AN INFORMATIONAL REPORT
ON
NON-MOTORIZED TRANSPORTATION
AS IT APPLIES TO MICHIGAN

August, 1973

STATE OF MICHIGAN

DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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Director

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WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS

STATE HIGHWAYS BUILDING – POST OFFICE DRAWER K – LANSING, MICHIGAN 48904

JOHN P. WOODFORD, STATE HIGHWAY DIRECTOR

September 18, 1973

Mr. Sam F. Cryderman
Bureau of Transportation Planning
Department of State Highways
and Transportation
State Highways Building
P.O. Drawer K
Lansing, Michigan 48904

Dear Mr. Cryderman:

According to your directive, submitted herewith is a report on non-motorized transportation. This document is meant to provide the Department with general information prior to program establishment. As indicated in the report, such establishment should be preceded by legal clarification of the authorizing legislation.

The report was written by Mr. Carl E. Jager, with research assistance from an ad hoc Non-Motorized Task Force. This Task Force was comprised of staff representatives from the Bureau of Transportation Planning and the Michigan Department of Natural Resources.

Sincerely,

R. J. Lilly, Manager
Advance Planning Division

MICHIGAN
THE GREAT LAKE STATE

SUMMARY OF RECOMMENDATIONS

(Amplified on Page 68ff)

1. Request legal clarification of the authorizing statute.

2. Establish bicycle routes along selected State trunk lines, the location and type of route to be determined on the basis of existing safety hazard amelioration, potential for use, and cost.

3. Establish formal contact with the Michigan Public Service Commission and the major utility companies to aid in feasibility determinations concerning the use of abandoned railroad rights-of-way and utility easements for trails.

4. Develop a comprehensive design standard and planning information manual for local governmental use.

5. Annually publish maps which show low-volume State trunk lines and State non-motorized routes.

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INTRODUCTION

The Michigan Department of State Highways has recently been directed by the citizens of this state to expand its area of highway responsibility to include, among other new areas of concern, provisions for non-motorized transportation (Section 10K, Public Act 327, Public Acts of 1972). This report provides some background information on the general subject of non-motorized paths, assembles some options available to the Department for implementing its new responsibility, and recommends some actions which the Department can pursue as general policy.

Little precedent for State action on non-motorized paths exists; regional or state experience which is available for scrutiny is of rather recent origin. Much of what is described here is, therefore, based on information supplied by interest groups around the State and our own suppositions of that which could be reasonably useful to the citizens of this State.

Although much of the information in this document is set forth from a "statewide" frame of reference and is intended primarily for use by the Department of State Highways, Counties and Cities -- each of whom also share in the responsibility for non-motorized facility establishment -- may find the report useful as a general reference.

The Michigan Department of Natural Resources has had an interest and has been involved in the study from its inception. Its experience

in trail establishment (outlined in the Background Section of the Report) has been an invaluable resource for this study.

During the study's progression, the Department, in cooperation with the Department of Natural Resources, hosted a series of public meetings at various locations in the state to "listen" to the citizen/user. At the meetings, those who attended were given information about the authorizing legislation, followed by an opportunity for discussion of numerous related issues. This informal dialogue between staff members and the audience was an additional important study resource. At each meeting a questionnaire, which attempted to complement the verbal information exchange, was distributed. (A copy of this questionnaire is included in the Appendix.)

Special note should be taken of the legislative authorization for non-motorized facilities. (Section 10K is reproduced in the Background Section of the Report.) The precise limitations, as well as the precise obligations associated with this new law are yet to be identified and finalized. It is outside the purview of this report, therefore, to attempt, either by direct statement or through implication, any kind of legal interpretation of the statute. In the absence of such clarification on a number of issues, the report instead addresses the issues from a rather broad context, and leaves any restrictive interpretations to a later date and to the appropriate legal specialists.

SYNOPSIS

Potential users of non-motorized facilities comprise three main groups: equestrians, bicyclists, and hikers-pedestrians. Within each of the three groups are various types of users, types which have implications for the kinds of non-motorized facilities provided. Facility examples could take the following forms.

a) Trails apart from highway alignments which serve a single non-motorized mode. (for example, a single bridle path)

b) Same as above but the alignment placed and the facility constructed so as to serve several non-motorized modes. (for example, a combination bicycle and hiking trail)

c) A roadway designated and popularized as a shared motorized-non-motorized facility. (for example, a bike route on or along a low-volume roadway)

d) Pedestrian facilities.

Location possibilities for the facilities include the roadway itself, its shoulder, within the highway right-of-way but apart from the vehicular traveled portion, abandoned railroad rights-of-way, various utility rights-of-way or easements, selected river bank corridors, abandoned roads and streets, and in some instances, fire lanes.

Safety concerns are paramount in non-motorized facility planning, because various conflicts potentially exist between both the motor

vehicle and non-motorized modes and among the non-motorized modes themselves. While trails completely separate from the highway provide for the safest type of use, trails which share a highway alignment fill a transportation need most directly and are the cheapest to institute as well. Compromises between the two positions do, however, appear to be feasible.

Four types of non-motorized trails are suggested for consideration, the first three, appropriate for bicycles, the last for all three non-motorized types:

1) A bikeway along a selected low volume highway (0-1,000 AADT).

2) A bike lane, adjacent to the roadway on the shoulder, for preferential bicycle use (1,000-2,500 AADT).

3) A bike route physically separated from the highway within or parallel to the highway right-of-way (2,500 + AADT).

4) A trail apart from the highway right-of-way, using an available utility or abandoned railroad right-of-way/easement-or new right-of-way.

A variety of construction materials are available which should work well for bicycle and pedestrian paths including, stone chips, soil cement, asphalt cement, hot-mix asphalt, soil asphalt, concrete, and even wooden walkways. Equestrian and hiking trails, since they usually need no specially prepared surface, will obligate few construction materials.

Section I

DEFINITIONS

In this report, the following definitions are operative:

Bicycle Path, Bike Path.	A trail for exclusive bicycle use.
Bicycle Lane, Bike Lane.	A bike path adjacent to the roadway, physically separated from it, and having a stripe, barrier or sign denoting that separation.
Bicycle Way, Bike Way.	A street or roadway designated for bicycle operation on a shared basis with motor traffic.
Bicycle Route, Bike Route.	Either a bicycle path, bicycle lane or bicycle way.
Department.	The Michigan Department of State Highways
Equestrian Path.	A trail for horseback riding or hiking use only.
Roadway.	The portion of the highway right-of-way prepared and used for motor vehicle travel.
Trail.	A separate travel corridor designated and maintained for use by non-motorized modes.

Section II

BACKGROUND

The American interest in non-motorized transportation considerably predates the motor transport era. Many of today's highway locations follow the early walking, hiking, and equestrian trails. Prior to the beginning of the twentieth century, the relatively few bicycles which were around were used mainly for sport and purely recreational travel; the "transportation" user was the horseback or horse-drawn rider. At about the same time that automobiles made their arrival (early twentieth century), the bicycle advanced in usefulness to include use in business-related trips. The new automobile introduction, the bicycle's increasing popularity, and the long established equestrian use resulted in a three way competition for transportation mode dominance. The automobile, with its speed and minimum of physical strain associated with its operation, coupled with the advent of mass production technology, easily won. The bicycle, the equestrian, and the hiker interests were dispersed and facilities for them were accordingly subordinated.

Levels of interest in horseback riding and bicycling have recently been burgeoning, however,

> Bicycling is on the upswing in America. Bicycle Clubs and machine manufacturers are experiencing booming times as people of all ages return to the quiet, individualistic form of transportation so popular at the turn of the century. Today, the bicycle has become a recreational device of such magnitude that it is developing into an important component of transportation.[1]

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[1] U.S. Department of Transportation/U.S. Department of Interior, "Bicycling for Recreation and Commuting", Washington, D. C., 1972, p. 5.

The reasons behind the upsurge in biking popularity are many, but most center around the environmental and economic advantages associated with its use. Probably the advance in bicycle technology has also been a necessary complement to the environmental dimension - now multi-speed, light-weight bicycles have increasingly opened the market for adult use, which in turn has boosted vocal and political support. Today there are approximately seventy-five million bicyclists in the nation, of which about one and one-half million live in Michigan. Nationally, bicycle sales have more than tripled in the last ten years, with production approaching and probably soon surpassing automobile production.

The equestrian interest is also increasing. Current estimates of the number of horses used for riding purposes in Michigan range from one hundred fifty to two hundred thousand and, although interest in horseback riding has remained more constant through the years than bicycling interest, these figures represent a substantial increase over just a few years ago.

In Michigan, until the passage in 1972 of Public Act 327, non-motorized facility planning was under the sole aegis of the Department of Natural Resources. Its statutory authority and present involvement in recreational trails, including those for use by motorized vehicles, is extensive. Its responsibility starts with its ownership of most of Michigan's public lands (State Forests, Parks, Recreation Areas, Game Areas, Access Sites and others), and its stewardship over public waters (navigable or public streams and waters). These large land and water areas are the State recreation areas; in all cases, providing for recreation is an important part of their management.

In addition, Act 316, P.A. 1965, states that the Department of Natural Resources, "is authorized to prepare, maintain and keep up-to-date a comprehensive plan for the development of the outdoor recreation resources of the State."

This act also gives the Department of Natural Resources express authority to participate in "any federal program concerning outdoor recreation", and requires that the Department of Natural Resources "shall coordinate its activities with and represent the interests of all agencies and subdivisions of the state having interests in the planning, development and maintenance of outdoor recreation resources and facilities." Existing law further authorizes the Department of Natural Resources to prepare a master plan for a State system of foot or horseback trails (P.A. 225, 1964).

Finally, a legislative resolution (No. 199, 1971) directs the Department of Natural Resources "to make a study of the State Parks and Recreation Areas and State Forests to determine where horseback riding trails and campgrounds can be established."

Resource Management Divisions - Parks, Forestry, and Wildlife all attempt to provide multiple use trails, e.g., hiking and horseback riding, and summertime non-motorized trails which can be used in winter for snowmobiling. The Parks Division purchases suitable lands (or interests in land) - located anywhere - for the establishment of State parks, whether these lands be for compact or lineal (trail) parks. The Forestry Division is limited to acquiring lands, or interests in land, as a part of the State Forest system. However, in the provision of trails within that system, it can, in the interest of a logical trail completion, extend trails outside State

forest lands. The Division accordingly acquires such additional lands.

On the other hand, the Wildlife Division is precluded from extending "its" trails outside game areas, since, to a substantial extent, its monies (from Federal and State taxes or fees on hunting activities and equipment) are limited to serving wildlife restoration and public hunting purposes. However, within State-owned game areas, other objectives - such as the provision of recreational trails - may be furthered if these objectives will serve wildlife purposes (e.g., hiking trails can also be hunting trails).

Currently, every State Forest, Park, Recreation Area and Game Area contains some type of trail -- whether it be a hiking, horseback, cross-country skiing, or snowmobile trail, except in the cases where the area is too small to support a trail facility. The Department of Natural Resources has also aided in the provision of canoeing trails, such as through developing canoe campgrouns and access points on rivers, and the dissemination of canoe trail information to the public.

With the exception of the two hundred ten mile long Shore-to-Shore trail (between Empire and Tawas in northern lower Michigan), and its spurs, most of the trails planned and developed by the Department of Natural Resources to date have been short trails. [A map is available for later inclusion which shows trails which are three or more miles in length.]

Also, the Department of Natural Resources has responsibility for distributing to local units of government, on a project-by-project basis, monies available from the Federal Land and Water Conservation Fund. A number of minor trails have resulted from this funding incidental to park development projects. Grants have been made in two specific instances for the purchase of abandoned railroad rights-of-way for trail purposes. In the past, the Department of Natural Resources has also had capacity for funding local recreation under the $100,000,000 Recreation Bond Act.

The Department of Natural Resources hopes to plan an overall trail

system for Michigan, i.e., trails for all motorized and non-motorized trail sports which would be integrated so as to avoid conflicts and optimize the use of land. One of the first tasks would be to inventory all potential railroad rights-of-way and ascertain which ones would fit into a trail system. Subsequent tasks will include the evaluation of trail needs for the various types of users and an attempt to supply these needs in a balanced way through the optimal use of Federal, State, local, and private lands.

Since such a trail system plan will take some time to prepare, and there will be opportunities for acquiring - and possibilities for losing - desirable trail lands in this period, the Department of Natural Resources - through its Office of Planning Services - is preparing interim guidelines on trails which will serve as an intermediate rationale for acquiring lands for trail purposes. The guidelines will also provide recommended means of acquiring lands, development standards, and suggestions for maintenance of trails.

States which now have provisions for funding non-motorized facilities from gasoline and weight tax monies (motor vehicle highway fund distributions) include:

Illinois -- which has a law which allows motor fuel tax funds to be used for the placement of bike route signs.

Oregon -- which recently passed legislation that requires one percent of the state motor vehicle highway fund be spent in the establishment of bicycle and foot paths.

Washington -- whose legislature in 1972 passed a law which provided that a portion of the vehicle fund tax be used to finance trail facilities.

Numerous other states have laws which specifically direct appropriations for non-motorized facilities from other funding sources apart from the motor vehicle highway fund. An extremely large number of

other states have bills pending which would provide for the appropriations from the motor vehicle highway fund. In addition, many states, usually through their highway or transportation departments, have provided direct liaison support with various communities as well as local interest groups in the development of facilities for non-motorized use.

Michigan's law, approved early this year, allows the state, counties, and cities, who receive monies from the Motor Vehicle Highway Fund, to spend "reasonable" sums for non-motorized paths. The full authorizing section follows:

> Public Act 327, Public Acts of 1972
> Sec. 10K. (1) Highway purposes as provided in this act include provisions for facilities for nonmotorized transportation including bicycling.
> (2) The department of state highways, the counties, cities and villages receiving funds from the motor vehicle highway fund shall expend reasonable amounts of such funds for establishment and maintenance of lanes, paths, and roads for nonmotorized transportation.
> (3) Facilities for nonmotorized transportation may be established in conjunction with already existing highways, roads and streets and shall be established when a highway, road or street is being constructed, reconstructed or relocated, unless:
> (a) The cost of establishing the facilities would be disproportionate to the need or probable use.
> (b) The establishment of the facilities would be contrary to public safety.
> (c) Adequate facilities for nonmotorized transportation already exist in the area.
> (d) Matching funds are not available through the department of natural resources or other state, local or federal government sources.
> (e) The previous expenditures and projected expenditures for nonmotorized transportation facilities for the fiscal year exceed ½ of 1% of that unit's share of motor vehicle highway fund in which case additional expenditures shall be discretionary.

The motor vehicle highway fund mentioned in this act was established by law (Act 51, Public Acts of 1951) and is a trust fund to which highway user taxes (taxes on gasoline sold and license fees) are paid and from which all highway projects are financed. As amended by Act 327, Public Acts of 1972, a distribution of monies from the trust fund is made quarterly in the following proportions (after deductions for administrative costs): 44.5 per cent to the Department of State Highways, 35.7 per cent to the county road commissions, and 19.8 per cent to the incorporated cities and villages. Each of the three units is then responsible for the road programs under its jurisdiction. Variations in the motor vehicle highway fund allocations between similar governmental units occur in proportion to road mileage, population, percentage of weight tax collected, as well as other circumstances which may be peculiar to particular units (for example - counties with heavy snowfall receive more than those with minimum amounts).

Section III

REPRESENTATIVE INTERESTS

The goal of the Department, relative to the provision of non-motorized facilities, is to aid in establishing a safe, useful and integrated system of transportation related non-motorized paths. Several interrelated objectives appear to be consistent with this broad framework, and are explored in this report:

1. A preliminary identification of types of potential users and their conception of a useful facility.

2. An exploration of alternatives available to the Department for the institution of a viable network.

3. An identification of known and suspected safety hazards involved in any type of facility institution.

4. An outline of general design standards and criteria, including typical costs.

5. Considerations of promoting and maintaining accepted levels of use, including facility maintenance and local/state planning liaisons.

As a result of the interests represented while the legislation pertinent to non-motorized facilities was being considered, the letters and comments received by the Departments of State Highways and Natural Resources immediately after the law was enacted, and particularly the comments and materials submitted at the public meetings (see Introduction), the Department has concluded that in Michigan,

four main interest groups are proponents and potential users of non-motorized facilities. Some individuals belong to more than a single group, but for purposes of identifiable advocate types, the groups are quite distinct. The following sequence of listing does not purport to indicate any particular relative degree of interest.

Equestrians

One distinct interest group is, of course, comprised of equestrians. Four types of facility needs appear to exist for this group, judging from preliminary indications at this time.

The first could be described as a long-distance, rural, trans-county facility with intermediate overnight camping facilities (usually quite rustic but with water and access for vehicles). This type of facility user is interested in riding from point-to-point, along a trail of several miles (one hundred or more). The already established "cross-Michigan" or Shore-to-Shore trail is an example of the type of continuous travel trail which many equestrians enjoy. The major item of importance to this type of path user seems to be both the adequate spacing and correct components of the camping areas associated with a successful trail.

A second type of facility need is a trail which describes a single loop with a given campsite as the focus for both trail starting point and terminus. The length of the trail should be about the distance that the rider could leisurely cover in about a day (about thirty miles). In most cases, the use of this trail means that the horse and his rider arrive at the campsite by trailer/car combination, the site normally being some distance from his home.

The third type is a variation of the second. Here several loop trails extend outward in several directions with a central campsite as their focal point. The resulting facility is not unlike a huge "clover leaf". Each individual trail could be of varying lengths, providing the equestrian with the option of either using two or more trails and returning to the campsite after each ride, or using the campsite as a "several day campsite" and riding all of the trails over a period of several days. Both this and the second type of facility described above could be integrated with the first by having the camping site on the long-distance trail serve as the focal point for the short loop extensions.

Finally, there is a large group of horse owners known as the "backyard" riders. In this group are many youthful riders as well as many relatively new horseowners. The representatives of this group are interested in short scenic rides "around home". It appears that this group in particular finds it difficult to find suitable places to ride.

Some generalizations about the equestrian class of non-motorized path users can be made, based on the communications received by the Department. First of all, most horsemen, regardless of their group affiliation, appear to disfavor riding adjacent to highways and streets. Since, in their opinions, the establishment of facilities has not kept pace with demand, many of them - especially the "back-yard, home based" riders have been obliged to use the established road network for their riding. But only the extremely well-trained horse is not frightened in some degree by a passing motorist. Secondly, whoever provides the necessary

supporting facilities (campsites) for a trail, whether it be the Department of Natural Resources, the Michigan Department of State Highways, or the various private interest groups, should recognize that beyond a few very critical components, the camping area does not have to be of elaborate design. Rustic facilities, with the area left as natural as possible, is important. Adequate water, sanitary disposal area and total size are the crucial elements in providing a successful site. Finally, nearly all horsemen find a hard paved surface unacceptable. An adequate surface is the "one God put here", the earth itself. The horse needs a "trackable" surface, yet one that is not so soft that his hoof sinks into the ground.

Bicyclist

The second distinct interest group is the bicyclist. The resurgence of bicycling interest in this state and in the country generally has already been noted. Among bicyclists, five types are in evidence. Again, many individual bicyclists can be identified quite readily as belonging to more than one group.

One type is the person who uses his bicycle for long distance racing. This bicyclist has only one goal -- to go from point to point in as short a time as possible. In terms of facility preferences, members of this group obviously would like to use facilities separate from, but parallel to, the existing state trunkline system, thus combining the advantages of already determined transportation corridors with a minimum of motorized interference. Members of this group are generally well organized and often pursue their avocation at selected and announced time intervals. The size of the group is not large and relative to

the total bicycling interest in this state, might properly be labeled as a "fringe" participant.

A second type which appears to have a considerably broader base of appeal is the long-distance leisure rider. Most of these riders ride across counties for considerable distances, or travel interstate, at present using low volume state trunkline arteries and county collector roads. Some of them refer to their activities as "bicycle camping". Many plan their route so that state parks or private campsites will be located at a day's ride interval along their route, thus providing the bicycle-camper with overnight stopping points. This bicyclist travels on "tour" much as the vacationing motorist does, the main difference (outside of sheer numbers) being in the quantity of equipment aboard and the distances each are able to cover over a given period of time. The rider begins and ends his bicycle trip at home.

A third type of bicycle rider is the participant in the car-bicycle travel combination. These riders transport themselves and their bicycles from their homes to some pre-selected recreational site. They then use their bicycles at the site for both leisure riding activity and for making necessary local errands while camping - errands which would ordinarily require the use of a car. When the time arrives to "break camp", whether that be after a short or relatively long stay, the bicycles are again stored aboard the motor vehicle or trailer and its riders use their motor vehicle to return home. This type of rural recreational use, where bicycles are first transported before being ridden, is becoming increasingly

popular in Michigan. A large percentage of these advocates are youthful riders who use their bicycles daily (weather permitting) for urban transportation to school, etc.

The last two groups - and these appear to substantially outnumber the first three - are two urban classes of bikers: the recreational, short distance rider and the commuter.

Members of this fourth group ride during their available leisure time, usually along low volume, residential city streets and rather infrequently along the main city arteries. Many school children are in this class; increasingly, adults are also becoming members. If park land is accessible, riding is pursued there; where trails exist or can be temporarily made along streams, river beds, or unused railroad beds, riding is done there. The emphasis is on short distance, leisurely riding with the rider's residence being the start and terminal locus of the trips.

The last group - the commuters - use their bicycles nearly entirely as an alternative to the motor vehicle for a variety of reasons, including the fact that many of these riders are too young to drive. The commuter bicyclists, for purposes of identification concerning facility needs, can be classified into four subgroups: the home-to-school commuter, the home-to-shopping point commuter, the home-to-work commuter, and lastly, the home-to-visit purpose rider.

While the increase in commuter bicycling is not overwhelming, and is hardly likely to replace auto commuters, it is nevertheless a growing local trend across Michigan and the country. Inspired by national publicity which includes strong editorials in major newspapers, the

commuter group of bicyclists continues to grow.

Hikers and Pedestrians

The third and fourth major divisions of potential facility users can both be rather loosely categorized under the imprecise designation of "on-foot" transportation - a reference to hikers and pedestrians.

The above description of hiking types generally has a less rigid definition of facility need, since many rural hikers prefer an undesignated, unimproved trail of their own making. The urban pedestrian is another matter. The provision for separate urban walkways for pedestrian movement has been incorporated into the design of even the earliest cities, and, until rather recently, the physical fabric of the urban area was strictly oriented toward a pedestrian walking scale. Today, however, the heavy concentration and diverse nature of land uses within central cities, coupled with the necessary motor vehicle highway system there, have served to create many conflict points between motor vehicles and pedestrians.

Pedestrians and the last two types of bicyclists represent a similar type of movement. Like bicyclists, much of the pedestrian activity is associated with a leisure pace - along low volume residential streets in the immediate vicinity of a home base - and usually involves walking for the purpose of trips to work, to school, to shopping areas and walking to and from visiting destinations.

There are other groups who, in theory at least, could be considered potential users. Very few members of these groups have identified themselves or actively promoted their interest in the context of the non-motorized law. These interests could conceivably include cross-country skiing, snowshoeing, dog sled racing, canoe travel, sidewalk wheel chair users, and others.

Section IV

FACILITY ALTERNATIVES

There are several potential alternatives available to the Michigan Department of State Highways under the authorizing law. The successful pursuit of any one or a combination of alternatives, however, may hinge quite directly on legal clarification of this authorization. The suggested alternatives which follow, therefore, should be viewed in that qualifying context. They are suggested with a view toward addressing at least some of the needs which members of the various use-classes listed previously have identified.

1. Separate Facilities. One option, probably the most expensive, would be for the Department to concentrate on establishing separate facilities to serve separately located non-motorized modes. One form which this approach could foster would be actual construction of rural bike route segments between either selected recreational nodes or established population centers. This would be a completely separated right-of-way designated for the exclusive use of bicycles with every attempt made to minimize cross traffic and other interference. Popular public or private recreation centers with a high potential for bicycling destinations or obvious places of bicycle interest (such as university towns, for example) with a corresponding bicycle origin potential could be connected with each other. The segments could be built as connecting links between county systems of non-motorized

trails or existing secondary trails.

A variation of the above would be to establish one long distance bike route which would be so placed on a continuous alignment that both population and recreational activity centers would be interconnected. A carefully planned alignment would both draw and disperse use along its length. Essentially, however, service would be available only to the users in the vicinity of the route, certainly a disproportionate level of service in the state as a whole would result.

Another possibility, under the same option of concentrating on separate facilities for separate modes, would be to direct resources toward establishing rural bike routes or separate equestrian trails either around or along a natural scenic feature. Several possibilities are apparent here, in both a rural and urban context. Water course channel banks, flood plains, metropolitan park developments are some possible locations, if both legal resolution and interagency agreements can be obtained.

In urban areas, a bike route which consists of one or more recreational, metropolitan loops is another possibility. Or, a bike route which usually, but not necessarily, follows an established local motorized facility and which is oriented toward filling the need for commuter use could be constructed.

As for the establishment of hiking and horseback riding trails, the Departmental emphasis can be an attempt to most directly fill the needs of equestrian according to type of rider as outlined above. The trail could therefore take the form of a hiking and/or equestrian trail which is a long distance, point-to-point facility; a number of loop

trails, a day's ride or day's walk length with termini at campsite; or loop trails with termini at some motorized transportation route which may or may not have urban connectors.

2. Combination of non-motorized modes - In theory at least, a second general option of the Department rests in the possibility of combining major modes of non-motorized transportation, either as adjacent or as shared paths within a single right-of-way. Public support for this approach, as expressed in the open forums which the Department hosted, as well as in letters and conversations directed to staff members, is hard to identify. While many bicyclists and equestrians show no hesitancy in criticizing use of adjacent paths, others obviously felt that already dwindling land resources, and similarity of riding purpose precluded a separation. It is, indeed, hard to separate legitimate perceptions from the felt need of these interest groups to present a united front in order to elicit the most positive response from the State. The outline of a consensus, however, appeared to develop from the belief that a compromise is necessary because of funding limitations: two adjacent paths, one paved, the other left "natural", separated a few feet if available terrain and right-of-way permit, are acceptable to both. And, to the degree that hikers find the location of these trails a challenge, they could and would also use the equestrian area of the path.

3. Non-motorized - Motorized combination - A third option open to the Department is to focus on combining non-motorized uses with the existing transportation network. This is only suitable for the bicycling mode, because, as mentioned before, the majority of horseback riders dislike riding close to traffic. Three possibilities are open under this option.

A bicycle route could be established merely by placing signs at appropriate intervals on suitable state trunk lines. Since the speed limit is generally the same on all rural state trunk lines, the significant variables for choosing routes would be the road traffic volume and, as mentioned above, the associated population concentration or recreation interest.

A second possibility is to institute a reserved bicycle lane immediately adjacent to the traveled portion of the highway. In most cases, this would logically consist of paving the shoulder of the trunk lines (if not already paved) and placing a paint stripe on the inside edge of the shoulder to clearly delineate the boundaries of the bikeway and thus clearly identify the separation points of the motorized traffic from the non-motorized.

A third possibility, at least where sufficient right-of-way exists, is to place the bicycle path within the right-of-way but completely apart from the actively traveled portion. This total separation entirely eliminates the motor traffic interference except at periodic cross road intervals. It is also the most expensive of the shared right-of-way types to build, even when it is built in conjunction with a new highway on a new location.

4. Revenue Sharing - The Department appears to have the option of using some, if not all, of its allotment of non-motorized money as a revenue sharing resource for local governmental programs. If this recourse is adopted, the potential at least exists for significant state review of non-motorized systems and construction standards. Standard criteria which all potential users of state funds would have to adopt before allotment is given, could be instituted. The money could be distributed without priority identification, or priority could be given to those who already have demonstrated local commitment to non-motorized plan development.

5. Pedestrian Facilities - The Department could decide to increase its current level of involvement with pedestrian facilities. Sidewalk emplacement on new projects where warranted and establishment of facilities to promote pedestrian continuity for pedestrian traffic are two possibilities.

6. North Country National Trail - Finally, the Department could elect to aid the establishment of a portion or portions of the Michigan section of the North Country National Trail. This trail is one of several national scenic routes recommended by the Bureau of Outdoor Recreation as a result of a request by Interior Department Secretary Udall to take the lead in a nationwide trails study. This particular trail would cover 3,170 miles from Central North Dakota through Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, and New York to New Hampshire. The Michigan portion follows - as its general alignment - the southern shore of Lake Superior in the Upper Peninsula, then along most of the western coastline edge of the lower peninsula, and then along the southern State border to the Indiana-Ohio State lines, where it diverts south into Ohio. This type of trail would ostensibly be open to hiking, bicycling, and horseback riding and would use, as much as possible, utility transportation lines, and occasional abandoned railroad rights-of-way. Guidelines for individual State participation in this specific trail have yet to be formulated, although some precedents do exist. Selection of this alternative would involve working closely with the Department of Natural Resources, since it has been designated as the official Michigan representative in liaison work with the Bureau of Outdoor Recreation.

Section V

LOCATION POSSIBILITIES

An examination of location possibilities for non-motorized trails reveals several available opportunities. Traffic flow data gathered by the Department for all portions of the State highway system indicates a scattering throughout the state of low volume (under an average of 1,000 cars per day) road segments under state jurisdiction. Within an acceptable range, specific categories of known traffic volumes with predetermined limits (discussed later) can be associated with the three types of bikeways, i.e., using bike route signs on the lowest volume segments, shoulder use with striping for the next higher volume category and completely separate routes for the highest volume. Once this level of identification is combined with points of recreation interest or population concentration, a given route selection is possible. Information on presently paved shoulders and their width (now available), continuity with existing or potential county systems, and service potential of the route, should, of course, be additional information that is evaluated before routes are selected.

Abandoned railroad trackage and its right-of-way in the state presents some possibilities for equestrians, hiking and bicycling routes. If legal roadblocks associated both with the authorizing law and the transfer of land from railroad companies to the state are not prohibitive, acquisition by either easement or outright purchase would be desirable for several reasons.

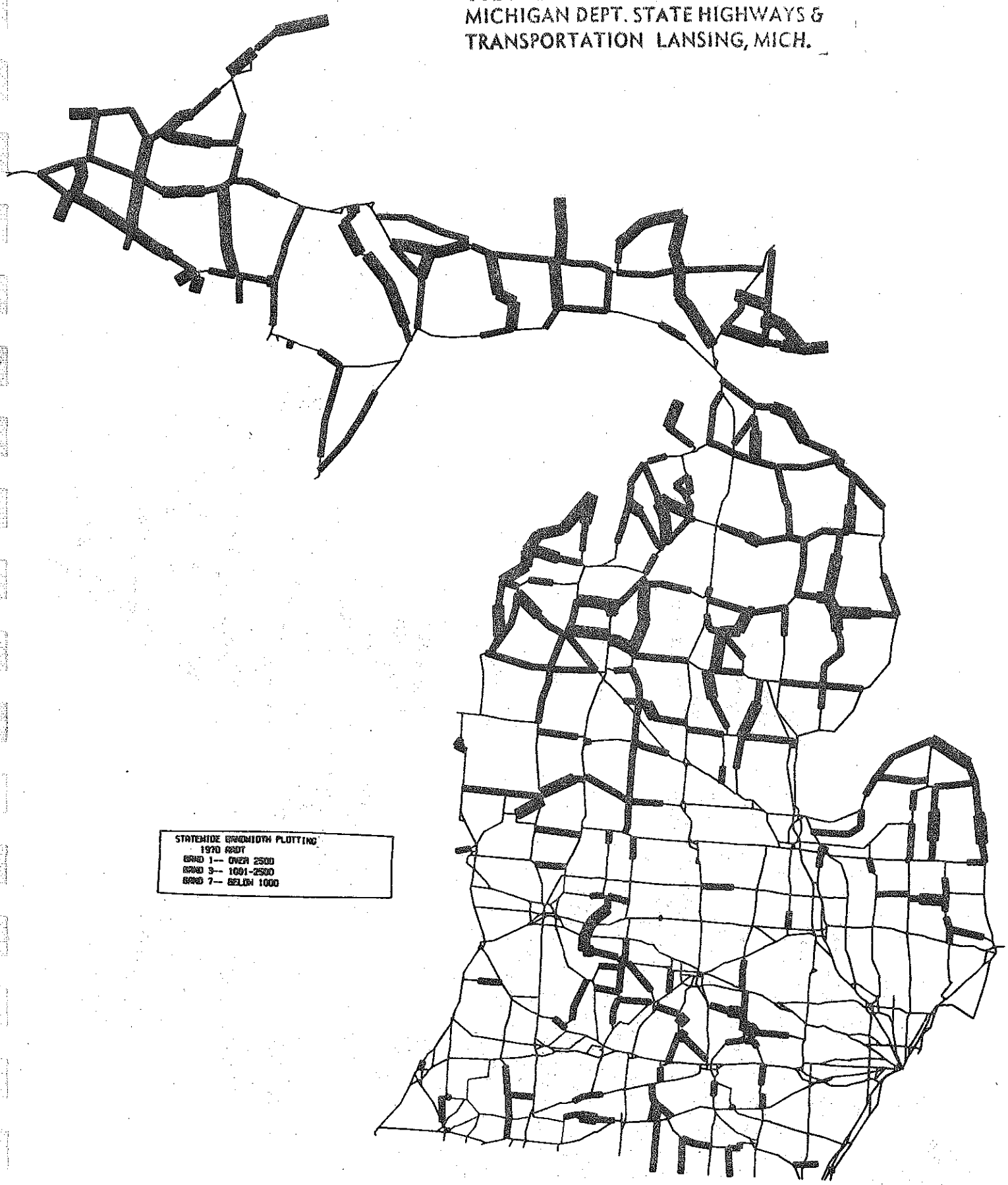

Figure I

A Bandwidth Plot Showing Three Groupings of 1970 AADT.

Figure II

A Bandwidth Plot Showing Three Groupings of Estimated 2000 AADT.

Since most railroad lines run through or very close to small communities, service centers for the non-motorized user would probably be available at useful intervals. Most of the rights-of-way already have pleasant gradients - especially for bicycling - and drainage problems usually are non-existent. A concentrated study of all abandoned lines would have to be undertaken, including documentation of remaining ties and rails, bridges, extensive undergrowth, erosion, and other problems for the potential trail portions, and selection criteria be established before actual negotiation for purchase of rights is undertaken.

Requests for information on railroad abandonment status can be directed by the Department to the Michigan Public Service Commission. Periodic information would then be forthcoming which would include the name(s) of the railroad company requesting abandonment, the location and terminal points of the segment(s) concerned, its length in miles, and periodic change in status of the abandonment request. A public hearing for abandonment is not always required. If the abandonment request is honored by the Public Service Commission, any subsequent title or easement transfer negotiation is done directly with the railroad company concerned.[2]

As far as selection criteria are concerned, standards can be observed which may eliminate many unsatisfactory portions. As one example, the Indiana Department of Natural Resources, with cooperation from bicycling organizations in that state, has listed the following criteria for selection of railroad right-of-way segments:

1. Located within a two-hour drive of populated areas and

[2]Conversation with Mr. C. E. Magoon, Director, Michigan Public Service Commission, Lansing, Michigan, April 23, 1973.

the primary source of users.

2. The right-of-way should be a minimum of twenty five miles in length and a minimum width of fifty feet.

3. In regard to aesthetic qualities and physical features, the topography should be pleasant and changing enough to sustain interest throughout a day's ride.

4. Points of Interest: historic areas, scenic overlooks, and other significant points should exist along the trail providing rider interest . . . .

5. Service facilities should be available to the riding or hiking public every six to ten miles along the trail.

6. Specific points of access should be designated and their exclusive use encouraged.

7. Consideration should be given to available existing trails so that possible connecting points could be established and duplication of trail service avoided.

8. Trail located near enough to Department of Natural Resources properties to facilitate maintenance and management.[3]

While the literature (both technical studies and publicity brochures) is replete with recommendations for using abandoned railroad rights-of-way, there are relatively few instances where bicycle and/or equestrian trails have actually been established on these locations. The usual legal stumbling block appears not to be insurmountable however, if the timing and sequence of the transfer events are correct. Application to abandon

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[3]Study Committee from Indiana Department of Natural Resources and Indiana Central Bicycling Association, Abandoned Railroad Rights-of-Way As Potential Bicycling and Hiking Trails, October, 1972, pp. 3,4.

nearly 700 miles of track in the State of Michigan are currently on file with the State's Public Service Commission. [A map is available which shows the already abandoned segments.]

Utility transmission rights-of-way as well as utility easements represent another rather large category of potential trail locations. Utility companies in Michigan either own, or lease (through easement purchase or other arrangement) land for over 16,000 miles of gas, oil, and electric transmission lines. Much of this is adjacent to or within already well defined transportation corridors; population nodes, therefore, could rather easily be connected using this right-of-way. It is possible, based on some informal contacts already held between utility companies and staff members, that some companies would be open to a discussion of such joint use if potential legal and liability questions could be resolved. Whether this type of joint use is acceptable to the potential user is of course a separate and equally important question. The bicyclists addressed themselves to the question at the public meetings; most admitted that while this was not their first location choice, if the particular location of the transmission line was so located as to fill a direct origin-destination need, they would prefer using it rather than the existing, often dangerous roadway. The desirability of those rights-of-way for equestrian trails is much more dependent on the route's aesthetic dimensions, as might be expected, and less so on their trip origin-destination relationships.

Other possibilities for location, although these may be more easily applicable for local (counties and cities) trail establishment, are certain major river bank corridors, abandoned roads and streets, and on occasion,

fire lanes. All of these have been suggested for trail use by interest groups around the country, their suitability for non-motorized application through governmental action, whether state or local, would have to be examined on a very specific project basis, before one could venture any general suitability statement.

A very important element in location selection, both at the level of facility sharing alternatives or in actual geographical emplacement, is the particular user concentration. At the local planning level, particularly the city context, the relatively small boundary circumference and high concentration of people make a sampling technique or general survey less difficult to design and implement, than when following a statewide frame of reference. Where equestrians, bicyclists and other potential trail users live, where they are and would be using trails if additional trails were available, or what percentage of the local users would use a state system - all central elements of a coherent state plan - are extremely difficult to determine. The problem is magnified because of the current lack of any statewide registering or licensing system for any of the non-motorized modes.

One estimate of the frequency of bicycle use by location (sub-areas of the state) is possible by comparing 1970 Michigan Census data with national average bicycle participation rates developed during 1972 by the U.S. Department of the Interior.[4] (See table following.)

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[4]U.S. Department of the Interior, Bureau of Outdoor Recreation, 1970 Survey of Outdoor Recreation Activities, Preliminary Report, February, 1972, p. 64.

Bicycling: Number of participants and days of participation, by selected socio-economic characteristics, 1970, persons 9 and over.

Characteristic	Number of participants (Thousands)	Percent of population	Recreation days (Thousands)	Days per person	Days per part.
Total U.S.	37,112	22.1	1,735,916	10.3	46.8
Sex and Age					
Total Male	17,911	22.4	1,060,307	13.2	59.2
9-11	4,298	66.6	422,280	65.4	98.3
12-15	5,131	62.1	436,082	52.8	85.0
16-17	1,243	31.5	51,448	13.1	41.4
18-24	1,855	17.9	39,938	3.9	21.5
25-34	1,995	17.3	36,582	3.2	18.3
35-44	1,788	16.4	31,686	2.9	17.7
45-64	1,434	7.1	30,919	1.5	21.6
65 and over	165	2.0	11,370	1.4	68.9
Total Female	19,200	21.8	675,609	7.7	35.2
9-11	3,976	63.6	278,495	44.5	70.0
12-15	4,585	57.3	195,999	24.5	42.7
16-17	1,581	40.6	33,610	8.6	21.3
18-24	2,903	24.2	46,699	3.9	16.1
25-34	3,043	24.4	59,633	4.8	19.6
35-44	1,812	15.8	29,464	2.6	16.3
45-64	1,223	5.4	27,037	1.2	22.1
65 and over	77	0.7	4,672	0.4	60.7
Race					
White	33,847	22.6	1,613,218	10.8	47.7
Negro and other	3,265	18.1	122,697	6.8	37.6
Population Density					
Big cities	5,353	20.7	185,509	7.2	34.7
Small cities and suburbs	14,490	23.3	704,909	11.4	48.6
Towns and rural areas	17,268	21.6	845,498	10.6	49.0
Place of Residence					
In SMSA	24,661	22.9	1,133,664	10.5	46.0
Not in SMSA	12,451	20.7	602,252	10.0	48.4
Nonfarm	11,177	21.1	535,795	10.1	47.9
Farm	1,274	17.4	66,457	9.1	52.2

Using this method, Michigan should be divided into sub-areas or "zones"; the five hundred eight zones of the Department's Statewide Traffic Forecasting Model, each of which is either a city, township or group of townships could be used.

Next, the male and female population in each of six age groups residing in each zone is accumulated. Then participation rates for age groups are used to estimate the yearly number of days of participation for each zone. Note that this is an indication only of frequency of participation, not place of participation. The results are shown graphically in Figure IV, along with a similar representation of simple population concentrations (useful for comparison) in Figure V. (See Appendix.)

Once the concentration of use-frequency is identified, location of attractors is the next step in this method. Top tourist attractions and known leisure time recreation spots - both public (state parks, forests and campgrounds) and private - would be one type of attraction which exerts a statewide influence. Other attractors of a more utilitarian nature should also be identified and included.

The locus of the equestrian interest may be harder to identify. Two horseback riding organizations - the Michigan Trail Riders Association and the United Michigan Horsemen - can provide some indication of the organized portion of that interest, this would partially ignore, however, the so-called "backyard" and younger rider. A monitoring of use after establishment may have to substitute for prior indication of potential use frequency in many cases.

Section VI

SAFETY AND LIABILITY IN MODAL COMPATIBILITY

Safety

The Department of State Highways, by virtue of its organization and function within State government, is concerned with safety considerations involved in facility construction and general intermodal integration, not with education, registration, or equipment standards *per se*. But in a sense, the Department's safety context is the most basic, since in the final analysis the safety of the individual rider or hiker cannot be guaranteed if faulty system planning is evident.

The equestrian and the motorist quite generally agree on one point - the question of compatibility between horseback riding and the motor vehicle. The safety problem inherent in a close mix of the two are obvious - most notably the horse's ease of fright and his resulting unpredictable behavior. In reality, few horseback riders have addressed the question of mixed use from strictly a safety context, but the general concensus appears to be that their mix is unacceptable, since in most cases alternative safer options are usually available to accommodate need. It is true, of course, that on highways with relatively wide rights-of-way, particularly those with an especially rural setting, the separation of facilities which yet share a common right-of-way would minimize the safety hazard, with the exception of the very real ones at crossroad intervals.

Many of the same safety reservations expressed by horseback enthusiasts are shared by hikers when viewing the auto/hiking compatibility question. Few urban hiking trails exist, but where they are present it appears that both the amenity which a trail seeks to provide as well as the relative safety which hikers expect are threatened. In the case of the urban pedestrian, it is a long established maxim that pedestrian facilities and motor vehicle facilities be kept separate, with strict controls over the rights of each when intersections force them to mix.

The safety concerns developing from the motor vehicle-bicycle mix is a subject that both drivers and bicyclists talk about at length. The growing popularity of the bicycle as an alternative to the motor vehicle has resulted in shared use of a facility essentially built to to accommodate the motor vehicle only. Such shared use of one facility built for a single mode obviously invites conflict, conflict usually resolved in favor of the motor vehicle.

It is quite apparent that only complete separation of bicycles and motor vehicles will provide complete protection to each; completely separated bikeways being the safest type of facility for both rural and urban situations. But it is also apparent that this kind of separation is most costly if bike facilities are planned apart from the road right-of-way - additional right-of-way, or easement, or dedication often being necessary. Where facilities would use other existing rights-of-way or easements, such as utility or drainage routes, major reduction in safety hazards as well as

reduced costs would be achieved.

In terms of separate yet shared facilities, two levels of sharing are possible, both with direct implications for safety achievement. One approach[5] would have the bike route located on an existing roadway, with exclusive lane space allocated to the bicycle, physically separated from automobile lanes by a structural barrier. Research in Europe (almost none has been conducted in this country) shows, as might be expected, that this type reduced the accident rate when compared with those having no barriers (described below), except at intersection points.[6] There are many types of barriers which can be used - much research needs to be done on the correlation of accident data with each of the various types. Some barriers involve nothing more than steel buttons in the roadway at 3 feet intervals, as is used in one Colorado city.[7] Such a barrier is little more than a warning. Other, more definitive barriers are planned for use in Oregon and other states.

A variation of the above, which has already been mentioned, is a painted stripe instead of a physical barrier to separate the two modes. Although little comparative research has been done between the two classifications, it is likely that speed of the motorist and the frequency of his

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[5]Cecka, Michael. Planning Bicycle Routes Within the Developed Community. East Lansing, Unpublished Master's Thesis, 1972, p. 63.

[6]Institute of Transportation and Traffic Engineering. Bike Way Planning Criteria and Guidelines. Los Angeles: School of Engineering and Applied Science, 1972, p. 45.

[7]Cecka, Michael, op. cit., p. 78.

turning movements would be important considerations as to which type to consider. Apart from financial restraints - which are very real indeed - cut-off points for speed and traffic volumes should be recommended for each type.

The least desirable bike route from an overall safety viewpoint, but generally the cheapest to institute, is the simple signing of appropriate routes, which thus designates them as a shared use facility. Here strict limitations on the appropriate routes to choose - with respect to vehicle speed and turning movements, traffic volume, road width and condition of the contemplated routes are important, since all parts of the roadway serve a dual mode. Problems again are particularly acute at intersections. Angles of interception and sight-distance problems often combine to generate problems between the motorized and non-motorized mode.

A bicycle-pedestrian mix on the sidewalks - especially in fairly concentrated residential or business districts of the city - merely transfers the danger from the bicyclist to the pedestrian. Conflict points are numerous and can only be partially ameliorated by considerably widening the sidewalk.

According to the National Safety Council, nationally more than 820 persons lose their lives and an additional 40,000 to 50,000 others suffer disabling injuries in bicycling accidents each year. Fifty-one died in Michigan last year. While most authorities attribute the rising toll to the fact that more and more bikes are continuing to compete

with autos for space on the road, some accident prevention can be instituted at the physical construction level. Many complaints are expressed about storm sewer gratings along urban bikeways. These often consist of steel bars laid along the curbs of streets over storm drains. Riders say their front wheels can slip between the bars, throwing them from their bikes. If they swerve to miss gratings, they invite being hit by a passing car. Other riders express annoyance at the dangers evident in riding on unpaved paths with today's narrow-wheeled bikes: loose dirt and gravel are a constant threat. Cracks and potholes along those routes that are paved are an additional threat - a pothole is distrubing to the motorist - it could easily be fatal to a cyclist. Sudden opening of car doors when riding parallel to a series of parked cars is often cited as a constant urban hazard.

In the final analysis, safety education for both children (introduced in the schools) and adults concerning the rights and responsibilities of both motorists and cyclists is a very important complement of actual safe facility institution in this state. The Michigan Cycle Safety Conference, in April, 1973, recognized this:

> A serious deficiency appears to be a general lack of overall education for bicyclists, both school youngsters and adults. And in the areas of safety literature, there appears to be precious little general information booklets available to school youngsters and others interested in bicycle safety, laws, and equipment and maintenance.[8]

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[8]Report of the Bicycle Task Force of the Michigan Cycle Safety Conference, April, 1973. p.1.

Conference members then went on to recommend -

> On the subject of education, there should be a concerted educational program for drivers of four-wheeled motor vehicles such as cars and trucks on how to "co-exist" with bicycles on our street and highway system. By definition, the bicycle is considered a vehicle and has rights on roads and streets as well as its motorized counterpart.[9]

And they concluded;

> In substance, there is one important by-product that could be the end result of concerted formal and information educational campaigns. Youngsters, at a very early age, would be indoctrinated into good safety habits into adulthood and behind the wheel of automobiles. This might be the single most important outcome of a concerted bicycle safety program in Michigan.[10]

Liability

When a right-of-way which is apart from the road right-of-way is used for a trail, liability considerations are of considerable importance to both the land owner (if easement or lease is used) and the trail user. In the case of a separate right-of-way, excerpts from the 1971 National Symposium of Trails are instructive. Here the advice is to a private trail committee as the advocate of a non-motorized segment trail rather than to a governmental unit, but the general comments have a dual application.

> The legal aspects of liability vary widely from one State to another; the important general rule, however, is that private and public entities which invite the public upon their land have a duty to remove obvious hazards or to warn the public of their existence. Where children are anticipated to use a trail unaccompanied by adults, the standard of safety is even higher. If necessary, substantial fences or other protective devices must be used to keep children from being attracted onto the trail and inadvertently being exposed to danger.

[9] Ibid, p. 2.

[10] Ibid.

In any case where the ownership of the land occupied by the trail is not conveyed, the private owner, corporate or individual, has a right to require that he be "held harmless" by the trail committee against any liability arising from the use of the trail. The committee thus must take steps to protect both itself and the owners of the property which the trail crosses.

At least three methods for dealing with the liability issue are available:

1. statutory immunity
2. individual waiver or release
3. insurance

Some States such as Illinois (Illinois Revised Statutes, Chapter 70, Section 31, et. seq.) have enacted laws which declare that a private landowner who allows the public to enter his land for recreational purposes on a nonfee basis shall not be liable to a member of the public who is hurt while enjoying such hospitality: One weakness of the law, however, is that it only protects owners of land in unincorporated areas: the original "model act" has no such restriction. Another weakness is that the act does not prevent the bringing of a suit, only stating that the owner should win where its terms are applicable. Provision must therefore be made for the expense of defending against possible lawsuits, even if they are misconceived or hopeless.

Personal waivers or releases may be useful on particular occasions when large groups are using the trail or working on it together. Under normal usage with the public free to come and go at any time, the obtaining of signed release forms is not practical. Furthermore, the signature of a minor is not effective and courts are likely to disregard printed forms anyway.

In the final analysis, the trail committee will normally have to carry some kind of insurance coverage to protect against lawsuits, whether well-founded or not. Some negotiation may be required between the trail committee and the property owners as to the required level of coverage since the size of the annual premium

> may be a substantial constraint on the future viability of the project. Comparison of several bids would also be advisable.
>
> The problems of insuring privately sponsored outdoor recreation facilities such as trails need to be examined. It is likely that the risk of liability is greatly exaggerated: the Appalachian Mountain Club, for instance, has never been sued in its 95-year history. If better experience data were available, the cost of outdoor recreation insurance might be substantially lowered. Furthermore, it is to be hoped that the direction of statutory and judicial interpretation will be towards greater encouragement of the recreational use of private land. With the cost of land escalating constantly, the future recreational needs of the metropolitan populace will increasingly have to be met through trails and other facilities established with the owner's consent upon private land.[11]

Michigan has a law (Public Act 201, 1953) exempting private landowners from being sued by gratuitous recreational users of their land unless gross negligence is shown.

> An act restricting suits by persons coming upon the property of another for the purpose of hunting, fishing, trapping, camping, hiking, sightseeing or other similar outdoor recreational use; and to declare the limited liability of owners of property within this state.
>
> 300.201 Liability of landowners for injuries to guests; gross negligence, willful and wanton misconduct.
>
> Sec. 1. No cause of action shall arise for injuries to any person who is on the lands of another without paying to such other person a valuable consideration for the purpose of fishing, hunting, trapping, camping, hiking, sightseeing or other similar outdoor recreational use, with or without permission, against the owner, tenant or lessee of said premises unless the injuries were caused by the gross negligence or willful and wanton misconduct of the owner, tenant or lessee.

[11]Department of the Interior/Bureau of Outdoor Recreation, Proceedings of the National Symposium on Trails, (Washington, D.C., June 2-6, 1971) pp. 92, 93.

Section VII

GENERAL DESIGN GUIDELINES AND TYPICAL COSTS

This section outlines some broad design and construction criteria that should be observed in trail or path establishment. It is not a substitute for a detailed specification report; such a report would cover a wider range of trail situations and would indicate acceptable and preferred ranges of standards. Such a compilation of standards, in a form that could be distributed to local communities, should be undertaken subsequent to the adoption of this report. (See Recommendations.)

For a state system, the easiest type of bikeway to institute, in terms of both cost and level of effort, is to designate a given segment of highway as a shared motor/bicycle facility by periodic sign emplacement. This signing simply notifies the motorist that bicycle use may be expected. This type of bikeway should not be established where the average daily motor traffic count exceeds one thousand (1,000) vehicles per day. The standard[12] "Bike Route" sign (see Figure III) should be the design used, except that the overall size should be increased from the recommended 18" by 24" to a size more easily read and comprehended by motorists using the higher speed rural trunklines.[13]

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[12]The signs identified in this section are consistent with standards set forth by the National Joint Committee on Uniform Traffic Control Devices.

[13]The standard is no doubt adequate for lower volume-lower speed city and county roads, but it is doubtful that this size sign would be adequate for generally higher speeds.

Additional motorist "warning" signs - "Watch for Bikes" and "Bike Xing" (at intersections with non-shared facilities) - may be placed along with the standard signs a minimum of five (5) "bike route" signs per mile in rural areas, with the addition of "Begin" and "End" at the origins and termini of the shared use. For urban areas the minimum should be doubled (at least one per block) with the "Bike Xing" sign placed at every intersection for the benefit of cross-traffic.

A second type of bike route is the use of a paved shoulder. It is important that this riding surface be paved and not simply packed dirt or gravel. Average annual daily traffic levels between 1,000 and 2,500 should be appropriate for this type of non-motorized/motorized adjacent use. Signing as recommended above should be instituted on these routes; in addition, a wide paint stripe should be placed at the inside edge of the bike route and the periodic lettering "Bikes Only" (suggested interval-equidistant between the "bike route" signs) should be stenciled on the shoulder. In any roadway so designated, the shoulder on <u>each</u> side should be used and each should be a one-way facility only. Each paved shoulder used as a bikeway should be a minimum of four (4) feet in width. Most shoulder paving, existing or planned, will exceed four feet, therefore, the bike route should be placed on the extreme right hand portion of the shoulder, thus separating motorized and non-motorized traffic as much as possible.

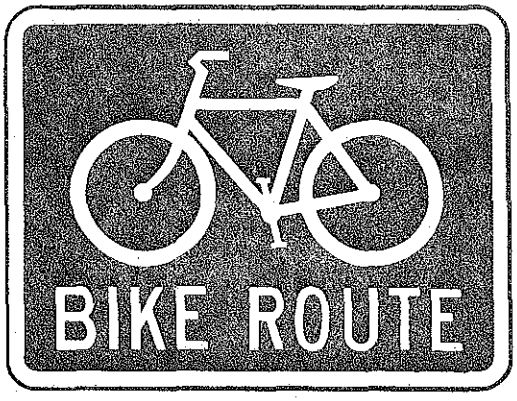
NEW STANDARD BICYCLE SIGNS

Authorized by the Bur. of Public Roads, Dept. of Commerce, and consistent with standards set forth by the Nat'l Joint Committee on Uniform Traffic Control Devices.

BIKE ROUTE

USE
A nationally-approved sign for marking an officially designated bicycle trail, appropriate both where a trail is separate from a street or highway and where a trail may be routed on selected roads and streets.

MATERIAL
Alloy aluminum or any other suitable metal, plastic or high-density plywood.



FINISH
Reflectorized if to be used at night by bicycles and automobiles, but otherwise not required.

COLORS
Standard Interstate Green, White. Green is sometimes referred to as PR Color #4 June 1965*

GAUGE OF METAL
Suggested: .064"

DIMENSIONS
24" x 18" mounted as horizontal rectangle

DESIGN
A bicycle symbol; the words BIKE ROUTE in 3" Series C letters.

CATEGORY
"Guide" or "Trail Blazer"

XING

USE
A nationally-approved sign for placement on a street or highway just in advance of a point where an officially designated bicycle trail crosses the street or highway.

MATERIAL
Alloy aluminum or any other suitable metal, plastic, high-density plywood.

FINISH
Reflectorized material as in warning signs if it must be effective at night.

COLORS
Standard Hi-Way Warning Yellow, Black; Yellow is sometimes referred to as PR Color #1 June 1965*

GAUGE OF METAL
Suggested: .080"

DIMENSIONS
30" x 30" mounted as a diamond.

CATEGORY
"Warning"

DESIGN
A bicycle symbol, the term XING in 6" Series D letters. "X" substitutes for "cross", shortening the word "crossing".

*U. S. Dept. of Commerce Color Tolerance Chart.

Figure III

ADDITIONAL INFORMATION

SUPPLEMENTARY ROUTE DIRECTIONAL SIGNS

When needed, a supplementary sign plate with a directional arrow may be placed below the Bike Route sign. The supplementary sign is a horizontal rectangle, 18" x 12" in size with an arrow symbol (vertical, left-hand, or right-hand) and a border in white on green background.

COLOR SAMPLES

Color Tolerance Charts showing acceptable standard colors and variations may be obtained by sending $6 to Clearinghouse, U.S. Dept. of Commerce, Springfield, Va. 22151. Ask for: Stock No. PB-169 553 COLOR CHARTS.

HEIGHT & MOUNTING

Signs erected at the side of rural roads shall be at least 5 feet above the roadway edge, measured from bottom of sign. In business or residence districts, and where parking is likely to occur or where there are view obstructions, the height should be at least 7 feet. Height to the bottom of secondary sign (arrow) may be 1 foot less than the appropriate height specified above.
There are no specifications for poles or posts used to mount signs. However, they should never be painted red. Treat wood posts with penta-chloro-phenol for rustic color & preservation.

FREQUENCY

There is no specified frequency; signs should be placed only where necessary, using existing poles to the fullest extent possible.

HELP IN ESTABLISHING BICYCLE ROUTES

Cycling is more popular today than ever. This year more than 61 million people of all ages are riding bicycles for a variety of reasons. If there are no riding facilities in your area, write to the Bicycle Institute of America, 122 East 42 St., New York, N.Y. 10017 for free publications and other helps which may guide your local campaign. The Bicycle Institute will also mail a list of free safety materials available in limited quantities.

MANUFACTURERS OF BICYCLE SIGNS

Nearly every city, county or state government has facilities for making signs, and may be consulted about manufacturing these two bicycle signs. However, if requested, the Bicycle Institute will provide the names of sign manufacturers who can provide these signs at minimum cost.

On segments or routes considered in conjunction with higher volume State roads (in excess of 2,500 vehicles per day) only complete separation between the bike route and the roadway is a realistic alternative; this is a third type of non-motorized facility. In all cases where this type of facility is planned to coexist in the same right-of-way as the motor vehicle, the minimum distance between the outer edge of the shoulder and the inside edge of the bikeway should be five (5) feet for a one-way facility. A one-way facility should always be paved and should be at least three feet in width. Where sufficient right-of-way is available and a two-way facility is desired, the separation from the roadway should be at least ten (10) feet and the bikeway a minimum of five (5) feet in width.

The final class of non-motorized pathway is one instituted apart from the highway right-of-way: parallel to the highway, along utility and railroad rights-of-way/easements, or in other locations indicated earlier. As implied earlier, this class of non-motorized paths is the most favorable for shared use among the several non-motorized modes. Opinion is varied and somewhat ill-defined on the subject of equestrian path/bike route compatibility. The only clear agreement within the two interest groups appears on the general subject of suitable surface for each mode: bicycles must ride on a paved surface - horses dislike a paved surface. Whether adjacent facilities, sharing a common right-of-way is or is not a useful approach can really only be determined on the basis of future experience with both types.

For bike routes apart from the road right-of-way, the two-way width criteria outlined above should be observed. For both equestrian and bicyclist use of this facility type, adequate vertical and horizontal clearances are important. An equestrian trail which is not part of a bike trail, should have a minimum of eight (8) feet width clearance and should be "brushed out" so that a minimum of ten (10) feet vertical clearance is available for unobstructed passage. No grade for either bike or horse trail should exceed ten (10) percent. Construction specifications which allow for adequate drainage, both for bike paths and equestrian/hiking trails are very important.

Hiking interest groups in the main express little disfavor with using an equestrian trail to pursue their activity (See questionnaire - Appendix).

An excellent summary of base preparation and surface types to consider for bikeways, especially when bike paths are planned is available in a brochure distributed by the American Institute of Park Executives. Portions of their discussion are reprinted here.

> Regardless of the type of surface used, the surface will deteriorate quickly unless there is proper preparation of the base and subbase at the time of construction. After clearing is completed, the subbase should be prepared by removing all of the top soil and stumps and roots. The subbase should then be compacted and, where necessary as in wet or unstable areas, stone or a proper material such as crushed stone, slag, etc., must be added to the subbase in order to make it stable. The type of soil in the area will have an effect on the construction, and details can best be worked out by seeking the advice of your municipal, county, or state engineer, or contracting firms.

Bicycle paths are usually laid out to the same construction specifications as light-duty roads, driveways, and service roads, or sidewalks. Here again, it must be remembered that in many instances vehicles will be used to maintain the bicycle paths and that construction should be of sufficient quality to support maintenance vehicles.

The base course which is laid on top of the subbase serves to support the wearing surface and to distribute the weight of vehicles, called loads, to the subbase. The type of materials used in the base course varies according to locality and availability, construction methods used, and type of surface used. Generally, the base course consists of graded aggregate, crushed stone, slag, etc. Under some circumstances, the base course may be made of soil cement, soil asphalt, or some other material.

Stone Chip - A technique that has been used successfully to construct bicycle paths is to prepare the subbase by removing all the top soil and then compacting the subbase. A five-inch layer of graded blue stone chip material is then placed on the subbase and compacted to three inches with a roller. The variation in size of the stone chips fills most of the voids to make a durable wearing surface, particularly after it has had some traffic on it.

When using this type of surface, care must be taken to protect the edges of the stone course so that it does not ravel. This means that the subbase must be scooped out to form a shallow trench into which the stone course can be placed. The earth on the shoulders is then filled back against the stone to prevent the edges from raveling. It is also possible to place metal or wood edging strips along the stone to hold it in place. A suitable wood strip consists of two-by-four or four-by-four redwood or cypress placed with the top edge at the same level as the stone and pegged in place with lengths of rods driven down through the wood and into the subbase. The soil shoulders are then placed back against the wood, and the wood forms a boundary very clearly defining the edges of the path and one that is aesthetically pleasing. In using metal edging strips on bicycle paths, care must be taken to insure that the metal is at the same level as the surface of the stone to prevent a cyclist who wanders off the path onto the edging strip from cutting a tire. . . .

Soil Cement - Soil cement is a simple mixture of pulverized soil combined with measured amounts of Portland cement and water and compacted to a high density. As the cementing

action occurs through hydration, a hard, durable semi-rigid material is formed. Suggested construction practices for soil cement may be obtained by contacting the Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois 60610.

Basic construction methods for soil cement are as follows: The area to be paved should be graded and shaped as required. All suitable soil containing organic material such as top soil, roots, humus, etc., should be removed and replaced with acceptable soil. The mixing of soil, cement, and water can occur in place. The quantities of cement to add to the soil must be determined by tests. Not enough cement for a particular soil will cause an inferior surface, however, more than enough cement is not harmful. Sandy and gravelly soils are the most favorable for soil cement construction. Silty and clayey soils are also satisfactory, but, the higher the clay content, the harder these soils are to pulverize. Clayey soils also require a higher cement content.

Although the amount of cement and water to be used varies with each type of soil, the amount of cement may be estimated as 10 percent of the volume of the soil cement which during construction will be compacted to six inches. Actual quantities of cement used can vary up to 16 percent. A 10 percent mixture of cement in a six-inch base course will use approximately .45 of a bag of cement per square yard. Water quantities can be estimated at eight gallons per square yard for a base six inches thick. The actual quantity of water to be added on a given day will vary according to the relative humidity, the rate of evaporation, and the water content of the soil prior to processing.

The technique used in constructing with soil cement consists of scarifying the soil, pulverizing it, and then shaping it to the desired finished surface. The proper amount of cement is then spread over the area in the correct proportion and dry mixed with the soil, completely and thoroughly. Water is then added in increments, and between each addition of water the soil cement and water are again mixed. This can be accomplished by using a scarifying device, disc harrow, scraper blade, etc. The amount of water added must be controlled because too little will result in improper hydration and will not permit proper compacting. Too much water will soak the mixture and make it impossible to compact it properly. When the proper amount of water has been added to the mixture of soil and cement, the entire mixture should then be compacted, a finish grading made to crown and grade the surface, and a final compaction

made. Time is an important factor since the final compaction must be completed within six hours after the mixing is started.

Soil cement, like other cement products, must cure to gain effective strength. It is firm and hard and will gain strength rapidly after the first few days of construction. In order to cure properly, a protective cover, such as moist straw or dirt, should be placed on the surface and maintained for seven days.

Soil cement is a good base, but it must have a seal coat to keep out moisture and a surface to take wear. Because it is made of soil fragments cemented together and if it is not protected, water will penetrate the fragments after a period of time and cause them to break apart. Also, abrasion on the surface will cause the exposed particles to deteriorate. The least expensive surface is a bituminous seal coat and stone chips.

A better surface and one that would be more durable would be an asphalt concrete wearing surface on top of the soil cement base. This can be accomplished by putting down a tack coat of bituminous material and then spreading and compacting a minimum layer of high density asphaltic concrete, usually one inch, then finish grading and compacting the mix.

Because soil cement as a construction method has not been widely used in many areas of the country, many contractors are not familiar with its use and would be at a loss in preparing estimates for a construction project of this type. The Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois 60610, has prepared a cost estimate form for soil cement construction which will enable those undertaking this construction method to make an intelligent evaluation of the cost involved. Generally speaking, soil cement construction six inches in depth will cost less than 50 cents per yard for materials and less than $1.00 per yard for labor costs, depending on locality. These costs are exclusive of the final wearing surface and protective coating for the soil cement. Where it is used, construction controls are necessary and someone with experience should supervise its construction.

Asphalt Cement - Asphalt is a strong, readily adhesive, highly waterproof, and durable cement. It resists the action of most acids, alkalies, and salts. It is a solid at normal atmospheric temperatures; however, it may be readily liquified by applying heat or by dissolving

it in petroleum solvents of varying volatility, or it may be emulsified.

Asphalt cement or paving asphalt must be heated in order to make it workable to mix it with aggregate or to spray. Liquid asphaltic materials are asphalts which have been mixed with volatile solvents in order to keep them in a liquid solution and make them workable. The volatility of the solvents and the rapidity with which they evaporate determines whether or not these liquid asphaltic materials are rated as rapid curing, show curing, or medium curing. For example, gasoline and naphtha, when used as solvents, evaporates quite readily and the asphaltic materials they are used in are rated as rapid curing. Kerosene evaporates more slowly and the liquid asphaltic materials in which this is used as a solvent are rated as medium curing. Where heavier, less volatile solvents are used, the liquid asphaltic materials are rated as slow curing. Liquid asphalt is also available in an emulsified form (mixed with water). Additional technical information on asphalt construction may be obtained by writing to; The Asphalt Institute, College Park, Maryland.

Hot-Mix Asphalt Concrete - Hot-mix asphalt concrete is one of the most commonly used paving materials and lends itself to bicycle path construction. It is usually made by screening aggregate, crushed stone, into various sizes which are then heated and dried and mixed in proper proportion with heated asphalt. This operation takes place at what is commonly known as a batch-mix plant. The asphalt is then transported while still hot from the batch-mix plant and spread in specified thickness and compacted. When it cools, it forms a wearing surface.

The surface course of asphalt concrete should be twice the thickness of the largest size aggregate contained in the mix. Asphalt concrete for bicycle paths is generally specified from one-and-one-half-inch to two inches in thickness on top of a four-inch aggregate base. Where an aggregate base is not used, a two-inch layer of asphalt concrete can be placed directly on the subbase and then a one-inch to one-and-one-half-inch asphalt concrete surface can be placed on top of this base. The construction will vary according to locality and local soil conditions and information can best be obtained by contacting municipal, county, or state engineers, and contracting firms. Costs vary according to locality but generally asphalt concrete will cost about 20 to 40 cents per square yard per inch thickness. Where bicycle paths are constructed with hot-mix asphalt concrete, they may be used as soon as they have cooled. . . .

Cold-Mix Asphalt Concrete - Cold-mix asphalt concretes are not used extensively for paving but they are made by mixing liquid asphaltic materials with aggregate. The most common application of cold-mix is for patching holes in existing asphalt concrete. When cold asphalt concrete mixes are used, sufficient time to allow the solvents in the liquid asphalt to evaporate is necessary in order for the asphalt concrete to set up properly. The cold-mix asphalt will remain soft until the solvents have evaporated, the length of time depending on whether slow-curing, medium-curing, or rapid-curing liquid asphalts were used to make the concrete. When used, it must be compacted by rolling or tamping.

Soil Asphalt - Soil asphalt is a semi-rigid durable material that is constructed by mixing soil with asphaltic binders. The soil to be made into soil asphalt is prepared by first establishing a good subbase, then pulverizing the soil to be mixed with asphalt. Liquid asphalt is then applied to the soil at the rate of three to six percent of the final volume of the soil to be treated. The liquid asphalt may be emulsified, but a medium-curing liquid asphalt usually is used. The entire mass of soil and liquid asphalt is thoroughly mixed with a grader blade or a disc harrow. For large jobs a special traveling mixing plant is used. Some water in the soil is desirable during the mixing process, about four to nine percent, depending upon the soil. Because a liquid asphalt has been used in this process, a curing time is necessary to allow about one-half of the solvents in the liquid asphalt and excess moisture to evaporate before compacting the mixture. After compaction the final curing time will vary according to the type of liquid asphalt used--and the soil asphalt will get harder as it ages.

Soil asphalt is a good base material; but, since it is a mixture of soil particles and unless it has a cover or seal coat on it to keep surface moisture from penetrating, it will deteriorate. A good surface coat for soil asphalt is a bituminous seal coat and stone chip. Soil asphalt will cost approximately 40 cents to 65 cents per square yard, four inches thick. When it is used for construction, someone familiar with the process should supervise the construction. Specific information on asphalt construction may be obtained by writing to the Asphalt Institute, College Park, Maryland.

Concrete - Twenty percent of the departments having bicycle paths have indicated that they are using concrete as a surfacing material. Concrete is very durable and once in place is relatively maintenance free. Successful construction calls for the building of a good base to prevent settling, heaving, etc. Concrete, unlike the other previously mentioned surfaces, is rigid. Any shifting occurring will cause the concrete surface to crack. Since the other services are pliable, some shifting can occur before cracking will appear.

The design specifications for constructing a concrete bicycle path would be the same as would be used for some sidewalks. This will vary according to locaity. Generally, a good, well-compacted subbase, with six inches of aggregate on top, is necessary. This should be followed by four inches of concrete. According to the Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois 60610, the thickness of the concrete slab would depend upon existing soil conditions and the type of foundation used.

When using concrete in large quantities, it is well to secure this from ready-mix plants and have it delivered by trucks. Quality control for the concrete mix is done at the mixing plant, and the same quality concrete is used throughout the project. When pouring concrete in a ribbon, as would be done for a bicycle path, joints must be made to allow for expansion and contraction. When pouring concrete paths, forms for the sides of the path must be used in order to level the path and/or to get proper drainage across it. After the concrete has been poured, it will have to be leveled using a straight edge; and, after it has begun to set, it will have to be finished for a proper surface.

Concrete will cost between $14 and $16 per cubic yard; exclusive of labor cost. Additional hauling expense for longer distances may be added to this cost.

Movable Walks - Wood walkways that have been used on sandy beach areas could also be used for bicycle paths in sandy areas and where shifting sands might cover an asphalt, concrete, or other surfaced path. Such a boardwalk is laid on the surface of the sand. It may be constructed from two-by-fours or two-by-sixes, pressure treated with a preservative to keep the planks from rotting where they are in contact with the soil. The planks are placed side by side and held together by wire or nylon line strung through predrilled holes. The boards are kept apart with one-half to one-inch spacers between them. These boardwalks can be constructed in short lengths and moved as needed to compensate for shifting sand.[14]

[14]Cook, Walter L. Bike Trails and Facilities, A Guide to Their Design, Construction, and Operation. American Institute of Park Executives, Inc., (no date), pp. 5-8.

Equestrians and hiking trails need no special surface requirements, with the exception that the surface be neither too soft (the horse's hoof will produce a suction action if submerged in marshy areas which will inhibit removal) nor, as has been already indicated, too hard (the horse needs a surface suitable for "tracking"). If a trail route or segment is expected to have a very heavy use, an additional surface preparation could consist of six inches of decomposed granite over the natural earth with six inches of sawdust or wood shavings mixed in. During hot dry summer periods, a light oiling would help to hold down the dust.[15]

Problems

The highway or street intersection represents one of the most baffling problem areas to a bikeway planner as well as to the motorist and bicyclist who attempts to coexist at this point. The problem is not confined to the obvious difficult maneuver of the bicyclist attempting to make a left-hand turn. As one planner indicates,

> In general, one assumes that only the cyclist who makes the left turn is in danger. . . . The cyclist who is traveling straight or makes a right turn is much more endangered because he is confident that he is safe on the right side and he does not suspect possible danger. In the construction of bikeway path systems, one has to acknowledge these dangers. One has to plan in such a way that the cyclists can recognize dangers in time in such spots where motor vehicle traffic touches or interests bicycle traffic.[16]

The first six of the next seven diagrams which follow have been compiled by U.C.L.A.'s Institute of Transportation and Traffic Engineering;[17] the last is from an AASHO preliminary study guide.[18] All show various methods which could be used in facility planning to provide cyclists with opportunities

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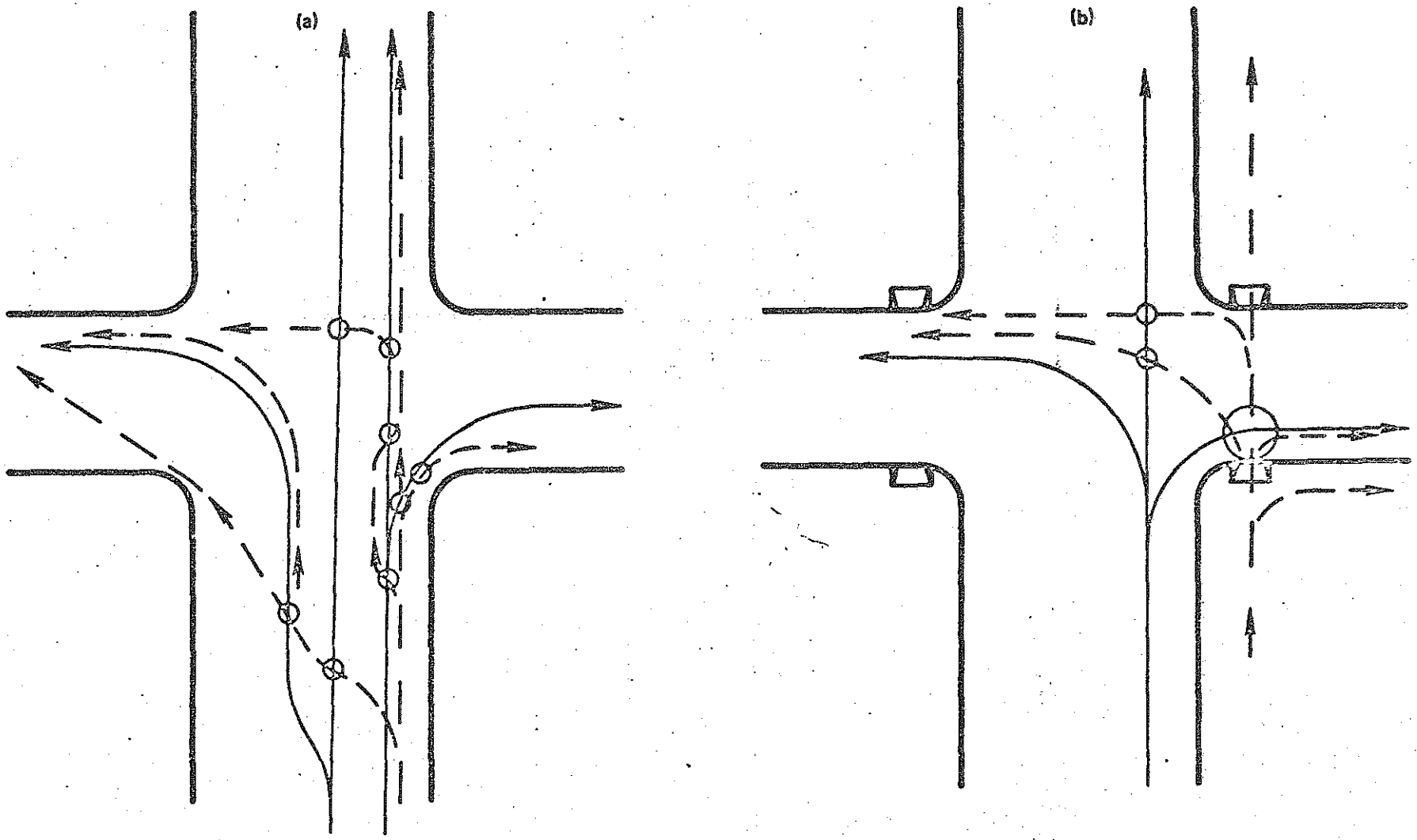
[15]Department of Interior - National Symposium of Trails, Op. Cit., p. 39.

[16]Highway Research Board (German), Guidelines for Bicycle Traffic, Cologne, Germany, August, 1963, p. 15.

[17]Institute of Transportation and Traffic Engineering, Bikeway Planning Criteria and Guidelines. (California, School of Engineering and Applied Science, University of California), April, 1972, p. 91ff.

[18]American Association of State Highway Officials, Proposed Guide for Bicycle Routes, April, 1973, (Draft only) p. 47.

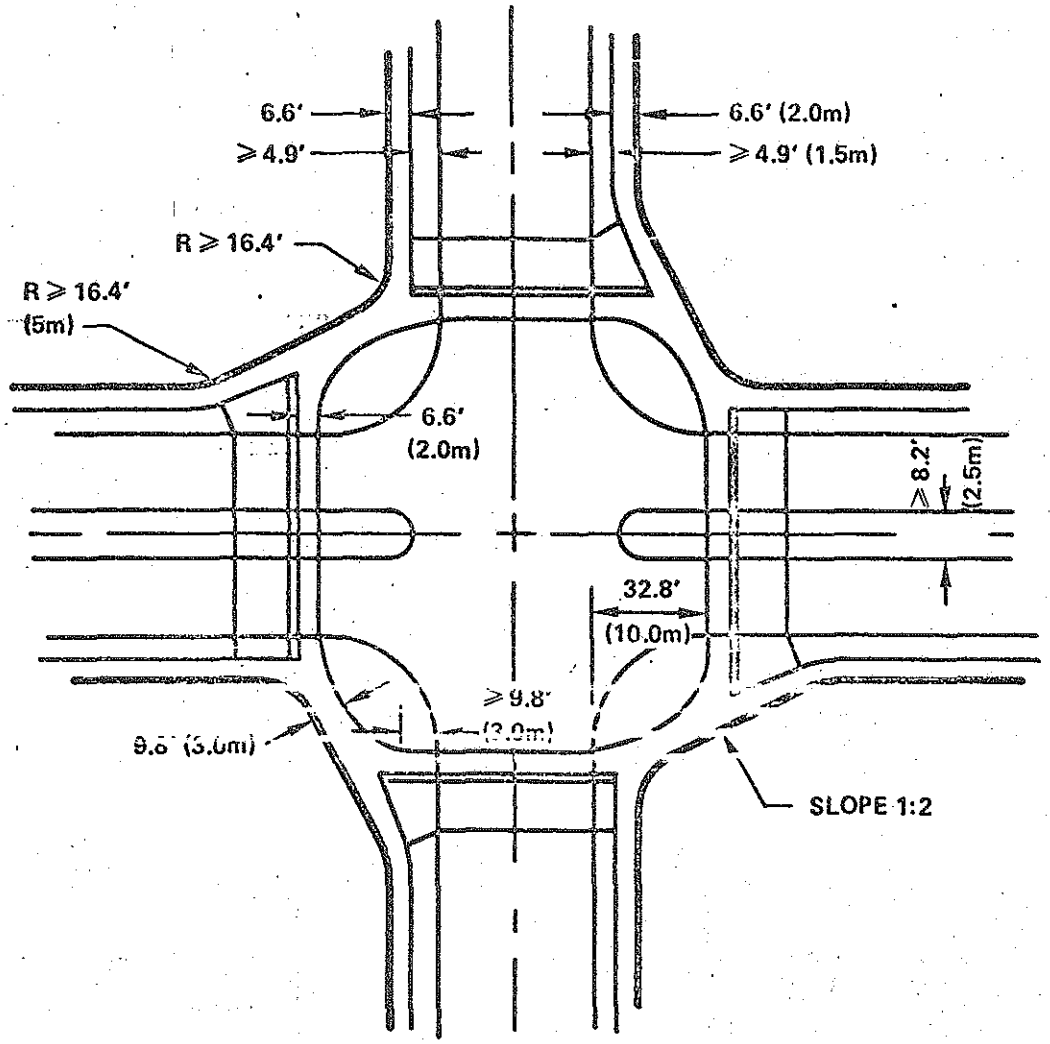


Various Methods Used by Cyclists to Cross Intersections.

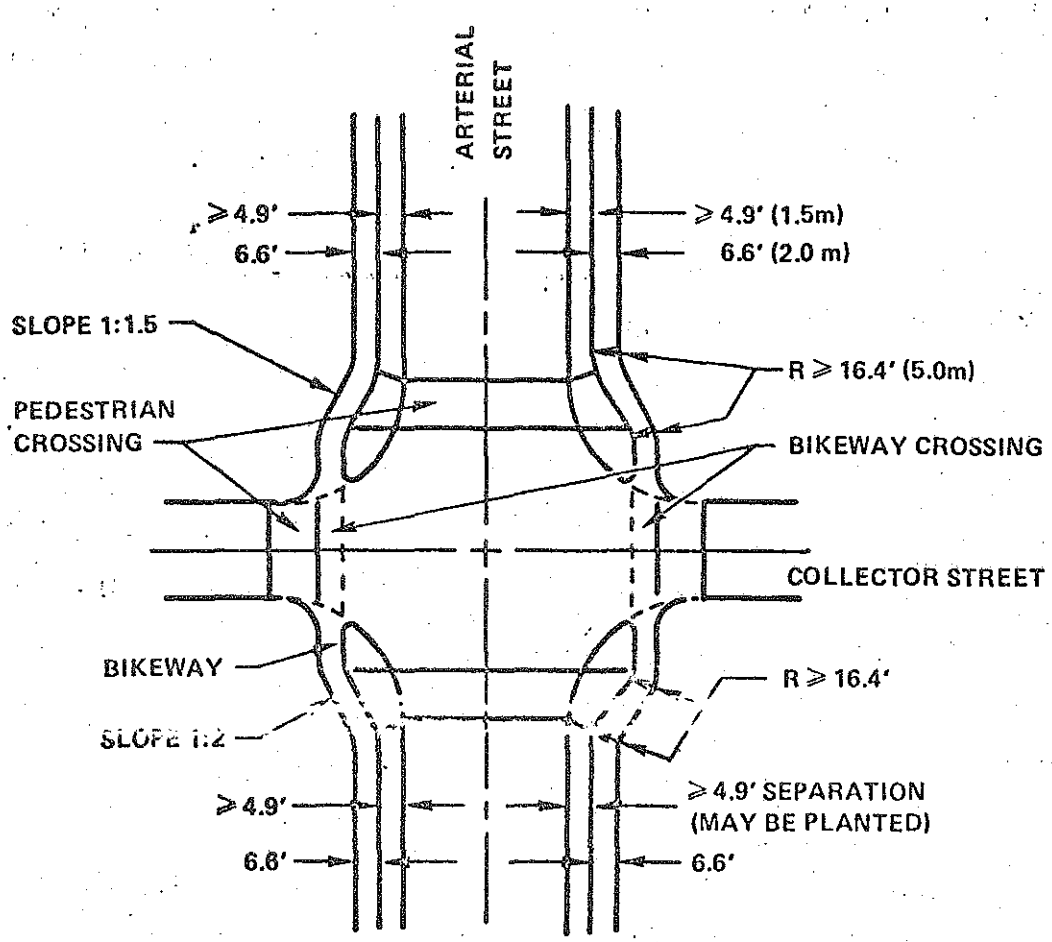
Possible Cyclist Trajectories

Automobile Trajectories

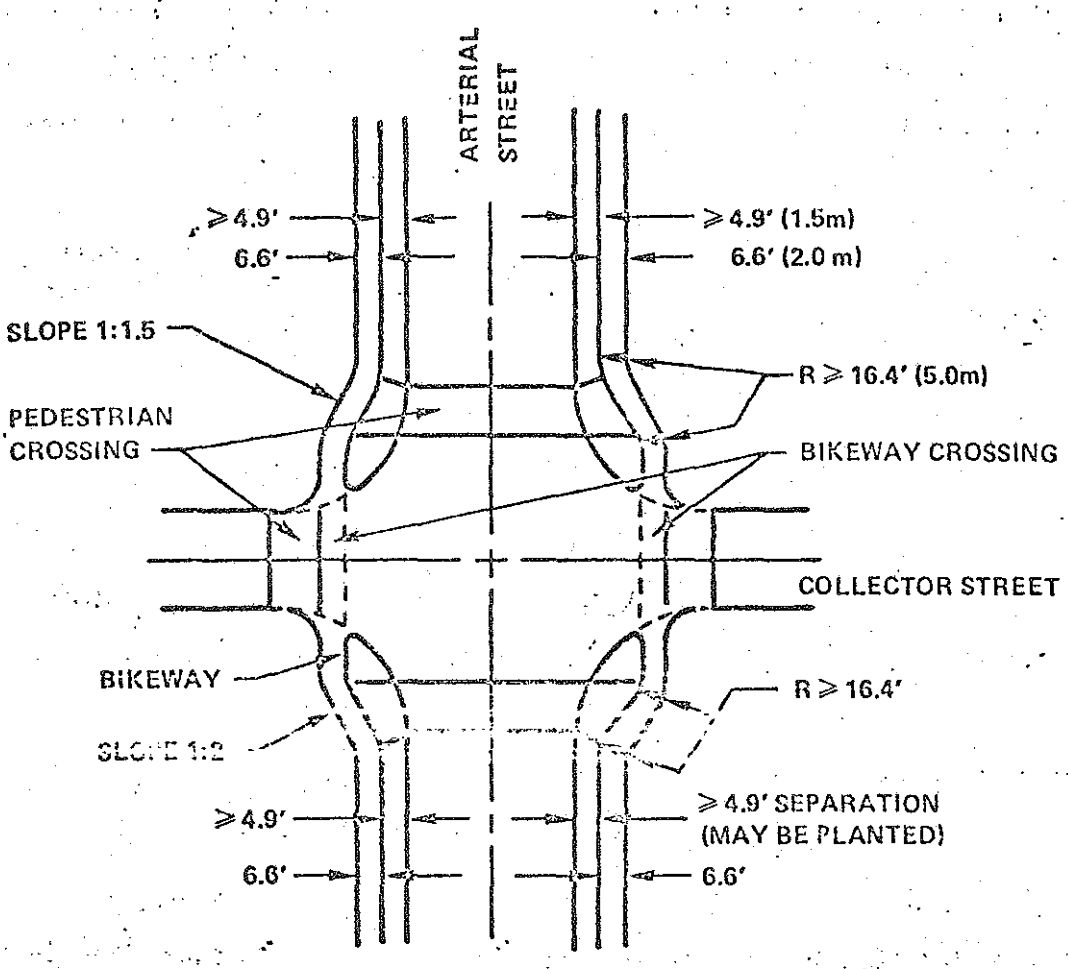
Conflict Points



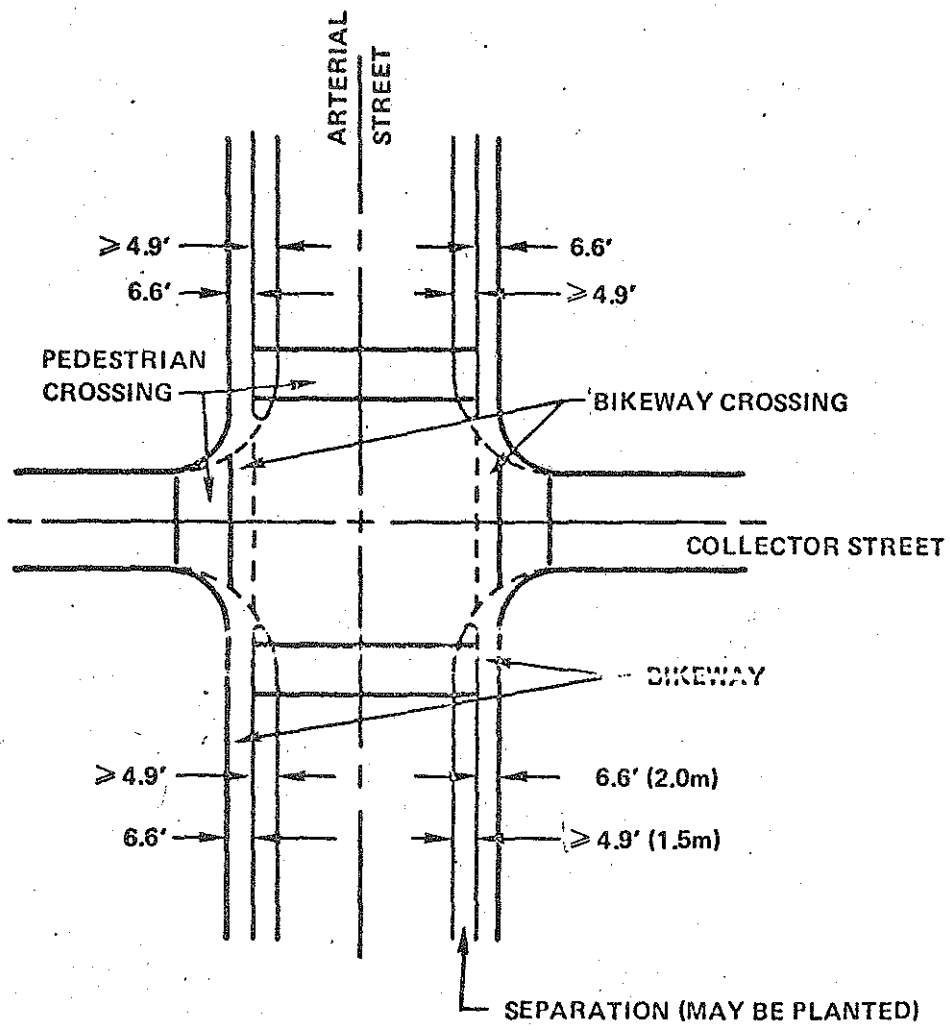
Recommended Intersection Design for Intersecting Arterial Roads with Bikeways on Each Road. Intersection is Asymmetrically Designed to Provide Bicycle Queue Areas at the Entrance to the Crossings.



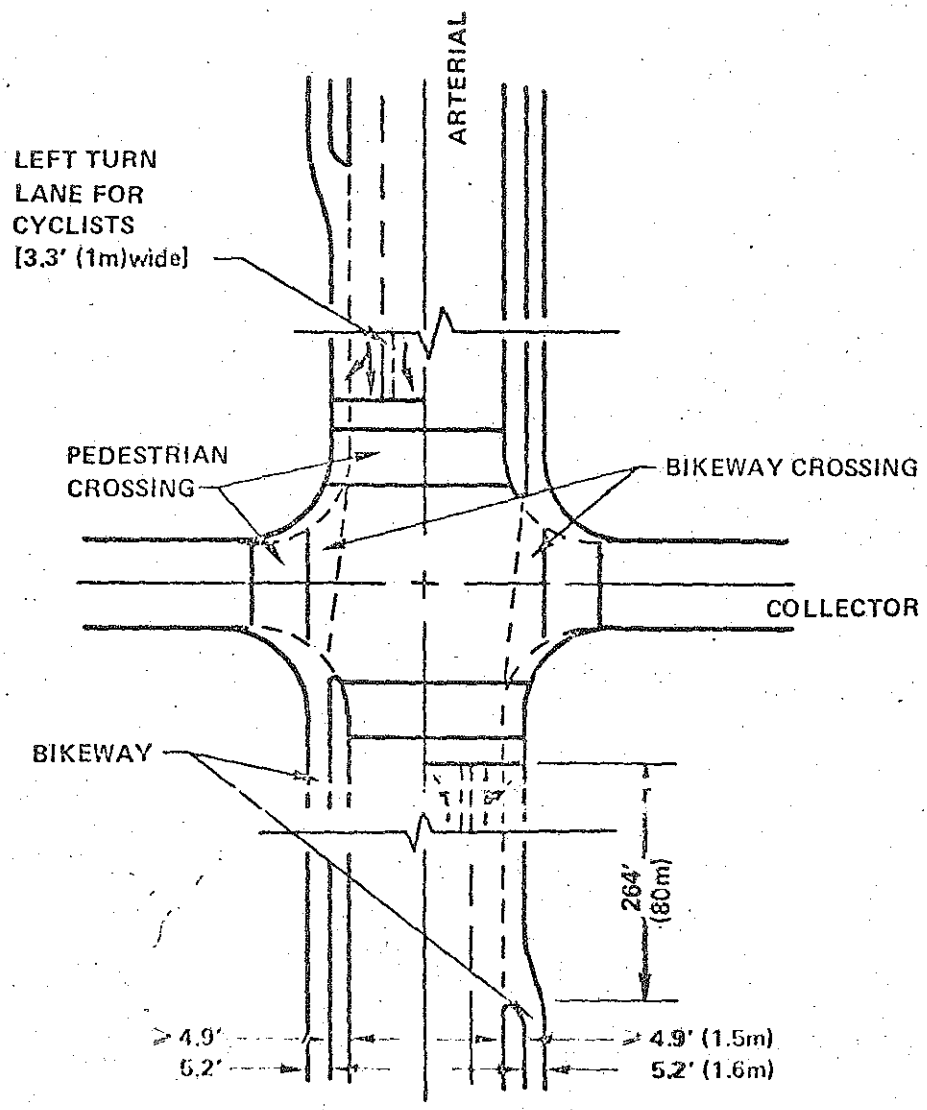
Recommended German Intersection Design: Bikeway on an Arterial Street Crossing a Collector Street. Bikeway is Separated from Motor Vehicle Traffic by a Strip. The Physical Design of the Bikeway Approach (Sharp Turns with Small Radii) Forces Cyclists to Reduce Their Speed Before Entering the Intersection.



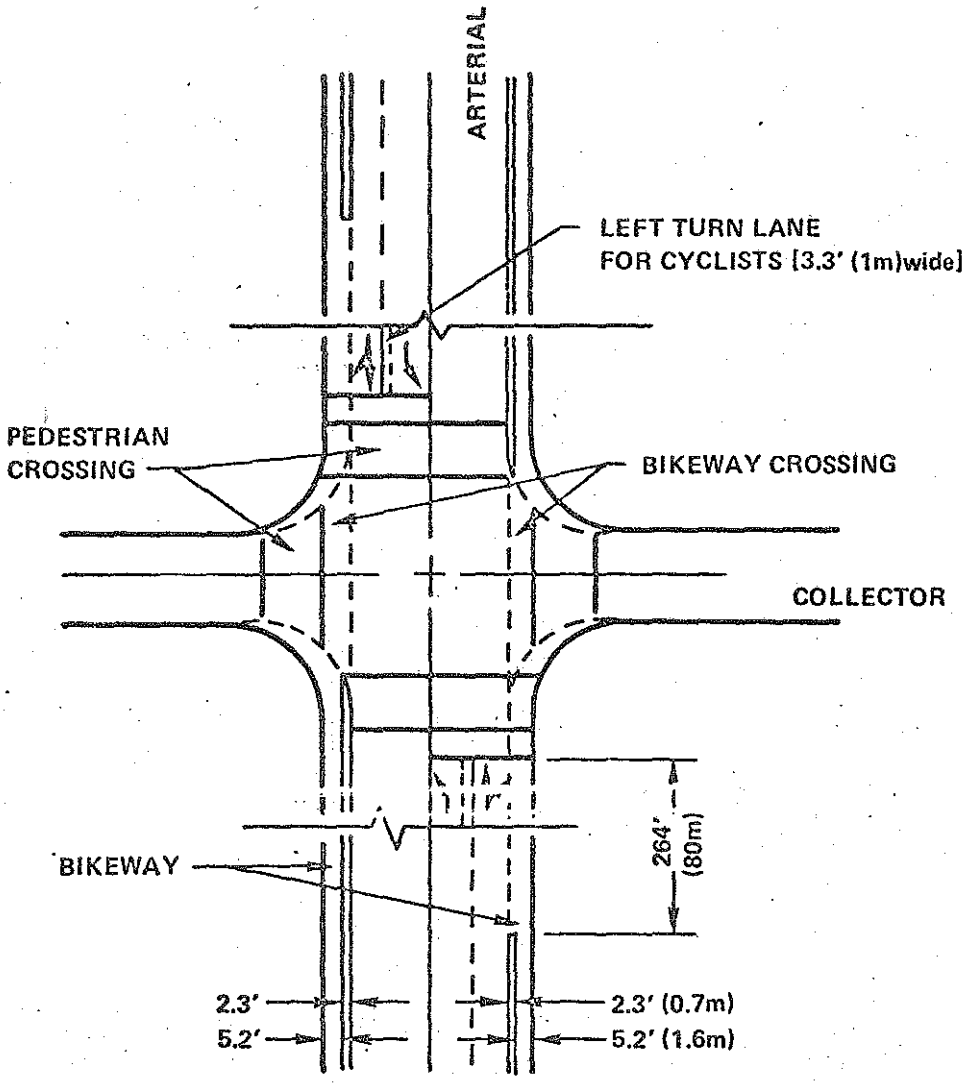
Recommended German Intersection Design: Bikeway on an Arterial Street Crossing a Collector Street. Bikeway is Separated from Motor Vehicle Traffic by a Strip. The Physical Design of the Bikeway Approach (Sharp Turns with Small Radii) Forces Cyclists to Reduce Their Speed Before Entering the Intersection.



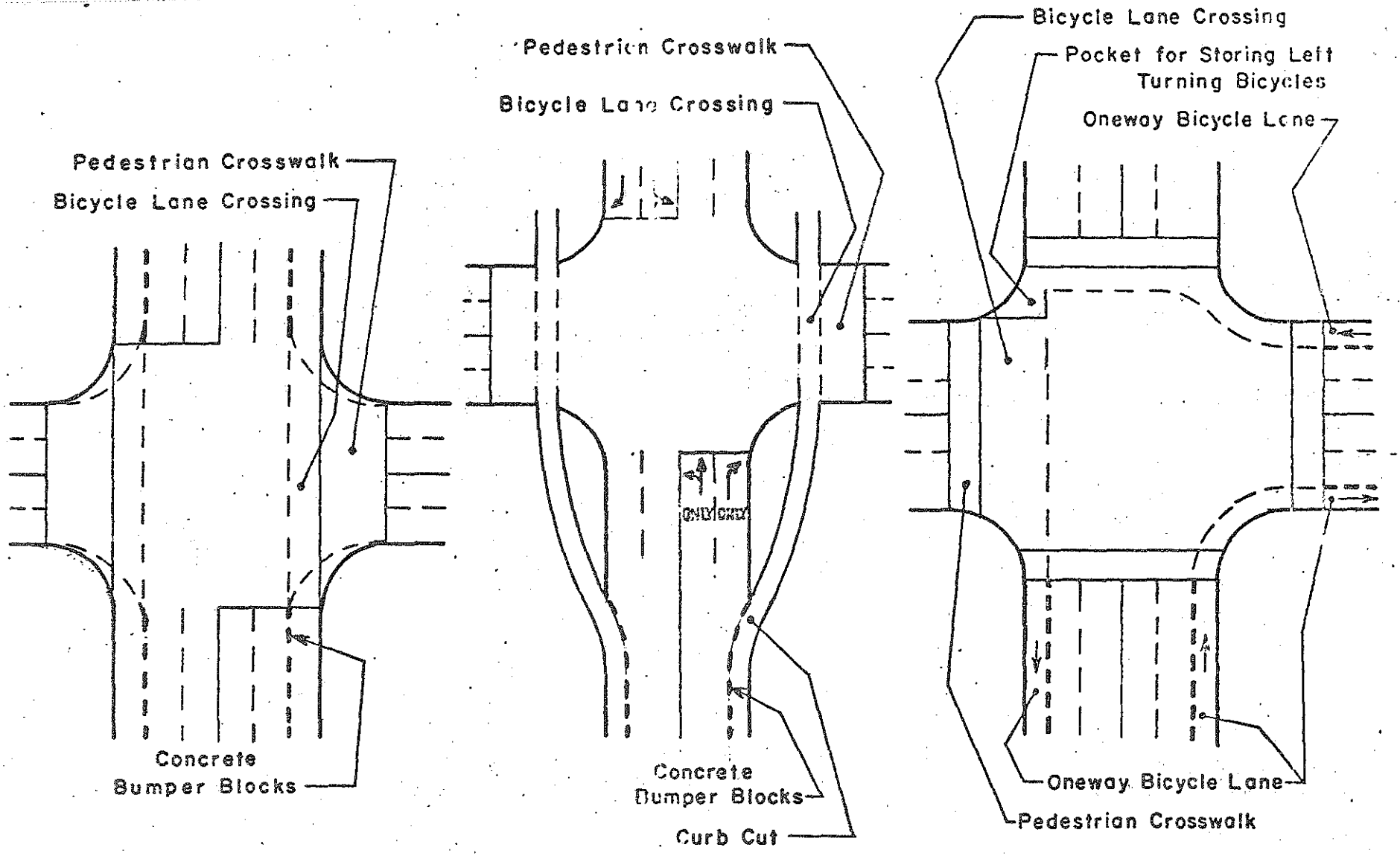
Recommended German Intersection Design: Bikeway on an Arterial Street Crossing a Collector Street. The Bikeway is Separated from Motor Vehicle Traffic by a Strip.



Recommended German Intersection Design with Bikeway on an Arterial Having Heavy Turning Movements onto the Collector Street.



Recommended German Intersection Design with Bikeway on an Arterial Street Having Heavy Turning Movements onto the Collector Street.



(a.) Bicycle Lanes crossing intersection

(b.) Bicycle Lanes offset to cross intersection

(c.) Bicycle Lanes continued on cross street

Typical Bicycle Channelization Arrangements
At Street Intersections

to negotiate intersections.

Although many communities have found it feasible to allow or even encourage the use of existing city sidewalks by bicyclists, the hazards to the pedestrian in this kind of mix are becoming increasingly foreboding. At the public meetings held throughout the State, when this kind of proposal was suggested, several disapproved and no one spoke in its favor; even when the proposal was made to widen sidewalks, only limited support was evident. As already indicated, when a bicyclist uses the sidewalk instead of the roadway, the danger is usually transferred from himself to the pedestrian. Neither bicyclists nor pedestrians are sufficiently prepared to cope with the frequent conflicts that result with shared sidewalk use. Potential collisions can occur when the bicyclist is both meeting and overtaking individuals. It should be noted that many communities in the state have already decided that this kind of mix exceeds acceptable safety limits and have - by local ordinance - prohibited bicycles from being used on sidewalks. Only when other alternatives are clearly not available, (the use of sidewalks may be the only realistic option in providing necessary short links in a larger network) should this approach be considered realistic, and then only if the sidewalk is widened sufficiently (eight feet or more). Curb cuts to establish path continuity at intersections will be necessary. If possible, some experimentation should be done with applying a dividing stripe in the center of such a widened sidewalk to test the feasibility of separating the walkers from the riders.

A significant problem associated with the construction of separate paths is the institution of techniques to discourage, if not prevent, motorized traffic use. For separate paths, the most frequently mentioned device (in the literature as well as in the public meetings throughout the state) is a combination of a barrier at origin and terminus of the

path with signs, which tell users that any type of motor vehicle is prohibited, frequently placed along the trail. Such a barrier would be large enough so that a person with a motorcycle, for example, would find it impossible to lift his machine over the barrier, yet small enough so that the hiker, the equestrian, and the bicyclist would have little difficulty going over it. Necessary maintenance crews and their vehicles, however, must have periodic access to the trail and, as the Ann Arbor Bike Path Study points out, this barrier technique "seriously discriminates against children and greatly detracts from the transportation utility of the path".[19]

Other techniques have been suggested; most of them however, applicable only to a bike path and not effective against potential abusers of equestrian and hiking trails. Thus:

> Another technique employs a gate that swings down flat with the riding surface when a bicyclist pushes up against it with his front wheel. The trick is to devise a release for the gate that is triggered by a bicycle and not by a motorcycle. The best approach so far seems to be a treadle embedded in a slot too narrow for a motorcycle tire but wide enough for a bicycle tire to fit into. The basis for differentiation is not great since balloon tired bicycles may have treads as wide as two inches, while the narrowest tread on a motorcycle may be as narrow as two-and-one quarter inches.
>
> With this technique reliable segregation probably will be impossible in all instances. It also may be difficult to prevent triggering of the treadle with a stick. However, the deterent effect of such a gate may be worthwhile. The design of the slot will require a good deal of experimentation to develop one through which a bicyclist can ride without spilling. Keeping the slot clear of leaves and dirt may also be a problem. The treadle and gate, however, probably can be designed as a fairly straightfoward spring-loaded mechanism.

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[19] Smith, Haldon L., Ann Arbor Bicycle Path Study. Ann Arbor, July, 1972, pp. 12-21.

> The third technique is to use a sound or heat actuated sensing device coupled with an alarm. A microphone and electronic filter can easily be arranged to trigger an alarm when the percussive sound of a motorcycle engine is sensed. Care in adjustment will be needed so as not to trigger too often on airplanes or other motor vehicles. Alternatively, a passive infrared sensor can be set to detect the momentary flash of heat from a passing motorcycle engine. These suggestions are well within existing technology, and probably could be implemented without too much expense. Their success would depend in part upon the sensors being fairly well concealed.
>
> Once triggered, the alarm can be transmitted by telephone, or preferably, by a small radio transmitter tuned to the local police frequency. A pre-recorded message can state the nature of the alarm and the location. It would then be up to the police to investigate the incident and to apply appropriate enforcement. Alarms can be used as backup to any of the barrier techniques suggested above, or several alarms can be placed at strategic spots along the path to thwart accessing the path by some round-about way.[20]

It is quite probable that the level of motorized use of equestrian portions of any non-motorized trail system not be high enough to warrant either patrol or the institution of appropriate barriers.

As mentioned, a serious problem exists for the bicyclist with regard to drainage grates. A number of individuals have expressed dissatisfaction with this hazard associated with their sharing of an urban roadway. One study sums up the problem very well and suggests a possible solution.

> The problem with drainage grates is not as simply handled as would be expected. Normally, grates consist of separated slats running parallel to the curb. Even with 3/8" wide slats and 3/4" slat separations the parallel slat configuration can entrap the narrow profile wheel of the modern light-weight bicycle. Since the design of grates, storm drains, and catch basins are based upon hydrodynamic calculations, solutions such as welding cross strips on the grate, or replacing the existing grate with zig-zag or horizontal configurations may not be feasible in many cases, since they may defeat the primary purpose

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[20]Smith, Haldon L., Op. Cit., pp. 12-21, 12-22.

> for which the drain is intended. Under these circumstances, and as a last resort, clearance around the grate with warning stripes should be considered, and where such hazards are infrequent, warning signs may be considered along with appropriate striping in an attempt to reduce the danger of the obstruction to the cyclists using the bikeway. However, when feasible from a hydrodynamic standpoint, the practice of welding cross strips on the grate is recommended as it provides positive safety to the cyclist at existing installations. For a longer range solution it may be feasible to develop (and mass produce) a zig-zag design grating for new construction (or replacement programs) along bikeways. In any event, drainage gratings do constitute a recognized hazard and therefore represent a possible source of civil action in the event of bicycle mishaps. This potential liability may or may not be reduced by the use of traffic control devices to warn and/or guide the cyclists around them. Only law suit experiences and court rulings can provide the answers to these questions.[21]

Other unique construction related considerations should be noted. Conventional asphalt spreaders and other construction machinery are convenient for working on widths with a minimum range of eight to ten feet. On paths that require a narrower width, part of the spreader could be "blocked out", thus a five or six feet width could be paved with conventional equipment. Materials for construction will be delivered by trucks, trucks which need sufficient clearance and stable surface to approach the site. In some places, if separate paths are planned, some hand work may be necessary, and possibly could raise the cost of construction even beyond the cost of a conventional machine laid walk.

A summary estimate of typical costs follows, the amounts, except where ranges are indicated, are minimum amounts.

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[21]Institute of Transportation and Traffic Engineering, Op. Cit., pp. 35-36.

Signs

The standard "Bike Route" (18" x 24") sign $12

posts[22] = $ 5

Five signs per mile = $85 to $100.

The oversize sign, which is recommended for rural installations, would probably cost considerably more.

"Bike Xing" and other informative signs have costs similar to the standard "Bike Route" sign.

The cost of signs associated with separate trails (such as notification at beginning/ending and signs prohibiting motorized use) are unavailable since design and size will not be uniform.

Striping

A single four-inch wide solid line = $300/mile.

Two applications are usually necessary - Total cost = $600/mile.

Paving a Shoulder (For work which is done at the same time as a highway construction or reconstruction project)

Two-inch bituminous aggregate surface five-six feet wide = $12/Ton of material.

Per mile - three hundred fifty tons needed = $4,200.

The portion of the "Clearing and Grubbing" cost which is attached to the shoulder paving portion of the total highway construction cost, Per Mile = Approximately $400.

In lieu of a bituminous aggregate surface, a "prime and double seal" application = $4,035.

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[22] Some signs could be mounted on existing posts.

Paths

Costs of bicycle path construction apart from the shoulder portion are considerably higher. A cost estimate for the various types of work would include:

Grading	=	$ 2,200
Drainage	=	2,200
Base	=	5,500
Surface	=	6,050
Engineering and Contingencies	=	2,500
Total	=	$18,450/mile.

The cost of constructing paths (in addition to right-of-way purchase, easement or lease cost) which are located outside of the highway right-of-way would be similar to the above. Fencing at some locations along the path may be required, and where instituted would raise the cost of construction approximately fifteen per cent. The "Clearing and Grubbing" cost may also be substantially higher.

Equestrian and hiking trails, since they generally need no special surface, will obligate little construction cost apart from the necessary clearing.

If separate rights-of-way were to be purchased for non-motorized facilities - the cost for a fifty feet wide route would range from $4,000 to $9,000 per mile depending on the location and variations in administrative costs. Purchase or transfer of easements, or leasing arrangements would of course involve considerably less expense than if the land is purchased.

The cost experiences of the Oregon Department of Transportation is pertinent here, since some trails there have been established apart from the highway right-of-way. These are bike and foot paths only.

> A wide range of costs has been experienced on the projects currently under construction, ranging from $28,000 per mile to $83,000 per mile. This range is due to the bikeway location, the necessity for bridges, riprap work along streams and retaining walls in some locations, while others require only minor grading and paving.
>
> The separated Class I bikeways are generally 8 feet in width, paved with a fine graded (Class C) asphaltic concrete surface along with a 4-inch aggregate base course. Bikeways are designed to withstand the loading of a light maintenance vehicle and freezing and thawing effects so that maintenance costs will be kept to a minimum.
>
> Following is a summary of some of the average costs experienced from the bikeway projects under contract:

<u>Grading Items</u>	
Clearing and Grubbing	$ 4,000/mile
Grading ($1 to $2.50/lin.ft.)	9,300/mile
Surfacing and Base ($1.75 to $3.30/lin.ft.)	15,500/mile
Drainage	2,400/mile
Miscellaneous Structures (Walls, Curbing, Guard Rail,etc.)	8,600/mile
<u>Bridges</u>	
Champoeg Park Bikeway - 160-ft. wood structure ($233/lin.ft. or $29/sq.ft.)	$37,300
E. Salem Bikeway - 64-ft. precast concrete structure ($184/lin.ft. or $23/sq.ft.)	11,930
Medford Bikeway - 160-ft. concrete structure 3-span ($434/lin.ft. or $54/sq.ft.)	69,500

(Note; All the above costs include 14.5% for engineering and contingencies)

> Excluding the costs of structures and costly riprapping, the average cost per mile for the separated bikeway facility is approximately $40,000. Including bridge costs and all items such as signing, fencing, et cetera, the bikeways averaged approximately $55,000 per mile.[23]

Oregon has also done some work on the subject of economic justification for building routes. They summarized their work and offered some of the following comments:

> An economic study was prepared by the Highway Planning Section to justify per mile expenditures of bicycle route construction. The basic approach entailed setting forth realistic assumptions about such variables as the cost of bicycling, time required for trips, and the value of time. Based on such assumptions, standard benefit-cost techniques were used to determine the feasibilty of bike routes for commuters, recreationists, and school children. The results were expressed in terms of the amount which could be expended per mile given a specified number of riders. (It was necessary to make assumptions about riders, since reliable estimates of actual use are not available.) While this method does not allow firm conclusions as to which of several justified bike routes to construct, it is an aid in distinguishing between worthwhile and poor investment.
>
> Some of the major conclusions are as follows:
>
> 1. With approximately 500 to 700 business commuters diverted from automobiles to bicycles, an expenditure of approximately $40,000 per mile would be justified for a bicycle route of four miles or less, it is unlikely that a commuter route of over five miles would be feasible. Also, with only about 100 commuters, it would be unwise to spend more than $6,000 to $8,000 per mile for a three or four mile route.
>
> 2. The construction of a recreational bicycle route of five to ten miles would be worthwhile at a cost of $30,000 to $60,000 per mile if it could draw approximately 25,000 riders annually--that is, if 500 riders were to use the facility for 50 days a year.
>
> 3. Bicycle routes designed to serve school children are the most difficult to justify with a benefit-cost framework, calling for per mile expenditures of

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[23] Oregon Department of Transportation, Highway Division, Oregon Bikeways Progress Synopsis, 1972, pp. 19-20.

only $10,000 to $15,000 for a two mile path. If, however, the route would obviously reduce accidents or was used for recreation, expenditures of two to three times these amounts would be reasonable.

> Conclusions of this study indicate that for trips of 5 miles or less, the bicycle has a comparative advantage over the automobile, from the standpoint of operating and time costs. Other less tangible benefits could be obtained from reducing automobile traffic, because drivers gain from reduced traffic congestion and reduced park-walk time. School-oriented bicycle routes are the most difficult to justify economically. However, safety advantages gained by providing adequate facilities would far outweigh actual economic factors.[24]

Construction materials consisting of a mixture of asphalt and crushed glass (glasphalt) are also now available for pavement construction and may in many cases be suitable for certain types of bikeway pavements. This technique would combine the advantages of resource reclamation and reuse with the institution of a transportation facility. This technique might be particularly suited for use by local governments in suburban and other urban fringe location areas. (See Appendix for background and general analysis of this technique.)

The responsibility for maintenance on routes located within the highway right-of-way will be the normal responsibility of the Department, and usual procedures for review of maintenance can be followed. If separate trails are instituted, it is likely that most users would be quite willing to assume part of the responsibility for trail maintenance. (See Question Number 15 of the Questionnaire - Appendix.) Clearing away various obstacles such as overgrowth, and other natural "intrusions"

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[24]Oregon Department of Transportation, Highway Division, Oregon Bikeways Progress Report, February, 1973, p.5.

could be a private user supplement to the necessary surface and erosion correction by the Department. 4-H groups, Scout groups, garden clubs, in addition to the equestrian, hiking, and bicycling organizations, would be potential groups from which to elicit help on a regular basis.

Much of the federal monetary aid available for either matching state and local non-motorized trail institution or available as outright grants is contingent on such a path or trail being defined and designated as a recreational trail only. There is therefore considerable indecision as to what federal matching funds or grants are available in conjunction with Section 10K of Act 327. Most, if not all, may be unavailable as funding sources. (The Appendix lists a summary of some of the major funding sources available for these trails so designated.)

Policy and Procedure Memorandum 21-23 (also included in the Appendix) sets forth the policy of the Federal Highway Administration relative to participation of federal gasoline tax revenues in support of non-motorized routes (bicycles).

CONCLUSION

A successful application of Section 10K, Public Act 327 - one that the public will support and will find useful - is largely dependent on three major considerations: the amount of money which can reasonably be set aside for this program, the degree to which both major non-motorized interest groups (bicyclists and equestrians) see that money used in their behalf, and lastly the degree to which these interest groups are involved during the planning and decision making stage.

The amount of money which can be actually spent for the construction of non-motorized facilities in any given year will be dependent on many variables, among them - the existing roadway construction program, the extent to which a need for non-motorized facilities exists and can be identified, the amount of money collected from vehicle gas and weight tax and thus available for distribution through the Motor Vehicle Highway Fund, and the contingencies listed within the law itself. If legally permitted to do so, some governmental units may find it possible to pool resources or delay expenditures for a time to build up a larger funding reserve.

In soliciting information from potential users, the Department sought to include as wide a spectrum of interest groups as the term "non-motorized" could logically embrace. The degree of interest shown at this point rather clearly establishes the equestrian and bicyclist (and to some degree the hiker) as the predominant classes of users.

It is important that both groups be given visible consideration for inclusion under 10K, unless and until legal interpretation of the statute indicates otherwise. If one group, for example, would be deleted from consideration, its support for the overall trail system could be lost, and indeed could turn into resistance.

Undoubtedly the single most important ingredient for successful non-motorized facility planning is the ingredient essential for all public planning: early involvement of the public. All planners are occasionally tempted to disregard the essential political nature of their planning and consequently fail to provide mechanisms for public involvement. It is important not only to ask for public contributions during an "information gathering stage" (which the Department has already attempted to do), but to continue such an interchange in the selection of specific projects.

PRIORITY AND JURISDICTIONAL LEVELS

Priority levels for equestrian/hiker facilities and bicycle facilities cannot rationally be combined, primarily because of the difference in transportation related interest between them, a difference which has implications for facility location and inherent safety levels. These two major interest grups are therefore placed into two separate priority classifications. The division of roadway responsibility - based on the nature of the road service provided - among state, county, and city governments has been legally established and well accepted. This division of responsibility should be closely followed in the planning and building of non-motorized facilities.

A. Bicycles

1. Basis For Priority

   a. Existing safety hazard amelioration

   b. Potential for use

   c. Cost

2. Priority Groups

   a. Urban (Metropolitan) commuter

      1. School trips (children)

      2. Work trips

   b. Urban (Metropolitan) short-to-medium distance recreation

   c. Urban-rural long distance

3. Jurisdictional Responsibility

   a. The establishment of facilities to serve school and work trips should normally be a municipal responsibility. The

addition of bicycle signs and/or striping along selected low traffic volume residential streets would usually constitute such establishment. In some cases, where route selection is an obvious and direct alternative to selection of a parallel, high-volume state trunk line, state aid in financing such a route could be considered.

b. Metropolitan recreational bicycle trips in association with the existing transportation network or additions to it should normally be the responsibility of the county or city government, or under their joint cooperative agreements. Low-traffic volume county roads should form the backbone of this system, with every effort made to reduce the use of high-volume routes as bike routes.

c. The urban-to-rural and the rural long distance bicycle trips should be the responsibility of state government. Since in many cases, a non-motorized facility need may be indicated along a high-volume state trunkline corridor, a feasibility comparison should be made between using a parallel county road (often a "turn-back") - in cooperation with the appropriate county road commission - and the use of the actual state roadway.

B. Equestrian/Hiking

1. Basis For Priority

a. Potential for use

b. Availability of land

c. Cost

2. Priority Groups

   a. "Backyard" rider

   b. "Single-day" rider (loop(s) facility)

   c. Long distance rider

3. Jurisdictional Responsibility

   a. Only in rare instances (where a need could be established within the confines of a rather large city park, for example) should a city consider establishment of a non-motorized trail for the specific use of the equestrian or hiker. It is recommended that any effort which is instituted on behalf of this group by the city should be one that is on a shared basis with a county-initiated project.

   b. The "backyard" rider (those who enjoy riding "close to home") should be the responsibility of the county government.

   c. The rural longer distance (either "straight-line", or "loop", or combinations) should be the responsibility of state government. (Close planning cooperation should be established between the Department, the Department of Natural Resources, and regional planning agencies.)

RECOMMENDATIONS

A. Existing Trunk Line System

1. Identify those portions of the current state trunkline network which have projected average annual daily traffic (AADT) levels within the three ranges outlined in this report (under 1,000, 1,000 to 2,500, over 2,500).
2. In cooperation with the Department's regional offices, Department of Natural Resources, the Michigan Tourist Council, Regional Planning Agencies and interested citizens, identify:
   a. Present high incidences of safety conflicts between motor vehicles and bicycles.
   b. Major recreational attractors.
   c. The portions of routes selected on a projected AADT basis (1 above) which have scenic and general aesthetic appeal.
   d. Nearby (to c above) population concentrations.
3. Establish routes with 2.a above a first priority, and routes selected from combining 2.b., 2.c., and 2.d. above the second priority.

B. Other

1. Establish formal contact with the major utility companies in Michigan, requesting official status on the possibility of acquiring a joint interest in their holdings for the purposes of trail use.
2. Establish formal contact with the Michigan Public Service Commission for listings of existing and proposed railroad abandonments. The Department, through its Transportation Planning Division, should invite and actively foster close cooperation with the Department of

Natural Resources, once potential and already approved abandonment portions are identified. Funding availability and limitations under Section 10K for this type of use should then be established.

3. Develop location and general selection criteria for equestrian/hiking trails. This should be done in close and direct consultation with appropriate special user groups.

4. Develop a comprehensive design standard manual. Such a manual would be for both state, county, and city use and be packaged in booklet form for easy distribution and subsequent reference. The manual would expand on the guidelines and information available in this report and would include detailed specifications on construction (grades, materials, widths, signs, striping, etc.). The manual should be updated periodically as experience in this new field provides an increased flow of information. A corollary to this manual, distributed with it, and also revised periodically, should be information on existing trails in the state - both publicly and privately instituted - and location of non-motorized interest groups. To insure accuracy and currency of such a document, some type of uniform procedural requirement should be established to insure that the Department becomes the clearinghouse for this information. Maps showing low volume state trunk lines, and those specific state routes periodically designated as bike routes should also be included.

5. On the basis of (1), (2), (3) and (4) above, establish an experimental bicycle/equestrian trail on independent rights-of-way. An evaluation of compatibility between adjacent non-motorized modes would be a subsequent action.

6. Consider the construction of sidewalks in conjunction with any new or reconstruction urban highway project, the decision on inclusion or exclusion to be made on the basis of an assessment of potential pedestrian activity along the highway.

7. Investigate the feasibility of reducing the present motor vehicle speed limit on some highways designated as bikeways.

8. Consider the establishment of a separate functional class of non-motorized roads. The legislation would appear to allow for this type of classification and justification for serving a non-motorized travel interest could thereby be broadened.

9. Annually publish maps for distribution which show:

   a. Low volume state trunk lines.

   b. State routes newly designated as bike routes.

10. Seek clarification of statute. The legislation authorizing expenditures for non-motorized facilities (Section 10K, Public Act 327), raises several specific questions on interpretation which should be resolved as much and as soon as possible before implementation procedures are started. Examples:

    a. Section 10K (1) Do "highway purposes" in this section include all rights of eminent domain normally associated with tradition concepts of highway purpose?

    b. Is the application of the term "transportation" restrictive in any sense, that is, would its application under this act normally exclude so-called recreationally oriented facilities, such as equestrian and hiking trails?

    c. If the answer is in the negative on the above - what is the significance of the words, "including bicycling"? Does this mean that justification for types of non-motorized uses <u>other than</u> bicycling is not inherent in the legislation and must therefore be individually vindicated?

d. Section 10K (2) Is "reasonable amounts" to be determined soley from exception (3) a) through e), or is this to be determined from additional criteria as well?

e. Does "lanes, paths, and roads" completely define "facilities" (subsection 1) or can various appurtenances (such as bike storage facilities or overnight rest areas) to "lanes, paths, and roads" be included in this term?

f. Section 10K (3) If any of the conditions 3 (a) through 3 (e) exist does this place a prohibition on providing facilities or merely remove the obligation to provide facilities?

g. General:

Does Section 10K allow highway administrators to establish a separate functional class of non-motorized paths?

Does Section 10K allow highway administrators either or both of the following options: To postpone use of non-motorized funds and thus, in effect, establish a reserve for later project applications; allow "pooling" of distributions so that joint funding of projects among governmental units is possible?

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APPENDIX

Announcement of Public Meetings

on Non-Motorized Transportation

MICHIGAN STATE
HIGHWAY COMMISSION
MACKINAC BRIDGE AUTHORITY – INTERNATIONAL BRIDGE AUTHORITY

WILLIAM G. MILLIKEN, GOVERNOR

E. V. ERICKSON, GRAND HAVEN, CHAIRMAN
PETER B. FLETCHER, YPSILANTI
CHARLES H. HEWITT, GROSSE PTE. FARMS, VICE CHAIRMAN
CLAUDE J. TOBIN, ESCANABA

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JOHN P. WOODFORD, STATE HIGHWAY DIRECTOR

LANSING 48904
PUBLIC INFORMATION OFFICE: PHONE 517/373-2160

FOR IMMEDIATE RELEASE March 2, 1973

LANSING -- Five public meetings to gather public sentiment on bicycle paths and other non-motorized transportation facilities have been scheduled by the Department of State Highways.

The meetings are in relation to Section 10-K of the recently enacted Transportation Package (Act 327): "Highway purposes as provided in this act include provisions for facilities for non-motorized transportation including bicycling."

The section adds, among other things: "The Department of State Highways, the counties, cities and villages receiving funds from the Motor Vehicle Highway Fund shall expend reasonable amounts of such funds for establishment and maintenance of lanes, paths and roads for non-motorized transportation."

The section is included in the new law, which raised state gasoline taxes by two cents a gallon.

State Highway Director John P. Woodford said the five public meetings will be held in five different cities, in cooperation with the Department of Natural Resources.

"Primary purpose of the meetings," Woodford said, "will be to provide interested groups and individuals with information about provisions of Section 10-K, and to give an opportunity for public discussion of the problems and issues to be considered in its implementation."

Interested groups and individuals are invited to attend the meetings to offer comments and suggestions about the need for, and character of, non-motorized transportation facilities, and to assist in developing a state, county and municipal program to meet the new requirements.

All five meetings will begin at 8 p.m. on the following dates and locations:

Tuesday, March 27, State Law Building Auditorium, Corner of Ottawa and Pine Streets, Lansing;

Tuesday, April 3, Pioneer High School Auditorium, 601 West Stadium Blvd., Ann Arbor;

Thursday, April 5, Central High School Auditorium, 421 Fountain, NE, Grand Rapids;

Tuesday, April 10, Grayling High School Gymnasium, 500 Spruce St., Grayling; and,

Wednesday, April 11, State Office Building Auditorium, 301 Ludington, Escanaba.

Written statements in lieu of, or in addition to, those made at the meetings, or requests for copies of Section 10-K, Act 327, should be sent to: Jack E. Morgan, Asst. to Public Hearings Engineer, Dept. of State Highways, P. O. Drawer K, Lansing, Mich. 48904.

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A-1-B-1-C-1-DX-1

Questionnaire

and

Summary of Responses

NON-MOTORIZED FACILITIES QUESTIONNAIRE

	Very Important	Fairly Important	Only Slightly Important	Unimportant	
1. How important to you are each of the following reasons for bicycle riding?					
Recreational Riding: Long distance	84	49	29	36	(1)
Recreational Riding: Short distance	118	53	13	20	(2)
Transportation: School	61	36	15	64	(3)
Transportation: Work	65	36	26	59	(4)
Transportation: Shopping	39	35	39	73	(5)
2. How important is each of the following in contributing to dangerous situations for the cyclist?					
Incorrect drain grate construction	66	59	38	21	(6)
Cars making right turns at intersections	57	60	51	17	(7)
Cross-traffic at intersections	65	71	35	15	(8)
Cars passing too close	142	33	5	12	(9)
Narrow shoulders	140	23	15	12	(10)
Other _____					(11)
3. When bicycles share a roadway with motor vehicles - how important are each of the following for enhancing the safety of the bicyclist?					
Signing only	34	63	41	25	(12)
Striping	68	62	26	16	(13)
Raised Barriers	100	41	14	18	(14)
Other _____					(15)
4. How important to you is the separation of pedestrians from bicyclists?	56	62	56	29	(16)
5. How important to you is each of the following as a reason to ride bicycles along streets with high automobile volume?					
Fewer stop signs	25	49	60	47	(17)
Less cross traffic	48	49	40	41	(18)
Shorter distance	41	53	32	39	(19)
Better road surface	82	38	28	29	(20)
Other _____					(21)
6. How important to you would each of the following be as a reason for increasing your use of a bicycle?					
Separate facilities to major destination areas	101	34	17	26	(22)
Auto-shared facilities along major arteries	51	46	29	44	(23)
Auto-shared facilities along residential and secondary streets	53	57	36	25	(24)
Auto-shared facilities on rural low-volume rds.	57	59	27	30	(25)
Widened sidewalks to accommodate both pedestrian and bicyclists	48	36	33	55	(26)

	Very Important	Fairly Important	Only Slightly Important	Unimportant	
7. What should be the focus of a Statewide effort to institute non-motorized trails?					
Connecting major recreational areas	127	48	19	12	(27)
Connecting regional shopping centers	33	47	61	61	(28)
A single long-distance facility along some established transportation corridor	70	48	49	28	(29)
Loops which connect a variety of recreation or economic nodes	110	62	26	12	(30)
Recreational - along a continuous and scenic natural feature	177	31	10	4	(31)

	YES	NO	
8. Can hikers and horseback riders use the same rural non-motorized trail?	224	37	(32)
9. In terms of general alignment, do cross country skiers and horseback riders desire a similar type of trail, in your opinion?	222	31	(33)
10. Would it be advisable to have cross-country skiers and hikers share a trail on an alternate seasonal basis?	213	33	(34)
11. Are separate, hard surfaced bicycle paths in rural areas also suitable for hiking purposes?	164	66	(35)
If you were hiking, would you use such a trail?	158	77	(36)
12. In your opinion, do bicycles and horses conflict if they share the same paths?			
If you are a bike rider	93	73	(37)
If you are a horseback rider	84	106	(38)
13. Can hikers and horseback riders share the same paths?	231	29	(39)
14. Would you support some type of earmarked use tax in order to supplement available funds for non-motorized facilities?	219	40	(40)
15. Would you be willing to be responsible for a portion of the maintenance of a non-motorized facility?	212	35	(41)

16. If non-motorized pathways are constructed physically separated from roadways, what techniques can be used to discourage motorized traffic use?

17. What kinds of techniques or institutional structures would you recommend to insure that consistent planning between local and statewide systems occurs?

Summary of "Open-ended" Responses
(in order of frequency of response)

Line 11	Trucks
	Poor pavement conditions
	Failure to yield right-of-way
	Unpaved shoulders
	Narrow lanes
	Speed
	Debris
	Left turns
	Narrow bridges
Line 15	Separate pathways
	Driver education, attitude
	Paved shoulders
Line 21	Only Access
	No curbs
	Faster
Question 16	Barriers
	Fines
	Signs
	Narrow entrance points
	Police Patrol
	Additional legislation
	Education
Question 17	Cooperation between all governmental units
	Statewide commission
	Communication with actual users
	Clearing with regional planning agency
	Volunteer Committees
	Commission within the Department

Policy and Procedure Memorandum 21-23

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C. 20590

POLICY AND PROCEDURE MEMORANDUM

Transmittal 285
March 14, 1973
HNG-1

1. MATERIAL TRANSMITTED

PPM 21-23, Bicycle Routes Along or Crossing Federal-aid Highways.

2. EXISTING ISSUANCES AFFECTED

This is a new issuance.

3. COMMENTS

This memorandum sets forth the policies and procedures of the Federal Highway Administration relating to the provision or inclusion of facilities for bicycle operation on Federal-aid highways, and Federal-aid and Federal fund participation in the cost of providing such facilities.

R. R. Bartelsmeyer
Acting Federal Highway Administrator

Distribution:
Basic

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

POLICY AND PROCEDURE MEMORANDUM

Transmittal 285
21-23
March 14, 1973

BICYCLE ROUTES ALONG OR CROSSING FEDERAL-AID HIGHWAYS

1. PURPOSE

This memorandum sets forth the policies and procedures of the Federal Highway Administration (FHWA) relating to the provision or inclusion of facilities for bicycle operation on Federal-aid system highways and Federal-aid and Federal fund participation in the costs of providing such facilities.

2. DEFINITIONS

a. Bicycle - A device propelled exclusively by human power upon which any person may ride, having two tandem wheels.

b. Bicycle Route - A continuous pathway designated for use by bicycles (including three-wheel cycles); it variously may follow a bicycle trail, a shared roadway or a sidewalk where such use is sanctioned.

c. Bicycle Trail - A separate pathway provided for the use of bicyclists. Where it parallels a highway it is separated from the roadways for motor vehicular traffic by an open space or barrier.

d. Shared Roadway - A portion of a roadway which is designated for use by bicycles. The particular portion of the roadway may either be shared with motor vehicles or be designated for use by bicycles only.

3. BACKGROUND

There is a growing interest in bicycling for recreational and other trip purposes. Where this activity occurs on the roadways of high speed and/or high volume highways both safety and efficiency are seriously impaired because of the dangerous mixture of motorized and nonmotorized modes of travel. Provision of bicycle trails separate from the vehicular traffic roadways will promote safety and will assist in retaining the motor vehicle carrying capacity of the highway while adding new bicycle capacity.

4. POLICY

It is the policy of the FHWA to encourage the provision of bicycle trails (as defined above) as parts of Federal-aid highway projects wherever conditions are favorable and a public need will be served. Accordingly, the work to construct bicycle trails may be approved by the Division Engineer where all of the following conditions are satisfied:

a. The trail is constructed in conjunction with, and concurrently with, a Federal-aid highway improvement, including reconstruction projects.

b. The trail is located and designed so as not to reduce the safety to motorists or pedestrians or create a hazard for bicyclists.

c. The trail will constitute a usable facility, having termini that are accessible to users, or will form a segment of such a facility located and designed pursuant to an overall plan of transportation development.

d. There is an agreement by a public agency for the operation and maintenance responsibilities for the trail.

e. The trail is within the right-of-way of a Federal-aid highway. This includes, but is not limited to, Federal-aid right-of-way acquired under the provisions of 23 U.S.C. 319 (Landscaping and Scenic Enhancement), 23 U.S.C. 135 (Urban Area Traffic Operations Improvement Programs) and PPM 80-1 (Right-of-Way Procedures (General Principles and Coordination with Other Government Agencies)).

f. There is reasonable expectancy that the trail will have sufficient use in relation to its cost to justify expenditure of Federal-aid and other public funds in its construction and operation.

5. PLANNING

Individual bicycle trails should in most cases be planned as parts of a larger system of trails and this system of trails in turn may form portions of an overall bicycle transportation system. Where 3-C planning operations (i.e. continuous comprehensive transportation planning process carried on cooperatively as set forth in PPM 50-9 (Urban Transportation Planning)) are in progress, consideration should be given to including bicycle trails as parts of the areawide transportation plan. Planning for bicycle trails is eligible for financing with planning and research funds as provided in 23 U.S.C. 307(c).

6. APPLICABILITY OF EXISTING LAW, REGULATION AND DIRECTIVES

Bicycle trail construction is to be done as an element of a Federal highway project. Accordingly, the provisions of 23 U.S.C. apply directly and normal Federal-aid procedures established by existing Policy and Procedure Memorandums are to be followed. This shall include, but not be limited to applicable sections pertaining to the following: equal employment opportunity, labor provisions, maintenance requirements and utility adjustment.

7. FUNDING

All classes of Federal-aid and Forest Highway and Public Lands Highway Funds are available for participation in the costs of construction of trails when located on an applicable Federal-aid system. Federal-aid funds may not be used for the independent purchase of additional rights-of-way for the sole purpose of accommodating bicycle trails.

8. FEDERAL-AID PARTICIPATION IN TRAIL FACILITIES AND APPURTENANCES

a. General - There may be Federal participation in the construction of trails for the grading, drainage, paving, traffic control devices, appurtenances, barriers, landscaping and structures, as necessary to accommodate the types and numbers of users expected on the trail.

b. Structures - As is found necessary for the development of a trail, Federal-aid funds may be used for walls, railings, additional width of bridges at overpasses and additional lengths of bridges at underpasses for trail continuity. Federal-aid funds may also be used to build highway-trail grade separations where:

(1) Vehicular speeds and crossing volumes are sufficiently high as to be judged to constitute a hazard to both trail users and motor vehicle traffic and the trail cannot be rerouted to provide a crossing via some other type separation structure, or

(2) The separation is necessary because the highway facility has complete control of access.

Washington Headquarters approval is required where it is proposed to route a trail over a sizable structure such as a major stream crossing or viaduct.

c. Appurtenances - It is not expected that there will be extensive provision of supplementary facilities such as bicycle racks, shelters, comfort stations, small parking areas, etc. However, where such facilities are found necessary for the safety and health of users, consideration may be given to providing such facilities as a part of trail development projects.

d. Traffic Control Devices - Necessary traffic control devices including signs, signals and pavement markings in accordance with PPM 21-15 (Traffic Control Devices on Federal-Aid and Other Streets and Highways) required for proper and safe utilization of a new or existing trail erected in conjunction with a highway improvement project may be financed with Federal-aid funds of the same class as the highway improvement itself.

9. TRAILS WITHIN THE RIGHT-OF-WAY OF EXISTING FEDERAL-AID HIGHWAYS

Approval is not to be given for Federal-aid highway projects that cover work only for the development of a bicycle trail along an existing Federal-aid highway unless such work is to be in conjunction with a highway improvement project. Where trails are provided by other agencies within existing Federal-aid highway rights-of-way, it is expected that they will comply with paragraphs 4b, c and d.

10. DESIGN CRITERIA FOR TRAILS

a. Trails should be designed and constructed in a manner suitable to the site conditions and the anticipated extent of usage. In the absence of national standards, the Division Engineer may determine the acceptability of proposed standards or design criteria for trail construction. In general, a bicycle trail should be designed with an alinement and profile suitable for bicycle use, with a surfaced pathway that will be reasonably durable, incorporate drainage as locally necessary and be of a width

appropriate for the planned one-way or two-way use. Where the trail crosses a street or highway at grade the location should be such as to insure adequate sight distance and the design should include traffic control devices for both the motor vehicle and bicycle traffic as necessary for safe operations.

b. Trails should be separated from the roadways a sufficient distance so that the vehicular roadway is not readily accessible to trail users. Where acceptable separation of the trail from the roadway cannot be otherwise attained, a barrier sufficient to discourage trail users from using the vehicular lanes should be erected. Where a bicycle trail along a highway crosses a natural barrier or a transportation route for which a grade separation is necessary, practical alternate structure treatments should be considered. It may be in order to aline the trail so as to utilize a highway structure (widened as needed) and with a barrier separation rather than provide a more expensive separate trail overpass or underpass structure.

11. SHARED ROADWAYS

a. Because of potential hazard to both bicyclists and motorists, proposals for the development of bicycle routes on existing streets and highways should be carefully reviewed. Shared roadway arrangements that result in bicycles operating on the through lanes or shoulders of high-speed or high-volume highways or operating in the lanes of high-volume streets should not be allowed. Within cities, streets can be used to provide reasonably safe bicycle lanes only along low-volume thoroughfares.

b. It is recognized that bicycle operations are governed by State codes and local regulations and ordinances. Where local ordinances permit and pedestrian volumes are not high, utilization of existing sidewalk systems together with proper intersection treatments may be suitable segments for bicycle routes.

12. TRAILS FOR EQUESTRIANS, HIKERS AND OTHER NONMOTORIZED TRANSPORTATION MODES

In some local areas, additional separate facilities for pedestrians, equestrians and possibly other individually operated units may be necessary. Where they constitute reasonably proper parts of a highway project these other types of trail facilities should be included. Since they largely are special case conditions, general policy statements are not in order. In general, the provisions herein for bicycle facilities are applicable for their inclusion in highway projects.

R. R. Bartelsmeyer

R. R. Bartelsmeyer
Acting Federal Highway Administrator

Glasphalt Construction Materials

USE OF SALVAGED WASTE GLASS IN BITUMINOUS PAVING

Ward R. Malisch

Delbert E. Day

Bobby G. Wixson

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University of Missouri-Rolla

Rolla, Missouri

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INTRODUCTION

The Solid Waste Disposal Act of 1965 was enacted to solve problems resulting from a continuing increase in the amount of solid waste produced in the United States each year. Not only the increasing amount but the changing character of these wastes also contributed to the dissatisfaction with methods of disposal traditionally used in most sections of the country. Thus, the act was designed to satisfy two basic purposes:

1) To initiate and accelerate research and development programs for new and improved methods of solid waste disposal including studies directed toward the conservation of natural resources by reducing the amount of wastes and unsalvageable materials and by recovery and utilization of potential resources in solid waste.

2) To provide technical and financial assistance to State and local governments and interstate agencies in the planning, development, and conduct of solid waste disposal programs (1)*

In the President's Message on Environment to the 91st Congress, a redirection of research was ordered to place even greater emphasis on techniques for recycling materials (2). This meant that solid waste should no longer be viewed as something of no value, to be collected and disposed of in the most economical manner. Instead, according to Richard Vaughn, solid wastes were to be regarded as "a resource out of place," to be recovered and reused whenever possible (3).

Recycling or salvage operations as a principal means of disposal have been unsatisfactory in most United States cities due to aesthetic, sanitary, and economic considerations. Even when partial salvage is used serious problems result from difficulties in separating various components from the heterogenous mixture of municipal wastes and the lack of stable markets and prices for salvageable materials (4). An important economic consideration is the transportation cost involved in bringing salvaged materials to market. Even if suitable technology is developed for separating municipal wastes, the economic benefits from such a separation will hinge upon the availability of markets in the area where the separation is accomplished. This, in turn, may require the development of new markets for salvage by-products.

Research now being conducted at the University of Missouri-Rolla (5) deals with a new means for using glass salvaged from municipal refuse. The proposed use for this waste glass is as an aggregate in asphaltic mixtures used for urban paving and maintenance operations. The advantages of this usage are apparent when the current means for recycling waste glass are considered. The major portion of the cullet (waste glass) used in glass making at present is derived from in-house process waste. Glass is segregated at very few waste processing facilities. One reason is that where hand labor is used, costs of separating and cleaning cullet have increased substantially (6). However, even if economical mechanical separation methods are developed, several other factors will limit the extent to which waste glass can be returned to the furnaces. Impurities must be removed since they may cause erosion of the furnace refractories or alter the color characteristics of the glass (7). As little as a tenth percent copper or a few tenths percent iron will produce appreciable color in clear glass. The slender ring of metal left around the neck of bottles with twist-off caps must also be removed and since this ring is aluminum, magnetic means can not be used.

If colorless glass is desired all colored cullet must be removed and this requires, in the absence of hand sorting, equipment such as high intensity magnetic separators or optical scanning devices. In the bottle redemption centers established by the Glass Container Manufacturer's Institute in cities across the nation (8) glass is segregated by color when delivered to the center, but this would not be the case for glass separated from municipal refuse. In the absence of color separation, the salvaged glass could be used only in manufacturing colored glass containers.

Transportation costs must also be considered in assessing the economics of returning glass to the furnaces. In some urban areas there is no conveniently located glass plant and profits realized by salvaging glass may be seriously eroded, therefore, due to high transportation costs.

A final factor to be considered is the total market potential for waste glass reuse in bottle making assuming that cullet of satisfactory quality can be produced. The amount of cullet used in a given operation depends upon the type of glass to be produced and may be as low as 10 percent or as high as 60 percent (7) of the raw materials. Even when the full cooperation of the glass container industry is anticipated in the use of cullet, it is doubtful that as much as one-half of the waste glass produced in the United States each year can be recycled in this manner. In a recent report on resource recovery from incineretor residue, it was concluded that the potential salvageable amounts of waste glass from six large cities studied, would swamp the cullet industry in those cities. The report stated that alternate uses and new product approaches in this area are vital (9).

Some of the problems involved in recycling waste glass to the bottle furnaces can be avoided by using the glass as aggregates in asphaltic concrete. While separation of the glass from other refuse is still necessary, contamination is not nearly as critical. Some contaminants such as brick, stone or other ceramics would present no problems, and even the presence of some tramp metals would probably be tolerable. Color separation would be unnecessary. A major advantage is that the waste glass could be used in the urban area where it is generated so that transportation costs are minimized. By substituting glass for portions of the conventional aggregates used in city street maintenance, a steady market would be assured for this waste component. The diminishing natural aggregate supplies in some urban areas further enhance this concept since aggregate costs increase with increasing haul distances. The depletion of suitable aggregates in localized areas or in some places, regions, has been recognized by national highway officials and has resulted in a study of promising replacements for conventional aggregates for highway use which is currently being concluded (10). Waste glass can most certainly be included in the list of promising replacements.

LABORATORY STUDIES

Under a grant from the Bureau of Solid Waste Management, U.S. Public Health Service, a laboratory investigation of the properties of glass-asphalt mixtures was initiated in the summer of 1969. Mixtures containing up to 95 percent glass by weight were investigated using waste glass obtained from non-returnable bottles which had been washed, crushed and screened into various size fractions ranging from 1/2 in. material down to material passing a No. 200 sieve. Particle shape for material retained on the No. 8 sieve is illustrated in Fig. 1. The Marshall design method was used for various gradations of the glass and it was found that mixtures satisfying Marshall design criteria recommended by The Asphalt Institute could be designed using penetration grade asphalts and aggregates composed entirely of crushed glass (11).

Water resistance of these glass-asphalt mixtures was found to be very poor, however, as specimens subjected to a standard soaking procedure deteriorated due to loss of adhesion between the glass and asphalt. Studies aimed at improving the water resistance of these mixtures were undertaken and several proprietary anti-stripping compounds were investigated as well as additions of hydrated lime. It was found that loss in adhesion, as measured by an immersion-compression test, could best be prevented by replacing a small amount of the minus No. 200 mesh glass with hydrated lime on an equal volume basis. As little as one percent lime on an aggregate weight basis resulted in 100 percent retention of dry strength after soaking for 24 hours in a 140F water bath (12).

Evaluation of other properties of glasphalt has also been carried out in the laboratory. Sieve analyses of glass recovered from Marshall test specimens have indicated some breakage of the glass due to mixing, compacting and testing. However, the changes in gradation were quite small when compared with changes noted in field studies of degradation in conventional asphaltic mixes and are not thought to be critical (11).

FIELD INSTALLATIONS

At the present time glasphalt test strips have been placed in five cities in the United States and at two locations in Canada. The authors have supervised installation at four of these locations and information concerning the others has been supplied for use in this report. Of particular interest in the test strips were the placement and compaction characteristics of the glasphalt, the surface texture, and the general performance characteristics (resistance to abrasion, rutting, stripping, etc.) Details of the different installations are as follows.

Owens-Illinois

The first glasphalt strip was placed at the entrance to the Owens-Illinois Technical Center in Toledo, Ohio, on October 4, 1969. The experimental strip was 18 feet wide, 58 feet long and varied in thickness from 1/2 inch to 4 inches. It was placed over an existing faulted concrete slab which had been tacked with a diluted cationic emulsion.

* Numbers in parentheses refer to bibliographic references

The glass used for the project was a mixture of drain cullet, broken bottles, and a small amount of a waste glass salvaged from municipal refuse in Houston, Texas. The predominant component of the mixture was the drain cullet, the particles of which are more nearly equi-dimensional in shape than broken bottles. Fig. 2 illustrates the shape characteristics of the material retained on a No. 8 sieve. Due to a deficiency in the fine sieve fractions, it was necessary to blend a masonry sand with the glass to supply additional fine material. The sand comprised about 20 percent of the total aggregate weight. The resulting gradation is shown in Table 1.

Atlas Paving, Inc. of Toledo was responsible for mixing and placing operations and the services of the Toledo Testing Laboratory were employed to carry out routine tests for aggregate gradation and properties of the asphaltic mixture. The materials were prepared at an asphalt batch mix plant with 2-ton capacity pugmill. A 70-85 penetration asphalt cement was used and a proprietary cationic anti-stripping agent was added by hand at the pugmill in an amount equal to 4 percent by weight of the asphalt cement. At this time, the beneficial effects of hydrated lime in imparting anti-stripping characteristics had not been discovered. The asphalt content was 5.5 percent (total weight basis).

The aggregate was heated to 275F and the asphalt to 325F prior to placing. Standard equipment and construction practices were used in placing the material. A Blaw-Knox 75 paver was used and the roller employed an 8 to 10 ton Gallion tandem. The glasphalt closed well under rolling and produced a smooth riding surface with little tearing or pick-up. The only difficulty encountered was the abnormally long time required for the tack coat to break due to a low ambient temperature and high relative humidity. The glasphalt was placed on the slab before the emulsion had become tacky in some places and this led to some difficulty with slippage between the mat and underlying slab during compaction.

Field Marshall specimens were molded and tested using standard Marshall testing procedures. Results are given in Table 2. The stability value was considerably higher than values obtained in the laboratory studies at Rolla which utilized all-glass aggregates. This was probably due to the shape characteristics of the drain cullet, the addition of masonry sand and the use of slightly lower penetration asphalt cement. A sample sawed from the finished pavement had a specific gravity of 2.14 which corresponded to 96 percent compaction.

Traffic volume over the strip has ranged from 400 to 1,000 vehicles per day with a large percentage of these vehicles being trucks. Inspection of the strip one year after placement indicated generally good stability of the pavement. One pronounced low spot which holds water was evident in the immediate area of the fault in the underlying slab. In this area, the glasphalt was 4 inches thick and wedging of the dip would probably have prevented the subsequent settlement. There was some indication of stripping at the surface. The pavement surface was rough in spots and sockets where larger particles had been dislodged were evident.

In a more recent installation, placed in October of 1970, a "stop-and-kiss" lane was paved with glasphalt at the Owens-Illinois Technical Center. The lane is 245 feet long, 9.5 feet wide and consists of 1 inch of glasphalt placed on a base of 7-in. thick conventional asphaltic concrete. All of the glass used for this project was obtained by crushing clean non-returnable bottles collected at a bottle redemption center in Toledo.

Anchor-Hocking

A 1,500 square foot parking lot and several entrance aprons were paved with glasphalt at the Anchor-Hocking plant in Winchester, Indiana, on June 8, 1970. The lot consisted of a 3-in. thick glasphalt mat placed on a crushed limestone base course which had been primed with an MC-30.

The glass used for this project was predominantly clean cullet obtained by crushing bottles in a hammermill and it was again necessary to use sand blended with the glass to supply adequate fines. The resulting gradation is shown in Table 1. DeBolt Concrete Company of Richmond was responsible for mixing and placing operations. An asphalt batch mix plant with a 2-ton capacity pugmill was used, and hydrated lime was added at the pugmill by hand, using two 50 pound bags per batch. The asphalt was a 60-70 penetration grade and the asphalt content was 5.5 percent (total weight basis). The mixture was placed at 275F with a Blaw Knox PF-65 paver and compaction was achieved with a Ray-go Romper vibratory compactor. The lot was placed in two 1 1/2-in. thick lifts and the roller was used without the vibrator for breakdown rolling and with the vibrator for finish rolling. The mix was found to be more tender than that used in Toledo and some crawl occurred when the roller was placed on the material immediately as it came from the paver. It was necessary to allow the material to cool to 250F to increase the asphalt viscosity to the point that the crawl was eliminated.

Inspection of the lot and entrance aprons four months after placement indicated excellent performance. The parking lot had been treated with a Jennite seal coat since a fueling area for fork lift trucks was adjacent to it. There were several "scuff marks" resulting from turning movements which occurred soon after placement. However, this is a characteristic of many conventional asphaltic concrete parking lots. The approach aprons, which had not been sealed, were in excellent condition with no evidence of any stripping. Fig. 3 illustrates the appearance of the glasphalt surface after four months.

University of Missouri-Rolla

A road to the University general services building and central receiving area was paved with glasphalt on July 10, 1970. The portion paved was 525 feet long and 20 feet wide with a thickness of 1 1/2 inches. It was placed over an existing surface treatment in which chuck holes had been patched with cold mix prior to tacking with a diluted SS-1 emulsion.

The glass used for this project was donated by the Glass Container Manufacturers Institute and came from three sources. The mixture of drain cullet and clean broken bottle glass was markedly more deficient in fines than the glass used in previous field installations. Due to this deficiency it was necessary to blend more fine sand with the glass in order to obtain a suitable gradation. Ultimately, two different gradations were used as shown in Table 1. In each of these the aggregate consisted of approximately 63 percent glass, 33 percent fine sand and 4 percent hydrated lime with the lime being added at the pugmill by hand.

Rolla Paving Company was responsible for mixing and placing operations. An asphalt batch mix plant with a one ton capacity pugmill was used and the mix originally came from the plant at a temperature of 300F. However, the drier temperature was later reduced to 275F due to difficulties in compacting the mixture at higher temperatures. An 85-100 penetration asphalt cement was used with asphalt contents of 5.75 and 5.5 percent for the coarser and finer mixes respectively. A 2 ton vibratory roller was employed without vibration for breakdown rolling and with the vibrator for finish rolling. Once again there was some difficulty with crawl of the mixture under the roller and it was necessary in some spots to allow the temperature to drop to 225F before rolling. In the section with the finer gradation the roller was leaving ridges as shown in Fig. 4 at temperatures as low as 175F. These ridges were gradually rolled out to produce the smooth surface shown in Fig. 5.

Field Marshall specimens were molded and tested using standard Marshall testing procedures. Results are given in Table 3. As indicated, the percent air voids was quite low for the coarse mixture but was within acceptable limits for the fine mixture. Sawed samples from the finished pavement were checked for density and the compaction ranged from 95 to 98 percent of the density of laboratory compacted specimens of the mix sampled at the plant. Two samples taken from the coarse mix both had densities of 98 percent while two samples from the fine mix had densities of 96 and 97.5 percent.

Traffic volume over the strip ranges between 500 and 600 vehicles per day with 50 percent of this traffic being trucks. Visual inspection of the surface six months after placement reveals some indication of surface material being lost as is shown in Fig. 6. However, this occurs only in one limited area at the entrance to a parking lot, and generally the strip is in excellent condition. Skid resistance tests, periodic core tests to determine degradation, and visual observation of performance will continue over a two year period.

Glass Containers Corporation

A street in the Fullerton Air Industrial Park in Fullerton, California, was paved with glasphalt on October 26, 1970. Plans for this installation were initiated by Glass Containers Corporation but since the road to be paved was a public thoroughfare, it was necessary to obtain special permission from the City of Fullerton to use glasphalt. Initially plans called for a section 600 feet long and 40 feet wide to be paved with a 3-in. thick layer of glasphalt. However, these plans were later modified so that the final width of glasphalt pavement was 30 feet with the other 10 feet of width being paved with conventional asphaltic concrete. The base course was a 7 1/2-in. thick layer of crushed rock equivalent to California Division of Highways Class 2 aggregate base. The subgrade was a silty sand which was compacted to at least 90 percent of maximum density as determined in the laboratory in accordance with the requirements of the California Standard Specifications.

All of the glass used for this project was obtained by crushing in a hammermill clean non-returnable bottles collected at a bottle redemption center in Fullerton. Rock dust was blended with the crushed glass and one percent hydrated lime by weight of the total aggregate to give the combined gradation shown in Table 1. This combined aggregate consisted of 63 percent glass, 36 percent rock dust and 1 percent hydrated lime.

Industrial Asphalt, Inc. was responsible for the mixing of the glasphalt and United Asphalt was the general contractor in charge of placement. A 60-70 penetration asphalt cement was used and the hydrated lime was added by hand at the pugmill. The asphalt content was 5.4 percent (total weight basis).

The glasphalt was placed in one 3-in. thick lift and compacted with an 8-10 ton tandem roller. Initial attempts at compaction resulted in excessive crawl, even at temperatures of 220F. It was necessary to hold up breakdown rolling

until temperatures were below 220F and marks were still being left by the roller when the mix temperature had dropped to 150F. After finish rolling, however, the surface was smooth and no roller marks were visible.

Test cores for density determinations were obtained soon after placement and the average percent of optimum Marshall density was 93 percent. This figure indicates that compaction procedures could have been improved since the average percent air voids in the compacted pavement was 10.6 percent.

Samples of the glasphalt mixture taken at the plant had a Marshall stability of 1,700 pounds and a flow of 0.135 in. for 75 blow compaction. After 24 hour water immersion at 140F the stability was 1,610 pounds for a 92 percent retained strength. Stability tests on a recompacted core yielded a stability of 1,485 pounds and a flow of 0.125 in.

Performance of this test installation will be carefully monitored and skid resistance tests as well as further core tests to assess degradation will be conducted.

Brockway Glass Co. Inc.

Approximately 1,700 square yards of roads leading through the employees parking lot at the Brockway Glass Company lot in Brockway, Pennsylvania, were paved with glasphalt on October 28, 1970. Three strips were paved, the longest being 212 feet by 24 feet wide. Thickness was 1 inch except for 156 square yards which was placed in two layers to a total depth of 5 inches. The 1-in. layer was placed as a surface course over two 2-in. layers of conventional Pennsylvania Department of Highways ID-2 binder which had been placed one week previously. The subgrade under all paving was composed of shale and ash spread over old refractory rubble and compacted through years of use.

The aggregate was a mixture of 54 percent glass and 46 percent sand by weight with the gradation shown in Table 1. Laboratory Marshall samples using 5 percent asphalt had a Marshall stability of 1,400 pounds and flow of 0.106 inches. No hydrated lime was used.

A 10 ton steel wheel roller and 2 ton vibratory roller were used for compaction. Sawed samples indicated that 93 percent of laboratory compaction was obtained.

No performance data are available yet concerning this installation.

Glass Container Council of Canada

Two glasphalt installations have been placed in Canada. The first was a road in the Dominion Glass Company's bottle making plant in Bramlea, near Toronto. It was placed on August 29, 1970, and contains about 200 tons of non-returnable pop and beer bottles. The glasphalt mixture consisted of 37 percent coarse glass (No. 4 to 1/2"), 28 percent fine glass, 28 percent natural sand, 2 percent hydrated lime and 5 percent 85-100 penetration asphalt cement. Gradation of the combined aggregate is given in Table 1.

A city street was paved in Scarborough near Toronto on October 17, 1970, using the same glasphalt mixture. It was approximately 500 feet long, 26 feet wide and 1 inch thick. One lane was paved with regular glasphalt while the other lane was paved with material containing two percent asbestos. The traffic count on this street is over 2,000 vehicles per day.

Pneumatic rollers were used for intermediate compaction of both the Canadian strips.

Glasphalt is being developed in Canada by a joint industry-government task force headed by H. Elliot Dalton, executive director of the Glass Container Council of Canada.

Summary of Field Installations

Experience with placing glasphalt at the locations mentioned above has indicated that few modifications in conventional mixing, placing and compacting procedures are necessary in order to achieve suitable results. In the mixing phase, the addition of hydrated lime by hand at the pugmill is not very efficient and the use of mechanical mineral filler feeding devices would be preferable. By reducing the temperature of the glasphalt to 250F to 275F as it comes from the plant it should be possible to minimize delays in compaction due to the tendency of hotter mixes to crawl during breakdown rolling. Since glass is essentially nonporous the higher drier temperatures should not be necessary for removing internal moisture. The optimum temperature of the material at the plant will vary, of course, with the temperature-viscosity characteristics of the binder used, the percentage of glass in the mixture, the haul distance, and the ambient temperature.

The experience to date indicates that smaller rollers and lift thicknesses less than 2 inches will produce greater densities.

Properties such as skid resistance, abrasion resistance and tire wear are presently being evaluated.

ECONOMIC ANALYSIS

It is clear that separating only glass from the municipal refuse for use in glasphalt would not be economically feasible. If we assume that 11 percent by weight (wet basis) of the municipal solid waste consists of glass (13) then approximately 9 tons of raw refuse would have to be processed to produce 1 ton of glass. Even if no further processing of the glass were necessary and it could be marketed at an optimistic $3.00 per ton, the costs of separation would far exceed this figure. Thus, the separation from raw refuse and utilization of waste glass in glasphalt must be considered as part of a larger recycling scheme aimed at reclaiming and marketing paper, ferrous metals, non-ferrous metals and other recoverable components. The successful application of glasphalt, from an economic standpoint, depends heavily upon developing markets for other reclaimed components.

In order to analyze the potential for utilizing waste glass in asphaltic concrete it is necessary to first estimate the quantities of glass which might be available and to determine the amount of this glass which can be used in paving. Residential and commercial solid waste generation in urban areas might reasonably be estimated to range between 2.5 and 5.5 pounds per capita per day (14). The percent glass by weight (wet basis) can be assumed to vary from 8 to 11 percent (13). Based upon these estimates, the amount of waste glass produced per million people in an urban area could range from approximately 36,000 to 110,000 tons per year. Based upon a survey of eight cities with populations in excess of 500,000, the amount of aggregate used for the maintenance of city streets ranged from 24,000 to 280,000 tons per million people per year. The average was approximately 140,000 tons per million people per year (15). Depending upon the gradation of the waste glass which could be obtained, up to 100 percent of this aggregate could be replaced by waste glass. Thus, in most of the larger cities, all or nearly all of the waste glass could be used in paving if the gradation were suitable.

The gradation of the waste glass separated from municipal refuse depends upon the separation procedures. Hand separation would result in a large percentage of whole bottles which would require further crushing and sizing. However, the mechanical separation systems developed to date have generally involved some form of crushing so that all of the resulting glass passes a 3/4-in. screen. Sieve analyses, Table 4, of waste glass samples obtained from municipal refuse separations facilities in Norman, Oklahoma, and Houston, Texas, indicate that nearly all of the glass is between the No. 8 and No. 30 sieve. If this material were used with no further processing it would be necessary to blend it with conventional aggregates to supply the sizes in which it was deficient. If we assume, for instance, that crushed stone and stone dust were available with the gradations shown in Table 5, a mixture of 40 percent stone, 39 percent stone dust, 20 percent glass and 1 percent hydrated lime would give the combined gradation shown in Table 5 which is similar to that used in previous glasphalt installations. The advantage of blending glass with conventional aggregate is that no further processing costs beyond those of separation would be incurred. The disadvantage is that, due to the limited size range of the waste glass, less glass could be disposed of in paving applications. In the example above, for instance, if a city of one million people produced 70,000 tons of waste glass annually and used 140,000 tons of aggregate annually, then 20 percent of this or 28,000 tons of glass could be used with the remaining 42,000 tons of glass being recycled for other uses or disposed of in sanitary landfill. A more desirable alternative might be to modify the grinding method used in the separation system to produce a better gradation in the waste glass product.

If a mechanical system for refuse separation produced a glass fraction consisting of particles with a maximum size of 1 1/2-inches, further crushing would be necessary to produce a material suitable for use in glasphalt. While this would represent an additional equipment cost, the closer control over gradation which could be exercised would increase the amount of glass that could be utilized in glasphalt. The economic analysis which follows is given for three cities of intermediate to large populations. A cost breakdown is given and assumptions are clearly indicated.

Assumptions

1. Population

City A	300,000
City B	1,000,000
City C	2,000,000

2. Refuse to be treated

   4.0 lb per capita per day

3. Percentage of glass in refuse

   10 percent by wet weight

4. Wastes have been collected and transported to the central separation facility where the glass has been separated.

5. Majority of separated glass ranges in size from particles 1 1/2-in. down to .187-in.

6. The glass is treated as follows:

   a. Glass is passed through portable crushing and screening unit.
   b. Finished product is stored in bins to be either used in city operated asphalt batch plant on site, or shipped to city operated or private plant at some other location.
   c. Finished product represents 85 percent of material passed through the crusher. The remaining material must be wasted or reused in some other manner.

7. Hydrated lime is required in glasphalt whereas it is not required in conventional asphaltic concrete. One percent by weight of the aggregate requires 20 pounds of lime which costs approximately $.02 per pound. Thus the use of each ton of waste glass will require an extra expenditure of $.40.

Calculations of Annual Cost

Annual glass available

City A (.10)(300,000)(4)(365) ÷ 2,000 = 21,900 tons
City B (.10)(1,000,000)(4)(365) ÷ 2,000 = 73,000 tons
City C (.10)(2,000,000)(4)(365) ÷ 2,000 = 146,000 tons

Capacity of crushing unit required (Assume 200 working days per year and 8 hours per day = 1,600 hours)

City A 21,900 tons ÷ 1,600 hours = 14 TPH
City B 73,000 tons ÷ 1,600 hours = 46 TPH
City C 146,000 tons ÷ 1,600 hours = 91 TPH

Equipment costs

City A 36 in. portable cone crusher and screening unit, radial stacking conveyor, 50 ton bin, front end loader $100,000
City B 36 in. portable cone crusher and screening unit, radial stacking conveyor, 50 ton bin, front end loader $100,000
City C 45 in. Portable cone crusher and screening unit radial stacking conveyor, 50 ton bin, front end loader $120,000

Annual equipment costs (assume 15 year life and 25% salvage value, 8% interest)

City A $ 10,760
City B $ 10,760
City C $ 12,910

Annual labor costs

City A [illegible] $ 30,000
City B 3 men at $15,000 per year $ 45,000
City C 3 men at $15,000 per year $ 45,000

Annual operating costs (Maintenance, liner replacement, power at $.15/ton)

City A 21,900 (.15) $ 3,285
City B 73,000 (.15) $ 10,950
City C 146,000 (.15) $ 21,900

Total annual costs

City A $10,760 + $30,000 + $3,285 = $ 44,045
City B $10,760 + $45,000 + $10,950 = $ 66,710
City C $12,910 + $45,000 + $21,900 = $ 79,810

Total amount of usable glass aggregate produced annually

City A (.85) x (21,900) = 18,600 tons
City B (.85) x (73,000) = 62,000 tons
City C (.85) x (146,000) = 124,000 tons

Amount of aggregate used in city street maintenance

City A .3 x (140,000 tons) = 42,000 tons
City B 1.0 x (140,000 tons) = 140,000 tons
City C 2.0 x (140,000 tons) = 280,000 tons

Annual savings from use of glass aggregate to replace conventional aggregate

(Assume conventional aggregate costs $2.00 ton, but added cost of $.40 per ton for lime if glass is used.)

City A 18,600 x ($2.00 - .40) $ 29,760
City B 62,000 x ($2.00 - .40) $ 99,200
City C 124,000 x ($2.00 - .40) $198,400

Annual income or loss from glasphalt operation

City A $29,760 - $44,045 = $14,285 (loss)
City B $99,200 - $66,710 = $32,490 (income)
City C $198,400 - $79,810 = $118,590 (income)

Results of this analysis are summarized in Table 6 and inspection of this table points up several items of interest. It indicates that all of the glass aggregate produced could probably be used in city street maintenance. The exception to this statement might be found in cities with extremely high population density. The income figures indicate that for the intermediate sized city (City A) glasphalt operations would not be profitable unless sufficient income were generated from the sale of other components (paper, non-ferrous metals, etc.) to cover the increased cost of separation over the cost of conventional disposal methods. However, if the glass were already separated it would probably be more economical to use the glass in glasphalt than to dispose of it in a sanitary landfill. In the larger cities, the income realized from use of glass in glasphalt could be applied toward the separation costs, although, as mentioned previously, they would offset only a small percentage of these costs.

In considering these estimates it should be kept in mind that the figures are very preliminary and that equipment, labor and operating expenses as well as the projected savings in aggregate cost could vary considerably in different areas. By testing samples of glass separated from municipal refuse in varying types of separation facilities it should be possible to more firmly establish equipment as well as operating costs. Also, when the glasphalt concept is considered for a particular municipality, aggregate costs can be fixed with considerably more precision.

CONCLUSIONS

The use of glass aggregates in asphaltic concrete has been shown by both laboratory and field tests to be a viable means for using waste glass. Performance of glasphalt field installations to date has been satisfactory.

Preliminary economic analysis indicates that this means for recycling glass is feasible in larger cities.

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TABLE 1

AGGREGATE GRADATIONS FOR GLASPHALT FIELD INSTALLATIONS

Sieve	Percent passing						
	Owens-Illinois	Anchor-Hocking	Rolla Coarse Mix	Rolla Fine Mix	Glass Containers Corporation	Brockway Glass Company	Glass Container Council of Canada
3/8"	100	100	100	100	99	100	100
1/2"	100	100	98	100	96	100	100
[illegible]	94	94	92	99	85	98	95
No. 4	62	71	75	87	63	74	59
No. 8	45	55	50	58	50	51	41
No. 16	35	33	38	44	34	30	30
No. 30	27	20	30	36	22	19	21
No. 50	18	11	15	17	14	12	10
No. 100	8	6	6	6	9	8	5
No. 200	3	4	4	4	6	6	4

TABLE 2

MARSHALL PROPERTIES OF OWENS-ILLINOIS GLASPHALT MIXTURE*

Stability, lbs	1460
Flow, 1/100-in.	14
% Air	3.8
% Voids in Mineral Aggregate	17.3
Unit Weight, pcf	139.8

* 50 blow compaction

TABLE 3

MARSHALL PROPERTIES OF ROLLA GLASPHALT MIXTURES*

Marshall property	Coarse mixture	Fine mixture
Stability, lbs	840	710
Flow, 1/100-in.	13	8
% Air	2.01	4.20
% Voids in Mineral Aggregate	14.88	16.34
Unit Weight, pcf	141.5	139.1

*50 blow compaction

TABLE 4

GRADATION OF GLASS SEPARATED FROM MUNICIPAL REFUSE

Sieve	Percent passing	
	Norman, Okla.	Houston, Texas
3/8"	100	100
No. 4	100	92
No. 8	92	47
No. 16	69	9
No. 30	24	1
No. 50	4	0

TABLE 5

SAMPLE BLENDING OF WASTE GLASS WITH CONVENTIONAL AGGREGATE

Sieve	Percent passing				Gradation of mixture
	Waste glass	Stone	Stone dust	Hydrated lime	20% glass 40% stone 39% stone dust 1% lime
1/2"	100	100	100	100	100
3/8"	100	78	100	100	91
No. 4	92	36	100	100	73
No. 8	47	7	89	100	48
No. 16	9	5	72	100	33
No. 30	1	3	54	100	22
No. 50	0	1	37	100	16
No. 100	0	0	24	100	10
No. 200	0	0	15	100	7

TABLE 6

ECONOMIC ANALYSIS OF GLASS AGGREGATE PRODUCTION

City	Population	Glass available annually (tons)	Total annual costs	Annual amount of usable glass aggregate (tons)	Annual amount of aggregate used in street maintenance	Annual savings from use of glass aggregate	Annual income or loss from glasphalt
A	300,000	21,900	$44,845	18,600	42,000	29,760	$ 14,285 (Loss)
B	1,000,000	73,000	$66,710	62,000	140,000	99,200	$ 32,490 (Income)
C	2,000,000	146,000	$79,810	124,000	280,000	198,400	$118,590 (Income)

Bicycle Participation and Population Density Maps

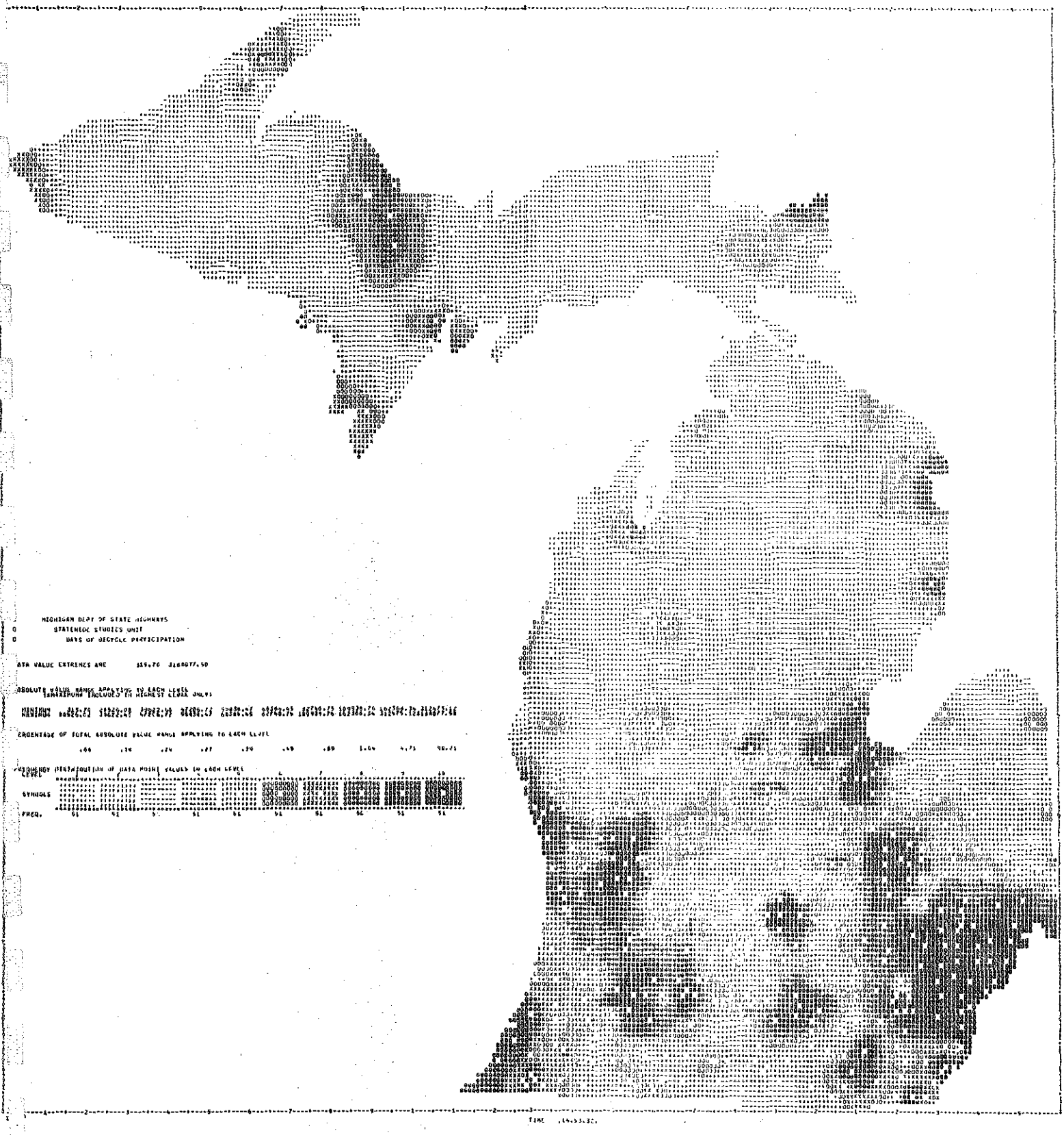

Figure IV

Bicycle Participation Frequency

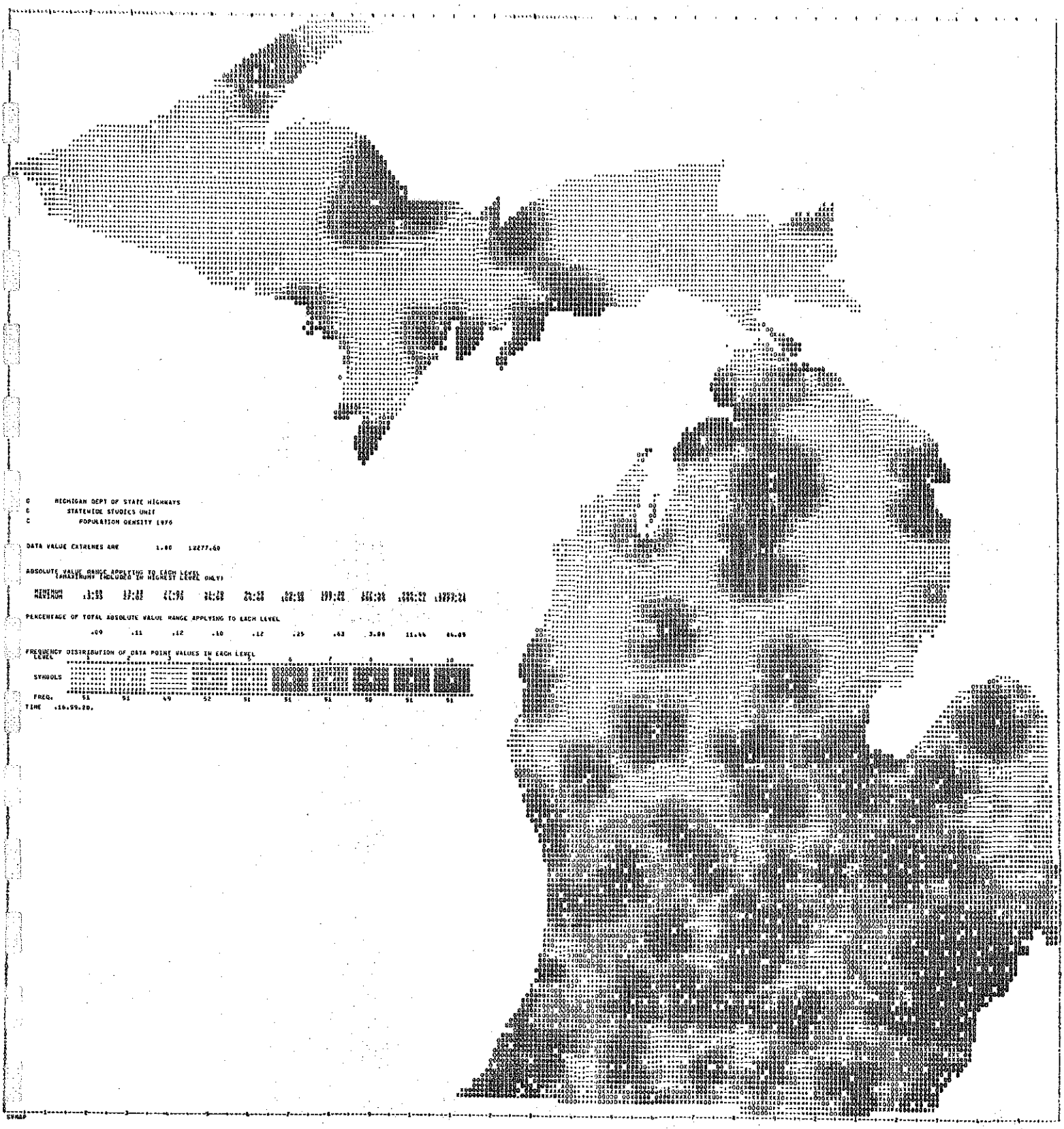

Figure V

Population Density

Sources (Federal) of Trail Funds

From a speech by Larry Mirkes, Acting Chief, Division of Land and Water Conservation Fund (State), Bureau of Outdoor Recreation, U.S. Department of the Interior, before the National Symposium of Trails - June, 1971.

SOURCES OF FEDERAL FUNDS, ADMINISTERED THROUGH STATE AND REGIONAL AGENCIES, FOR CONSTRUCTION OF BIKE PATHS AND RECREATIONAL TRAILS - Department of Agriculture, Interior, Housing and Urban Development.

As many of you know from your associations and dealings with Federal, State, and local governments, the number of programs which potentially offer financial assistance in acquiring and developing recreational facilities borders on being staggering. The catalog of Federal domestic assistance programs contains about 800 pages and lists over 1,000 programs, many of which deal either directly or indirectly with recreation and related issues.

Let me tell you briefly about some of these programs - how they work and how you get them to work for you. My own sense of priorities (and perhaps self preservation) suggests that I begin with the Land and Water Conservation Fund. The Fund was approved as an Act of Congress on September 3, 1964. It was established to (and I quote from the statement of Purpose), "assist in preserving, developing, and assuring accessibility to all citizens...and visitors ... such quality and quantity of outdoor recreation resources as may be available and are necessary and desirable ... by (1) providing funds for and authorizing Federal assistance to the States in planning, acquisition, and development of needed land and water areas and facilities and (2) providing funds for the Federal acquisition and development of certain lands and other areas."

The Act established 60 percent of the Fund as the States' share and 40 percent as the Federal Government's share. Additionally the Act established a ratio for allocating the States' share to the various States and limited the Federal share principally to acquisition of private lands within established boundaries of certain Federal areas. The Fund can assist the States and local units of government as well in planning, acquiring, and developing recreation areas and facilities. Although some modifications have been made in the original Act over the years, the basic requirements and constraints are relatively unchanged.

Each State has developed a Statewide Comprehensive Outdoor Recreation Plan which provides overall guidance to its outdoor recreation programs. Projects for which assistance is requested must be in accordance with that plan and requests must be submitted through a State official who administers the Fund for his particular State. These men are usually familiar with, if not actively engaged in, park and recreation or conservation work.

Specifically related to trails, we believe the Fund has a good record. In July 1966, twelve urban trails were approved for funding from the Secretary's Contingency Reserve Fund. (Monies in the Contingency Reserve as retained for high priority projects or those needing immediate action.) The original estimate of cost for the Federal share of the 12 trails was about $367,500. Eleven of these trails were completed with a total of nearly $280,000 being contributed by the Land and Water Conservation Fund. The eleven cities that profited from this initial trails program were Arlington, Va., Chicago, Denver, Detroit, Milwaukee, New York, Omaha, Philadelphia, Phoenix, San Francisco, and Seattle. Since that time, we have approved or qualified for Fund assistance trail projects amounting to several hundreds of thousands of dollars and ranging from $750 to $425,000. Several of these trails are among those either dedicated

or under consideration as part of the national system. In addition, many of the major park development proposals for which Fund assistance is requested also include trails of one sort or another.

Proposals submitted for Fund assistance must not only be accordance with the aforementioned State Comprehensive Outdoor Recreation Plan, they must also be sponsored by a public agency. Therefore, those of you who represent non-governmental organizations wishing to apply for Land and Water Conservation Fund assistance need to begin with your local unit of government. Your local representatives can then contact the person or agency administering the Fund in your State to ascertain the changes of your project being funded, what priority it may have, and how to go about preparing the application. The Bureau of Outdoor Recreation offices have attempted to simplify the forms and procedures and to expedite review and action for all project applications. More changes are coming. Hopefully these simplified procedures will alleviate some of your fears about becoming wrapped up in bureaucratic red tape and will encourage you to make greater use of the Fund.

Now for some other programs. The Department of Housing and Urban Development has several assistance program that may be of some help in planning, acquiring, and developing trails and related recreational facilities.

Perhaps the best known of the planning assistance programs is the "701." Its application to trails is rather indirect. The objective of the "701" program is to establish the comprehensive planning process and improve the quality and efficiency of land development in urban areas. Planning grants are normally made for two-thirds of the project cost and may equal three-fourths in redevelopment or similar type areas. A broad range of subjects including recreation may be addressed in the planning process, which includes, among other things, development plan preparation, programming capital expenditures, and coordinating related plans and programs.

HUD also administers a number of open space acquisition and development programs. Section 702 of the Housing Act of 1961 provides for assistance in the form of project grants for at least 50 percent of the costs of acquiring and developing open space areas. In addition to assisting in acquisition and development, this program also has as an objective the provision of needed park, recreation, conservation, scenic, and historic areas in the urban environment. Under the present arrangement, land must have been acquired under this program to be eligible for development assistance under this program. However, the "Housing and Urban Development Act of 1970" approved on December 31, 1970, as P.L. 91-609 eliminates that requirement. Thus, effective July 1 of this year, HUD will be in a position to broaden its base of support for recreation related programs in urban areas. This should add significantly to the potential for developing urban trails, bikeways and the like. As with "701" assistance, this program is essentially limited to State and local governmental agencies. However, it is worth noting that assistance is also available to Indian tribes, including Alaska Indians, Aleuts and Eskimos.

The Housing Act also provides substantial amounts of assistance to new community developers. This is an area that should be very closely watched, for the planning of a network of trails integral to other new community facilities can provide a relatively low cost, simply constructed unifying element in the community fabric.

Section 706 of the Housing Act of 1961 and Section 705 of the Housing and Urban Development Act of 1965 also provide matching grants to encourage and expand community activities in beautification and improvement of urban areas. Again, a variety of basic recreation facilities including trails qualify as beautification and improvement projects.

The Department of Agriculture also administers a number of programs that are worth a close look when seeking avenues of assistance for developing recreational opportunities. These range from guaranteed or insured loans to rural non-profit community associations to grants and cost sharing on a variety of projects.

A program with great potential but currently unfunded is GREENSPAN. This program, authorized under the Agricultural Act of 1970, contains provisions for funding assistance to acquire cropland for purposes of preserving open space, developing recreation facilities, and establishing land conservation practices to preserve and protect open spaces, natural beauty and recreation opportunities.

Under the Greenspan program, grants could be authorized to Staten and local governmental agencies to assist them in purchasing cropland for various open space, recreation, and pollution control purposes.

The Cropland Adjustment Program authorized under the Food and Agriculture Act of 1965 also provides incentives for conversion of cropland to public recreation purposes. In addition, the Program provides for supplemental agreements under which farmers may receive additional payments if they agree to permit, without other charge, public access to their lands for hiking, hunting, fishing, and trapping.

These programs and other administered by the U.S. Department of Agriculture are handled locally by the Agricultural Stabilization and Conservation Service Office. These offices are generally located in each county seat. If you believe you have a project essentially rural in nature, there is a good chance the Agriculture Department has an assistance program that will help.

We have here in Washington a strong proponent of bikeways who has literally pedalled onto the scene. Fortunately, he is in a position to have an extremely beneficial effect on trail and bikeway construction. This is the Secretary of Transportation John Volpe. Only recently it was announced that approximately $2 million would be made available for regular interstate highway program funds for the construction of a bikeway along the I-66 extension between Rosslyn just across the Potomac and the Beltway some 8 or 10 miles west. The bikeway would be built in 8 to 10 sections but its construction is unfortunately contingent upon approval of the proposed interstate. However, whether this bikeway is built or not, the potential for development of trails and bikeways within the myriad of highway corridors spanning this Nation in every direction is slowly being revealed.

This very quickly summarizes what appears to me as some of the major Federal programs that can assist in developing trails and related recreational facilities. Let me close by saying that hopefully, with some coordination between programs administered by the various agencies and levels of government, and greater awareness on the part of you people here and the general public of what can be accomplished through these many programs, a nationwide system of trails accommodating a wide variety of uses and users will, in the very near future, become a reality.