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Highway Route Designation Criteria For Bicycle Routes: Handbook

Research, Development, and Technology

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U.S. Department of Transportation
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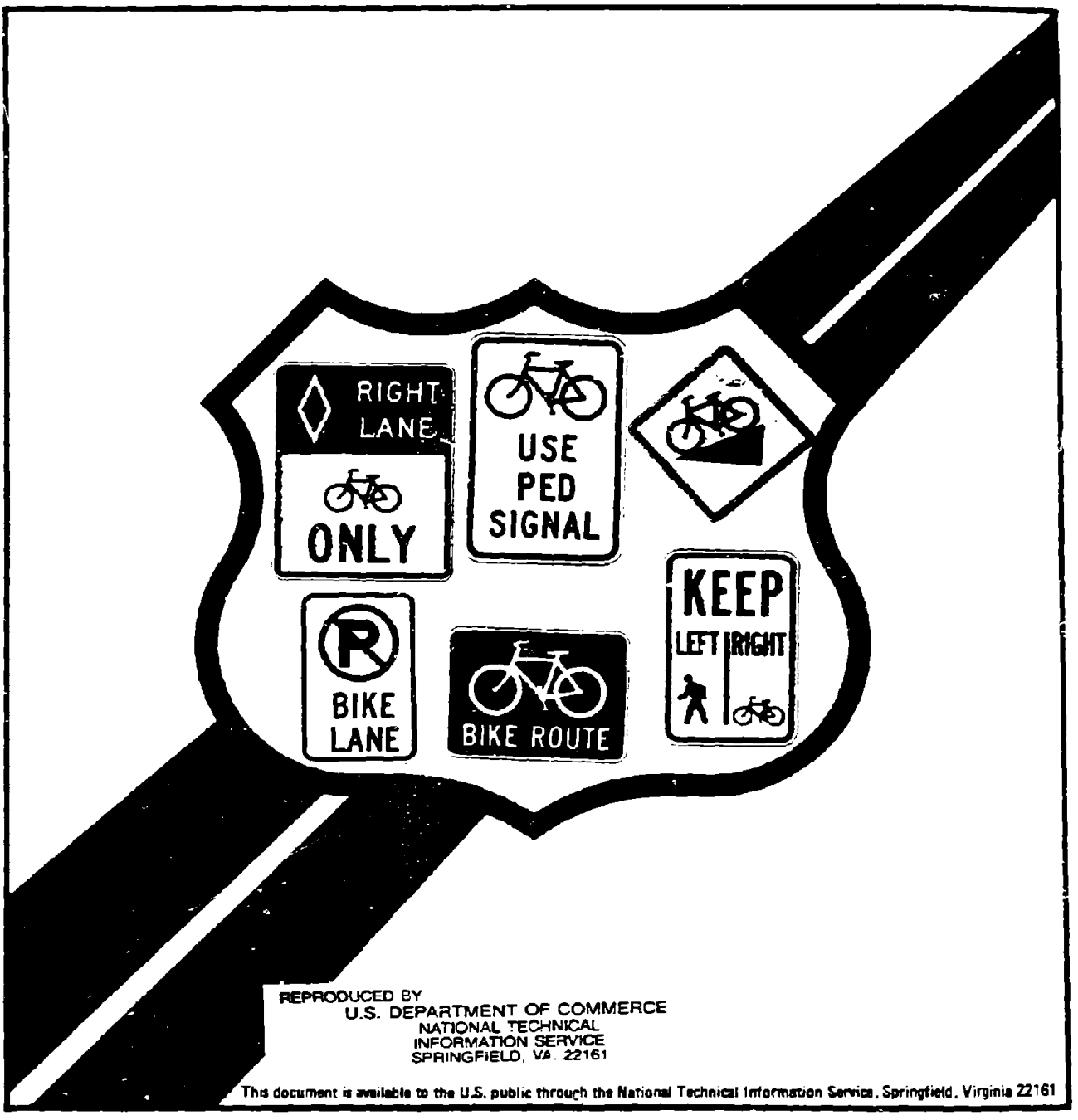

FOREWORD

The handbook on Highway Route Designation Criteria For Bicycle Routes is designed to simplify the task of selecting and designating streets and highways as bicycle routes. It provides project guidelines for the various types of bicycle route projects, i.e., rural touring routes, urban recreation routes, urban access routes, and urban route networks. The handbook is intended for use by State and local transportation agencies, but should prove useful to any agency, organization, or individual interested in recommending routes for bicycling.

The handbook is based on the results of the research study titled Highway Route Designation Criteria for Bicycle Routes, report number FHWA-RD-86/066. The study involved a review of the literature as well as a review of selected case studies of the practices currently being used to designate bike routes.

No distribution of the handbook was made. The contents were condensed in a Technical Summary and this was distributed to the FHWA field offices according to the numbers requested for Technology Sharing Reports. Copies of the handbook are available from the National Technical Information Services, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4690.

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Director
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16. Abstract

The purpose of this project was to conduct a survey of the literature and state of the art related to bicycle route selection and designation and to develop a synthesized set of factors for use by State and local transportation officials and other agencies and organizations involved in the selection and designation of streets and highways for bike use. The results of the project are presented in a Final Report and this handbook. The Final Report provides a review of the background of bike routes, identifies the major factors related to route alignment and route suitability, discusses the processes involved in route selection and the options available for route designation. Four special topics are also treated: the use of controlled access freeway shoulders by bicycles, research needs related to bike route selection and designation, liability aspects of bikeway designation and bike mapping.

The Handbook is designed to simplify the task of selecting and designating streets and highways for bike routes. The topics covered include the definition of bike routes, the purpose(s) which affect suitability, approaches to planning and selecting bike routes and guidelines for various types of route projects.

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Unclassified	Unclassified	65	

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METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS FROM METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.6	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons(2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
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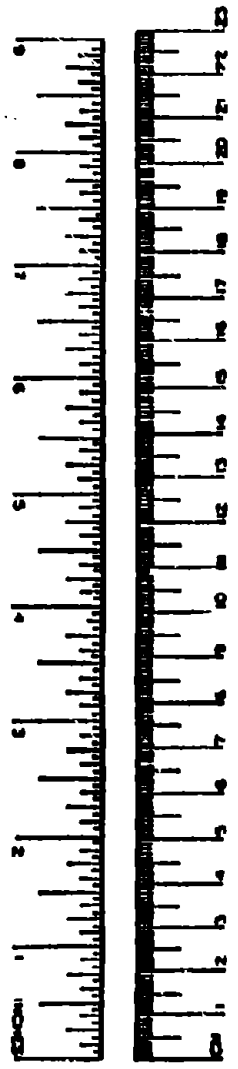

APPROXIMATE CONVERSIONS FROM METRIC MEASURES

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares(10,000 m^2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

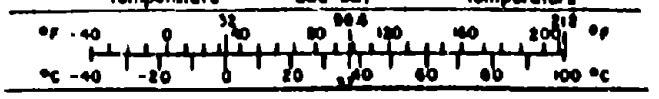

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd.)

LIST OF FIGURES

INTRODUCTION

About This Handbook

This handbook is designed to simplify the task of selecting and designating streets and highways as bicycle routes. It is intended for use by state and local transportation agencies, but should prove useful to any agency, organization, or individual interested in recommending routes for bicycling.

Scope

The topics covered in this document include:

- what bike routes are.
- the purpose(s) of bicycle routes.
- the factors which affect route alignment.
- the factors which affect the suitability of streets and highways for bicycling.
- approaches to planning, selecting and designating routes.
- guidelines for various types of route selection and designation prcjects.

Three special discussions are included as appendices: liability considerations related to bicycle route designation, evaluating the use of controlled access freeways, and mapping.

Source

The information contained in this handbook is based on a study of bicycle route selection and designation sponsored by the Federal Highway Administration and conducted under contract by the Bicycle Federation of America, Inc. The conclusions and recommendations were derived from reviews of the literature and the current practice associated with bicycle routes.

Basic Assumptions

Certain assumptions underlie the approach taken in this handbook to bicycling and bicycle routes:

- That bicycles are generally defined as vehicles and are entitled to the use of most streets and highways.

- That some streets and highways are more suitable for shared use by bicycles and motor vehicles than are others.

- That while any individual may legally operate a bicycle on the streets and highways, it is appropriate to expect of cyclists a minimum level of knowledge of traffic regulations, bicycle operating skill, and judgment. Further, that bicycle routes should not be designed to encourage individuals without such capabilities to ride on the streets and highways.

- That the duty of a State or local transportation agency to maintain a bike route is the same as the duty to maintain an other street or highway on which bicycle use is permitted but t vulnerability to lawsuit might be greater since the bicycle route may invite or encourage bicycle use. (See Appendix A: Legal Liability Concerns.)

- That there is always some risk associated with bicycling, as with all modes; that no route can provide a totally risk-fre environment; and that therefore, no route should ever be described as being "safe."

- That route selection will always require judgments to be made as to when to waive conformance with one factor in

favor of another, and that few routes will ever conform completely with any set of criteria.

- That designating bicycle routes is intended to provide guidance information, and does not imply any warrant regarding the safety of the route for cycling.

- That it is not intended that any of the information described herein be used to absolutely "disqualify" any street or highway from possible designation as a bicycle route. Similarly, it would be a misapplication of this handbook to use the information to conclude that any street of highway is not suitable for bicycle use because it fails to conform to the criteria given for any of the various factors. The findings of research study will not support any such determination.

BIKE ROUTE OVERVIEW

Definition

A variety of bicycle facilities (a general term denoting improvements and provisions to accomodate bicycling), have been developed over the past two decades. With these facilities has come a variety of definitions to clarify the numerous alternatives. The American Association of State Highway and Transportation Officials (AASHTO), has provided the most widely accepted definitions in their **Guide for the Development of New Bicycle Facilities** (1981). These include:

- BIKEWAY: Any road, path, or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

- BIKE PATH: A bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent right-of-way.

- BIKE LANE: A portion of a roadway (or shoulder) which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.

The AASHTO definition of bike route, however, does not adequately describe the full range of facilities that are included in the scope of this handbook and in the research study which preceded it. Therefore for the purpose of this handbook bike route is defined as:

a way for bicycles which may utilize existing roadways shoulders, or bicycle facilities (e.g., bike path), and which is designated by signs, pavement markings, maps or by some other means.

This definition takes into account the fact that many currently designated bike routes were developed by nontransportation agencies and private sector organizations, and that the majority of designated bike routes are not defined by signs, but rather by maps.

The Purposes of Bike Routes

The purpose, or objective, of designating bicycle routes should include one or more of the following:

- To reduce cyclist risk by identifying routes which are judged to be more suitable for cycling than other choices.
- To improve access and mobility by identifying routes which penetrate barriers and/or avoid bottlenecks and obstacles.
- To promote bicycle use and accommodate demand by defining recreational "facilities" and more suitable routes.
- To enhance the quality of the bicycling experience by identifying attractive routes, with desired amenities and support services.

Reasons for Bike Routes

The basic function of a bicycle route is to provide guidance or directional information to bicyclists for one or more of the following reasons:

- To define a recreational "facility," and guide them along it.
- To lead them to a specific destination.

- To identify a bypass to a barrier.

- To lead them through, across, or around a complex connection (such as the access/egress associated with a major bridge).

- To identify a route judged to be more suitable for cycling than other more obvious choices.

- To identify a connection or link between otherwise discontinuous segments of special bicycle facilities.

- To identify a specially permitted use, such as use of a bridge sidewalk or of freeway shoulders.

When a Bike Route is NOT the Answer

While the Bike Route sign has at times been used to provide directional assistance in all of the situations noted above, it may not always be desirable to designate a facility as a bike route. For instance, the following are examples of cases where use of the traditional Bike Route sign would not be appropriate:

- Where highway design (e.g., narrow lanes), or traffic conditions (e.g., high traffic volume), render it inappropriate to encourage use.

- Where the information might better be presented through the use of maps.

- Where there is insufficient demand to justify such action.

- Where directional information is needed but bike route designation would create an ambiguous message.

Presenting Route Information

There are three different approaches to helping cyclists select routes:

1. By providing them with information on the relative suitability of various streets and highways.

2. By preselecting and designating specific routes.

3. By identifying a network of general routes using more suitable streets and highways.

Number three is essentially a combination of the first two approaches.

Finally, a Word About Bicyclists

Bicyclists come in great variety: from eight year olds tasting their first freedom with their own vehicle; to adults just taking up bicycling again, for fitness or fun; to experienced cyclists routinely riding for recreation or transportation (e.g., commuting). There is wide range in ages, skill, judgment, experience, trip purposes, and desires. Child cyclists, while frequently possessing excellent bicycle handling skills, often lack the experience, training, and judgment to cope with the hazards of operating a bicycle in traffic. Novice adult cyclists are frequently willing to take less direct routes to avoid heavy or high speed motor vehicle traffic. Operator error is a frequent cause of accidents for this type of cyclist. Experienced bicyclists are skilled and have an extensive knowledge of bicycle operation in traffic. For utilitarian trips they usually prefer a direct on-street route, even if they must cope with heavy traffic.

As noted above, this handbook is based on the assumption that anyone operating a bicycle on the streets and highways should be expected have the basic capabilities needed to ride safely under normal traffic conditions, or be under the immediate supervision of such a person. Bicyclists without these basic capabilities should not be encouraged to ride on streets and highways.

Facilities such as bike routes should be intended to serve moderately experienced bicyclists with these basic capabilities. This is significant for both the selection and designation of bicycle routes.

WHAT MAKES A GOOD BIKE ROUTE?

Before a bike route can be selected from among the various alternatives in a given corridor, a host of factors needs to be analyzed. These factors help to define the requirements of a good route for cyclists. These factors include those items that respond to the needs and desires of cyclists, (alignment factors) and those that reflect the degree to which a street or highway accommodates the shared use of motor vehicles and bicycles (suitability factors).

Alignment Factors

Selection of a particular alignment for a bike route should be based on a consideration of conditions which:

- affect the desirability of a bike route such as attractiveness.
- are necessary for the route to function as intended such as directness and continuity.
- might limit the feasibility of a particular route such as bottlenecks.

The principal alignment factors to be considered include the following.

- **Attractiveness:** The attractiveness of a route is a very subjective quality which could include such aspects as scenery, points of historical interest, water access, variety of terrain and opportunities for recreation and diversion. Different cyclists will define "attractive" differently, and attractiveness, as a characteristic, will have greater or lesser significance depending on the trip purpose and route type.

- **Grades:** Hills can affect both the desirability of routes to cyclists and the operational safety of these routes. While some cyclists may seek the challenge of steep grades, other riders might prefer to avoid routes with a lot of hills, unless the alternative route has less desirable traffic conditions. Steep grades can also affect the interaction of bicycles with motor vehicles along the routes. Uphills can cause cyclists to weave and to operate at significantly reduced speed, thereby causing conflicts with overtaking traffic unless additional lane width is provided. On the downhills, cyclists can reach speeds equal to motor vehicle traffic thereby placing increased demand on the cyclist's ability to handle the bicycle safely. Surface conditions become increasingly important on downhills since they affect stopping distances and handling characteristics.

  The significance of grade in the alignment of possible bike routes can vary geographically. Grade may pose much more of a problem to cyclists in areas with relatively flat terrain than it does in those sections of the country where steep hills are common. Cyclists in these areas quickly learn how to cope with hills and accept them as a necessary part of every bike trip, rather than something to be avoided.

- **Services:** Users of bicycle routes will be in need of certain services either along the route or at their destinations. Potential routes should therefore be examined to determine the extent to which they provide these essential and desired services. Rural touring routes should have available food, water and restrooms, and long-distance routes should also include housing/camping and such facilities as bike shops, and laundromats. Urban utilitarian routes should consider the need for secure parking at the various destinations served.

- **Security:** The potential for criminal acts against bicyclists, especially along remote bicycle routes, and the possibility of bicycle theft at parking locations, should be considered in the selection of potential routes. Street lighting is an important characteristic to look for along routes in developed areas, and along routes likely to be used by commuters. Street lighting also serves to increase the conspicuity of cyclsits, thereby reducing the risk of nighttime car/bike collisions.

- **Directness:** Directness of the route refers to the extent to which a route covers the shortest distance between points A and B. Directness, as a route characteristic, has different significance for recreational and utilitarian cyclists. The utilitiarian cyclist is usually unwilling to deviate any distance at all from the shortest possible route, while the recreational cyclist will accept some deviation from the shortest path to avoid unpleasant or hazardous conditions, as long as the deviation is not out of proportion to the length of the whole trip.

- **Continuity and Simplicity:** For a route to serve the needs of bicyclists it must be continuous, logical, and not unduly complex. The route should provide clear connections to the destinations bicyclists are likely to seek, and it should not lead cyclists into hazardous conditions and then abandon them with a "Bike Route Ends" sign. The route should also be logical, avoiding unnecessary and circuitous turns and connections. An overly complex route can be hard to follow, increasing the likelihood that a cyclist could wind up in the midst of a hazardous operating environment or get lost.

- **Right of Way:** Bicyclists do not like to stop. They will tend to avoid those routes with stop signs at many intersections. Where a regular bicycle route encounters stop signs there typically will be a high incidence of cyclists' violations. It is also important to consider the desirability of traffic

controls where a bicycle route intersects a collector or arterial street, to help assure that cyclists will be afforded a regular, controlled opportunity to cross.

- **Access and Convenience:** Bicycle routes should be within easy reach of cyclists and should provide access to their likely destinations. In urban areas this means developing routes to serve residential and employment areas, retail centers, transportation facilities, recreation centers and other public facilities. In rural areas attention should be paid to finding routes which are reasonably accessible to major population centers and good points of access, such as public transportation and major highways. Major rural long distance routes should ideally be along corridors which serve as a trunk routes , and should have connector spurs to population centers and other regional touring routes.

- **Overall Feasibility:** Finally a particular alignment must work for the cyclist. It must be free of major bottlenecks and barriers. It must not pose too many difficulties for the anticipated users. It must be maintained at a reasonable level. In summary, it must provide a cycling environment which is viewed to be superior in some measure to the alternatives.

The significance accorded these alignment factors will vary depending on the project type. The most important factors for each project type is presented in the PROJECT GUIDELINES section.

Suitability Factors

Besides identifying certain factors which help make a specific alignment of a particular bike route desirable and feasible, it is also possible to identify factors which make any given segment of a street or highway suitable for bicycle use.

"Suitability" is best thought of in terms of a continuum (and not as an absolute); that is, any particular section of a street or highway may be more or less suitable for cycling than some other

street or section, and it may be rated in terms of its relative suitability based on a nominal scale (e.g., easy, moderately demanding, very demanding).

There are two main categories of factors to be considered in determining the suitability of a street or highway for accommodating cycling. The first deals with those factors that specifically affect the degree to which a street or highway can physically accommodate shared use by bicycles and motor vehicles. The second category of factors are those affecting the general suitability of a particular street or highway for bicycle use.

a. Factors Affecting Shared Use

The degree to which a particular street or highway can accommodate shared use is typically the most important factor in establishing suitability. If bicycle and motor vehicles can occupy the same lane, or the lane and adjacent shoulder (if permitted by applicable laws) with sufficient space for both to operate safely and efficiently, the route will be suitable for both modes. When determining if a street or highway can accommodate shared use, it is necessary to first determine what space is available, and then to assess how much space is actually desired to accommodate shared use under the conditions present on that roadway.

The amount of space available is determined by the width of the outside or curb lane, the presence and condition of a paved shoulder, and the condition of the right-most portion of the useable pavement. Outside lane width should be measured from the left-most edge of the gutter pan, edge stripe, parking lane, shoulder, or regular obstruction (e.g., drainage grate) to the center line or lane stripe. The pavement condition, including the presence of collected debris at the right-hand side of the lane or shoulder and possible surface deterioration, will affect the amount of available space. If paved shoulders are present and in reasonably good condition and where the state vehicle code permits bicycle use of shoulders, they can be included in the total amount of space available for shared use. If shoulders are to be included in the determination of the space available, they

should be inspected to establish that the surface will be acceptable to bicyclists.

The amount of space required for shared use will be affected by such factors as traffic volume, traffic speed, traffic mix, grade, and the presence of parking. As traffic volume and speed increase the amount of space desirable for separation will also increase. As the percentage of truck traffic increases, particularly on higher speed roads, there will be a need for greater lateral separation to minimize the effects of wind turbulence.

The presence of parking on a street will essentially either reduce the amount of space available or increase the total amount of space desired for shared use. Streets with diagonal parking should be avoided, if possible, unless a very wide (16 to 18 ft [4.9 to 5.5 m]) travel lane is adjacent. For a parking lane to accommodate shared use it should be at least 13 ft (4 m) wide, with 13.5 or 14 feet (4.1 or 4.3 m) being desirable. If bicycle travel is to be accommodated in the travel lane adjacent to the parking lane, it should be noted that a parking lane less than 8 ft (2.4 m) wide will reduce the effective width of the adjacent travel lane because cyclists will need to ride further into the travel lane in order to avoid the possibility of being hit by opening car doors. Where a parking lane serves as an additional travel lane at rush hour, the amount of available space needs to be reassessed based on said lane use for this period.

In urban areas, where shoulders are not likely to be present, the outside lane width which will best accommodate shared use for the widest range of cyclists and conditions is 15 ft (4.6 m). Where curb lanes are wider than 15 ft (4.6 m), the possibility of dual lane use by motor vehicles increases, especially when the traffic volume is at or near capacity. In rural areas with low ADT, narrower lane width can be acceptable as long as there is adequate sight distance. Also, narrower lanes are more tolerable on lower volume, multi-lane roads than they are on single lane roads because overtaking motorists will generally have the adjacent lane to pull into to pass.

On high speed rural routes with limited sight distances, space for cycling on the shoulder may be preferable to a wide outside lane because of the channelizing effect of the edge stripe. In urban areas, wide curb lanes are preferable to shoulders in most instances with one possible exception being for major arterials with high volume, high speed traffic.

For urban arterials and rural routes with posted speeds above 40 mi/h (64 km/h), or for highways with significant truck traffic, the desirable shoulder width to accommodate bicycle use off the roadway is 6 ft (1.8 m), (assuming a 12 ft [3.7 m] travel lane).

b. Other Factors Affecting Suitability

Once the determination has been made concerning the potential for a street or highway to accommodate shared use, attention should be given to examining other factors that affect the general suitability of the facility for bicycling. This would included factors that can affect potential risk for cyclists, that can represent hazards, or that can constitute especially demanding situations for moderately experienced riders.

(1) INTERSECTIONS. Since intersections and driveways are the location of the majority of bicycle/motor vehicle collisions, they should be considered an important factor in assessing the suitability of potential bicycle routes. Since intersections cannot be avoided, particularly in urban areas, the following six criteria should be used to compare potential alternative routes on the basis of the risk associated with intersections and driveways:

- o The approach volumes on the cross streets.
- o The number of intersections and driveways per mile, and the volume of turning traffic.
- o The number and type of special intersection treatments (e.g., free right-turn lanes or freeway interchange ramps).

- o The land use patterns (commercial, service, industrial, and office developments can be expected to generate traffic which could increase the risk under some circumstances).

- o The level of traffic control at specific intersection conflict points.

- o The presence of any special intersection or driveway hazards caused by obscured or restricted sight distance.

(2) SIGHT DISTANCE. The role that sight distance plays as a factor in the assessment of suitability varies considerably between rural and urban routes. There are three negative consequences associated with restricted sight distance on rural routes:

- o Limited sight distance on two lane routes (reflected by a high percentage of yellow line or no passing zones) will occasion a greater incidence of overtaking conflicts.

- o Limited sight distance on two lane highways will make it more difficult and potentially more dangerous for motorists to pass slower moving bicycles.

- o On narrow highways, especially high speed facilities, limited sight distance increases the overtaking risk.

The potential for obstructions such as hedges, walls, and fences to restrict sight distances for either bicyclists or motorists at intersections or driveways should be assessed. Where such hazards are found the appropriate response would be to treat the situation rather than eliminate the route from further consideration.

When calculating sight distances for a particular segment of possible bike route it will be necessary to adjust for the greater height of the bicycle and bicyclist and for the combined effect of narrow profile and unusual position of the bicycle on the roadway (at the right edge rather than towards the center).

(3) TRAFFIC CONTROL DEVICES. The presence or absence of traffic control devices and whether these devices react to bicycles can affect the suitability of a route for bicycle travel.

Streets and highways designated as bicycle routes should generally be through streets. Frequent stop signs will induce some cyclists to ignore the route in favor of through streets, and others to ignore the stop signs.

Designated bicycle routes should ideally cross high volume or high speed arterials at intersections controlled by traffic signals. Traffic signals on designated bicycle routes, and on other streets as well, should be visible to bicyclists. This can be a serious problem where programmed visibility heads are employed. The traffic signals should also have a sufficient clearance interval, either yellow or yellow plus all red, to provide for cyclists to clear the intersection, based on the formula contained in AASHTO's **Guide for the Development of New Bicycle Facilities.** Finally, where vehicle detectors are used in conjunction with demand-actuated signals, all such detectors should be adjusted to respond to bicycles, including those set in left turn bays. The loops should be set within 1 ft (0.3 m) of the curb or edge line in order to detect bicycles in their usual position on the roadway.

(4) PARKING. The presence of parking along a potential bicycle route affects the amount of space required for shared use and also creates some potential hazards for cyclists. Parking can restrict sight distance at or

near intersections and driveways. Lower density or intermittent parking can result in risky behavior by inexperienced cyclists as they weave from a curbside position around the occasional parked motor vehicle. In general, the risk for cyclists varies directly with the turnover rate and density of onstreet parking. This will typically be high in commercial areas.

(5) PAVEMENT AND SURFACE FEATURES. In addition to affecting the amount of space available for shared use on the roadway, pavement condition can also affect the overall suitability of a route for bicycle travel. Because of the lack of suspension, narrow tires, short wheel-base, and high center of gravity of bicycles, bicyclists are acutely aware of the smoothness of the pavement and adversely affected by surface irregularities and features. Bicyclists will generally seek to ride on the smoothest portion of the pavement even if that requires moving further into the travel lane or off the shoulder and onto the roadway. In rural areas, it is particularly important to avoid unpaved or gravel roads.

The area of the pavement which is of most concern to cyclists, the right hand portion of the roadway and the shoulder, is also the area of the pavement most likely to deteriorate and the least likely to be maintained. The most hazardous pavement condition is associated with different surface levels which create ridges which run parallel to the direction of the roadway. This is typically found in conjunction with pavement overlays, the connection between the pavement and the curb and gutter, and the roadway-shoulder interface. The presence of these ridges is not acceptable for a designated bicycle route, and may well constitute a liability on any street of highway used by bicycles.

Other pavement irregularities such as potholes, bumps, and raised fixtures should be identified and treated in conjunction with the designation of any bicycle route and on any street used by bicyclists.

Surface debris (sand, broken glass, gravel, etc.) can cause both inconvenience in the form of punctured tires, and loss of control for bicyclists. Routine sweeping of a bicycle route is therefore an important consideration.

Railroad crossings and drainage grates pose such a clear, well-documented hazard for cyclists that immediate remedial treatment is called for wherever they are identified, especially on streets or highways which are or may be designated as bicycle routes. Treatments such as rubberized railway crossings and flange way filler for railroad crossings and bicycle safe drainage grates are readiy available and should be utilized.

Other surface features such as utility covers, pavement markings and expansion joints can, under certain circumstances, be hazardous to cyclists. Therefore, any route under consideration for designation as a bicycle route should be surveyed to identify the presence of these features. Each should then be assessed to determine, whether in fact a hazard exists. All identified hazards should be treated either by eliminating or correcting the situation or by marking the feature with the appropriate warning signs and markings.

The problems associated with surface features and pavement conditions pose a liability risk for state and local agencies whether they occur on a bike route or on any other street on which bicycles are permitted. They should be treated immediately wherever they are identified. The presence of these hazards, therefore, is not an appropriate basis for eliminating a potential route from consideration for designation as a bicycle route.

HOW TO SELECT AND DESIGNATE A BIKE ROUTE

This section provides an overview of the steps involved in the process of selecting and designating any type of bicycle route.

Defining the Project

The bicycle route selection process should begin with consideration of three basic questions:

- Why establish a bicycle route or routes?
- Who is it intended to serve?
- What type of route is needed?

The development of bicycle routes by public agencies should be considered as one possible activity in the broad context of addressing the needs and desires of the bicycling public. Other options include everything from providing safety education and training programs and increasing enforcement activities, to identifying and repairing hazards on streets and upgrading highway design standards to accommodate bicycling. Is bicycle route development a priority?

Bicycle routes should not be viewed as excusing bicyclists from the responsibility of being capable, qualified operators of their vehicles. Neither should the designation of bicycle routes be used as an excuse for tolerating inadequate or hazardous street and highway conditions on other, non-designated routes. So why establish bicycle routes?

Bicycle routes should serve a very specific function--providing guidance or directional assistance. In so doing, designating a bicycle route may help accomplish any of the following objectives for cycling:

- To reduce cyclist risk.
- To improve access and mobility.
- To promote bicycle use and accommodate demand.
- To enhance the quality of the bicycling experience.

It may be helpful to think of designating bicycle routes as providing a **service.** The needs and interests of cyclists, i.e., those whom the route is intended to serve, should be paramount in the route selection process. Thus, the following questions should also be considered when deciding whether to undertake a bicycle route project.

- Who wants or needs this service?
- What is the level of demand for this service?
- How important is this service to bicyclists?
- What are the costs of providing this service (including the opportunity costs of not doing something else instead)?
- What are the benefits of providing this service?
- Are there other means of providing this service?
- Are there other agencies or organizations that are already providing this service, that are more appropriate providers of this service, or that should be part of any effort to provide this service?

If the decision is made to go forward with a bicycle route project, the following items should be defined to provide the necessary foundation for the planning and selection process.

1. The type of route project(s) to be undertaken:
   - Rural touring route.

- o Urban recreation route.
- o Urban access route.
- o Urban route network.
- o Statewide or regional suitability assessment.
- o Urban or metropolitan suitability assessment.
- o Controlled access freeway shoulder use evaluation.

The first four project types listed are discussed in detail under PROJECT GUIDELINES. Statewide and urban suitability asessments are discussed further in the section B below titled "The Suitability Approach," and in Appendix C: Mapping. A discussion of evaluation procedures for bicycle use of controlled access freeway shoulders is contained in Appendix B.

2. The types of users/cyclists to be provided for:
   - o Ages.
   - o Cycling experience.
   - o Cycling capabilities (distances, grades, etc.).
   - o Percentage of first-time, one-time, occasional, and regular or frequent users of the route.

Selecting the Route

There are several approaches which can be used to select bicycle routes. The specific choice of which to employ will likely be a function of the resources available (including data, time, funds, and labor) the type of route being planned, and professional judgment. Three basic approaches are detailed here. (Please refer to the section on PROJECT GUIDELINES for recommendations on which approach to use for the various project types.)

A. The Planning Approach

This approach is essentially one of successively refining the focus of the route selection effort until a route choice emerges. The typical steps in this process would be as follows:

1. Develop a detailed statement of the objective of the route project, including, as appropriate, origins and destinations, general corridors, service areas, network or grid size or density, and any other information which helps to define the extent and/or boundaries of the area under consideration.

2. Develop a detailed description of the characteristics which are most desired in the route. This can be thought of as "performance criteria" for the route.

3. Collect data on the study area or corridor including some or all of the following (depending on the type of route):

   - o Existing bicycle travel patterns.
   - o Frequent origin/destination points.
   - o The extent of current bicycle activity.
   - o Boundary points of exit/entry.
   - o Bicyclists' preferences, concerns, insights.
   - o Points of interest such as parks, recreation areas, historic sites, scenic areas, services, etc.
   - o Potential barriers and bottlenecks, and opportunities to get through or around them.

4. Plot the information on a map of the area. Based on the opportunities and constraints thus defined, identify candidate routes.

5. Assess the suitability of the candidate routes both in terms of accommodating shared use and potential hazards. The significance of various factors will vary depending on the type of route being considered.

6. Tentatively select route which seems to best satisfy the key characteristics and which is judged to be adequately suitable for cycling. The route should then be reviewed by bicycle. Bicyclists' input would be critical at this point to insure that cyclists' needs are identified. This review should include:

   - o Noting any existing or potential hazards.
   - o Assessing the conformance of the route with key characteristics.
   - o Evaluating the suitability of the route.

7. Assuming the route still represents a valid choice, any existing hazards should be treated either by correcting the problem or by use of appropriate warning devices (i.e., signs and/or pavement markings).

B. The Suitability Approach

There are two ways in which suitability assessment is used as an approach to bicycle route selection:

- o All streets and highways (or at least all other than neighborhood streets) are assessed and the "findings" or information is presented to potential users in the form of a map--and the choice of any specific route is left to the user.
- o All streets (as above) or just some streets are assessed and the findings are used as a basis for recommending specific streets as bicycle routes (either with signs or maps).

Suitability assessment has emerged as the most popular approach to presenting guidance information to cyclists. Most new route planning efforts have employed some form of suitability assessment. The assessments are made using one or both of the following techniques:

- o Objective. Uses "hard" data, as available, on such factors as lane width, speed, and ADT. The analysis may involve the use of computer modeling techniques. This type of assessment provides users or decision-makers with a general insight into how "suitable" the street or highway is for cycling, but is not especially sensitive to potentially important specifics.

- o Subjective. Uses cyclists' input either in the form of summary assessments, or in terms of observations and evaluations of either specific factors or more general characteristics.

In order to determine what specific combination of techniques might best support a suitability assessment effort, it is necessary to decide what factors are judged to be most significant, what data are available and the form/format that the data are in, the quality of the data, and the resources available to collect and analyze the data.

The previous discussion on assessing street and highway suitability provides insights on what are generally considered to be the most significant factors affect suitability. More information on the factors which are believed to be particularly important in establishing the suitability of a street or highway to serve as a specific type of route is included in the next major section on "PROJECT GUIDELINES."

The following case studies on two different approaches to suitability assessment provide suggestions on how such a project might be undertaken.

Portland (OR) Bicycle Suitability Map: The Portland suitability map, issued in 1979, is largely responsible for shifting much of

the subsequent focus of urban bicycle route designation to suitability mapping.

The first step in the process of developing the map entailed finding out what cyclists wanted. It was discovered that no one could agree on any streets that were unsuitable for bicycling and should be left off the map. Every street had its supporters. Some bicyclists liked neighborhood streets, where traffic is both light and slow. (Intersections on neighborhood streets in Portland do not have stop signs or traffic signals.) Other cyclists were uneasy on neighborhood streets because of the cross traffic. These riders preferred through streets--even though traffic might be higher--because intersections on these streets are protected by traffic controls. Some bicyclists preferred the very busiest streets for the same reasons that car drivers pick them: they provide the fastest routes between two points. It was decided to produce a map that would show all these things and allow individual cyclists to pick their own routes, according to individual tastes.

The next step was to rate the streets. Again, cyclists were consulted. A series of workshops was held, and maps were displayed with all the neighborhood streets designated with a single color indicating that they would all be included in the same category on the final map. One by one, each of the remaining through streets were color-coded as "hardest to ride," "easiest," or "intermediate" based on cyclists' input. Where opinion differed, both colors were indicated.

The third step involved reconciliation of the workshop input to affect consistent assessment throughout the city. This was accomplished by having a single individual review the evaluations for all the streets by bicycle, and by collecting data on traffic volumes, speed, and road width. This information was combined with the workshop input and streets were ranked in one of five categories:

- Neighborhood streets: intersections not protected by stop signs or signals; less than 1,000 cars per day; speeds of 25 mi/h (40 km/h) or less; width and surface varies.

- Easy through streets: intersections protected by traffic controls; speeds up to 30 mi/h (48 km/h); low traffic streets with less than 5,000 vehicles per day; medium traffic streets with 5,000 to 10,000 vehicles per day with wide outside lanes or shoulders; a few neighborhood streets that are good alternate routes to adjacent difficult streets.

- Medium through streets: intersections protected by traffic controls; speeds up to 35 mi/h (56 km/h); medium traffic streets with 5,000 to 10,000 vehicles per day; high traffic streets with 10,000 to 20,000 vehicles per day with wide lanes or multiple lanes in each direction; low traffic streets with under 5,000 vehicles per day that are too narrow for cars to pass bikes comfortably.

- Difficult through streets: intersections protected by traffic controls; speeds up to 45 mi/h (72 km/h); high traffic streets with 10,000 to 20,000 vehicles per day; very high traffic streets with over 20,000 vehilces per day with wide shoulders; medium traffic streets with 5,000 to 10,000 vehicles per day that are too narrow for cars to pass bike comfortably.

- Very difficult through streets: intersections protected by traffic controls; speeds up to 55 mi/h (88 km/h); very high traffic streets with over 20,000 vehicles per day; high traffic streets with 10,000 to 20,000 vehicles per day that are too narrow for cars to pass bikes comfortably.

In the introduction to "Suitability Mapping: the Portland Experience," an article published in **Bicycle Forum** magazine, Number 5 (1980), Janet Schaeffer, Portland's bicycle coordinator at the time, wrote, "The map presents all the information an urban cyclist needs to custom design his or her own route anywhere in Portland."

For further information on the Portland map, contact the Program Manager, City of Portland Bicycle Program, 1120 SW 5th Avenue, Room 834, Portland, Oregon, 98204.

High Point (NC) Bike Map: The High Point, North Carolina bicycle suitability map was developed through the use of a more objective, computer-based approach for the collection and analysis of data. The map both provides suitability information on all streets, and identifies certain routes for pleasure riding. The methodology (which derives in part from an earlier effort in Greensboro, NC) consists of the following steps:

1. Find out what technical data are available.

2. Choose the independent variables to be considered. The following are recommended:

   - o Traffic volume.
   - o Lane width.
   - o Number of lanes.
   - o Shoulder condition.
   - o Amount of on-street parking.
   - o Number of commercial driveways.
   - o Speed limit.
   - o Presence of hills and/or curves.

3. Choose all streets to be modelled; break into segments.

4. Choose sample segments for model calibration.

5. Collect technical data for sample segments

6. Collect average ratings (by cyclists) for sample segments.

7. Use multiple regression to choose variables and calibrate the model based on the sample.

8. Collect appropriate data for remaining streets.

9. Rate all streets using model.

10. Field check ratings and rerate where necessary.

11. Map ratings.

For more information on the High Point Bike Map, contact the North Carolina Bicycle Program, NC Department of Transportation, P.O. Box 25201, Raleigh, North Carolina, 27611.

C. The Cyclist-based Approach

The cyclist-based approach to route selection involves an agency or organization asking cyclists to identify their preferred bicycling routes in the city, region, or state. These routes are then designated as bike routes either with maps or with signs. Although the planning and suitability aproaches both require cyclist input, the cyclist-based approach differs from these two in that it **only** uses cyclist input. There is no other analysis of traffic conditions, hazards, or other suitability or alignment factors. The cyclist-based approach is based on the assumption that experienced cyclists have taken these factors into consideration in the selection of their regular routes. The routes are in essence "cyclist-tested."

There are a variety of ways to obtain cyclist input for this approach. Some jurisdictions publish maps of the area in the newspaper and ask cyclists to mark their preferred routes and send the maps in to be reviewed. It is also possible to post the maps at bike shops and to distribute them to members of local bike clubs. Another approach would be to invite cyclists to attend public meetings where the maps are posted. The cyclists can then discuss their routes and/or mark them on the maps.

The cyclist-based approach can also be used for suitability assessments. Cyclists are asked to rate all the streets in an area according to their suitability for bicycling. This information is compiled and conflicts resolved and then the results are presented on a suitability map.

The cyclist-based approach is a very viable approach for agencies and organizations to use in route selection. It is particularly suited for private sector organizations interested in mapping bike routes since these groups may not have access to hard data on traffic volume, traffic mix, and lane width.

It is likely that most efforts to select and designate bicycle routes will involve some blend of two or more of these three approaches. The PROJECT GUIDELINES section suggests recommended route selection approaches for each route type. Cyclists should always be part of field-checking a proposed route for potential hazards and final evaluation.

Many route selection projects have been based entirely on the imput of cyclists, either through the process of cyclists recommending specific routes, or by having cyclists perform suitability assessments.

Designating Bicycle Routes

There are two basic mechanisms for designating bicycle routes: signs and maps. Signing bike routes is exclusively a government function while any organization, group, or individual may, if they so choose, publish and distribute maps.

The standard for signing is defined by the **Manual on Uniform Traffic Control Devices** (MUTCD), published by the Federal Highway Administration. A companion document, the **Traffic Control Devices Handbook**, provides much additional useful information.

Two basic type of signs for marking bicycle routes are included in the MUTCD:

- The BIKE ROUTE sign; the very familiar white on green device (D11-1).

- A Bike Route marker (M1-8 and M1-9). This device is much less well known. It is a black on white marker with a small diagram of a bicycle and a number.

The MUTCD also includes a full set of "plaques" which can be used in conjunction with the Bike Route sign to provide additional information on destinations, direction changes and distances. The MUTCD also provides for a black on yellow Bicycle Crossing sign to be used at locations where bicycles are expected to cross a street or highway.

As part of the larger study which produced this handbook, a third sign has been recommended. This would be a "pathfinder" type marker, smaller than the existing signs, with only a small bicycle diagram and room for a brief destinational message and a directional arrow. This device would be intended for use in situations where guidance or directional information is necessary or desirable, but where designation of a bike route, as would be implied by the use of the Bike Route sign, would be inappropriate or even undesirable.

A second recommendation that has been made relates to the use of the Bicycle Crossing sign, (W11-1), the yellow on black warning sign used to alert motorists about a bikeway crossing the roadway. There are several instances in which it would be desirable to have a standardized sign that could be used to alert motorists to the presence of bicyclists on the roadway without using the regular Bike Route sign, which might encourage bicycle use on a difficult or demanding road segment. Allowing for the use of the Bicycle Crossing sign in these situations could accomplish this.

Finally, signs should be used more extensively to alert bicyclists to the presence of hazards that might cause loss of control, such as bridge grates, rough pavement, or manholes. The MUTCD provides for a Hazardous Condition Sign (W8-10), a yellow on black warning sign, and supplemental plaques which describe the hazard. These are not extensively used, however. Since bicycles are more vulnerable to pavement irregularities than other vehicles, a special effort should be made to alert cyclists

to the presence of these hazards, particularly those which cannot be removed or modified.

In addition to signs, there are two basic types of maps which can be used to designate bike routes:

- A suitability assessment map.
- A route map.

In some cases, such as the High Point, NC bike map, a single map may incorporate both types of information.

Further information on mapping as a route designation technique is provided in Appendix C: Mapping.

PROJECT GUIDELINES

This section provides additional definition, background information and general suggestions on the various types of route projects.

Rural Touring Route

Rural touring routes are the major type of rural route. They may be linear or loop-type facilities, and can range in length from 10 miles to transcontinental distances.

- TYPICAL USERS: The typical users of these routes will be adults, with some children under close adult supervision. Most cyclists will be at least moderately experienced, and will generally have the capability to ride 20 or more miles. Riders may use the route as individuals, small parties, or in very large groups. Rural routes can be expected to routinely serve a significant percentage of first-time and one-time users.

- KEY ROUTE ALIGNMENT FACTORS:

  - Attractiveness.
  - Services.
  - Continuity.
  - Grade (importance will vary from rider to rider).
  - Overall Feasibility.

- PRIMARY SUITABILITY FACTORS:

  - Traffic Volume.
  - Lane Width or Shoulder.
  - Pavement.
  - Traffic Mix.

- RECOMMENDED SELECTION APPROACH: For long-distance routes, especially when developed by a public agency, the planning approach is probably best suited. The statewide suitability assessment approach likely has a more limited appeal to most potential users, but does provide useful information. For regional routes, the cyclist-based approach is recommended since local cyclists usually have well-developed regional routes established and can offer extensive information on services and points of interest as well as preferred alignment and suitability.

- RECOMMENDED DESIGNATION TECHNIQUE: Route maps. Signing is not recommended because of the low volume of use, the cost of signing, and the high potential for sign vandalism which compromises the reliability of the whole signing effort.

Urban Recreation Route

Traditionally, this has been the most popular type of designated, signed bike route. Routes may extend from 2 or 3 miles, to 50 or more, depending on the opportunities. Many routes incorporate special bicycle facilities, where they exist. This type of route frequently serves as a neighborhood-type facility.

- TYPICAL USERS: These routes attract the widest range of users, both in terms of ages and cycling capabilities, including many young riders and novice adults. There is a wide range of frequency patterns with significant percentages of both regular and first-time users.

- KEY ROUTE ALIGNMENT FACTORS:

  - Access and Convenience.
  - Continuity.
  - Right of Way.
  - Attractiveness.
  - Security.

- Grade.
- Overall Feasibility.

- PRIMARY SUITABILITY FACTORS:

  - Lane Width or Shoulder.
  - Traffic Volume.
  - Traffic Speeds.
  - Intersections.
  - Pavement.
  - Parking.
  - Traffic Controls.

- RECOMMENDED SELECTION APPROACH: The planning approach, combined with careful suitability assessment. Cyclist-based will have less utility because of the likelihood that the cyclists involved would be significantly more experienced that the typical user. Input from cyclists should not be overlooked, however.

- RECOMMENDED DESIGNATION TECHNIQUE: Ideally, if a route will accommodate most levels of expertise, the Bike Route sign will effect the greatest use for the route. Many of the potential users will not be aware of, nor would they likely use maps. Care must be taken to avoid signing a route which might attract users who do not have sufficient expertise to handle the traffic conditions which they would likely encounter. Such routes would best be handled with a map.

Urban Access Route

This type of route can serve many different functions. It can identify a by-pass to a barrier such as a prohibited facility, it can identify a way across or through an obstacle like a major bridge, and it can identify a preferred route for commuters and for acess to community facilities, among other things. Primarily, access routes serve either specific purposes or specific destinations.

- TYPICAL USERS: The users will vary with the specific purpose of the route, but will generally be at least moderately experienced cyclists. Most will be regular, or at least repeat users. Trip purposes will depend on the nature of the route.

- KEY ROUTE ALIGNMENT FACTORS:

  - Directness.
  - Right of Way.
  - Access and Convenience.
  - Continuity.
  - Overall Feasibility.

- PRIMARY SUITABILITY FACTORS:

  - Lane Width.
  - Traffic Controls.
  - Intersections.
  - Pavement.

- RECOMMENDED SELECTION APPROACH: The best way to identify most types of access routes is to solicit input from cyclists currently traveling the route.

- RECOMMENDED DESIGNATION TECHNIQUE: Two approaches are possible. The first would be the proposed new "pathfinder" type sign, which would provide guidance assistance without the excessive and probably inappropriate distinction conveyed by the Bike Route sign. For many access-type routes the best designation approach is to provide the information on a map.

Urban Route Network

The route network is essentially an attempt to combine various aspects of route selection and designation to form a generalized set of routes which effectively identify suitable streets which can be used to gain access to a variety of destinations.

- TYPICAL USERS: The route networks currently in place and designated with Bike Route signs are likely to attract the same wide range of users that are drawn to the recreational routes--because there is no way to tell one from the other! Indeed, some route networks have been developed to serve as a system of recreational routes. This is acceptable if the route selection process has identified routes suitable for this wide variety of users, but if the routes are selected with the expectation that the users will be at least moderately skilled cyclists, there could be difficulties for novice riders.

- KEY ROUTE ALIGNMENT FACTORS:

  - Access and Convenience.
  - Continuity.
  - Right of Way.
  - Overall Feasibility.

- PRIMARY SUITABILITY FACTORS:

  - Lane Width.
  - Traffic Volume.
  - Traffic Speed.
  - Intersections.
  - Traffic Controls.
  - Pavement.
  - Parking.

- RECOMMENDED SELECTION APPROACH: A combination of the planning approach and suitability assessment is one option. Another is to solicit cyclists for their basic routes, or the routes with they consider most suitable for various corridors.

- RECOMMENDED DESIGNATION TECHNIQUE: Bike maps are the most reasonable approach to designating an urban route network since the cost of installing and maintaining the large number of signs would be prohibitive. Consideration should be given to posting these maps at

various locations to provide first-time users with an overview of the route network. If signs are desired in addition to maps, the Bike Route Marker would be most appropriate. In this case, a route numbering system should be devised (as is done with highway routes) and identified on the bike map. This would permit users to plan a route to any particular destination by selecting and following the various network routes which most closely approximated their travel line.

APPENDIX A

Legal Liability Concerns*

During preliminary stages of development of the Handbook, concerns were expressed regarding the potential legal liability associated with designation of bicycle facilities. When a perso using the designated bicycle route is injured, will a lawsuit an significant legal liability be the reward for the agency which designated the route and has responsibility for it? Concern was also expressed about the Handbook itself. Could it and other similar guidelines be used as a weapon to help establish liability in a lawsuit?

Such concerns seem legitimate. We live in a litigious age. We regularly read of new record-high judgements being rendered in favor of injured parties. Lawyers advertise to drum up more and more business. The wall of legal immunity which formerly protected the government from lawsuits is being dismantled, and what better party could there be to sue than the government, with its virtually unlimited resources.

We can understand the concern of the government employee who wonders whether designating bicycle routes will just bring a lot of legal trouble and a drain on the public treasury. But are such concerns reasonably based upon a thorough understanding of the liability problem, or are they simply unsubstantiated fears. If there is a serious problem with legal liability, what can be done about it. These concerns are briefly addressed here. For a more complete discussion, see the paper referenced in the below.

The kind of legal liability which concerns us here would be based on a finding that the government entity which designated

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* This part of the Handbook is a synopsis of the conclusions of a study entitled, Liability Aspects of Bikeway Designation, by John W. English, published in December, 1985 by The Bicycle Federation, 1818 R Street, N.W., Washington, DC 20009. Note that for consistency with the Handbook this synopsis uses the term "bicycle route" to refer broadly to facilities designated for bicycle use, while the larger study uses the term "bikeway."

the bicycle route and which controls and maintains it was in some way negligent with respect to a user of the facility. Negligence is conduct which creates an unreasonable risk of harm to others. In order to establish negligence, the bicycle route user would have to show that the government entity had a duty to conform to a particular standard of conduct for the protection of the user against unreasonable risk, that the government breached that duty, that the user was injured, and that the injury was proximately caused by the government's negligence.

In determining what constitutes an unreasonable risk, the courts will balance the magnitude and probability of injury against the social value of the conduct which created the risk and the burden of protecting against it. The precise standard of conduct applicable to the government in regard to bicycle routes would vary with circumstances. In assessing the circumstances, the following bicycle-specific factors must be considered:

First, bicycles have greater susceptibility to certain roadway conditions than some other vehicles. Thus potholes and other pavement defects, drainage grates, railroad tracks, expansion joints, manhole covers, steel construction cover plates, oil slicks, wet pavement, ice and snow, loose sand or gravel, broken glass and other debris, broken or uneven pavement edges, a drop-off between the roadway and the gutter or shoulder, and many other factors, all of which might pose no difficulty for most traffic, can constitute serious hazards for bicycles.

Second, bicycle presence and position on a roadway is somewhat predictable. Bicycles are prohibited on some roadways. On the other hand, heavy bicycle traffic may be anticipated on some roadways for various reasons, including a designation of the roadway as a bike route. Also, bicycle position on the roadway is somewhat predictable; most bicycle travel takes place near the right edge of the roadway, and bicycles are often trapped in that position by other traffic and cannot maneuver around hazards. These are realities which may contribute, in a particular case, to defining the appropriate standard of conduct.

In its defense, the government entity might assert that it is immune from liability for its negligence. Under the doctrine of governmental immunity, the government cannot be sued for negligence unless it first gives its permission. In the last few decades, this immunity has been reduced, but the general rule

remains that one can sue the government for negligence only under terms and conditions specified by the government. Under the most common pattern of governmental immunity today, the government may be held liable for negligence in regard to ministerial functions but not discretionary functions. High-level policy decisions, like those often involved in route selection and design of a bike route, are immune, but operational-level decisions, like those involved in bike route maintenance operations, are not immune.

With these legal concepts in mind, we can now address some specific concerns of government agencies contemplating the designation of bicycle routes.

How does designation of a bicycle route affect the potential liability of the governmental entity which controls the facility? It is our opinion that designation of a bicycle facility will have virtually no effect on the potential liability of the government entity which controls the facility.

That conclusion may seem surprising. We are not suggesting that there is no liability involved with bicycle routes. Quite the contrary is true. What we do conclude is that the liability already exists with respect to bicyclists who are injured as a result of hazardous conditions on the highways. The standard of conduct required of the government with respect to a bicyclist on a bicycle route does not differ significantly from the standard already required with respect to bicyclists on the highways. On balance, the potential liability should be the same for bicyclists on bicycle routes or highways.

Obviously, our conclusion takes a broad governmental perspective. From the standpoint of particular government agencies, designation of bicycle routes may affect potential liability by shifting it from one agency to another. If the park department designates bicycle routes on its land, bicycle traffic may be shifted from the highways onto the bicycle routes, and some potential liability may be shifted from the highway department to the park department, although total potential governmental liability remains unchanged. This should not be a serious problem for agencies. Most bicycle routes are designated on existing highways, so there is no shifting of liability. Also, as we will discuss below, it is possible through an appropriate risk management program to minimize bicycle route liability, keeping it at an acceptable level.

It is important to distinguish two areas of potential liability in regard to a bicycle routes. First, there is potential liability for negligent designation or design. Second, there is potential liability for defects or hazardous conditions on the designated route. Each of these requires some discussion.

A claim of negligent designation or design might be based upon an allegation that a dangerous route was selected, or that the facility was improperly designed. This kind of claim is not likely to be successful. It questions governmental decisions which involve the exercise of discretion and policy judgement at the planning level. Such decisions are still protected by governmental immunity in most jurisdictions. Where the route selection and the design plans were approved by the appropriate legislative or administrative body (the city council or the highway board, for example) or by a high-level administrative official, it is most unlikely that the courts will find negligence. This is often referred to as "design immunity."

Design immunity is not absolute, however. If the government acted arbitrarily in approving the design or route selection, or if the design or route was so clearly defective that no reasonable person could approve it, then it is not immune to judicial scrutiny. A bicycle route which clearly did not conform to appropriate design standards at the time it was designed will probably not be protected by design immunity in spite of the fact that the plans were approved by the highway board.

It is also important that the particular aspect of the design or route selection which is alleged to be negligent was approved. The city council may have approved the route and the design for the bike lane on main street, but if nothing in the design plans or the council's deliberations refers to the parallel-bar sewer grates which are in the road where the bike lane will be, then design immunity will not cover that aspect of the bike lane, and the city may well be liable to a bicyclist injured by that hazard.

The second area of potential liability is for defects or hazardous conditions on the designated route. A claim of this type, which alleges negligent maintainence or failure to warn of a hazard, is more likely to succeed. It questions governmental decisions at the operational level which are generally not protected by governmental immunity.

Examples of conditions which could be the basis of a negligent maintentance claim would include a failure to remove loose gravel or a fallen tree limb, to fill in a pothole, or to replace or repair a missing or malfunctioning traffic-control device. The government agency must have notice of the condition before there is any duty to correct it, but notice will be presumed when the condition has existed for such a period of time that the agency should have known about it.

Hazardous conditions can also arise out of design factors which would normally be protected by design immunity. For example, a bicycle route which was originally safe may be rendered hazardous by changed traffic conditions. It may also be that the route was poorly designed and was always hazardous. In either case, design immunity will not protect the government in perpetuity. The government cannot ignore a record of accidents on a bicycle route evidencing that it is hazardous in actual operation. Once the government has notice that a hazardous condition exists, it must take reasonable steps to alleviate it.

Just what is the government required to do to alleviate the hazard? The courts are unlikely to find the agency negligent for failing to renovate or reconstruct the bicycle route. That kind of action would invariably involve a high-level policy decision, a discretionary function. What the courts will often require is corrective action of the type which can be undertaken at the operational level, the kind of work which can done by the maintenance department. The primary obligation would be to give warning of the hazardous condition to persons using the route.

All of this suggests that there certainly is potential liability associated with bicycle routes, especially in the area of maintenance operations. Is this potential liability the same as the existing potential liability to bicycles operating on the highway? Does the government's responsibility for maintenance and hazard removal increase when a facility is designated as a bicycle route? Is the government more likely to be found liable for an injury which occurs on a designated bicycle route than for the same occurrence on a non-designated facility?

We believe there is no significant increase in liability associated with bicycle route designation. That is, assuming we have two highways, one including a designated bicycle route, and the other without a designated bicycle route, with both carrying

the same amount of bicycle traffic and all other factors being equal, the potential liability of the government, and the maintenance responsibility, would be the same for both highways.

The question with respect to maintenance responsibility should be viewed from both a practical and a legal perspective. We noted earlier that bicycles have greater susceptibility than other vehicles to certain roadway conditions. That fact should receive consideration in maintenance operations on any highway which carries bicycle traffic, and certainly on any designated bicycle route. From a practical viewpoint, that is probably more likely to be done on bicycle routes than on non-designated highways, even those which carry a significant volume of bicycle traffic. If that is true, some people might conclude that designating a bicycle route results in increased maintenance responsibility. A more correct conclusion in that case would be that current maintenance practices on facilities which are not specifically designated for bicycles are inadequate, exposing the government to unnecessary risk of liability.

From a legal perspective, maintenance responsibility on a bicycle route is the same as on any highway carrying similar bicycle traffic. The primary legal impact of designating a bicycle route lies with its potential for focusing bicycle traffic to a particular location. The duty of the government to maintain the way in reasonably safe condition for bicycle traffic is somewhat greater where bicycle traffic can be anticipated. Certainly that would be true for a bicycle route. It may, however, be equally true for any other highway carrying bicycle traffic even though it is not a designated facility.

With respect to the overall liability question, there are factors involved with bicycle route designation which appear to increase potential liability, but there are other factors which appear to decrease it. The perception that designated routes have been designated because they are safer than other routes, and the fact that bicycle routes may invite and encourage bicycle use, are factors which may add to liability. On the other hand, risk of liability can be more easily controlled on bicycle routes than on the highway system as a whole. When appropriate route-selection criteria are used and care is taken to eliminate bicycle hazards on the route, the risk of liability can be significantly reduced. Further, designation of a bicycle route can result in some diminished responsibility for adjacent

roadways because of the reasonable expectation that bicycle traffic will use a safe and well-maintained bicycle route in lieu of the adjacent roadway which carries mixed traffic. On balance, designation of bicycle routes may have more potential for decreasing than for increasing liability.

The number of reported judicial opinions relating to government liability for bicycle route injuries is very small. In one case, the front wheel of the bicycle dropped into a drainage grate in the curb lane of a roadway which had been designated as a bicycle path. The trial court held that the bicyclist was contributorily negligent in failing to see the grate and avoid it. The appeals court reversed and remanded for a new trial, noting that the bicyclist had no reason to expect a hazardous grate on the roadway, particularly since the city had designated the area in question as a bicycle path and had even erected a sign so stating in very close proximity to the sewer grate. The court held that it was a jury question whether or not the bicyclist should have seen the dangerous grate, recognized the danger, and avoided it. In several other cases the courts have noted in their decisions that the roadway on which the bicyclist was injured was not designated as a bicycle route. The fact was unimportant in the resolution of each case, but such comments could be interpreted to mean that the judges would have considered such a designation significant had there been one.

What is the impact of this Handbook, and of the various laws, regulations, guidelines, and standards relating to bicycle routes, on the government's potential liability? The impact of such documents can be very significant, either as a positive or a negative factor. They are often admissible in court as evidence of the standard of conduct which should be applied to the government entity in the design, construction, operation, or maintenance of highways and bicycle routes.

If the government entity has complied with the requirements and recommendations established in these documents, that will be strong evidence that the government has met the required standard of conduct and is not negligent. The opposite will be true if the government has failed to comply with the requirements and recommendations. Obviously it is important for each agency to identify all relevant documents of this type, to assess which are important to that particular agency, and to assure that compliance is maintained.

There are a number of state and federal laws which specify a standard or require development of a standard for the design and construction of bicycle routes. Compliance with all applicable laws and regulations is obviously very important. Laws and regulations with mandatory provisions can serve as a basis for a finding of negligence per se if the mandate has been violated.

One of the most important documents to consider is the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD has been adopted as a national standard by the federal government. It has some legal status in every state, and has been adopted by statute or regulation as the state standard in many states. The MUTCD contains a chapter dealing with traffic controls for bicycle facilities. It contains extensive provisions regarding signs, markings, and signals used on bicycle facilities. Although most of the provisions are not mandatory, a few are.

There are also a number of safety codes, guidelines, or standards which have been developed by private organizations or by government agencies. This Handbook is one example. These documents lack legal status, but can provide evidence of the standard of conduct which should be required in any particular case.

What can the government entity do to reduce the potential liability related to bicycle route designation? The single most important step which any government entity can take to reduce potential liability is to reduce accidents. The primary goal should not be to avoid liability but to control the risk of injury to highway users.

The transportation system should provide for the safe and efficient movement of a variety of different personal mobility options, including bicycles and automobiles, among others. Where that system fails and a user is injured as a result, compensation should be provided. Reform in the legal system in the past few decades has moved in the direction of breaking down barriers to the compensation of the injured. One result of that reform is that government entities are encountering an ever increasing problem with liability. It will be most unfortunate if undue fear of governmental liability impedes desirable progress in the transportation system.

Some liability will be encountered. Proper insurance coverage or budgeting for self-insurance to cover potential liability will do much to alleviate undue concern. A competent risk management program will help to assure that the government entity is doing all that it can to be responsible stewards of the public treasury. The following are some specific suggestions for managing the liability risk associated with bicycle routes:

1. It is very important that route selection and bicycle route design conform to acceptable standards. Careful compliance with applicable laws, regulations, route selection criteria, and design standards should greatly reduce the risk of injury to bicyclists using the route, and thus also the risk of liability. Compliance with such standards also provides strong evidence that the agency used reasonable care. Even if a particular city or state government agency is not required to comply with any particular standards, that agency should identify the best prevailing standards and comply with them.

2. Maintenance operations should also conform to acceptable standards. The maintenance department should have written procedures to follow in maintaining all highways in reasonably safe condition for bicycle traffic. Certain conditions are known to endanger bicycle traffic. It is very important that all such bicycle hazards be removed, especially from bicycle routes. The case discussed earlier in which a non-bicycle-safe drain grate was left in the curb lane of a roadway designated as a bicycle route represents an incredible lapse in risk management. If a hazard cannot be removed, it must be protected with barriers or, at least, clear warning signs must be installed.

3. The actual experience with bicycle traffic on all highways, and especially on bicycle routes, should be monitored. Even when the bicycle route design is absolutely in compliance with the best available standards, if the route is hazardous in actual operation, the government must take reasonable steps to alleviate the hazard. Regular inspections of bicycle routes by maintenance personnel trained to identify bicycle hazards should be made. All reports of hazardous conditions received from bicycle route users, police, or other government agencies should be thoroughly investigated. Reports of accidents involving bicycle traffic should be reviewed and the site investigated to determine whether a hazardous condition exists.

4. Written records of all of these activities should be made. The fact that the agency took appropriate action in response to a hazardous-condition report, or the fact that the maintenance department makes regular bicycle route inspections, will avail not at all unless the agency can prove it with a written record in court a decade or more later. Such written records must be more than informal notes kept by one or more agency employees. The records should be part of a formal record keeping structure designed to chronicle all of the agency's activities which may later be significant in a liability action. The records should be dated and signed by the person making the record and by an appropriate supervisor.

5. The agency should carefully avoid making statements that a designated bicycle route is "safe," or that it is "safer" than some non-designated route. We have already noted that there may be a pre-existing public perception that bicycle routes are designated because they are safer than other routes, and that this perception may increase potential liability. That perception should not be augmented by additional safety claims. We are aware of a number of bicycle route system maps which make this mistake. They contain statements that the routes were selected for bicyclist safety, or that use of the designated routes is recommended for safety. Some maps even classify routes for different cyclist skill levels. These maps are often produced by the agency which controls and maintains the bicycle routes. Statements such as these open the door to a different basis for liability claims, and introduce an element of risk which is difficult to quantify. Such statements should not be made.

With careful attention to risk management, we believe that designation of bicycle routes will not increase the potential liability of government entities. It is even feasible that a carefully implemented bicycle route program could reduce injuries to bicyclists on highways and actually result in an overall reduction in liability experience.

APPENDIX B

Controlled Access Freeway Shoulder Use Evaluation

Bicycle use on the shoulders of controlled access freeways tends to be a controversial subject despite the fact that such use has been permitted in some areas on certain facilities for more than 25 years. The controversy has centered around the concern of some members of the highway engineering community regarding the compatibility of bicycles and high speed traffic. The bicycling community has claimed that there is frequently greater separation from high speed traffic on the Interstate shoulder than there is on the alternative rural routes posted at the same speed.

As part of the study of bicycle route designation criteria, a review was made of the current practice regarding the use of freeway shoulders by bicyclists. The conclusions of this review are as follows:

- Many states currently permit bicycle use on all or part of their Interstate system.
- Although data are limited, there is no evidence to suggest that there are any unusual safety problems created by allowing bicyclists on freeway shoulders.
- The general basis for permitting use of the shoulders is the absence of an alternative route or when the alternative route(s) are likely more hazardous or less direct.
- There are two conditions which have typically initiated consideration of bicyclists' use of freeway shoulders:
    1. A request from cyclists.

2. A comprehensive review for freeway/Interstate facilities by the State Highway Administration.

- Objective procedures have been developed for assessing the relative safety/risk and directness of alternative routes.

The Arizona Department of Transportation has adopted a policy which essentially allows bicycle use on rural freeway shoulders unless a safer and reasonably convenient alternative exists. The Pima (Arizona) Association of Governments has developed a detailed procedure for assessing whether a specific alternative route is in fact safer or reasonably convenient. The approach expands on a model originally developed and used by the Colorado Department of Highways for a statewide assessment of their Interstate system. Although the Arizona procedure was developed to determine which sections of the freeway system should be closed to bicyclists because reasonable alternatives exist, it can equally well be used to determine which sections of a freeway system should be opened up to bicyclists because no reasonable alternative exists.

This procedure is summarized below and can be used as is, or adapted to reflect local conditions and values.

In order to actually apply the two important factors [safety and reasonable convenience] as criteria for evaluation, quantitative measures of both safety and reasonable convenience must be identified. Such measures need to be readily available and pertinent to bicycle safety and convenience. Research of current knowledge in these areas resulted in the following synthesis of pertinent measures into a systematic two level procedure for evaluating alternative routes. If an alternative to an Interstate route proves to be both safer and more reasonably convenient as a result of applying Level I of this systematic evaluation procedure, then a more extensive Level II investigation of that alternative route's safety and convenience for bicycle travel is warranted. If the evaluation so indicates, or if there is no alternate route, the Interstate route should be opened to serve bicycle travel needs.

LEVEL I

Methodology for Determination of Reasonable Convenience

Reasonable convenience to the bicyclist will vary depending on the distance of the trip involved. The material in the chart below was developed to provide standards for the extent of route diversion acceptable while still providing for reasonable convenience.

STANDARDS FOR ACCEPTABLE ROUTE DIVERSION

Interstate Trip Distance (mi)	Maximum Ratio of Alternate Route Distance Interstate Route Distance	Resultant Maximum Added Travel Time (min)
0 - 25	1.20	25
26 - 50	1.15	38
51 - 100	1.10	50
101 or more	1.05	varies

figured at 12 mi/h

It can be persuasively argued that people traveling by bicycle should be able to choose a travel route requiring the least travel time, as do motor vehicle operators. However, until more experience and data become available, and are analyzed, these standards can serve.

Methodology for Determination of Safety

According to work accomplished by the Colorado Department of Transportation there are a variety of measurable factors which directly influence highway safety for bicyclists. These include, in no particular order: sight distances, traffic mix, grades, conflicts with parked vehicles, lane width, traffic volume, miscellaneous hazards, (e.g., cattleguards), roadway and shoulder

surface condition, cross traffic, and traffic speed. Another factor which is valuable in assessing highway safety for bicyclists is the rate for accidents which involve single vehicles (Cross' study found the 37.8 percent of all fatalities experienced by bicyclists occurred when an overtaking motorist struck the bicyclist from the rear--mostly on rural roads.) The single vehicle accident rate is the most effective quantitative indicator of how frequently drivers using a specific road tend to stray off the road, whether due to environmental or operator characteristics.

Of the eleven factors identified above, the following are usually available for all Interstate highways, as well as for virtually all potential alternate routes: traffic volume, speed, roadway (including paved shoulder), lane width, and daytime single vehicle accident rate. Values derived from them can provide simple, quick, and sound alternative route bicyclist safety evaluations. The three specific measures to be used include:

- o Daytime single vehicle accident rate.
- o Traffic volume per lane vs. roadway lane width.
- o Traffic speed vs. roadway lane width.

Direct comparison of the Interstate segment being considered with the identified alternate route(s) can take place, using the quantification of these three measures, as described below.

Daytime Single Vehicle Accident Rate: Either available, or computable from available accident data. Expressed as the number of accidents per aggregate of distance of travel (i.e., 5.3 per 1,000,000 vehicle miles of travel). The route with the lowest rate would receive 0 points and the route with the highest rate 5 points. Any route between these two extremes would receive a proportional number of points based on its relative rate.

Traffic Volume Per Lane vs. Roadway Lane Width: Each route being evaluated would receive a point score based on the chart shown in Figure 1.

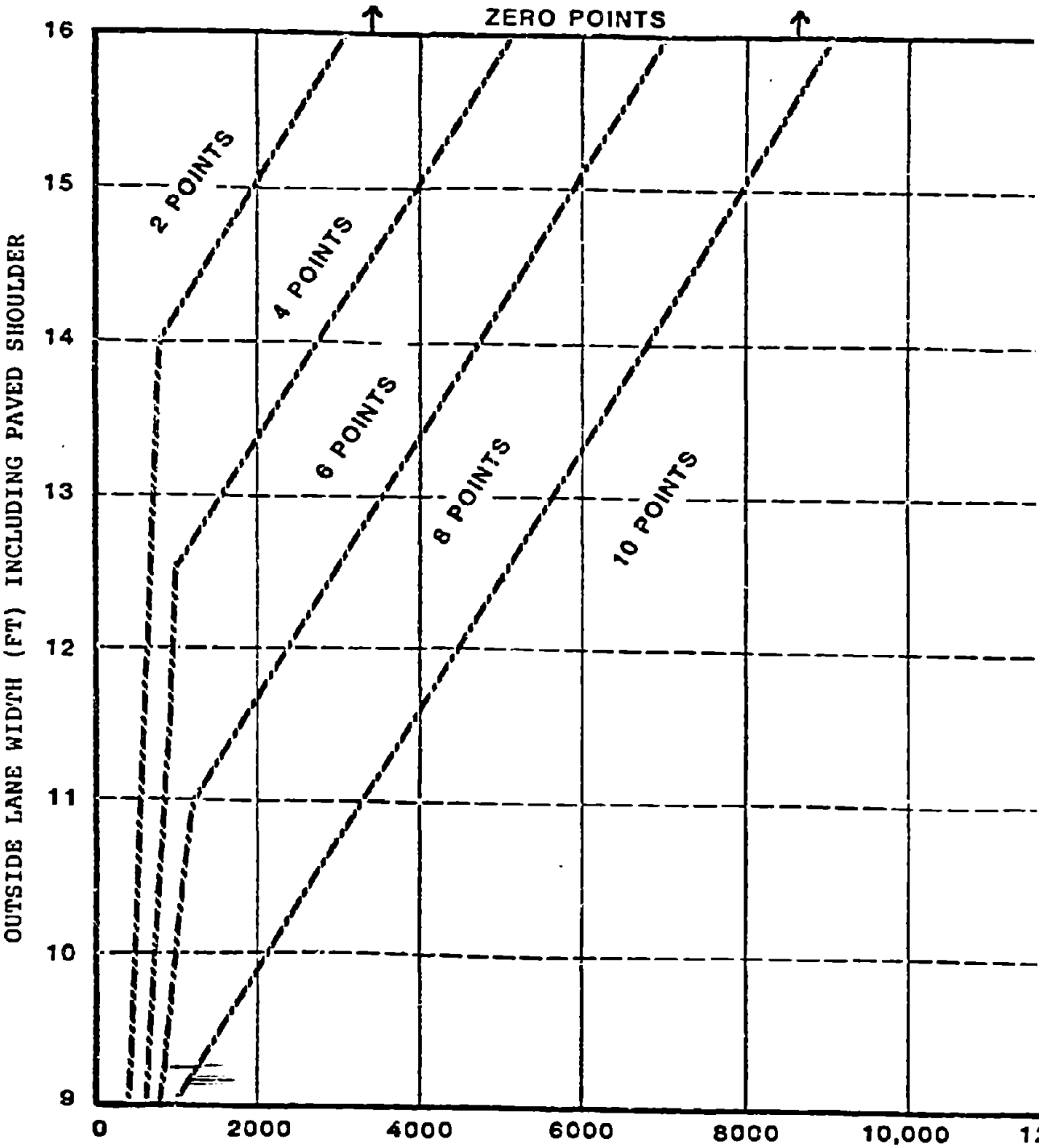

FIGURE 1. TRAFFIC VOLUME PER LANE VS. ROADWAY WIDTH

Traffic Speed vs. Roadway Lane Width: Each route being evaluated would receive a point score based on the chart shown in Figure 2. The speed to be used would be the posted speed.

Composite Safety and Convenience Assessment: Each route being considered will have a composite Safety Score, as a result of the above analysis, and a reasonable convenience determination. An alternate route will warrant a more detailed evaluation if two conditions are met: (1) the route is safer, based on its point score; and (2) the route's distance does not exceed the distance allowed as a result of applying the Standards for Acceptable Route Diversion.

LEVEL II

If the alternate route warrants further evaluation, such evaluation should include, in addition to the measures already used, those listed below. In each case, the points are assigned to the route as a whole, not on a per mile or similar basis.

Roadway or Shoulder Surface 0 to 10 points

Surface condition of the roadway is important to bicyclists. A continuous, smooth asphalt surface is the most desirable and would rate a "0." Asphalt or concrete with cracking or raised seams which would cause an uncomfortable ride would rate 4 to 6 points. Severe cracking, numerous potholes, and conditions which could cause damage to the wheels of the bike, or cause the bicyclist to swerve excessively or to lose control of the bicycle, would rate 9 or 10 points. Freeway shoulder rumble grooves which run contiguous to the shoulder edge would rate 6 to 8 points, grooves filled partially for bicycles would rate 2 to 4 points, and grooves installed according to a "bikeable" design would rate 0.

Potential Conflicts with Parked Cars 0 to 5 points

These conflicts will typically be found in towns or cities. If there is no parking, or where parking is not

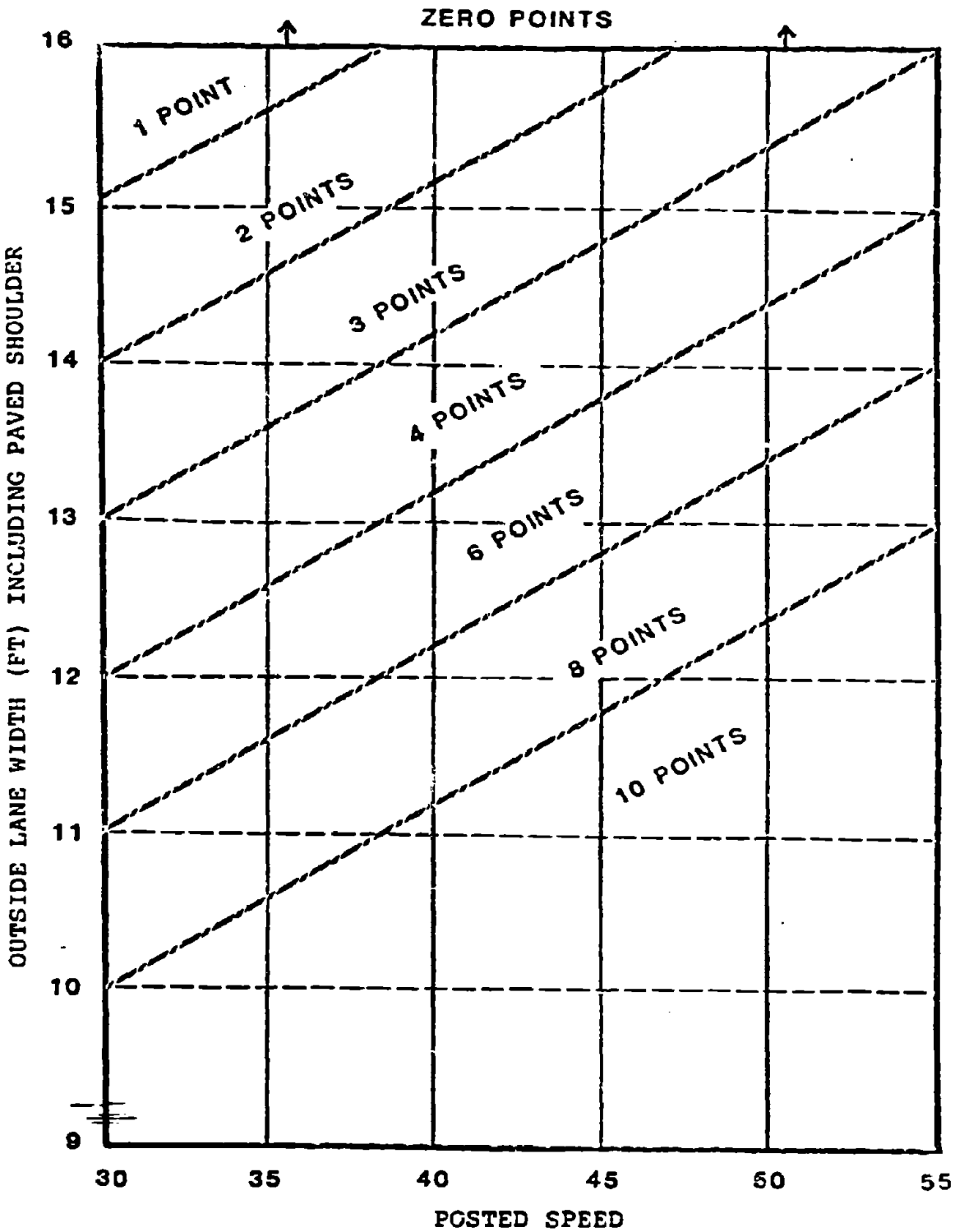

FIGURE 2. TRAFFIC SPEED VS. ROADWAY LANE WIDTH

a potential hazard, score 0. If there is parallel parking, score 2.5 points; score 5 points for diagonal parking.

Grades 0 to 5 points

Grades may be a source of problems. Score as indicated on Figure 3. If grades are unknown, estimate them.

Sight Distance 0 to 5 points

Score 0 if sight distance is not a potential problem. Score up to 5 points, depending on the degree to which sight distance presents a problem.

Miscellaneous Roadway Hazards 0 to 5 points

Railroad crossings, cattle guards, drainage grates, and areas which have excessive loose gravel on the paved surface (normally found where a gravel road intersects a paved road). Identify the specific hazard and its location. Cattle guard score 5. Railroad crossing 3 to 5 depending on condition. Drainage grate, score 5; if bicycle proof, identify and score 0; if striped to indicate grate's presence, score 1. Loose gravel, score 3 to 5 points.

Traffic Mix 0 to 5 points

The percentage that trucks represent of the total average daily traffic (ADT). Less than 1 percent score 0 points, 1 to 5 percent score 1 point. 6 to 10 percent score 3 points, and over 10 percent score 5 points. Include Recreational Vehicles (including pickups with campers, cars pulling trailers) as trucks in your estimate. This will occur most frequently near camp grounds, points of interest, and recreational attractions.

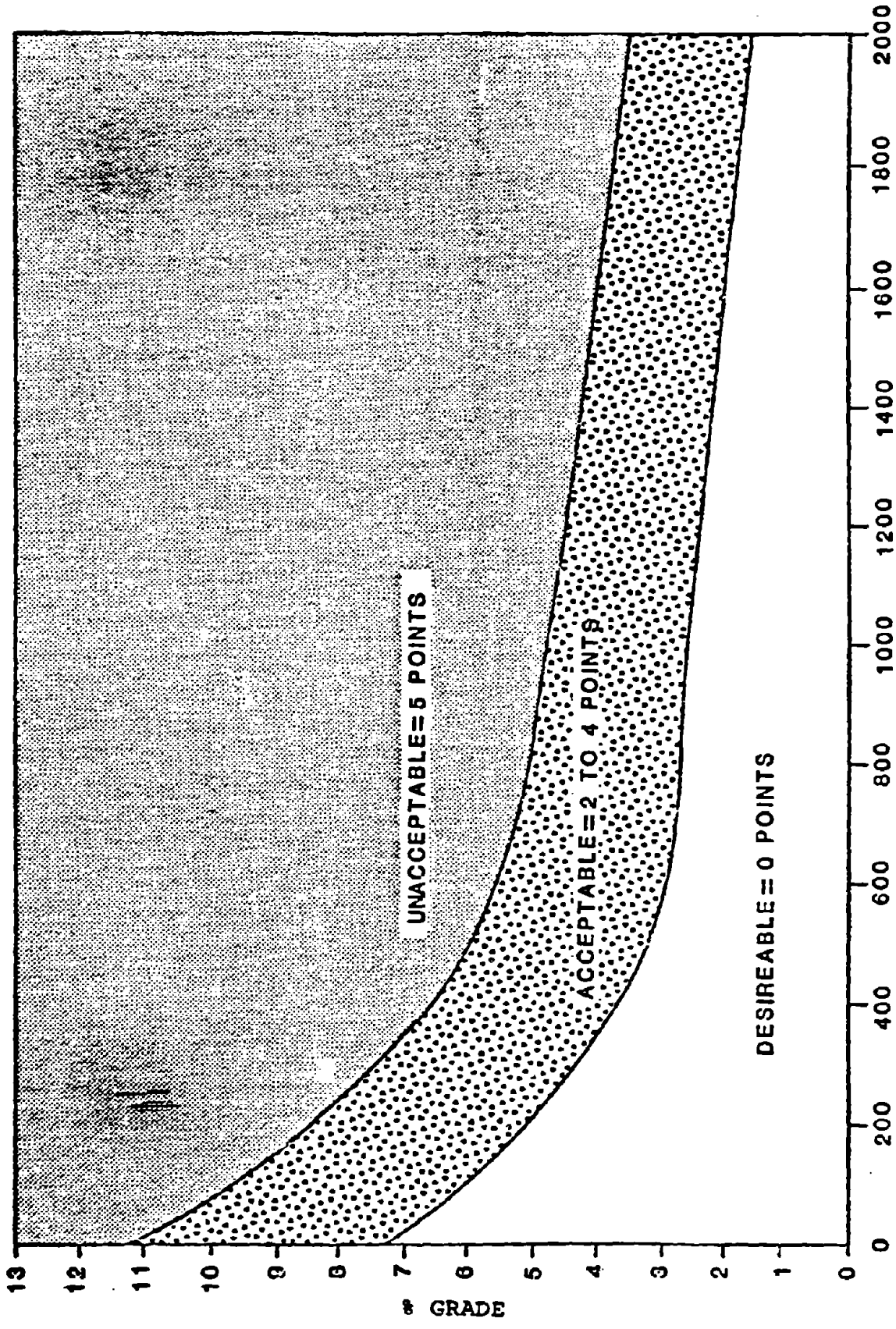

FIGURE 3. GRADE/DISTANCE BASED ON 6 MI/H SPEED
(Roadway grades and Bicyclist's Speed)

Potential Cross Traffic Conflicts 0 to 5 points

Assign an estimated point value to this potential safety hazard. This will result from an intersection with a high volume street, several intersecting streets, or a commercial area.

Secondary Composite Safety and Convenience Assessment: The same evaluation should then be applied to the Interstate segment. The point score can then be compared, with the route having the lowest point score being indicated as the most appropriate route for bicycle travel. If the two routes score within 5 points of each other, they should be considered equal, and the route with the shortest distance identified as the most appropriate route for bicycle travel.

If an Interstate segment has no parallel alternative route, then no evaluation is required. Such segments should be opened to bicycle travel without delay.

APPENDIX C

Mapping

[NOTE: The following presentation is a summarized version of reports on four workshops on bicycle mapping (Workshop nos. 35, 36, 37 and 38), presented at PRO BIKE 84: the Third International Conference on Bicycle Programs, held in Miami, Florida in December, 1984. The workshops were lead by Ms. Mary Meletiou and Ms. Melissa Marion, both of the North Carolina Department of Transportation, Bicycle Program. The workshop reports were prepared for the **Conference Proceedings.**]

Introduction

The proliferation of all types of maps for bicyclists in the last few years has created a vast resource for anyone who is considering the production or updating of a bicycle map. The first bike-boom bicycle maps were produced over 15 years ago. Since that time, the art of mapping for bicyclists has evolved. At first, map users were pleased to have any type of specialized map showing bicycle route information. Users were not very critical or demanding. Now that the bicycle has become an established mode of transportation for millions of people, and a regular form of adult recreation, there is a great demand for good, high-quality maps to guide the commuter, weekend cyclist and long-distance tourist.

Mapping for bicycles is not a new idea. Turn-of-the-century cyclists were responsible for some of the earliest road maps produced in this country. Some of these maps were very sophisticated, indicating the condition of roads, steepness of hills and noting locations of services.

In more recent years, a variety of creative ideas have been applied to the presentation of bicycle-oriented road information. A thorough evaluation of the existing bicycle maps will provide the prospective map-maker with a wealth of information on the

"do's and don'ts" of bicycling cartography. Almost all maps can be improved in some way. Some of the earlier maps (such as Bikecentennials's) have undergone extensive revisions in format and provide a useful study in the evolution of bicycle maps.

Map Users

The majority of current bicycle maps are designed for adults. The complexity of many of these maps implies that the bicyclist is also expected to be a sophisticated map reader. This implicit assumption should be questioned by project coordinators and map designers -- many other adults and children may also be potential map users but with a very different set of map reading skills and needs.

Types of Maps

Bicycle maps exist in a variety of forms to serve the needs of the various types of bicycle users. Some maps outline short, recreational loop rides. Others describe the bike route system of a locality. Still others offer information to bicycle commuters on the most direct routes to various employment centers. Many maps define a particular long-distance touring route, showing additional information such as availability of services and points of interest along the route. Some maps indicate the suitability for bicycling (shared use) of some or all of the streets and highways in a given urban or rural highway system. Defining the function of the map and identifying the primary user group for whom it is intended will help to determine the type of map which should be produced.

Bicycle maps are typically one of two types: route or suitability. Route maps show just a few preferred travel streets connecting key points within the city, or designated bike routes. Suitability maps usually involve a complete street rating system where all (or most) streets are rated and coded for their "bicycling suitability."

A suitability map generally covers a large area (an entire state, a region, or an individual county or city) and attempts to rank the roads throughout that area as to suitability for bicycling. Collected information is generally shown on a large base map,

using several different colors or various screenings of the same color to highlight the different categories of rated roads.

Route maps show one or more routes in an area, using a strip map or single sheet format. This type of map can be used to show routes ranging from local loop rides of five to ten miles (8 - 16 km) to interstate routes of 3,000 miles (4,800 km) or more. Strip maps are usually used for long point-to-point routes. Loop routes are usually shown in their entirety on one sheet of paper, which varies in size relative to the overall distance of the route and the scale which is used. The level of detail shown on the existing route maps varies greatly. At one level is the simple schematic map which shows road numbers. At the other extreme is the full color, highly detailed map which shows a complete road network, geographic features and points of interest and includes extensive information on conditions and services along the route.

There are advantages and disadvantages to either approach. A route map often doesn't start or end in a convenient place for the rider, although many people are willing to transport themselves and their bicycles to a given starting point in order to ride on an established route. A suitability map, on the other hand, offers many more choices for trip start/end points and in this way serves the needs of a larger number of riders.

Usually more information on services, point of interest, terrain and roadway conditions is offered on route maps, making this type of map attractive to new or inexperienced bicyclists as well as to experienced bicyclists traveling in an unfamiliar area. The more frequent rider often does not need this level of information and will prefer the variety of route options offered by a suitability map.

Some maps attempt to combine both approaches and incorporate the strengths of each without their associated drawbacks -- route maps are easier for users to interpret and easier/cheaper to produce, while suitability maps allow more flexibility for bicyclists to select individualized travel paths. Another slightly different approach is exemplified in the Missoula, Montana bicycle map. Streets are coded for a range of roadway factors, but they are <u>not</u> presented as "more' or "less" suitable

for bicyclists. Rather, the categories are described in detail in the legend and the individual bicyclist is allowed to decide the suitability of a given roadway based on his/her skill and ability.

Collection and Analysis of Street Information

For either route or suitability maps, it is necessary to gather and analyze street information, which may be primarily subjective or objective in nature. Volunteers (trained or untrained) who ride city streets and rate them according to perceived suitability typically provide the more subjective type of data base (which is then used to establish routes or street ratings). Alternatively, many maps are based on objective roadway assessments which use data collected from existing records or on-road measurements.

Some maps are based almost entirely on user perceptions, while others are based solely on physical roadway characteristics. In a few cases, computer-assisted rating systems have been employed, and some of these systems attempt to combine and weight subjective perceptions and objective measurements.

Map Format

The two basic formats used for bicycle maps are strip-maps and fold-out maps. Each has its advantages and disadvantages. For small-scale mapping projects, a 10 - 15 mile (16 - 24 km) recreational loop, for example, choosing the format is simple. This type of map is almost always printed on an 8.5 x 11 inch (22 x 28 cm) or 8.5 x 14 inch (22 x 36 cm) sheet of folded paper. Maps showing city-wide bicycle route systems are generally presented in a large fold-out format (designed to fit standard cut paper sizes for cost breaks), as are most commuter-oriented city bicycle maps.

Touring maps come in both varieties and even in a combination of the two. The earliest touring maps were produced in the strip-map format, usually measuring 8 x 4.5 inch (22 x 11 cm) to fit in the map packet of a handlebar bag, with a scale of 1 inch=4 miles (1:250,000). Later, touring maps showing a variety of routes through an area were developed, making use of the larger fold-out

format. More recently, maps have been developed in the strip-m format, with a series of segments printed in sequence on a larg fold-out brochure. This approach allows the user to fold the brochure to show various segments, maintaining the compactness information possible with strip-maps, without the problem of having to keep track of numerous pieces of paper on which the separate segments are printed. Suitability maps are almost always printed as a large fold-out map, sometimes requiring more than one sheet of paper.

Map Content

Readability is a very important feature of any map. The clarity of the information presented depends on two things: the overall map design and its careful execution; and maintaining a balance between level of detail shown and creating a cluttered map by trying to show too much information.

The purpose of the map and the needs of the potential users will help to dictate the information which should be shown and the manner in which it is presented. It is useful to review existin maps for ideas and insights into what will and will not work. I is also important to remember that certain information has more relevance in some environments that others. For example, in hilly or mountainous country, information on frequency and steepness of climbs is much more important than in an area with unvarying terrain.

While map content may vary a great deal, there are a few items which should be included on every map:

- title and the words "Bike Map" displayed prominently on the cover (oddly enough, many bicycle maps give no clue as to what they really are on the outside cover),
- legend, scale of miles (or kilometers) and north arrow,
- date of publication and the name and address of the map producer,
- locational map, showing how the area covered by the map relates to the larger area such as city, county, or

State (more important for touring maps where users may not be familiar with the territory and thus require a point of reference),

- o description of how to use the map, fully describing any suitability rating system which is used, and

- o a section on traffic laws and safety information; also a "qualifying" statement regarding who the map is intended to serve (level of cyclists skill assumed), and a disclaimer noting explicitly that the map producers make no claims regarding the absolute "safety" of cycling on any street or highway -- there is always some risk associated with cycling.

Map Design

A number of design features must be considered in planning a bicycle map. One important aspect is to determine the potential limitations -- size, number of colors, manner of folding, etc. -- imposed by the capabilities of the printer who is to be used. Overall design usually evolves as a compromise between cost of various features and the relative importance of each feature. For example, cost of multi-color printing may reduce the amount of money available to print a map of a certain size or on a particular type of paper. Availability of an appropriate base map may free resources to be used to develop more complex informational overlays. Designing a map which requires the use of fewer color overlays could mean that a greater number of copies can be produced with existing funds. Developing maps for bicyclists is a complex process. It is a new field of cartography where few standards exist and innovations and new ideas are included in each new mapping project. Several hundred bicycle maps have been produced during the last ten years.

Map Production

A bicycle map is often the result of cooperation among several agencies and groups, each contributing a portion of needed funds and staff time. Many bike maps have been produced through an arrangement where municipal agencies donate staff time for project development while actual map production is funded by

outside sources including the Federal Highway Administration, Urban Mass Transportation Administration, and Environmental Protection Agency. Successful maps are usually produced under the direction of one or a small group of highly motivated individuals.

Based on an informal survey of approximately 50 urban bicycle mapping projects, nearly 70% were overseen by municipal or regional public agencies (e.g., planning departments, park and recreation programs, and traffic engineering divisions) while the remaining 30 % were most typically carried out by bicycle clubs, advocacy groups and nonprofit organizations. During the past ten years, Bikecentennial, Inc., "The Bicycle Travel Association," has researched and mapped over 15,000 miles (24,000 km) of bicycle routes throughout the United States.

In short, it is possible to undertake bicycle mapping projects with a wide range of potential public and private sources of support. A 1982 amendment to the Federal Surface Transportation Assistance Act explicitly permits use of 100% federal-aid funds for certain bicycle-related projects, including mapping. Whatever the funding source, nearly all map project coordinators report that the amount of effort involved in producing a high quality map is substantial (i.e., greater than originally anticipated), and that the careful coordination of all involved agencies and volunteer groups is essential.

Finally, in any discussion of costs the question of charging the user for the product arises. There are two distinct points of view. Some people believe that a nominal amount, $1 - $3, should be charged for the map to help defray the costs of production, revision and reprinting. Others believe that free distribution of maps gets the maps into the hands of users who might not otherwise realize the opportunities for bicycling in their locality. ~~Both~~ points of view are valid.

Additional Information

Bicycle Federation of America, Inc.
1818 R Street, NW, Washington, DC 20009

- organizes the PRO BIKE conferences and publishes the **Proceedings** (80, 82, and 84) each of which include several reports on mapping.

- publishes **PRO BIKE NEWS**, a monthly newsletter which regularly reports on the publication of new maps.

Bicycle Forum, Inc.
P O Box 8311, Missoula, MT 59807

- publishes **BICYCLE FORUM**, a journal on bicycle programs, which has featured many articles on bicycle maps, and mapping techniques.

Bikecentennial, Inc.
P O Box 8308, Missoula, MT 59807

- researches and publishes maps of bicycle touring routes throughout the U.S.

- publishes the **Cyclist's Yellow Pages**, a resource guide of touring information which lists map available for all areas of the country, and **BikeReport**, a monthly magazine which frequently features articles and news on bicycle mapping.

- operates a "bookstore" which stocks for sale many of these maps.

Bicycle USA/~~The~~ League of American Wheelmen
Suite 209, 6707 Whitestone Road, Baltimore, MD 21207

- publishes **BICYCLE USA**, a "monthly" (nine times/year) magazine which frequently features articles and news on bicycle mapping.

- maintains a listing of bicycle maps.