planters can be used to force turning movements. As is the case with all traffic calming techniques, the chosen configuration can and should be tested with easily placed temporary barriers. In addition, many alterations that force turning movements can be implemented in a semi-permanent fashion until funds become available to implement the full design.

All traffic calming measures can potentially impact how community services are provided. Rather than be a deterrent to implementing traffic calming measures, communities should integrate plans for providing emergency, maintenance, and snow and debris removal services in their traffic calming plans.



Figures 5-17 and 5-18.
Objects in the roadway such as planters or bollards can also be used to force turning movements as seen on this restricted-access street.



Traffic Calming Techniques:
Rotaries

Rotaries are a traffic calming technique for slowing traffic in intersections. Rotaries force traffic to follow the edges of the intersection during the turning movement, as opposed to a diagonal turn across the intersection.

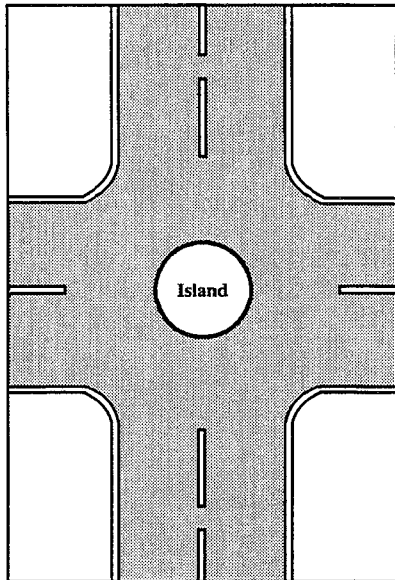


Figure 5-19.



Courtesy: *The National Bicycling and Walking Study*. U.S. Dept of Transportation and Federal Highway Administration

Figure 5-20.
Seattle Washington has successfully used over two hundred small rotaries in residential neighborhoods to calm traffic.

Figure 5-21.
An early autumn morning at a multi-modal rotary on the Minneapolis campus at the University of Minnesota. The rotary helps calm bicycle, bus and motor vehicle traffic so that heavy pedestrian traffic can be accommodated in this busy intersection. On the left is one of two stops at this major transit node for inter-campus and intra-campus bus service.



**Traffic Calming Techniques:
Chokers**

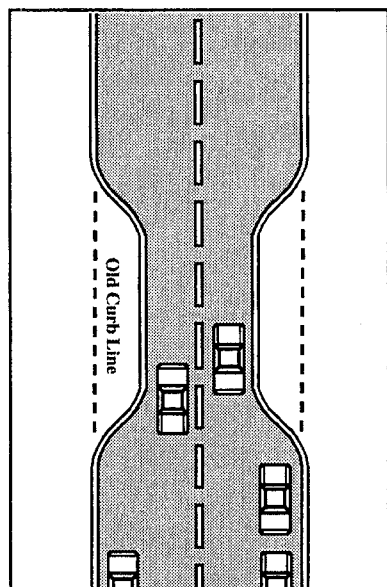


Figure 5-22.

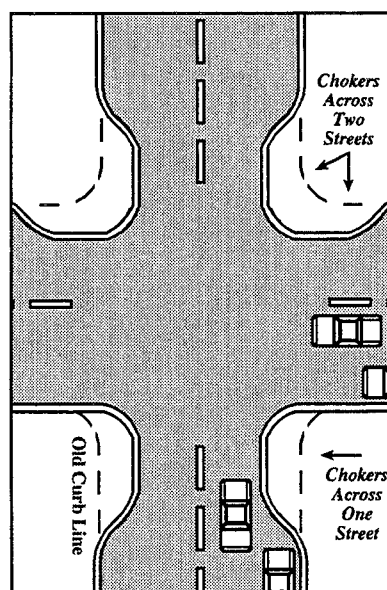
Chokers are a technique for slowing traffic by physically narrowing the travel lane so that the motor vehicle must slow to maneuver through it. Chokers can be used mid-street or at intersections.

Chokers implement another concept that traffic calming techniques use: the closer objects are placed to the roadway, the slower the traffic. Signs, light fixtures, vegetation and other street furniture that are close to the street make it more difficult for the motorist to proceed in a smooth and unrestrained manner. Chokers achieve the same effect by bringing the curb-line inward.

In addition to slowing traffic, chokers also return roadway space to pedestrian use and urban activities. When used with the raised intersection technique, chokers are even more effective.

Chokers at intersections also physically indicate a change in roadway conditions to motorists. Depending on their design, and on the location and type of street, chokers can, for example provide a visual and physical signal that a busy intersection is ahead or that the intersecting street is a different type of street (e.g., at arterial/local street intersections).

When chokers are used in corridors that must provide on-street parking, the length of one parking spot, or less, is all that is required for the choker. In many urban corridors, parking is not allowed this close to the intersection anyway.



Figures 5-23 and 5-24.

Intersection and mid-block chokers slow traffic on this street between a residential neighborhood and a park. In commercial areas, chokers can return space to pedestrian use and urban activities.



**Traffic Calming Techniques:
Median Barriers**

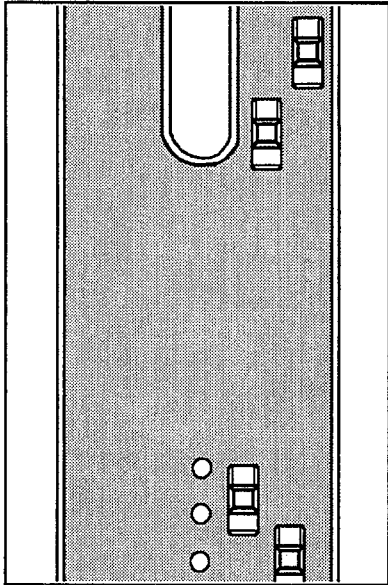
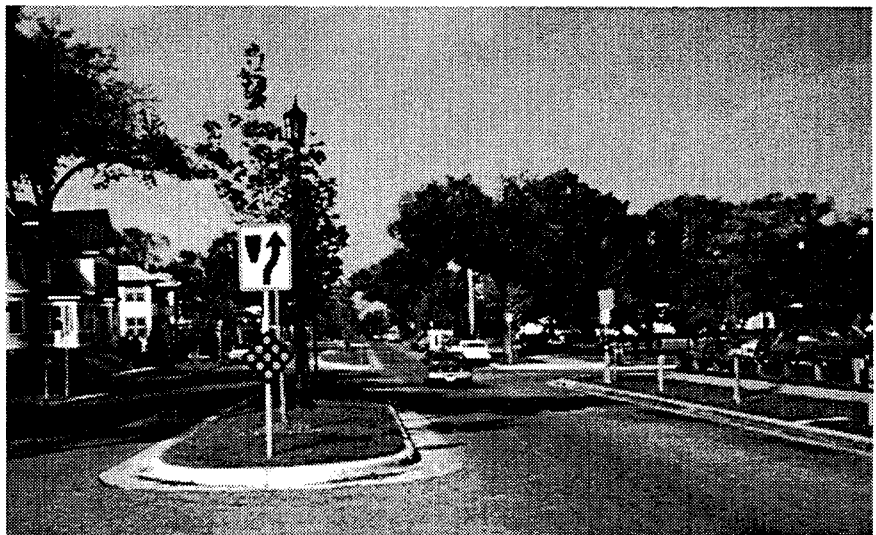


Figure 5-25.

Figure 5-26.
An historic fountain featuring the statue of an elk in downtown Portland, Oregon. The fountain functions as a median barrier that slows traffic. The two vehicles in front of and behind the fountain are parked vehicles belonging to the city.



Figure 5-27.
A newly constructed median barrier on a busy arterial that cuts through residential neighborhoods. Traffic calming measures were requested by residents to slow traffic and return a more human and neighborhood scale to the street.



**Traffic Calming Techniques:
Diagonal Diverters
Culs-de-Sac**

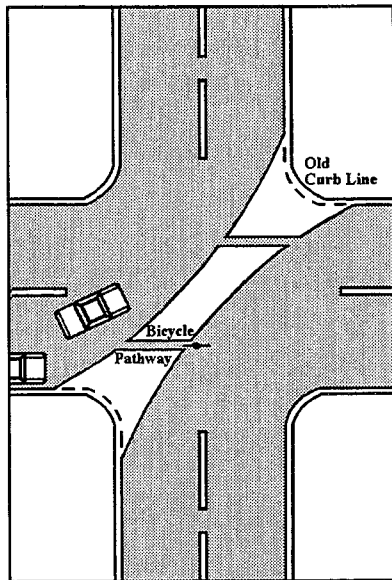


Figure 5-28.

Figure 5-29.

This cul-de-sac in Davis, California shows how motor vehicle traffic is largely blocked from continuing, but pedestrian and bicycle traffic are permitted to go on. On the other side of the passageway, a bicycle boulevard connects this local street to the larger bicycle network.

The diagonal diverter and cul-de-sac entirely block an intersection to through traffic. Cul-de-sac techniques create dead-end streets. Diagonal diverters create an “eye-brow,” or U-shaped street with the adjacent grid pattern of streets. These techniques can be used to prevent motor vehicle through traffic, but depending on the application, can also prevent bicycles and even pedestrians from passing through.

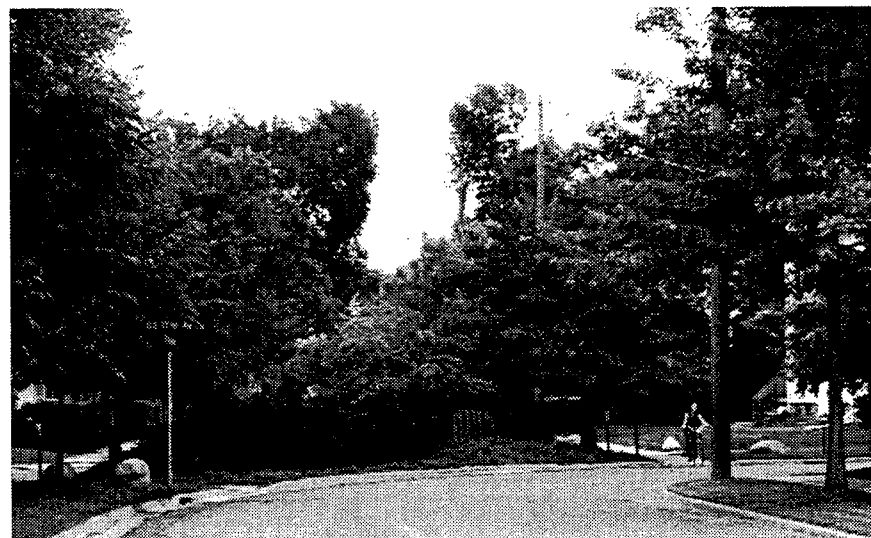
Communities should carefully evaluate the impact of entirely closing an intersection, especially to non-motorized traffic. The cul-de-sac and diagonal diverters drastically alter the character of a street by isolating it from the rest of the urban fabric of connecting streets.

These treatments can make wayfinding more difficult, especially when imposed on an entire neighborhood. If traffic calming is the goal, the implementation of culs-de-sac and diagonal diverters can frustrate visiting motorists, causing them to become lost and to wander extensively through a neighborhood to get to their destination.



Figure 5-30.

A diagonal diverter in Minneapolis, Minnesota which would present a barrier to all modes of traffic if a sidewalk were not provided.



Traffic Calming Techniques: Raised Intersections

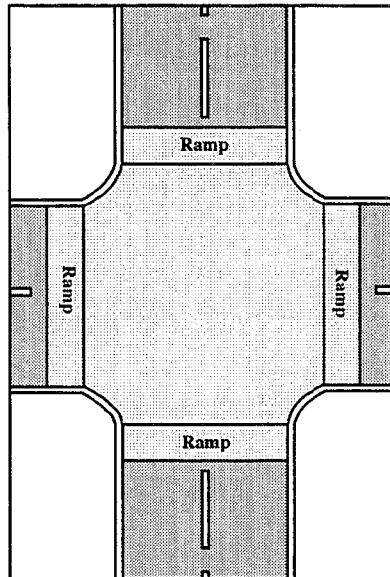


Figure 5-31.

Raised intersections are created by elevating the level of the intersection above that of the roadway, usually to the level of the pedestrian, or sidewalk space. There are two basic configurations: one where the entire intersection is raised, the other where the pedestrian crosswalk is raised. At raised intersections, the motorist travels up a ramp to enter the intersection or to cross over the crosswalk.

Raised intersections, particularly raised crosswalks, need not require an expensive implementation. Semi-permanent, raised crosswalks can be built by piling and leveling asphalt to build the ramp. This suffices until funds are available for a more permanent and aesthetic treatment.

Raised intersections are an effective traffic calming technique for a number of reasons. First, the pedestrian space is “spatially continuous” throughout the crossing. In contrast, the motor vehicle’s space is spatially discontinuous. It is broken visually and spatially by the rise in elevation. Today, we normally experience the opposite conditions. The configuration of curbs at intersections make the motor vehicle’s space continuous and the pedestrian’s space discontinuous.

The continuity of pedestrian space throughout the entire intersection physically and psychologically configures the intersection at a pedestrian scale. In this space, the motor vehicle is a guest, having had to arrive at the space (travel up to it) and depart from it (travel back down to the roadway). Once in the space, the motor vehicle is obviously using the pedestrian’s space. Because they are raised above the motor vehicle space, raised intersections also make cyclists and pedestrians more visible to motor vehicles about to enter the intersection.



Figure 5-32.

A raised crosswalk in York, England makes pedestrian space continuous across the street and vehicular space broken, or discontinuous. Therefore, the crosswalk serves as a warning device to slow vehicles down. The raised crosswalk is further accentuated with textured paving, different colored surfaces and on-pavement markings.

Courtesy: The FHWA Study Tour for Pedestrian and Bicyclist Safety in England, Germany and The Netherlands.
The U.S. Department of Transportation and the Federal Highway Administration

**Traffic Calming Techniques:
Raised Intersections**

Raised intersections are also effective for implementing bicycle facilities.

- If bicycle facility on the street has been raised to the level of the sidewalk, then the bicycle facility remains spatially continuous at a raised intersection.
- If the bicycle facility is at the level of the motor vehicle, the cyclist's space, like the motor vehicle's space, is discontinuous when raised intersections are used. This configuration will slow bicycles, making a safer crossing for pedestrians. The bicyclist still benefits from this configuration because the bicycle's pedestrian-size scale fits that of the pedestrian-scaled intersection.

Designing with raised intersections is an effective method of implementing modal priorities in the roadway. The physical design of the roadway shows priority by making the corridor space of a mode spatially continuous with its intersection space. In contrast, a lower priority is physically articulated when the corridor space of a mode is spatially discontinuous, or broken, both visually and physically.

**Traffic Calming Techniques:
Context of Place
The Civic Contribution of Streets**

Because effective traffic calming measures are a designed response to the context of the street, to its setting and to its traffic function, communities willing to implement traffic calming measures should seek professional expertise in traffic calming applications.

In addition, communities should also be prepared to consider the impacts of traffic calming on fire, police, emergency, maintenance and garbage services. Communities should plan to include these considerations in the planning process and be prepared to implement changes in how the services are provided. This should be done in conjunction with the planning and design of the traffic calming features.

Traffic calming techniques have been proven successful in Europe for slowing traffic, and fostering bicycle transportation and pedestrian use of the street. They have also been shown to effective tools for designing urban streets and intersections that respond to their context of place and to their setting. The benefits and success of carefully applied traffic calming techniques outweigh the new kinds of urban planning and design efforts they require.

As expertise is gained, the planning and design of traffic calming measures will become second nature to communities —as they are now in The Netherlands and elsewhere in Europe. The planning and design of traffic calming measures also benefit communities in another way — they require that communities specifically address the civic contribution of all of their streets, regardless of scale.

Wayfinding in the City

Network legibility describes the ability of roadway configurations to enhance or detract from wayfinding — that is, the traveller’s understanding of how to get from one place to another.

A legible network provides logical connections and patterns of facility spacing and is consistent in providing these connections.

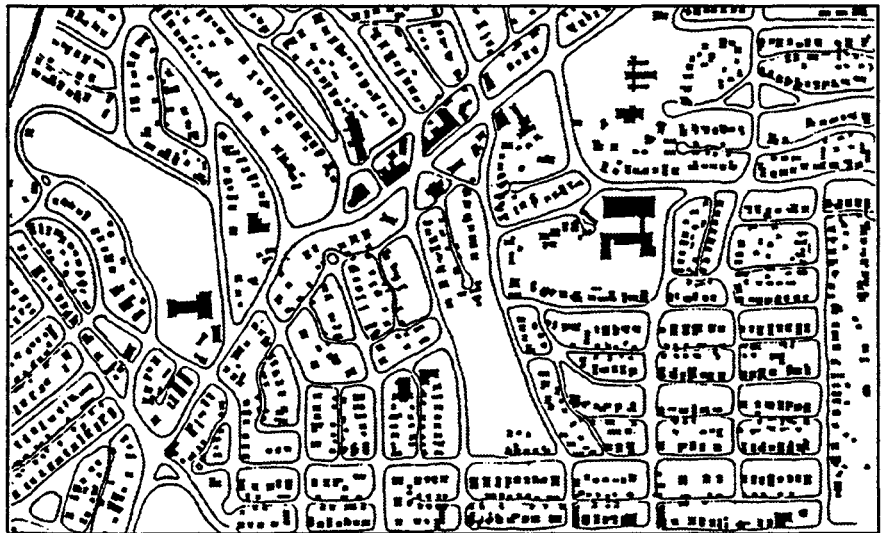
Network legibility is an important attribute of all roadway systems in their role as providers of a transportation service. Network legibility describes the ability of roadway configurations to enhance or detract from wayfinding — that is, the traveller’s understanding of how to get from one place to another. Network legibility is particularly important for bicycle networks because the bicycle’s smaller infrastructure could create conditions that make the best cycling route from point A to point B less readily apparent to the cyclist who is *en route*.

Planning and designing for wayfinding can be difficult in urban areas where the network of existing roads is to accommodate the bicycle transportation system. However, an attribute of legible roadway networks is that the network displays a clear logic in its connections throughout the city and that it is consistent in doing so. *Therefore, a legible network provides logical connections and patterns of facility spacing and is consistent in providing these connections.*

Motor vehicle networks display legibility. For example, the spacing of the motor vehicle’s urban arterials is recommended to be one mile. In communities where this has been implemented, any motorist knows when travelling on a larger scaled urban arterial, that there is another one about one mile away in either direction. The pattern becomes even easier to grasp when one travels on a gridded system of streets — the next arterial can be expected about 10 blocks away.

In blanketing urban areas with bicycle facilities to accommodate both longer and shorter trips, a fairly strict adherence to the recommended spacing of facilities can be used to make the bicycle network legible. If this is done, cyclists can *rely* on the regular spacing of corridors and the regular spacing of intersections with other bicycle facilities to help them find their way through the city, as cyclists.

Figure 5-33.
Planners should study patterns of community roadways to determine what patterns of bicycle facilities will provide the necessary system connectivity and increase network legibility. Logical connections and patterns of facility spacing can enhance the legibility of the bicycle network.



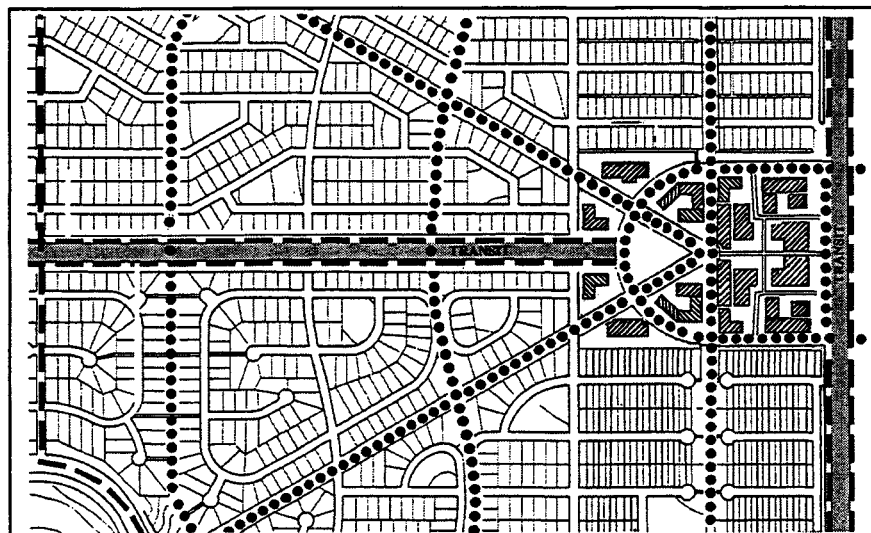
Network legibility makes the notion of the bicycle friendly zone even more important. The implementation of bicycle friendly zones, with a regular spacing of bicycle expressways and bicycle boulevards leading into the zone, creates a portion of the system that not only “works” for the cyclist, but demonstrates a legible network of a viable transportation option as well.

When planning logical connections and patterns of facility spacing of the bicycle network, planners should study patterns of community roadways to determine what patterns of bicycle facilities will not only provide the necessary system connectivity, but will increase network legibility. Gridded systems of streets are the easiest to interpret. Less common, but equally legible are radial systems of streets, where streets radiate to and from a center, like the spokes on a wheel. Combinations of the grid and radial systems can often be found in urban areas. At the other end of the extreme are suburban patterns of development where cul-de-sac and eyebrow streets terminate winding systems of collectors and arterials. However, even within a seemingly unpatterned suburban style of development, patterns can sometimes be found. A common pattern is the warped grid, or a grid defined by undulating lines. Even if a suburban pattern of existing streets is not legible, the network of bicycle facilities can be planned to be legible if the community is willing to develop bicycle roadways that are, in part, physically separate from the motor vehicle’s system.

Despite all attempts to plan legible networks where the network’s own logic describes how it takes it users around the city, signage will still be needed to help people navigate. This is true for the

Figure 5-34.
A fairly strict adherence to the recommended spacing of facilities can be used to make the bicycle network legible.

- Key**
 - - - - - Bicycle Expressway
 Bicycle Boulevard
 = = = = = Bicycle Byway
 ===== Transit



motor vehicle's system where all streets are labelled and buildings numbered, so that exact locations can be found. These signs help the travellers understand where they are in relation to destinations.

A common misconception in the planning and design of bicycle facilities is that bicyclists do not need this same amount of signage. However, the opposite is true. As travellers in the roadway, the bicyclist needs at least the same amount of planning attention to the signing of routes and destinations in the city. Signs should say that the bicycle facility leads to the sports arena, downtown or uptown, the university, or another major bicycle facility. This is particularly important if the bicycle facility departs from a parallel orientation with the motor vehicle's facility, veering off in an unknown direction and to the visiting cyclist, an unknown destination. If this occurs and the cyclist is headed to a destination known to be along the motor vehicle's route, the cyclist is apt to abandon the bicycle facility and travel along the street known to go to the destination. A sign at the junction of departure indicating the destination of the route, helps keep the cyclist travelling on the facility.

Providing network legibility to the cyclist is yet another challenge to the planner attempting to create a viable bicycle transportation network of a smaller scale within the network of a larger infrastructure. It is certainly one of the least explored areas of urban and multi-modal transportation planning. However, it is essential to building a competitive and successful bicycle transportation system.

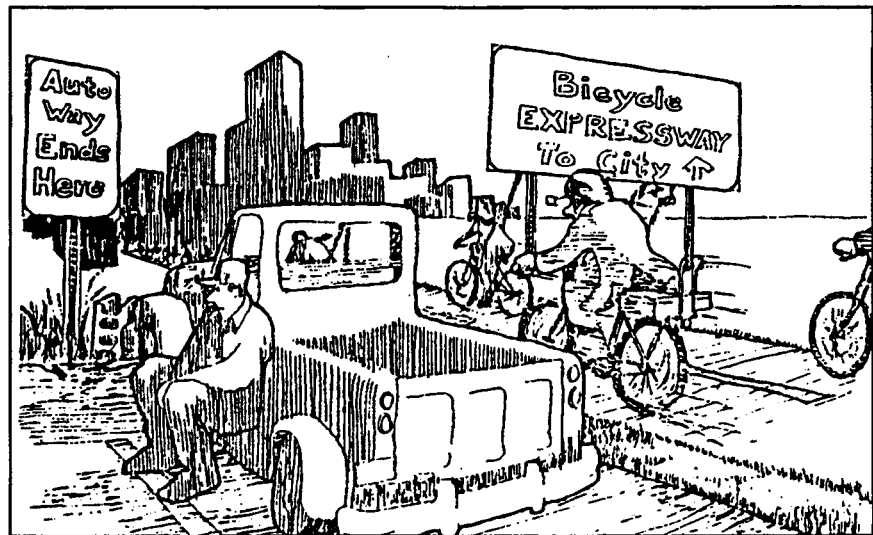


Figure 5-35.

Appendix A: Text from ISTEA

The following is selected text from the Intermodal Surface Transportation Efficiency Act of 1991.

Section 2. Declaration of Policy

It is the policy of the United States to develop a National Intermodal Transportation System that is economically efficient, environmentally sound, provides the foundation for the nation to compete in the global economy and will move people and goods in an energy efficient manner.

The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner, including the transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nations' preeminent position in international commerce.

The National Intermodal Transportation System shall include significant improvements in public transportation necessary to achieve national goals for improved air quality, energy conservation, international competitiveness, and mobility for elderly persons, persons with disabilities, and economically disadvantaged persons in urban and rural areas of the country.

The National Intermodal Transportation System shall provide improved access to ports and airports, the Nation's link to world commerce.

The National Intermodal Transportation System shall give special emphasis to the contributions of the transportation sectors to increased productivity growth. Social benefits must be considered with particular attention to the external benefits of reduced air pollution, reduced traffic congestion and other aspects of the quality of life in the United States.

The National Intermodal Transportation System must be operated and maintained with insistent attention to the concepts of innovation, competition, energy efficiency, productivity growth and accountability. Practices that resulted in the lengthy and overly costly construction of the Interstate and Defense Highway System must be confronted and ceased.

The National Intermodal Transportation System shall be adapted to "intelligent vehicles," "magnetic levitation systems," and other new technologies wherever feasible and economical, with benefit cost estimates given special emphasis concerning safety considerations and techniques for cost allocation.

**Intermodal Surface
Transportation Efficiency
Act of 1991 (ISTEA).
United States Statutes at
Large, Vol. 105, Part 3.
U.S. Government Printing
Office, Washington, D.C.
1991. p. 1914.**

The National Intermodal Transportation System, where appropriate, will be financed, as regards Federal apportionments and reimbursements, by the Highway Trust Fund. Financial assistance will be provided to State and local governments and their instrumentalities to help implement national goals relating to mobility for elderly persons, persons with disabilities and economically disadvantaged persons.

The National Intermodal Transportation System must be the centerpiece of a national investment commitment to create the new wealth of the Nation for the 21st century.

The Secretary shall distribute copies of this Declaration of Policy to each employee of the Department of Transportation and shall ensure that such Declaration of Policy is posted in all offices of the Department of Transportation.

Section 1024. Metropolitan Planning

General Requirements. It is in the national interest to encourage and promote the development of transportation systems embracing various modes of transportation in a manner which will efficiently maximize mobility of people and goods within and through urbanized areas and minimize transportation-related fuel consumption and air pollution. To accomplish this objective, metropolitan planning organizations, in cooperation with the State, shall develop transportation plans and programs for urbanized areas of the State. Such plans and programs shall provide for the development of transportation facilities (including pedestrian walkways and bicycle transportation facilities) which will function as an intermodal transportation system for the State, the metropolitan areas and the Nation. The process for developing such plans and programs shall provide for consideration of all modes of transportation and shall be continuing, cooperative and comprehensive to the degree appropriate, based on the complexity of the transportation problem.

Factors to be considered in development of transportation plans and programs by each Metropolitan Planning Organization:

- (1) Preservation of existing transportation facilities and, where practical, ways to meet transportation needs by using existing transportation facilities more efficiently.
- (2) The consistency of transportation planning with applicable Federal, State, and local energy conservation programs, goals and objectives.

-
- (3) Need to relieve congestion and prevent congestion from occurring where it does not yet occur.
 - (4) The likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all applicable short and long-term land use and development plans.
 - (5) The programming of expenditures on transportation enhancement activities.

• • •

- (13) The overall social, economic, energy, and environmental effects of transportation decisions.
- (14) Methods to expand and enhance transit services to increase the use of such services.

**Section 1025.
Statewide Planning**

State Planning Process. Each State shall undertake a continuous transportation planning process which shall, at a minimum, consider the following:

• • •

- (3) Strategies for incorporating bicycle transportation facilities and pedestrian walkways in projects where appropriate throughout the State.

• • •

- (10) Transportation system management and investment strategies designed to make the most efficient use of existing transportation facilities.
- (11) The overall social, economic, energy, and environmental effects of transportation decisions.
- (12) Methods to reduce traffic congestion and to prevent traffic congestion from developing in areas where it does not yet occur, including methods which reduce motor vehicle travel, particularly single-occupant motor vehicle travel.
- (13) Methods to expand and enhance transit services and to increase the use of such services.
- (14) The effect of transportation decisions on land use and land development, including the need for consistency between transportation decision-making and the provisions of all applicable short-range and long-range land use and development plans.

Glossary

- Barrier Separation** A physical and spatial separation of the bicycle's space with continuous vertical barriers or a series of vertical objects, such as trees, posts, and street furniture.
- Bicycle Access Facilities** Bicycle facilities that aid the cyclist in moving comfortably, conveniently, and safely between bicycle expressways, boulevards or byways and the entrance (or doors) of destinations. There are two kinds of bicycle access facilities: *parking facilities* and *transition facilities*. Transition facilities are designed and engineered to prevent conflicts between cyclists and motor vehicles or pedestrians along the path that brings the cyclist to the parking facility.
- Bicycle Boulevards** Bicycle facilities that provide a high degree of connectivity within and between neighborhoods and districts of an urban area. Bicycle boulevards provide this connectivity at a smaller scale and a slower speed than the bicycle expressway. Well-planned bicycle boulevards should connect the entire city in networks of boulevards.
- Bicycle Byways** Bicycle facilities that provide a high degree of access and connectivity within the neighborhood. In most cases, bicycle byways are shared roadways located on local (mostly residential) streets and alleys. They connect the residence to low volume neighborhood attractions.
- Travel conditions on busy retail arterial streets will necessarily put bicycle travel on them in the category where operating speeds and frequency of stops are within the range defined for bicycle byways. Planners and designers should therefore be prepared to provide other features of the bicycle byway on these kinds of facilities. Connects the residence to low volume neighborhood attractions and provides the connective fabric to and from bicycle boulevards and expressways.
- Bicycle Expressways** Bicycle facilities that move cyclists the longest distances across metropolitan areas in the most time-efficient manner (with the fewest interruptions). The number, quality and length of the facilities comprising a community's bicycle expressway network provide the means for the bicycle to compete with the automobile where trip travel times are concerned. Bicycle expressways connect major employment, retail, commercial, industrial, residential and entertainment destinations.
- Bicycle Friendly Zone** Areas of the city that are blanketed with a complete set of bicycle facilities, making it possible to travel everywhere in the zone on safe, convenient, integrated, and attractive bicycle facilities. Use of automobiles and the presence of automobiles is diminished to a significant degree and convenient transit options should be available for travel to the zone.

Demarked Space	A continuous space or lane clearly marked for bicycle use only, with striping, contrasting materials, paving or treating the full bike lane surface with a contrasting color. All approaches should be supplemented with signage identifying the bicycle facility.
Distance Separation	A horizontal (distance) separation of the bicycle facility and motor vehicle space.
Feeder Routes	Bicycle or transit facilities that bring people into a bicycle friendly zone.
Grade Separation	A vertical separation of the bicycle facility from other modes. With motor vehicles, the bicycle facility is higher than that of the motor vehicle. In urban areas, curbs are usually used to accomplish this kind of separation, where bicycle space is raised slightly above motor vehicle space.
Implementation Strategy	A plan for the phased order of facility implementation formulated to demonstrate success at each phase of implementation.
Intermodal	The use of one or more different modes of transportation to reach a destination; e.g., bicycling for a portion of a trip and busing for a portion of a trip.
Land Use Policy	Goals and procedures adopted by a community to guide the development and the use of land in the community. Transportation should be a major component of all land use policy.
Marketing Plan	The portion of a bicycle transportation plan that describes an organized effort to provide information and education to the public regarding, bicycle friendly zones, bicycle facilities and bicycle transportation in general.
Mixed Space	Driving space used by both motor vehicles and bicycle traveling at very low speeds, equal to and comfortable for bicycle operation, <19 kph (<12 mph). Traffic calming techniques are used where necessary to make it physically impossible for motor vehicles and bicycle to travel at faster speeds.
Mode	A term used by the transportation profession for describing <i>types</i> of transportation. (For example, bus, bicycle and pedestrian are three different modes of transportation.)
Modal Prioritization	A step in the transportation policy-making process wherein the prioritization of modes within the context of public policy is stated. Reflects the priorities that the community places on each mode of transportation and establishes a link between policy and that which is planned, designed, and built.

Modal Priority	The preferential rating of each mode. Should be explicitly stated at every level of development; from the policy-making level, to district or site level development specifications, to specific intersection designs.
Mode Share	Modal split represented as a percentage of total trips.
Modal Split	The number of trips each mode represents from a total number of trips taken between origin and destination zones. For example, if 2000 trips were made between zones A and B in a specific time period and 1/2 of those trips were made by bicycle, the modal split for the bicycle is 1000. The modal share is 50%.
Multi-Modal	Use of the same space by more than one mode of transportation; e.g., a roadway that is used by motor vehicles and bicycles is a multi-modal roadway; a bicycle facility that is used by cyclists and in-line skaters is a multi-modal facility in practice.
Person Mile	Occurs when a person travels one mile.
Person Trip	Occurs when one person travels to one destination.
Shared Space	Space shared by both bicycles and motor vehicles in a set-aside, right-hand lane, posted at 10 to 12 mph. Must not be used where motor vehicle traffic in the through traffic lanes exceeds 10,000 ADT or 30 mph.
Transportation System	A set of different kinds of interacting and interdependent roadways that work together to provide different kinds of transportation function.
Transportation Management System	A comprehensive, organized set of strategies to manage traffic.
Transportation Policy	Goals and procedures adopted by a community to guide the planning, design and construction of transportation systems in the community. Transportation policy should be a major component of all land use policy.
Trip Travel Time	The time it takes to travel from point A to point B. Does not include parking or the trip between the parked vehicle and the door.

Notes

1. This includes small towns under 50,000 in population in rural areas where there are a sufficient number of people living in or near town to effectively use bicycle transportation to reduce single-occupancy vehicle use for some daily trips. The terms as they are used here also include areas of sprawled land use — both inner and outer ring suburbs — as well as traditional inner city areas. The term “urban” is used in contrast to “rural,” where densities are generally not sufficient enough to warrant a need for a bicycle transportation system.
2. U.S. Department of Transportation and Federal Highway Administration. (1992) *Summary of Travel Trends: 1990 Nationwide Personal Transportation Survey*. Prepared by Patricia S. Hu and Jennifer Young. FHWA-PL-92-027.
3. Robinson, Michael. (1993) “Civilizing Suburbia.” Landscape Studies Center, Department of Landscape Architecture, University of Minnesota, draft manuscript.
4. Taebel, Delbert A. and Cornehl, James V. (1977). *The Political Economy of Urban Transportation*. Port Washington, N.Y.: Kennikat Press.
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6. In most metropolitan areas today, this amounts to 30% of the total amount of land used. In cities like Los Angeles, calculations of the amount of land used by streets usually total 50-60%.
7. U.S. Department of Transportation and Federal Highway Administration. (1994) *The National Bicycling and Walking Study: Transportation Choices for a Changing America*. Final report. FHWA-PD-94-023.
8. AASHTO Task Force on Geometric Design (1984). *A Policy on Geometric Design of Highways and Streets*. Washington, D.C.: American Association of State Highway and Transportation Officials (AASHTO).
9. 12 mph is a leisurely pace on a bicycle. 20 mph is a fairly fast pace, though the author frequently clocks commuting cyclists at speeds greater than 25 mph. The author has clocked pedestrians at 4.5 miles per hour using a bicycle odometer.

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10. U.S. Department of Transportation and Federal Highway Administration. (1992) *Summary of Travel Trends: 1990 Nationwide Personal Transportation Survey*. Prepared by Patricia S. Hu and Jennifer Young. FHWA-PL-92-027.

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 14. Kroll and Sommer. (1976) "Bicyclists' Response to Urban Bikeways." *Journal of the American Institute of Planners*, Vol. 43, No. 1.

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 15. U.S. Department of Transportation and Federal Highway Administration. (1994). *Selecting Roadway Design Treatments to Accommodate Bicycles*. FHWA. Prepared by Wm. C. Wilkinson III, A. Clarke, B. Epperson, R. Knoblauch. FHWA-RD-92-073.
 16. Bicycle Institute of America. (1993) *Bicycle Reference Book, 1992-93*. Washington, D.C.

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 17. Vahl, H.G. and Giskes, J. (1990) *Traffic Calming Through Integrated Urban Planning*. Paris, France: Amarcande.

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