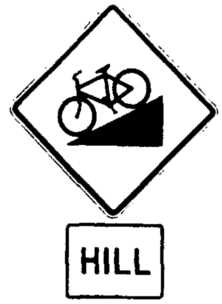
JULY, 1974



THE GUIDELINES AND CRITERIA FOR BIKEWAY AND BIKEPATH NETWORK PLANNING IN METROPOLITAN CENTERS

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK
NORTH CAROLINA, 27711

CONTRACT: 4-02-04395

BY

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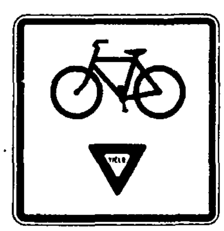

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Land Use Planning Branch
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EPA Project Officer: Lewis D. Tamny

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE

As part of the effort to implement transportation control strategies for the improvement of air quality, these Guidelines have been developed to assist persons engaged in planning and in establishing exclusive bicycle lanes outside the usual roadway right-of-way (ROW); and of bicycle parking and security measures which will instill confidence on the part of the bicycling public.

A separate document of Guidelines and Criteria for planning bikeways and bikepaths within existing roadway right-of-ways will be undertaken in response to public and regional demand.

1.2 CONTENT

These Guidelines include physical design criteria for exclusive bicycle lanes, environmental assessment considerations, rules of the road for motorists or bicyclists where exclusive bicycle lanes cross or intersect with established motor vehicle roadways, or with other publicly used trails or lanes outside roadway ROW.

Principally addressed by these Guidelines is the development of bicycle facilities in a metropolitan milieu with emphasis on the access to and egress from the Central Business District (CBD) and of adequate, secure parking.

Although these Guidelines address various bicycle transportation alignments outside the usual roadway ROW, one option is presented wherein a bikeway parallels a public road ROW and thus may be considered a useful guide for planning a bicycle lane within such a ROW.

The technical criteria, methods and procedures represent a synthesis and a distillation of applicable bicycle facility planning experiences in the United States and in foreign countries.

CHAPTER 2

DETERMINATION OF NEEDS

2.1 EXISTING AND POTENTIAL BICYCLE COMMUTATION

The first and fundamental values to determine quantitatively are: (1) how many residents of the region do now use bicycles to travel between their homes and frequent destinations (called generator points) for all or for part of the transits, at what times of day, how often, and along what routes of travel; and (2) how many additional residents now using other modes of transportation would use a bicycle for all or part of these transits if safe and convenient bikeways were made available.

These determinations should be established through accurate survey methodology by which broad and representative population samples will identify the actual and the probable bicycle users, their characteristics and their desired lines of travel. The projected volume of use along identified desired lines of travel should be interpreted logically and useably by establishing desire lines which penetrate completely from collector areas to a generator point.

The latter may be a high employment point, a popular shopping point, a campus or any other likely place. The desire line and the proposed penetrating alignment should be compatible, with the desire line having been developed from user surveys and the penetrator lines having been established from subsequent planning.

2.1.1 SURVEYS

2.1.1.1 Cordon Counts

Traffic engineering personnel should, when existing bicycle use so justifies, establish cordon counts to inventory actual bicycle usage into and out of the CBD and other target zones of interest. Cordon counts are only useful for determining existing volumes on an hourly basis. An additional effort to the numerical count could provide origin and destination data, and depending on the additional methodology employed, could provide user characteristics. The cordon count will give the existing relationship of bicycle use to other transportation modes used. There is insufficient experience and data to permit extrapolation of cordon count values to predict volumes of bicycle use after improvements are made.

For epidemiological purposes, the probable rate of occurence of individuals stating they are now commuting bicyclists is less than 5% in most areas of the United States. A well known exception is Davis, California with 31% which matches the actual use of bicycles on arterial streets in some major European cities, such as Copenhagen.

2.1.1.2 Surveying at the Generator Points

For comprehensive planning purposes, reactive data collected through surveys at generator points will usually provide the most valuable information on both actual and probable bicyclists, their characteristics, the desire lines of travel and other useful origin and destination data. Employers and building managers will have an interest in the administration of such surveys because of the possible employee benefits and improvements in traffic circulation.

Some generator points present a different evaluation process. A good example is a popular tourist generator point. When existing facilities already exist for bicycle use and for bicycle parking, - and the fact is or will be made known to tourists, slightly under 4% of the visiting motor vehicles can be estimated to carry bicycles on racks for use at the destination.

Prior experience has demonstrated that bicycle commutation is more common when penetrator distances are reasonable, where the bikeway grades are tolerable, and if secure bicycle storage or parking is available. In order to obtain the most accurate estimates possible for potential bicycle usage, and thus of the required facilities, the survey should be carefully framed to obtain realistic values from the survey respondents. In projecting demands for utility bikeways the planner should maintain a growth factor consistent with local demographic tendencies and land use plans.

2.1.1.3 User Group Surveys

Active bicycling groups or clubs can provide more expert advice on existing needs and deficiencies than can the general population. The survey design should reflect (1) the skewed nature of the population and (2) a much higher response rate. For epidemiological purposes, individuals in this category occur 2% or less and their likelihood of bicycling thirty miles or more in a week is 50%. For technical operating data, i.e. specific impediments or hazardous conditions, this group will provide the most valuable information.

2.1.2 OTHER PERTINENT DATA SOURCES

2.1.2.1 Local Police and Motor Vehicle Departments

The planner should avail himself of police and motor vehicle statistics on injuries arising from motor vehicle and bicycle conflicts. These statistics will provide situation data and will identify danger areas for bikeway alignments; and will indicate areas and corridors which can benefit from corrective design or which must or should be avoided; or may indicate justification for exclusive bikeway facilities.

Police also will be able to assist in planning secure parking areas and to determine financial or manpower implications for patrolling exclusive bikeways. In recent years, bicycle larceny has increased significantly, and the threat of the loss of a bicycle is known to be a deterrent to utility bicycling.

Therefore, a comprehensive bicycle plan must address the multijurisdictional problem faced by police in their attempt to reduce the incidence of bicycle theft and to increase their return-to-owner rate of recovered bicycles. Therefore, the plan should address at least two objectives: (1) regional agreement on registration and (2) a central file for reported stolen bicycles.

2.1.2.2 Local Planning

Zoning, land use and park experts can make significant contributions by identifying or designating land space for possible bikeway corridors and for projecting demographic and land use values. The comprehensive plan should incorporate these factors when establishing penetrator routes to accommodate desire lines of travel.

Park and Recreation planners have unique qualifications to assist in the regional plan since there are heavy demands on them for recreational bicycling. The combination of recreational and utilitarian justification for certain alignments should not be ignored. This follows from the fact that many CBD's are in riverine setting and tributary stream valleys are often designated parkland. Under appropriate environmental safeguards, this land may be usable for exclusive and safe bikeways.

Recreational bike trail alignments are rarely utility motivated and bike trail design criteria in parkland differs considerably from that of utility bikeways in similar settings. But, the multipurpose design can sometimes be effected through reasonable design compromises, environmentally and economically. The differences should be quantified.

2.1.2.3 Legal Considerations

City attorneys or community solicitors should be involved early in the planning process. Many localities have existing regulations related to bicycle movement, rules of the road, authorized travel areas, prohibited areas and some form of bicycle registration.

Many such regulations were enacted when the use and design of bicycles were significantly different than the situation today. While the evolution of new traffic control warrants for utility bicycling is fluid, the distinction between former and present use and design is quite apparent. For example, the design of some roadway intersections and the legal constraints governing movement of bicycles make it impossible for bicyclists to negotiate some intersections safely or legally.

In case of a bicyclist approaching an intersection along a street with a right-turn-only lane he may be confronted with the following problems: (1) legally he may be confined to the right-turn-only lane (local ordinances often state that bicycles must be ridden only on the extreme right side of the roadway) and cannot either legally or safely cross motor vehicle lanes to make a left turn; (2) he will be in violation of law if he makes a left turn or proceeds straight through the intersection from the right-turn-only lane; and (3) even in making a right turn he will be in danger of colliding with a right-turning motor vehicle.

The traffic control warrants for solving this particular problem may take one or a combination of the following: (1) if bicycles will be allowed to turn left at the intersection they should be allowed to move to the left-turn (center lane) before arriving at the intersection or (2) be provided with and required to use an exclusive bike crossing lane adjacent to the pedestrian crosswalk (if such is present), in which case the left turn would be accomplished by two successive street crossings similar to the maneuvers of a pedestrian; (3) for bicycles proceeding straight through the intersection allow them to move to the through motor vehicle lane or alternatively cross the intersection in a bike crossing lane on the pedestrian signal phase, in which case the bicyclist would be subjected to danger of conflict with right-turning motor vehicles similar to that of pedestrians; (4) only special signal phases for bicycles could eliminate most conflicts in such intersection situations.

In many localities such engineering design changes as those suggested above are subject to state or local laws and to judicial precedence on questions of public liability where no specific statute covers all the obligations and rights of bicyclists in unique situations. Certain roadway ROW situations fall under Federal Law which prohibits bikeway alignments. In particular, the legal review will identify legal constraints and possible legal remedies both of which should be addressed in the planning.

2.2 INVENTORY OF EXISTING RESOURCES, CONDITIONS AND MOTIVES

2.2.1 Motives and Interests

The motivating forces behind comprehensive bikeway planning may differ from community to community. Generally, utility bicycle proponents may be health enthusiasts, environmentally concerned citizens, commuters exhausted by motor vehicle costs or from fuel shortages. Such user characteristics may be useful in the planning to determine general propensity to use a bicycle arising from socio-environmental settings of the demographic units under study.

Employers, for example, may want their employees to have an additional economical choice of mode of travel to the point of employment. The employer and the employee union will have a direct interest in any bicycle network plan involving parking facilities on one hand and the possibility of significant gains in employee spendable income reserves.

Retail business has a vital interest in the city core as well as in a suburban shopping area. The increased use of bicycling for some forms of shopping has been taking hold and retail groups are concerned about secure and convenient bicycle parking and handling in relation to other customers and to parcel pick-up areas.

2.2.2 Existing Resources and Conditions

The community should appropriately baseline the relevant existing facilities and resources to determine actual public use of facilities such as roadways, parklands, and parking facilities; and to determine which might be made available for bicycle lanes, trails, exclusive bikeways and other bicycling infrastructure.

2.2.3 Existing Transportation Network Conditions

Main arterials into the CBD should be evaluated and classified according to their intensity of motor vehicle use and to their legal or regulatory status. A classification such as that devised by the State of New Jersey is a particularly useful step in the planning process.

In New Jersey the state-controlled highway system was inventoried and classified as to acceptability for bicycle use into the following four classes: GREEN: conducive to safe riding, shoulder wide and in good condition, traffic volume very low; BLUE: caution when using, shoulder fair to good, traffic volumes could cause safety hazard; AMBER: extreme caution when using, shoulder in poor condition or less than six feet wide, traffic volumes would cause definite problem; RED: avoid, no shoulder, curbed, extensive parking, state or Federal highway with restrictions on bicycle use.

The intended classification should reveal which arterials are under excessive motor vehicle pressure and which, for reasons of volume or of speed, may be hazardous for bicycling. This determination is as valuable as the classification of suitable roadways to neatly ascertain, on a status quo basis, the inventory of available bikeway penetrators. Where there is an obvious gap between an important desire line and a lack of potential penetrators, an exclusive bikeway is indicated.

2.3 ESTABLISHING VOLUME/CAPACITY CRITERIA OF A BIKEWAY NETWORK

2.3.1 Limitations

Applicable traffic control warrants to identify criteria for establishing exclusive bikeways do not yet exist in the United States. Some such criteria does exist in a few foreign countries. In some cases, the criteria is unattainable in the very jurisdiction which established the values. Criteria is generally based on a certain number of bicyclists per hour or per day passing a measuring point, and of motor vehicles; the results of which provide additive combinations to determine the type, number and width of bicycle lanes or bikeways.

2.3.2 Volume Criteria on Exclusive Bikeways

Volume capacities should be reported or estimated as a function of number of lanes and of one-way or two-way traffic flow. Criteria and computations used in the Netherlands is representative of other foreign criteria, though somewhat more conservative. The Netherlands criteria is summarized as follows:

Traffic Direction	Number of Lanes	Effective Lane Width	Estimated Capacity Bicycles/hr.
One-way	1	3.2 ft.	1,700 - 2,000
One-way	2	3.2 ft.	3,400 - 4,000
Two-way	1	3.2 ft.	850 - 1,000
Two-way	3	3.2 ft.	1,700 - 2,000

2.3.4 Procedure

The network plan should quantify the expected differences in mix of transportation modes along a penetrator route on the basis of a safe bikeway design having been made available. The capacity of the bikeway, whether one or more lanes and either one or two-way, and its design should be rationalized on the basis of safe handling by an average utility bicyclist at the time of peak capacity.

CHAPTER 3

BIKEWAY CONSTRUCTION

3.1 GENERAL

Five particular task studies should be undertaken prior to the selection of final penetrator alignments:

(a) The probable size and geographical extent of the bicycling infrastructure.

(b) The desire lines from collector areas to generator points or zones.

(c) Present and projected bicycle use for each desire line or corridor.

(d) The locations of significant generator points and numbers of commuters and modes of commutation associated with each.

(e) Available locations for parking and/or intermodal transfer points.

The results of these studies will enable the planner to align the penetrators either within or outside of ROW, and to determine the exclusive bike lanes that are needed and their infrastructure. Where utility bicycling can not be safely or efficiently located in a ROW, the alternative alignments outside the ROW should be found to accommodate utility bicyclists.

3.1.1 Suitable Exclusive Bikeway Sites

3.1.1.1 Parklands

Some parklands are often ideal locations for bikeways, primarily for recreational bicycling but increasingly for utility bicycling as well. For utility use, linear parkland is the most advantageous, although any parcel of parkland may be usable if it falls along the desired penetrator route.

Parklands often provide the safest bikeway routes but in some instances have the extra corresponding protection of environmental regulations. In some instances the adverse impact caused by bikeway construction could be unacceptable (23 U.S.C. 138: 42 U.S.C. 4331 (b)). In many cases the potential adverse impacts can be reduced to an acceptable level through the application of suitable design and construction criteria and performance stipulations. While these might increase construction costs, the total cost of implementing a bikeway network may be less than if other alternatives are used.

These cautionary considerations are not meant to steer planners away from parklands as sites for exclusive bikeways. They are intended to highlight the judgment factors to be considered. Because parkland characteristics are so variable, some parkland may be unsuitable for bikeways because the adverse environmental impact will be unacceptable and some may be unsuitable for other reasons, such as adverse topography over which it would be prohibitively expensive to build bikeways.

3.1.1.2 Utility Corridors

Utility corridors have the advantages of being cleared linear spaces connecting suburban power, sewer and water treatment plants with cities. Gravity sewer routes are usually free of steep grades; but often have the disadvantages associated with numerous stream crossings, being discontinuous at road crossings, and often traversing poorly drained land. Water and sewer lines are often publicly owned while other transmission facilities such as gas, petroleum, telephone and power, might be publicly or commercially owned.

Utility rights-of-way are often only easements across numerous parcels of private property and any agency proposing to use such a right-of-way for a public bikeway would have to negotiate new and specific easements with each of the landowners, as well as with the utility company, for use of the right-of-way; and assume liability for the operation of the bikeway as a public facility. If the right-of-way is owned outright by the utility or if the utility is publicly owned, easements and assumptions of liability might be more easily negotiated.

3.1.1.3 Abandoned Railroads

In recent years much railroad ROW has been abandoned. A major portion of which is in rural areas. A railroad ROW offers the advantage of direct routings penetrating into an urban core, easy gradients, a stabilized roadbed and the opportunity to construct bikeways without creating new adverse environmental impacts. Building a bikeway within the ROW of an operating railroad is often not feasible for reasons of safety and liability. Even a seldom used siding ROW may be unsuitable for the same reasons unless satisfactory technical and safety features can be established.

3.1.1.4 Canal Banks, Floodways and Levees

These areas are usually publicly owned or are covered by publicly owned easements. They are often contiguous to or part of parkland areas. Paved floodways in urban settings make suitable sites for utility bikeways if flooding is infrequent and the routing matches a needed penetrator corridor.

Flash flooding can be a serious hazard for floodways and provision should be made, in appropriate cases, for: (1) flood warnings, (2) emergency exiting from depressed floodways, and (3) rapid and effective bikeway closure during a flood warning or flood alert. These alignments offer nearly level routes except for short, steep bank ascents and descents.

Where a motor vehicle road already exists on a canal bank or levee, a bikeway paralleling this road might be preferable to paralleling other roads, as routes would have few steep grades and usually fewer intersections with roads and streets. Displacement of, and conflict with motor vehicles would be low or nil for a floodway which passes under intersecting roadways. This important advantage should be weighed against available overhead clearances and local flooding hazard history.

3.1.1.5 Shores of Lakes and of Reservoirs

The shores of natural and man-made lakes or reservoirs are suitable for exclusive bikeways when they: (1) are relatively undeveloped and publicly owned, (2) are watershed which can accept the impact of bikeway construction, and (3) provide routes that have continuity of a penetrator route without being excessively circuitous.

The last criterion is usually the most limiting factor for utility alignments. If the body of water is within a stream valley park it will be protected by the same environmental safeguards as other parkland routes.

3.1.1.6 Maintenance Roads

Seldom used maintenance roads often lead to power and sewage treatment plants or parallel public utility and transmission lines. If publicly owned or covered by publicly owned easements through private property, bikeways can often be accommodated with minor changes in existing arrangements regarding easements or liability.

3.1.1.7 Easements Through Private Property

Easements can be most readily obtained in areas of new development or of urban renewal and new land use where bikeway plans and easements can be required through local ordinance. For example, Fairfax County, Virginia, has amended the County Subdivision Control Ordinance (Chapter 23 of the County Code) by adding the following to Section 23-2(i):

> "In addition trails or walkways shall be constructed by the developer in accordance with the general locations shown on adopted comprehensive plans together with such other connecting trails or walkways within the subdivision. When such trails or walkways are to be constructed, fee title or easements shall be conveyed to the Fairfax County Board of Supervisors, Fairfax County Park Authority, Northern Virginia Regional Park Authority, or a Homeowners Association, as deemed appropriate by the Director. The final location and design of trails or walkways is to be determined by the Director after review by the Fairfax County Park Authority and/or the Northern Virginia Regional Park Authority..."

3.1.1.8 Purchase of Private Land

The fee simple purchase of land for exclusive bikeways may sometimes be economically prohibitive in the CBD or in some high land value zones but may be the only reasonable link or method to complete an otherwise reasonable penetrator route.

3.1.1.9 Other Public Lands

Relatively few communities have public forests, military reservations, research stations, and other public facilities or land which are either extensive or close enough to the CBD to provide potential and usable bikeway routing. Public school lands are most adaptable when contiguous to other public lands such as parks. They are often discontinuous, however, and sometimes present particularly sensitive security problems to school administrators.

While all bikeway network planning requires that adequate safety and security provisions be incorporated, the planner should meet the security requirements peculiar to school administration when alignments through or next to school land is under consideration.

CHAPTER 4

BIKEWAY DESIGN CRITERIA

4.1 GENERAL CONSIDERATIONS

Because comprehensive utility bikeway planning is new and is to be superimposed upon a complex infrastructure of man-made and natural features in a metropolitan setting, the physical parameters to be established should be flexible and reasonable.

Rigid adherence to an ideal lane width, for example, could result in a determination that a particular penetrator route is unfeasible. On the other hand, too great a relaxation of minimum standards may result in an unsafe or unused bikeway. The first planning step should be to incorporate into the planning process the individuals experienced in weighing trade-offs among factors of safety, routing, traffic, security, engineering design, cost and environmental assessment.

4.2 SPECIFIC DESIGN CRITERIA

4.2.1 Width

It is general and accepted practice today to establish the minimum width of a two-way bikeway at 8 feet. Within this width, it is possible for two bicycles to meet, pass and maneuver safely at reasonable speed under conditions of moderate bikeway volume. This width also permits the passage of maintenance vehicles of average dimensions. Since maintenance and keeping bikeways free of litter is one of the major requirements for safe bicycling, this minimum width is usually required for one-way bikeways intended for utility bicycling. From the cost considerations, the average linear cost per foot for an 8 foot width is generally more cost-beneficial than for the narrower 6 foot width, the minimum acceptable width for virtually all circumstances and settings.

4.2.2 Side Clearances

Side clearances should be a minimum of two feet on either side of a two-way bikeway with greater clearances on the inside of curves, especially on curves of short radii and where the pavement has some banking. A recommended course is to slightly widen the pavement on curves. Bike trails in densely wooded settings should be cleared of undergrowth and of low hanging tree branches, particularly on the inside of curves. One-way bikeways generally require the same lateral clearances except on the outside of curves.

4.2.3 Vertical Clearances

Little rationale for criteria to determine vertical clearance to static objects is given in domestic or foreign literature. The minimum can be quantified on a physical basis up to a certain distance beyond which various psychological and safety margins are added. The State of Oregon has determined the desirable minimum clearance to be 9.5 feet and the minimum to be 8.5 feet, subject to the on-site engineer's approval.

4.2.4 Grades

Local standards rather than technical criteria are often the basis in establishing the "maximum" or the "tolerable" grade for a given distance of travel. In the Netherlands where flatland is generalized, a 5% grade is considered unacceptably steep. However, in Denver, Colorado, an 8% grade for short distances is acceptable. The maximum short distance grade should not exceed 10% and this should be acceptable only if no other reasonable alternative exists.

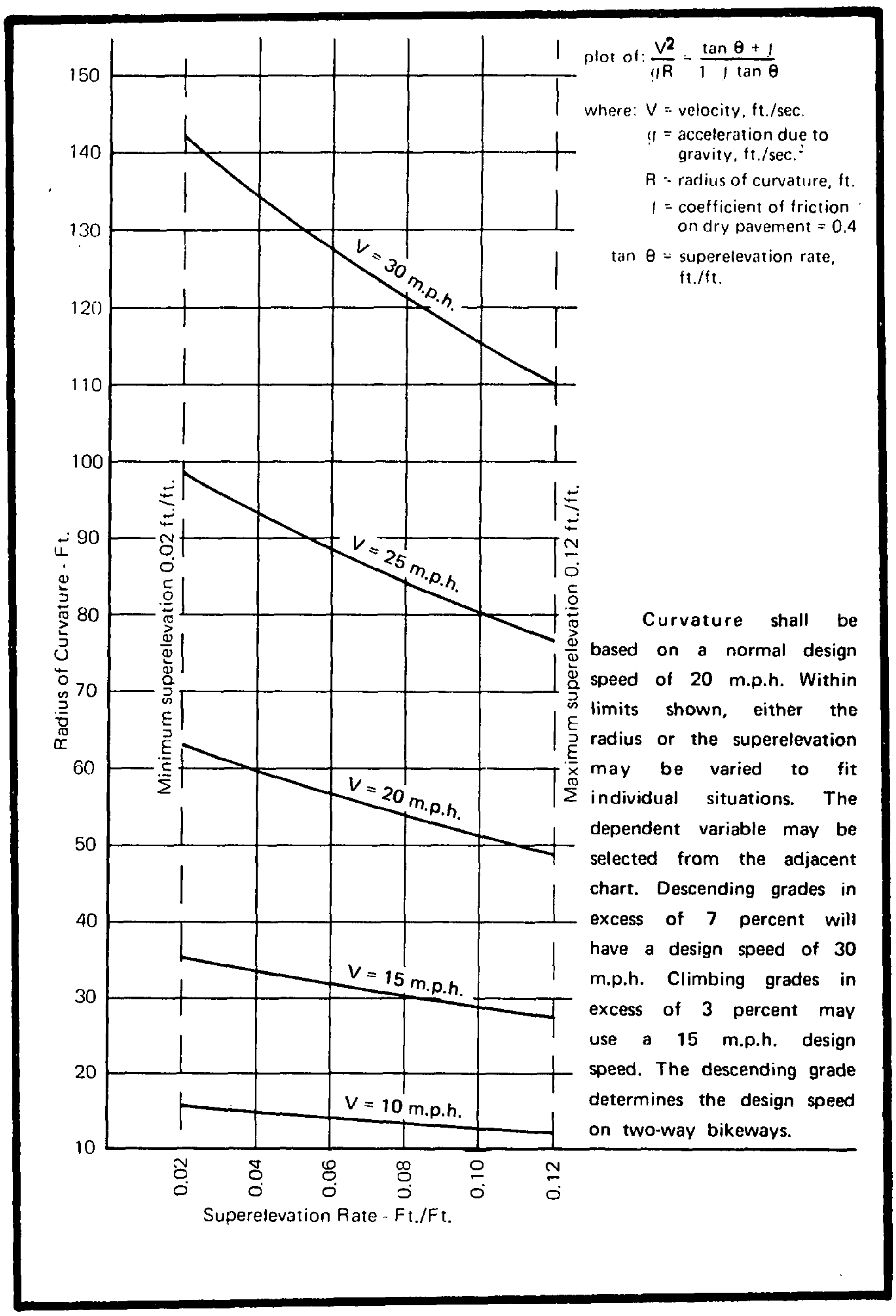
Except for banked curves, cross sloping should be 0.02 foot/foot for both drainage and ridability.

4.2.5 Curves

Criteria for curve radii and banking (superelevation) of bikeways should conform in the first instance to the design speed of the bikeway. The State of Oregon has computed the following chart of values which has since been adopted by the American Association of State Highway and Transportation Officials (AASHO).

Figure 1

Standard Superelevation for Bikeways



The routing planner should eliminate as many safety and engineering problems as possible by avoiding sharp curves at the bottom of steep or of long grades. In this situation, the degree of curve banking to provide increased safety to the descending bicyclist may be unnegotiable for the ascending bicyclist. One alternatative in such cases is to safely design for slower descending speed.

4.2.6 Stopping Sight Distance

The sight distance necessary for bicycling safety is related to the visibility available to the bicyclist in seeing danger or hazards in his line of intended travel and to have adequate time to brake or to take evasive action.

When bicycle brakes conform to standards of the U. S. Consumer Product Safety Commission, i.e. stopping in fifteen feet for certain types of bicycles at 10 mph, and for other types at 15 mph; and perception-reaction time is 2.5 seconds, the minimum stopping sight distance on an exclusive bikeway would be 70 feet on a level, dry surface for a bicycle approaching an obstacle at 15 mph. A considerable number of bicycles have been found to be operated with defective brakes. Therefore, it is recommended that planners take into account the AASHO Design Stopping Sight Distance for bicycles:

Table 1

DESIGN STOPPING SIGHT DISTANCES FOR BICYCLES

For downhill gradients of:

DESIGN SPEED	0%	5%	10%	15%
MPH	FEET	FEET	FEET	FEET
10	50	50	60	70
15	85	90	100	130
20	130	140	160	200
25	175	200	230	300
30	230	260	310	400

CHAPTER 5

PRESENT AND MODIFIED RULES OF THE ROAD

5.1 GENERAL CONSIDERATIONS

Local regulations for bicycles now range from various forms of tolerated use to rules providing special consideration and encouragement. Rules of the road for bicyclists involve their relationship with motor vehicles and with pedestrians, motorcyclists, equestrians and other bicyclists. Basically, when bicyclists are given equal status and equal rights with motor vehicles, the bicyclists have a higher incidence of fatalities and severe injuries from conflicts with motor vehicles than from any other category of bicycling-related conflicts.

It is important to consider the rules of the road related to bicycling in context of today. Roadways are congested with motor vehicles in metropolitan areas. Bicycles have become more popular and their utility use is increasing. Bicycling injuries are the most common type of injury treated in hospital emergency rooms according to the National Electronic Injury Surveillance System.

Rules are needed which will efficiently and safely regulate both bicycle and motor vehicle travel while taking into consideration the different maneuvering capabilities and potential for injury in bicycle-motor vehicle conflicts.

5.2 RULES FOR ROADWAY/BIKEWAY INTERSECTIONS

Whether a bikeway alignment is on-road or off-road, the route will eventually cross a motor vehicle roadway or merge into an intersection area. In such cases, a sign warning should be provided to advise the bicyclist of a potential hazard area. Although nationally accepted warrants have not yet been established for intersection design involving a significant mix of bicycles and of motor vehicles, there are established traffic control criteria for safely merging lanes onto a main roadway. Generally speaking, where there is a choice for bringing an off-road bikeway into a roadway intersection, a controlled, signalized intersection is safer for the bicyclist than an uncontrolled intersection, so long as there are appropriate warning signs and controls advising the motorist of the new intersection mix.

Prior European studies demonstrate the wisdom of bringing a bikeway onto a roadway gradually during the merge, and with good visibility for the motorist to see the bicycles and to recognize the new roadway mix. These considerations are needed to offset the false sense of security held by the bicyclist enjoying the protection of an exclusive bikeway.

5.3 ACCIDENT INCIDENT

One of the best examples of "false sense of security" by bicyclists is provided by the 1960 analysis of bicycle injuries in a French national sampling of 1.08 billion motor vehicle/bicycle miles. The study was published by l'Organisme National de Sécurité Routière. For relevancy, the accident/death rates in Tables 2 and 3 have been converted to a one million vehicle mile rate for the situations involving motor vehicle and bicycle conflicts, and other conflict situations.

For the two traffic situations below, Case #1 involves conflicts at intersections, and Case #2 involves conflicts which did not occur at intersections:

TABLE 2

	BICYCLIST INJURY/10^6 BIKE MILES			BICYCLIST FATALITY/10^6 BIKE MILES		
	2-W Bikeway	1-W Bikeway	No Bikeway	2-W Bikeway	1-W Bikeway	No Bikeway
#1	2.70	4.12	7.08	0.26	0.29	0.23
#2	4.69	3.24	5.28	2.60	0.00	0.46

This study was based on controlled data collection for 296 road segments totalling 521 miles in length and involving a total of 1,016 bicycle accidents causing either an injury or fatality. The size of this sample provides a reasonable basis for concluding that bicyclists seem to drop their guard when an exclusive bikeway merges into a motor vehicle roadway setting, which is more apparent if rates in Table 2 are compared to corresponding rates in Table 3:

TABLE 3

	INJURIES ON BIKEWAYS	NO BIKEWAYS INJURIES ON ROADWAY OR AT INTERSECTIONS
Bike on Bike	9.81	6.59
Bike / pedestrian	2.89	16.48
Bike / motor vehicle	4.62	152.69

Data: Courtesy of Ministère des Travaux Publics et des Transports, Paris (1972)

It is also apparent that the bicyclist's vigilance is only part of the safety considerations, and that increasing motorist vigilance is an integral goal for a comprehensive bikeway plan.

5.4 OFF-ROAD BIKEWAY SIGNS

Standard Uniform Traffic Code signs and pavement markings (15) should be used whenever possible to preserve continuity and familiarity in traffic controls. Shapes, color and legends which are recognized by the public should, whenever possible, be maintained.

However, for reasons of safety in off-road situations, signs along bikeways which have dense vegetative backgrounds should avoid color combinations with poor visibility in these settings. Dual border colors around black legends on white background are recommended, the dual colors being bright against both spring and fall foliage patterns. The minimum off-road sign size is 18 in. x 18 in.

CHAPTER 6

PARKING AND SECURITY

6.1 GENERAL PLANNING CONSIDERATIONS

As bicycling increases in popularity as an acceptable mode of transportation it becomes immediately evident that parking facilities are a paramount requirement for any circumambient ring through which desire lines penetrate toward the CBD. It is within this ring, located about two miles from the CBD, that a transistion from one mode of travel to another is most apt to occur. The planner should establish this ring, or belt, so that it will accommodate mixed mode transits involving bicycles for those banlieu residents* who will most benefit from the facilities.

This planning aspect addresses the need to accommodate the commuter who may travel to the peripheral area by motor vehicle and then use a bicycle to travel two to four miles to his destination in the CBD.

Facilities might be located at or made available by public agencies, service organizations, associations of parking lot owners, or by private interests. For example, local churches with large parking lots might make weekday use available.

6.2 MIXED MODE COMBINATIONS

The mixed modal transit might take many forms including that, for example, of fringe parking and then completing the transit by use of public transportation. It is important to note that there are several mixed mode combinations involving the use of

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*
Banlieu From "banlieue" (Fr.) which means: the collection of neighborhoods and districts outside the central city and contributing to its existence.

bicycles. A number of such combinations include the following:

1. Bicycling into the circumambient, or buffer zone, and continue by bus into the CBD.
2. Bicycling to a subway or rail station, store bicycle and enter CBD by public transportation. May use second bicycle at CBD.
3. Travel to the zone by motor vehicle and continue to the CBD by bicycle.
4. Bicycling all the way to CBD.
5. Use bus or rail to zone and bicycling from there to CBD.

The planner should initiate an inventory of available space in the buffer zone for determining what potential parking facilities are available for bicyclists. Consideration should also be given to additional space becoming available for bicycles as automobile parking spaces are withdrawn through programs of attrition or through new local regulations. Attrition can take many induced forms such as reassigning a parking place given up by a subscribing motorist and making that space available for a number of commuting bicyclists. The space itself, when privately owned, would still return rental income to the owner through reasonably established parking or storage rates for bicycles.

The planner will also need to evaluate the suitability of the various bicycle storage systems for the various sites where bicycle parking will be needed; especially the degree of security afforded, the costs to the parking facility owner and bicyclist, and the manpower needed to operate the storage system. Denver, Colorado bikeway planners (3) evaluated four systems where bicycles would be locked to racks of various designs, including the standard rack which was the most economical but had a low security rating and was recommended only for schools and other high activity areas. The cost of the storage racks ranged (in 1972) from $140.00 to $350.00 per twelve unit rack. Completely enclosed bicycle storage lockers cost $150.00 or more per single bicycle storage unit.

6.3 PARKING AND SECURITY CRITERIA

In addition to existing public parking facilities, other potential parking space may be made available for overnight use, or during particular times of the day or of the week. The inventory of actual and potential parking facilities should be quantified under local conditions. Some of the elements to be used when establishing the criteria for the inventory are:

1. Location of the facility and the number of bicycles to be accommodated are assigned priorities as determined from generator surveys and the subsequent analysis.

2. Location is near or on a route penetrating to the CBD or providing continuity from one demonstrated collector area to a generator.

3. Origin and destination factors reconciled to the length of the desire line.

4. Protection against theft of stored or parked bicycles.

5. Safe access to and egress from parking facilities.

6.4 POTENTIAL BICYCLE PARKING SITES

Potential and actual bicycle parking facilities can exist in a variety of locales among which the following should be examined:

- Existing parking facilities
- School and educational areas
- Recreation and park areas
- Libraries
- Community and shopping centers
- Subway, train and bus terminals
- Business and Government office buildings
- Airports and boat docking areas
- Apartment building grounds
- Banks and other financial facilities

6.5 ASSURING THE AVAILABILITY OF PARKING FACILITIES

Some commercially owned automobile parking facilities are often used at capacity while other facilities a quarter mile away are used well below capacity. Even some of those parking facilities operating at capacity can often accommodate substantial bicycle parking without depriving motor vehicles of their allotted spaces and without interference to egress/access patterns of those motor vehicles. Nonetheless, the planner should consider, where it is necessary, a program of administrative and legal measures to redistribute motor vehicle parking and thus assure the availability of bicycle parking under secure conditions. Administrative action through an amendment in the operating business license approval process or legal action through a local ordinance setting a required ratio of automobile to bicycle parking spaces are two methods available to accomplish this.

6.6 PROVISIONS FOR SECURITY

Bicycle theft is an unfortunate social companion of today's increasing popularity of bicycling and the theft rate in many areas of the country has reached alarming rates. Bicycle theft is a quantifiable deterrent to utility bicycling. A comprehensive bikeway network should incorporate the active planning participation of local police to address the issues of (1) reducing bicycle theft and (2) increasing the return-to-owner rate of those bicycles recovered by the police.

CHAPTER 7

ENVIRONMENTAL CRITERIA

7.1 GENERAL CONSIDERATIONS

7.1.1 The Need for Quantitative Assessment

Although the general promotion of bicycling is often considered beneficial for the environment and for the well being of the bicyclist alike, a planner should take into consideration the probable impact associated with the building of the public infrastructure of an exclusive bikeway network. The actual and comparative environmental impacts are best determined by a careful quantitative assessment. The magnitude of the needed assessment should be dictated by the size of the network and by the existing nature of natural and man-made resources involved or potentially involved by the network.

The first step should be the determination of construction and of design criteria against which the environmental assessment can be measured and the impact determined. Whether on-road or off-road, the planning must be interdisciplinary and the baseline established on-site, as, for example, the procedures used by Brooks and McFaden (1) for measuring impact of off-road vehicles on vegetation.

7.1.2 Safeguarding Values

Any off-road bikeway plan should incorporate the means to minimize the adverse environmental impact that may occur. One criteria is to prevent the reduction in water quality in a watershed where the bikeway would be located. Erosion and siltation are just two factors to consider in protection of the quality of land and of water.

Of nearly equal importance, but more difficult to quantify, are the locally held aesthetic values that deserve protection, such as an existing parkland vista, from an undue intrusion by the alignment or associated landscaping of a bikeway.

For air quality protection, the distinction between improving air quality by bicycling and the short term reduction in air quality during bikeway construction should be remembered. One of the primary methods of improving air quality is to reduce the exhaust emissions of motor vehicles. When motorists are motivated or induced to substitute bicycling for motoring as a transit mode, a quantifiable improvement in air quality becomes possible to establish.

7.1.3 Environmentally Sensitive Areas

Stream valleys by their delicate nature require unique and careful baseline and environmental assessment and special construction criteria. Depending on the applicable local, state and federal regulations which affect the stream valley's potential use, the planner should determine to what degree a bikeway on such land is responsive to protective and to land use policies. While a utility bicyclist often prefers a direct route to his destination, the pleasant and natural surroundings of a stream valley bikeway would probably offset any loss in commuting time.

The land-elevation-stream settings are so varied and complex that no general rule or guideline can be established, except that an environmental baseline should invariably be the first planning step to determine the eventual advantages and disadvantages of alternate alignments.

A bikeway offers a unique opportunity for public access to parkland which might be a stream valley. It should be remembered, however, that metropolitan parklands have high value for public recreation and are enjoying increasingly conscientious protection from an environmentally concerned public which will insist on careful environmental assessment.

7.2 CRITERIA AND ASSESSMENT PROCEDURES

7.2.1 Construction Criteria

In order that the environmental assessment accurately reflect the environmental effects of bikeway construction, the construction criteria should be drawn up in considerable detail prior to assessment, i.e. the assessment should quantify such matters as soil excavation and tree removals which are based on construction criteria for allowable cuts and fills and planned width of the bikeway. Construction criteria which will minimize damage to natural resources should be delineated by both engineers and environmental specialists so that construction methods and procedures can be defined for each differing bikeway segment.

For off-road bikeways one environmentally protective construction criteria is the reconciliation of construction access routes with utility bicycling access routes to the main bikeway. This reconciliation is often possible and will reduce the total environmental impact of bikeway construction.

7.2.2 Multiple Use Considerations

Sewer lines often follow stream valleys because of the obvious advantages of gravity flow and use of these corridors for bikeways is economically and environmentally advantageous if the design criteria for both are imposed during initial alignment studies for the utility. A lesser economic advantage is likely if the multipurpose approach is adopted after alignment or construction of the utility. The greatest economies and least total environmental effects are affected when the multiple purpose uses are concurrently planned and concurrently or successively constructed; i.e. bikeway built along utility corridor immediately after completion of the utility and using the same cleared space, access roads, etc.

7.2.3 Principal Environmental Factors

7.2.3.1 Air Quality

One of the principal goals of implementing bikeways and encouraging bicycle use is the improvement of air quality by reducing motor vehicle exhause emissions. In most urban areas existing and projected air quality parameters are available and these baseline data should be used to project the effects of implementing bikeway plans on air quality.

7.2.3.2 Noise

Noise level standards for the construction phase and for the projected long term phase are design criteria. Representative sound level readings on the db(A) scale should be taken during the baselining on a linear basis to permit a quantification of impact determination for subsequent construction criteria and for bicycling safety design. In cases where a bikeway may be in a high noise zone and also in a roadway intersection zone, bicyclists may be put into a prejudicially hazardous posture by being exposed to dangers that in other settings they would be able to hear. Where adverse noise levels are apt to be generated during the construction phase, the plan should include proposed controls for abatement measures.

7.2.3.3 Water Quality

Water quality standards and local regulations are design criteria. The most likely effect on water quality from a new bikeway will result from hydrologic changes. There will be changes in existing drainage patterns and increases in local rainfall run-offs from surfaced areas and possible increases in erosion and sedimentation. These effects are both short term and long term. The plan should include sound hydrologic protection standards and sediment control plans. Increased run-offs should be safely and lawfully handled by the drainage design.

7.2.3.4 Land Use and Conservation of Natural Resources

Of first importance is the quantification of those land, vegetative and wildlife resources that would be irreversibly committed to the project. Use of the resources are most amenable to being conserved by careful bikeway planning and implementation practices. In comparison to highways, damage to these resources can be avoided by careful routing and special construction criteria to a relatively greater degree since bikeway design speeds are lower, bicycle handling parameters are less severe, and construction equipment is smaller.

A careful field quantification procedure will provide the planner with the necessary quantification of environmental data and of construction data. This dual set of data will provide the means and elements to make precise cost comparisons among alternate alignments.

CHAPTER 8

CITIZEN PARTICIPATION

8.1 GENERAL CONSIDERATIONS

The guidelines have already addressed the value of incorporating expert citizen participation during the early data collection phase of comprehensive bikeway planning. General citizen participation may take several forms during the early phases of planning in addition to the forum of public hearings which are required after a plan is drafted. Two specific forms of citizen participation are recommended to the planner for implementation before the draft comprehensive plan has been administratively adopted and promulgated for formal public review and comment.

8.2 REPRESENTATIVE OPINION

A record of representative opinion should be maintained. There are two courses of action which fulfill this goal. The first is to mail out a letter announcement to those public and private organizations who will obviously be affected beneficially or adversely on the project. The letter should briefly describe the project and should contain the general description of various actions or changes likely to occur if it should be implemented, and the study procedure should be outlined in a manner clearly understandable to the average citizen. The letter should request advice or comment on any aspect or intent of the program and on the methodology intended to be followed by the planner in the study. The second course is to follow up about thirty days later by telephoning any organization which has not answered the written request for comment and advice. All reasonable advice so received should be incorporated into the goals or methodology of the study.

8.3 SPECIFIC OPINION

Once the field data and background data has been collected and the analysis has taken place out of which the desire corridors manifest themselves, the planner should prepare a document which indicates some of the principal alternatives of precise penetrator routes. This document should be made available for review and comment by organizations previously contacted with a special emphasis on reaching groups and private interests along or situated within obvious zones of influence of the alternative penetrator alignments.

The specific comments generated by this review will provide invaluable guidance to the planner for evaluating public acceptance or public preferences for some alternates and public opposition for others.

During the review phase for specific opinion, the planner should include all new groups in which the generator point surveys have identified as existing or probable bicycle users.

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P

Iroquois Research Institute

PARKING FACILITIES

LOCATION MAIN ENTRANCE ______________ 1

Interviewer ______________ Job No. __________ Date ______________

1 Name of principal person interviewed at facility ______________

Title of person ______________ Telephone no. ______________

2 Facility owned by ______________

Mailing address ______________

____

3 TYPE OF PARKING FACILITY

- ☐ Open parking lot only 2
- ☐ Building (s) and lot 3
- ☐ Building (s) only ______ 4

______ 5 Number of entrances

______ 6 Number of exits

- ☐ Single parking level 7
- ☐ Two levels 8
- ☐ Three levels 9
- ☐ Four levels 10
- ☐ Five or more levels 11 ______ 12

4 Entrance No. 1 on ______ 20 Exit No. 1 on ______ 30

Entrance No. 2 on ______ 21 Exit No. 2 on ______ 31

Entrance No. 3 on ______ 22 Exit No. 3 on ______ 32

Entrance No. 4 on ______ 23 Exit No. 4 on ______ 33

X

5 Special facilities noted: ______________

______________ Guards? 35

6 Ownership: ☐ Local 36 ☐ Absentee 37 ☐ Other 38 ______________

7 Access: ☐ Public 39 ☐ Private 40 ☐ Other 41 ______________

8 Total square footage: Lot ______ ft.^{2} Bldg. ______ ft.^{2} 1______ 42

Total auto spaces now: Lot ______ Bldg. ______ 1______ 43

Total bike spaces now: Lot ______ Bldg. ______ 1______ 44

Total motorcycle spaces now: Lot ______ Bldg. ______ 1______ 45

9 Verified by ______________ on ______________ (date) at ______________ (time)

S3 P

B SUITE 215, 6301 LEESBURG PIKE
FALLS CHURCH, VIRGINIA [illegible]

Iroquois Research Institute

Your assistance in providing the following information will be very valuable to determine what type of bicycle paths or bicycle lanes would be most beneficial in this community. Please complete this questionnaire as accurately as possible. Then return it in the manner indicated at the time you received it. Thank you.

OFFICE USE ONLY

PLEASE PRINT YOUR REPLIES TO THE QUESTIONS IN THIS SECTION

1. What is today's date? ____________ 2
2. What is the postal ZIP CODE where you normally live? ____________ 3
3. Name two streets at the first intersection you pass when you leave your home for:

   WORK ____________ 4 and ____________ 5

   SCHOOL ____________ 6 and ____________ 7

   ERRANDS ____________ 8 and ____________ 9

4. If you received this questionnaire on your way to work or to school, please indicate the approximate distance from your home to:
   If the distance is less than one mile, give the fraction: i.e. 3/4 mile. WORK _____ miles 10 SCHOOL _____ miles 11
5. If you have completed another questionnaire by Iroquois Research Institute within the last sixty days, please indicate where or how you received it and whether you completed the questionnaire:

   ____ 12

   N 12

6. Give the address of your destination at the time you received this questionnaire:

   ____________________ 13

   ____

PLEASE PLACE A CHECK MARK OR A CROSS IN THE APPROPRIATE SQUARES FOR YOUR REPLIES TO QUESTIONS BELOW OR PRINT YOUR ANSWER - WHICHEVER APPLIES. THANK YOU.

7. Is the address of the destination you provided as a reply to question 6 above that of:

   ☐ Your regular place of employment? 20
   ☐ Your school or place of study? 21
   ☐ A place you regularly shop at? 22
   ☐ A recreational area? 23
   ☐ Other 24 Explain: ____________

8. Print the approximate time when you were given the questionnaire: ________ AM OR PM? 30
9. What is your sex? ☐ Male 31 ☐ Female 32

10. Are you married? ☐ Yes 33 ☐ No 34

11. Place a circle around the number which shows the highest school year you have completed.

ELEMENTARY SCHOOL 40	HIGH SCHOOL 1 2 3 4 50	COLLEGE 60
1 2 3 4 5 6 7 8	9 10 11 12	1 2 3 4 5 6

12. What was your personal income last year?

   ☐ No income 71
   ☐ $1 to $5,999. 72
   ☐ $6,000 to $7,999. 73
   ☐ $8,000 to $9,999. 74
   ☐ $10,000 to $11,999. 75
   ☐ $12,000 to $14,999. 76
   ☐ $15,000 to $24,999. 77
   ☐ $25,000 or more 78

13. What is your present age group?

   ☐ 14 years or less 79
   ☐ 15 to 19 years old 80
   ☐ 20 to 24 years old 81
   ☐ 25 to 29 years old 82
   ☐ 30 to 34 years old 83
   ☐ 35 to 39 years old 84
   ☐ 40 to 44 years old 85
   ☐ 45 to 49 years old 86
   ☐ 50 to 54 years old 87
   ☐ 55 to 59 years old 88
   ☐ 60 to 64 years old 89
   ☐ 65 years or older 90

14. Do you consider yourself a regular bicycle commuter? ☐ Yes 91 ☐ No 92

   91

15. About how many times a week do you travel this direction at the place you were given this questionnaire?

   ☐ Once 93 ☐ twice 94 ☐ three times 95 ☐ four times 96 ☐ five or more times 97

16. If you answered YES to question 14 above, indicate how you park your bicycle:

   ____

   ____

X ____
a ____
b ____
c ____
d ____
e ____
f ____

PLEASE TURN OVER

Iroquois Research Institute

SUITE 215, 6201 LEESBURG PIKE
FALLS CHURCH, VIRGINIA 22044

TEL: 703 - 534-8200

2

FIELD JOB NUMBER ________ 1

UNIT [ ] 2 SEGMENT [ ] 3 S V [ ] L R 4

DAY ______ 122 MO. ______ 123 19 ____ 124 BY ________ 8

9. WATER QUALITY.

STATION NO. OR SITE	SAMPLE NO.	VOLUME OF SAMPLE	DATE	TIME 24H00	LABORATORY NO. ASSIGNMENT	
						701
						702
						703
						704

10. NOISE

STATION NO. OR SITE	HEADING	TEMP. °C	DATE	WIND VEL.	CEILING	READING db	
							801
							802
							803
							804
							805

11. TREES AND OTHER TALL VEGETATION. R = REMOVE A = AFFECTED

USE LONG FORM 2A FOR LONG SEGMENTS

QUANTITIES

SPECIES	DBH	<- 2"	2 - 6"	6 - 10"	10 - 14"	14 - 18"	18 - 24"	> 24"	TOTALS	
	R								R	125
	A								A	225
	R								R	126
	A								A	226
	R								R	127
	A								A	227
	R								R	128
	A								A	228
	R								R	129
	A								A	229
	R								R	130
	A								A	230
	R								R	131
	A								A	231
TOTALS	R	138	139	140	141	142	143	144	R	145
TOTALS	A	238	239	240	241	242	243	244	A	245