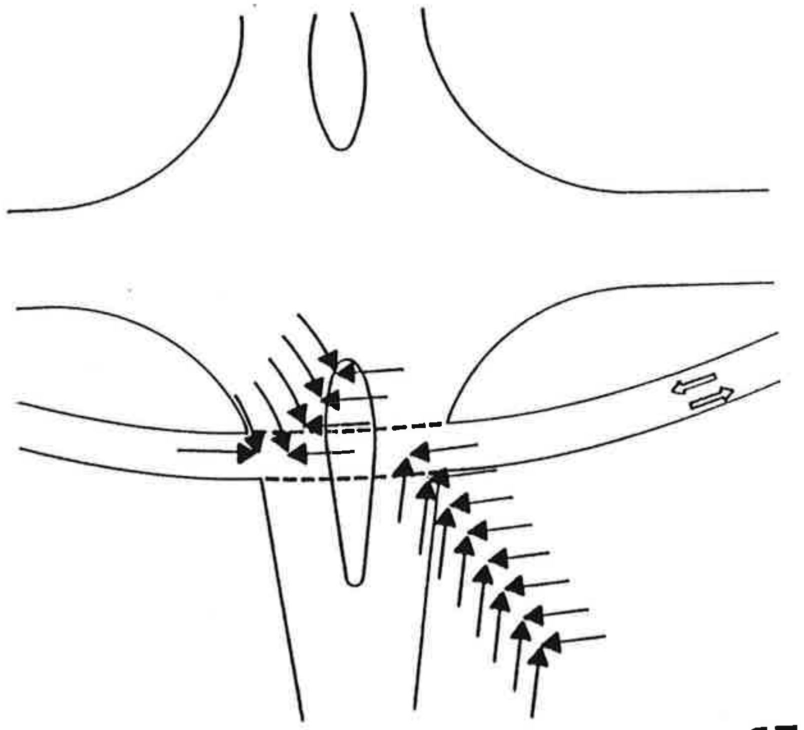
tions (15). Experience indicates that control devices are needed where bike and motor vehicle traffic is frequent though not necessarily heavy. Where installation of a control device is inconsistent with roadway function, such as at midblock on an arterial street, a grade separated crossing should be considered.

New-town planners in England and The Netherlands have considered grade separations so essential to provision of effective community wide accessability that grade separations are provided on all bikeway-roadway crossings, with the roadway partially elevated to ease gradients on the bike underpass (6,7). Partial roadway elevation (or depression) in the case of overpasses is an effective way to ease bikeway gradient with minimized street access and linkage problems and cost problems inherent in full roadway elevation (or depression) as described previously.

TWO-WAY BIKE PATH HAZARD

European experience plus limited experience in Davis has indicated a high accident potential on two-way bikeways at unsignalized intersections with streets and driveways. Figure 15 illustrates an accident history of a typical intersection in The Netherlands (4). Auto-bike collisions involving bikes travelling opposite to the direction of 'right-hand-rule' traffic flow overwhelmingly predominate.

The cause is obvious. Vehicular traffic on the northbound approach in the figure has eastbound cross-traffic as its primary concern while entering the intersection and neglects to monitor nearside westbound bike traffic.



15

INTERSECTION ACCIDENT HISTORY

Similarly, traffic on other approaches, regardless of their turning intent, are primarily concerned with vehicular cross traffic proceeding from their left. This traffic poses the most immediate danger to themselves and their concern with it leads them to neglect the 'wrong-way' bike traffic which approaches from the opposite direction. Two areas in Davis have experienced accident problems stemming from this. A general recommendation is to limit two-way pathways to areas where intersections and driveway crossings are infrequent and to provide warning signs reminding motorists of the presence of two-way bike path crossings where they exist.

DRAINAGE, GRATE HAZARDS, CURBING

Since a high level of utility-oriented cycling continues through periods of inclement weather, provision of drainage facilities on urban cycleway systems is essential to ensure that surface water does not accumulate. For on-street bike lanes, normal roadway drainage systems are generally adequate but may involve two types of deficiency. In areas of limited pavement width where the gutter area has been assumed to comprise part of the bike lane width, water in the gutter will narrow the effective lane width and induce cyclist encroachment on the motor vehicle travel way. Poor drainage with standing water in the bike lanes will also lead to encroachments and accident hazard. More serious is the problem of drainage grates with slats parallel to the curb. These allow the cycle wheel to drop or may trap it often flipping the cyclist over the handlebars in the process. In Davis this is not a problem, as curb inlets are used exclusively, although after repeated roadway resurfacings, severe dips may be encountered near the curb inlet. For other communities welded cross-strips on existing curb-parallel gratings or replacement with curb-perpendicular or recently produced zig-zag or honeycomb grate patterns are possible solutions although in extreme cases this may compromise hydrodynamic efficiency.

For sidewalk and independent pathways a slight pitch or crown (1/4 inch per foot minimum) will ensure adequate runoff. Cross-slope paths should be ditched on the high side to prevent flows across the pathway and adequate provisions for drainage should be made in level areas where there is little runoff and where soil drainage properties are poor.

TRANSITION AREAS

Transition areas, the termination of an on-street bike lane or sidewalk bike path, the change from a two-way path along on side of the street to one-way paths on both sides of the street or the shift of a two-way path from one side of the street to the other, to cite a few examples, are areas involving increased accident hazard and elements of inconvenience which may lead cyclists to ignore the special facilities provided for them in favor of the motor vehicle roadway. The importance of proper transitions is illustrated in a negative way in Davis by the refusal of most northbound cyclists to use the two-way sidewalk pathway along A Street. This is because of the lack of a proper transition to the mixed traffic, right-hand-rule operations which exist north of Russell Boulevard where the pathway terminates.

Figure 16 presents European design treatments for several types of transitions. Shown on Figure 16-a is an example of the termination of a one-way sidewalk pathway with continuation through a curb break to an on-street bike lane on a widened roadway pavement section. While the continuation to a widened roadway section is uncomplicated, termination of a sidewalk path onto an unwidened roadway section requires more sophisticated treatment as illustrated on Figure 16-b. It shows an 82 foot (25 meter) widened transition area to enable the cyclist to establish a visual relationship with and weave into the motor vehicle traffic stream. Figure 16-c illustrates the transition from on-street lanes or mixed traffic to a one-side, two-way sidewalk pathway. The 'jughandle' treatment results in an improved angle of incidence between crossing bikes and motor vehicles and makes the cyclists intention of crossing quite apparent to the motorist. Placement of traffic bars leading in to the 'jughandle' is desirable to lead the cyclist into the handle and eliminate short-cut, diagonal crossings. Figures 16-d, e, and f show two-way sidewalk pathways shifting from one side of the roadway to the other. The jughandle treatments to provide right angle crossings and forward field of vision sight relationships are illustrated on 16-d with improper and preferred treatments illustrated on 16-e and 16-f.

CYCLE TRIP-MAKING AND ACTION RADIUS

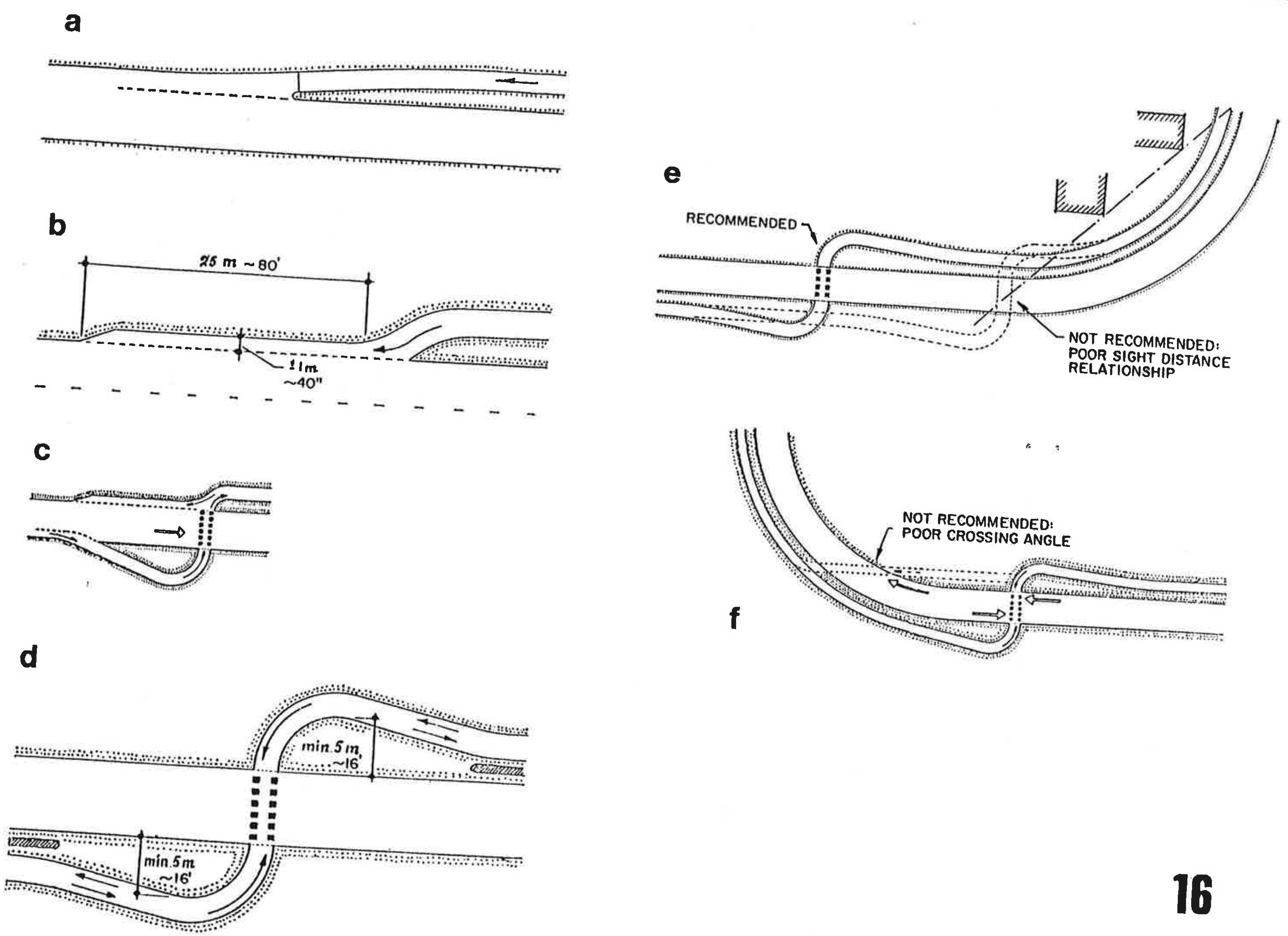
Cycle trip generation in Davis residential areas appears closely related to the primary trip focus of the area's residents and the distance of the area from the community's major activity centers, particularly the university. While definitive trip production rates expressed in terms of population and locational characteristics are difficult to quantify, the following trends are indicated in Davis.

In areas where the primary work trip orientation is to Sacramento and other locations outside of Davis, cycle trip rates are low (for Davis). In areas with heavy University of California orientation, cycle trip rates are high and may approximate the motor vehicle trip generation rates of households in other residential communities (5 to 8 or more trip productions per dwelling unit per day). For areas with primarily Davis internal but non-University oriented trip focus, cycle trip making falls between the above extremes.

Reasons for the propensity to cycle usage among University oriented travelers are clear. Within a radius of slightly over 1.5 miles from the central campus, the cyclist has a distinct travel time advantage as the cycle provides virtual door-to-door transportation while motor vehicles are excluded from the central campus and must be parked in peripheral lots. Thus, a few minutes walk is added to the campus end of each motor vehicle trip. A second major factor is that the individual's cycle is available for internal campus circulation during the course of the day while the automobile is not useful for this purpose. On a dispersed campus such as U.C. Davis, this utility for intra-campus circulation can be an important element of access mode choice. A further incentive to cycle usage is the cost of campus parking and the competition for prime spaces in close walking distance of principal campus activity centers. While lower auto ownership among students undoubtedly contributes to the high university-oriented cycle usage, this is not a primary factor. The 1971 University Housing and Residence Statistics indicate many students and other members of the campus community who have autos available do not use them for campus access trips. Over 40 per cent of the U.C. Davis students keep a motor vehicle at their college residence, yet only some 20 per cent drive motor vehicles on campus access trips. Of the total campus community (students, faculty, staff) nearly 85 per cent have motor vehicles available but only some 45 per cent drive to campus.

Low cycle trip rates in areas with high external trip orientation reflect the fact that the level of physical exertion and travel time which would be required for these longer trips is beyond the range of acceptability. Results of travel surveys in Davis and European cycle travel data indicate the vast majority of utility oriented cycle trips are less than 3 miles in length and average trip lengths less than 1.5 miles. And trip length clearly affects choice of cycle mode for internal as well as external trips. The U.C. Davis transportation statistics show two-thirds of the students residing within two miles of the campus use the cycle as their primary campus access mode. At greater distances the percentage drops sharply as does the frequency of trip making.

Experience in Davis seems to indicate that physical psychological barriers, such as freeways, railroads, drainage or irrigation canals with limited numbers of crossing points or major streets and highways, the crossing of which involves an actual or even supposed element of hazard, may also be a significant factor in residential cycle trip generation. Cordon observation of two residential developments separated by such barriers from the principal community activity centers in Davis indicated relatively low cycle trip generation rates, on the order of 1.3 trips per dwelling unit per day. When



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TRANSITION TREATMENTS

one of these neighborhoods was linked by means of a grade separation, cycle activity increased visably, although the latter situation has been observed only informally. Estimating the impact of barriers on cycle usage is difficult although barrier impact is probably reflected in the decrease in cycle mode split percentage with distance to activity centers as the probability of encountering barriers increases with trip length.

III

THE CAMPUS AREA

The University of California Davis campus is the focus for most bicycle travel in the community. Bike activity on campus is so intense that bike traffic congestion, a phenomena experienced perhaps nowhere else in North America, occurs daily during all morning class break periods.

In addition to bike traffic congestion, bike related accidents are a serious campus concern. In the fall 1971 quarter, bike related accidents comprised the second highest category of injury accidents reported at the Student Health Center (exceeded only by intramural athletics) and accounted for nearly 15 per cent of all campus accidents.

CAMPUS ACCIDENT STATISTICS AND REPORTING

Over the last four academic years an average of 175 injury bike accidents have been reported at the Student Health Center. Of these, nearly one-third occur off campus. Restriction of motor vehicle access on the central campus to emergency, service, and a limited number of other vehicles has virtually eliminated the problem of auto-bike collisions in this area. Auto-bike accidents are primarily a problem in the city and the campus perimeter areas.

One-third of the bike related accidents reported at the Student Health Center resulted from bike-bike or bike-pedestrian collisions or from spills while avoiding collisions. This is reflective of the level of bike and pedestrian congestion in the central campus area. More than 40 per cent of the bike accidents reported at the Center appear to result from instability and other inherent characteristics of the bike itself. Causes include faulty equipment, foot in wheel, skids on slippery pavement and other falls. Many of these types of incidents may be influenced by deficient facilities provisions. Campus bike facility improvements outlined in the following sections are of three types: those designed to reduce congestion and congestion-produced accidents in the central campus, those designed to eliminate auto-bike conflicts on the campus periphery and those designed to improve areas where the physical facilities provided exacerbate inherent bike instability conditions.

Prior to presentation of individual site improvement plans, some commentary on campus bike accident reporting is in order. Most on-campus bike accidents produce relatively minor injuries and property damage; the parties leave the scene under their own power and campus police are not involved. As a result, the normal procedures of police accident reporting and analysis of accident history by location are circumvented. But the accident experience information is an essential tool used by safety engineers in identifying locations where physical facilities are contributing to bike-accident occurrence and in designing counter measures.

Although the police reporting procedure is often bypassed in the case of bicycle accidents, accident reports are collected at the Student Health Center. This appears to be the most logical place for collection of bike accident information. Desirable improvements over existing reporting procedures would include better pinpointing of accident locations including direction of travel of persons involved, maintenance of an accident location file (a log of accident report numbers by location) and periodic review of accident reports at high-frequency locations by the Architects and Engineers or Environmental Health and Safety offices.

CENTRAL CAMPUS AREA CHANNELIZATION

Nearly one-third of the bike-involved accidents reported at the Student Health Center resulted from bike-bike or bike-pedestrian collisions or bike riders falling while avoiding other bikes or pedestrians. These figures are especially significant since between one-third and one-fourth of the accidents reported at the Center are accidents which actually occurred off campus, accidents which tend to be predominantly other types. Thus, nearly half the bike-involved accidents on campus are bike-bike or bike-pedestrian collisions or accidents while avoiding such collisions.

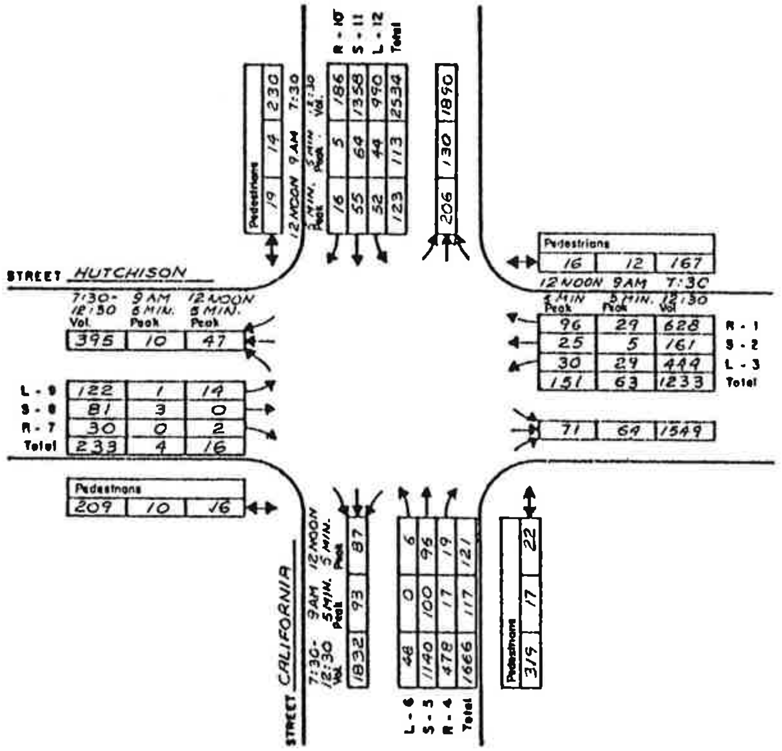
Primary cause of these accidents appears to be the intense, unregimented bike-pedestrian traffic on campus at class break periods and the inability of the individual cyclist or pedestrian to determine the intent of all the other cyclists and pedestrians on the path, street or intersection in his immediate vicinity. Very few cyclists on campus bother to give turning signals. It is doubtful if turning signals would be much benefit at the busier campus intersections where over 200 bicycle movements have been counted in a single minute, and especially with the myriad paths chosen by turning and straight-through cyclists.

The objective of the bike channelization projects described herein is to replace the ineffective active individual communication described above with implicit, mass communication which can be effectively perceived and understood at the congested intersections and to enforce regular, predictable patterns of movement through these intersections.

Hutchison Drive - California

This intersection has the most intense bike activity of all intersections on campus. In the five-hour period between 7:30 AM and 12:30 PM, some 11,000 bicycles were observed passing through the intersection as indicated on Figure 17. As reported to the Student Health Center, six injury bike-accidents occurred here in academic year 1969-70, seven in 70-71, and two in the Fall Quarter of 71-72. Non-injury accidents (which go unreported) and near-accidents occur daily at almost every class break.

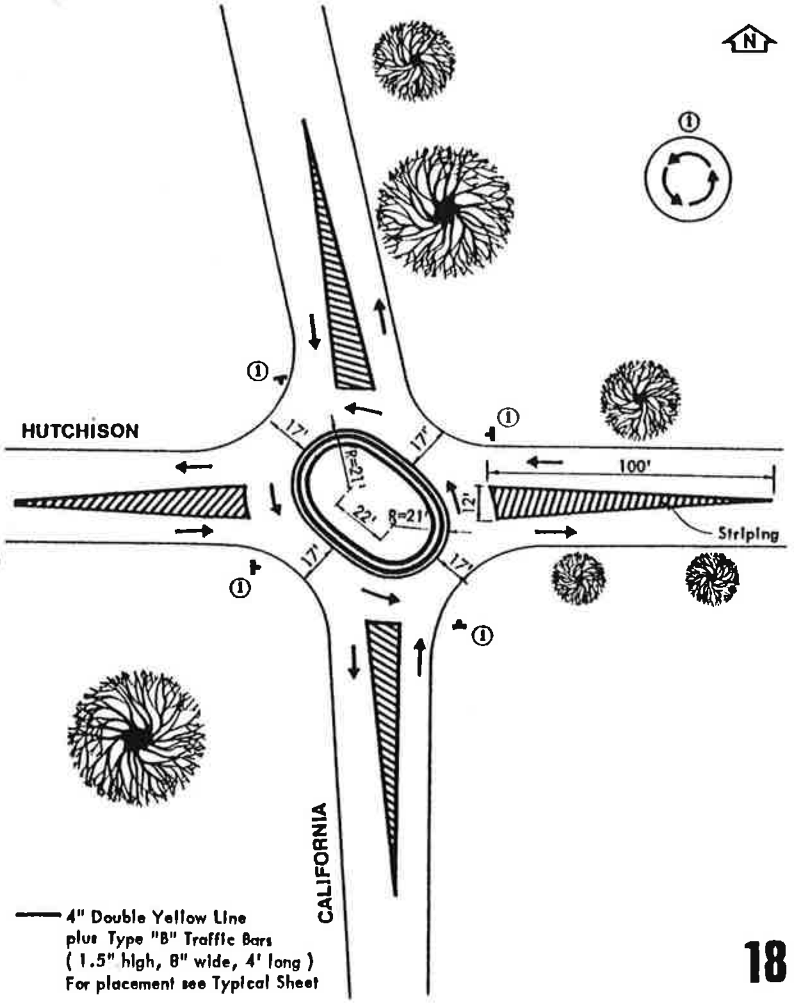
Any channelization for bikes must meet the needs of emergency, service and other motor vehicles permitted on the central campus. Though this traffic is extremely light, the west gate to the "closed portion" of the campus is located on Hutchison 200 feet west of the California-Hutchison intersection and virtually all traffic entering or exiting the gate must pass through the intersection. Additionally, the campus Fire Station is located on Hutchison Drive to the east and any channelization must allow fire vehicles to pass through at relatively high speed.



17

BIKE TURNING MOVEMENTS
HUTCHISON · CALIFORNIA INTERSECTION
7:30 AM · 12:30 PM

After consideration of several types of channelization for the California-Hutchison intersection, a traffic circle as illustrated on Figure 18 was proposed. This type of facility would translate the critical bike conflict or crossing movements into safer weaving movements. The circle would establish a regularized pattern of flow and would be self-enforcing during the class-break peak traffic periods. That is to say, heavy ridership in the proper direction around the circle would make wrong-way riding virtually impossible. As indicated on Figute 18, the "circle" would actually be oval with its axis along the intersection diagonals. This would provide the longest possible weaving distances for the bikes while still enabling all motor vehicles except tractor-trailer combinations to turn around it. The circumference of the oval would be delineated by Standard California Type "B" traffic bars (see detail on Figure 19) which would allow fire-emergency vehicles to pass over it at speed; tractor trailer combinations would also turn across the circle if necessary but these latter vehicles could probably be routed to other entrances to the closed campus.



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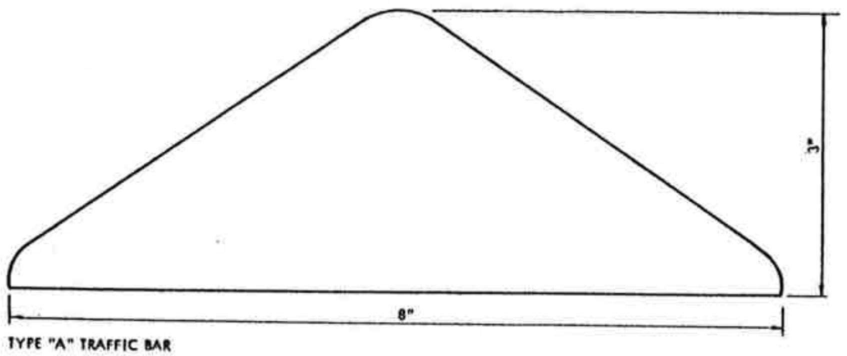
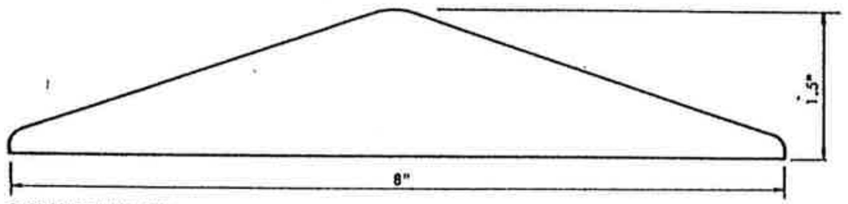
INTERSECTION IMPROVEMENT
HUTCHINSON AND CALIFORNIA

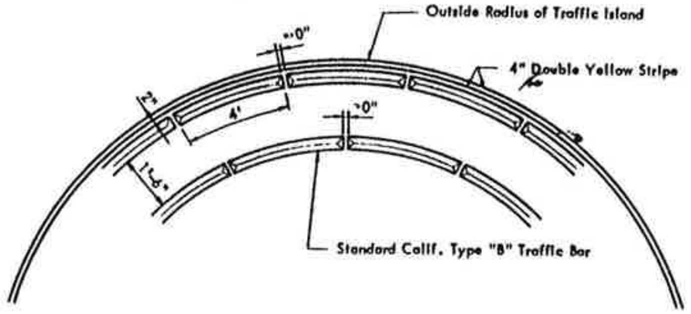
In May 1972, such a circle , constructed of temporary materials, was placed at the Hutchison-California intersection and observations of its effectiveness, including video tape recordings of peak class-break traffic, were made. Experimentation revealed a number of salient features. Generally, the circle operated as intended. Despite a breakdown in advance publicity, most cyclists



TYPE "A" TRAFFIC BAR



TYPE "B" TRAFFIC BAR



TYPICAL PLACEMENT
Type "B" Raised Traffic Bar

19

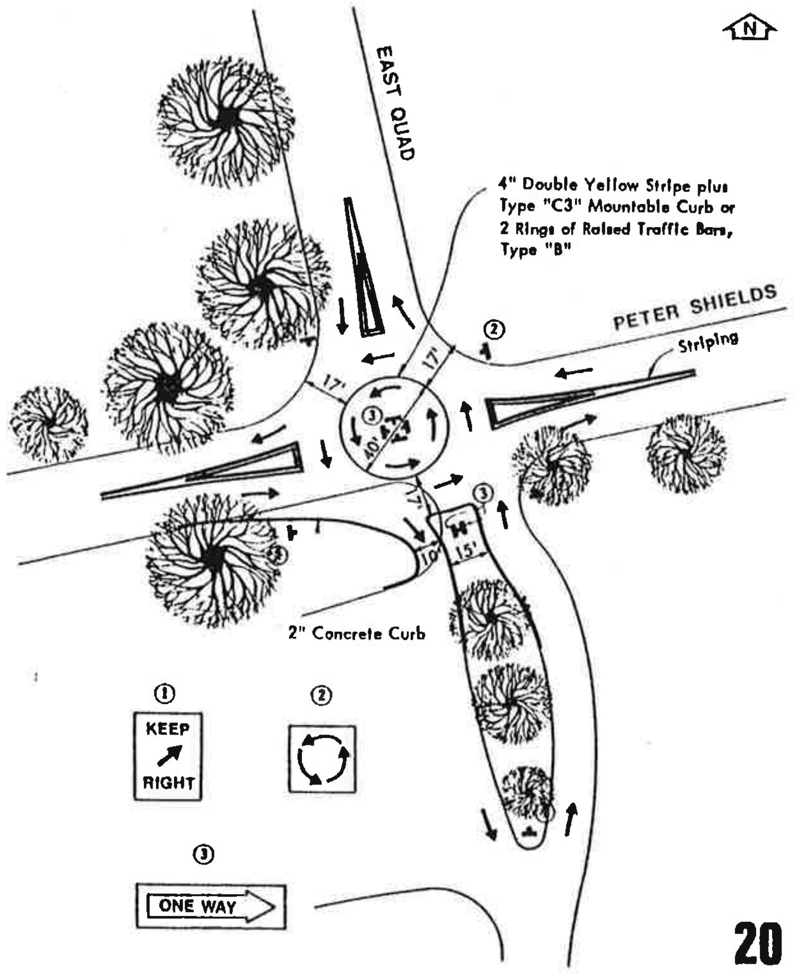
TYPICAL PLACEMENT
TYPE "B" TRAFFIC BARS

traveled around the circle in the proper direction and it operated smoothly in peak traffic periods. Even with the temporary approach channelization of traffic cones, which could easily be ignored by cyclists, few cyclists chose to ride in the wrong (clockwise) direction and the traffic circle proved quite self-enforcing in class-break periods. Cyclists attempting to go the wrong way in the peak periods generally had a difficult time. When the temporary circle (oval) was reduced in size, it lost some of its self-enforcing characteristics as wrong-way cyclists had more room to maneuver. Autos and single unit trucks were readily able to turn around the circle. A fire-pumper truck (not on an emergency call) and a large refuse collection vehicle were able to round it as well. The circle provided an additional benefit to motor vehicle traffic in enabling it to pass through the intersection safely during peak bicycle traffic intervals. Currently, motor vehicle traffic at this intersection comes to a virtual standstill, particularly on the Hutchison "stop" sign controlled approaches as bikes continually preempt the right-of-way. With the experimental circle in place, motor vehicles were able to safely merge with the bikes moving around it and pass through the circle at low speed. The circle did pose a problem for the "elephant train" which is used to transport campus visitors. However, the "train" will be able to mount and cross the permanent installation proposed. Enforcement of bike parking regulations in the vicinity of the circle is essential to its successful operation. Bike parking along prohibited curb area in the vicinity of the intersection, severely constricted bike and motor vehicle flow around the circle. Bike rider reaction to the experiment was generally favorable despite some confusion due to inadequate advance publicity. No accidents or near-accidents occurred during the trial period.

On the basis of the experimentation, it is concluded that a traffic circle similar to that presented on Figure 18 would improve conditions at the Hutchison-California intersection. The facility as dimensioned in the figure appears to be effective in achieving the objectives of this channelization. However, further experimentation may be desirable to determine if a slightly reduced island would function as effectively.

East Quad - Peter Shields Intersection

This intersection is very similar to the Hutchison-California intersection in terms of bike traffic volumes and congestion. However, motor vehicle traffic is lighter and one leg of the intersection is a bike path only and forms a slightly skewed intersection. Because of the similar conditions, a traffic circle is also recommended at this location as displayed on Figure 20. As indicated on the figure, this scheme would necessitate minor widening and directional channelization of the south leg of the intersection. This would entail enlarging the existing landscape island in the bike parking lot along the path and marking one-way directional pathways along this island.



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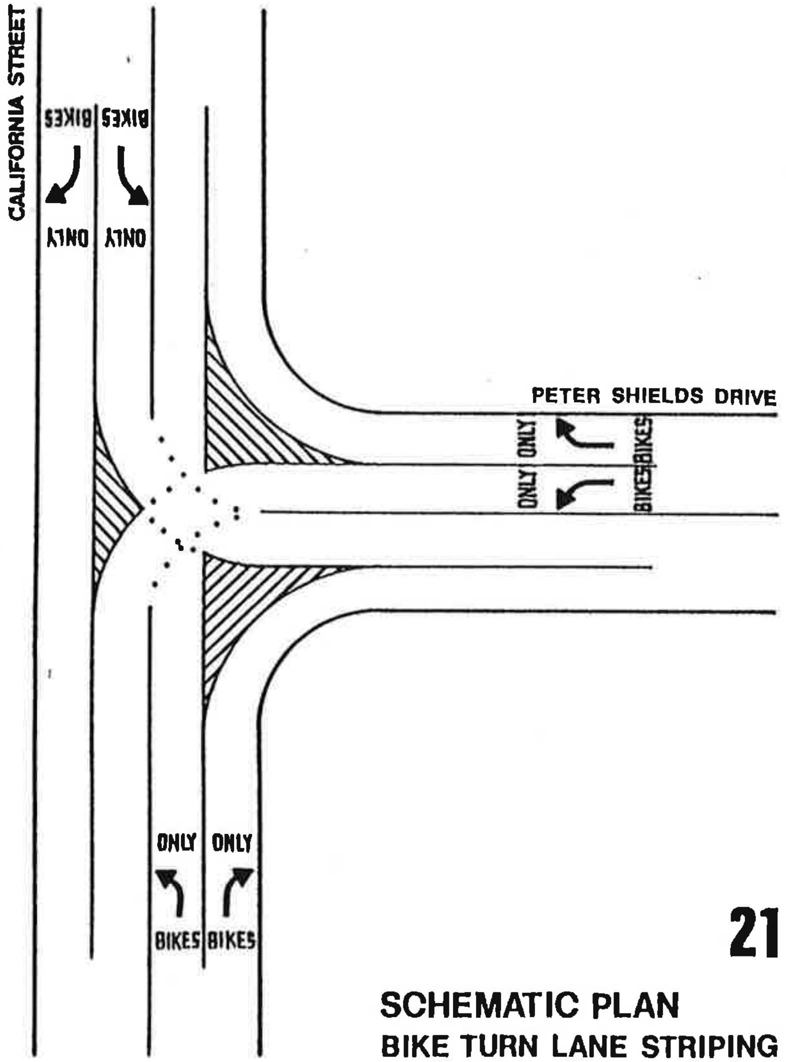
INTERSECTION IMPROVEMENT
PETER SHIELDS AND EAST QUAD

California-North Quad, California-Peter Shields and North Quad-East Quad Intersections

Bike traffic problems at these street intersections on the "closed" portion of campus appear to result from a breakdown in communication between riders. Most riders don't bother to give turn signals and, if they did, because bike traffic is so heavy, it is doubtful that the individual could successfully monitor them to establish predictable intent of all the riders in his immediate vicinity. A possible solution lies in striping, designated through and turning lanes for bikes. This replaces the active, individual communication of signaling with an implicit, mass communication. Riding in the proper lane, unlike hand signaling, involves no special effort for the cyclists so cyclists are likely to use the proper lanes and the grouping of cyclists by turning intent simplifies the individual's task of identifying those cycles with which he has potential conflict. A striping plan for the intersection of California with Peter Shields is indicated on Figure 21. Similar striping would be provided at North Quad and East Quad and a slightly modified version at California and North Quad which would demarcate certain movements to and from the bike path which forms a fourth leg at that intersection. This striping could also be used at the intersections of West Quad with North Quad and East Quad.

The concept of striping or color coding the various lanes appears to have two shortcomings. It is a voluntary form



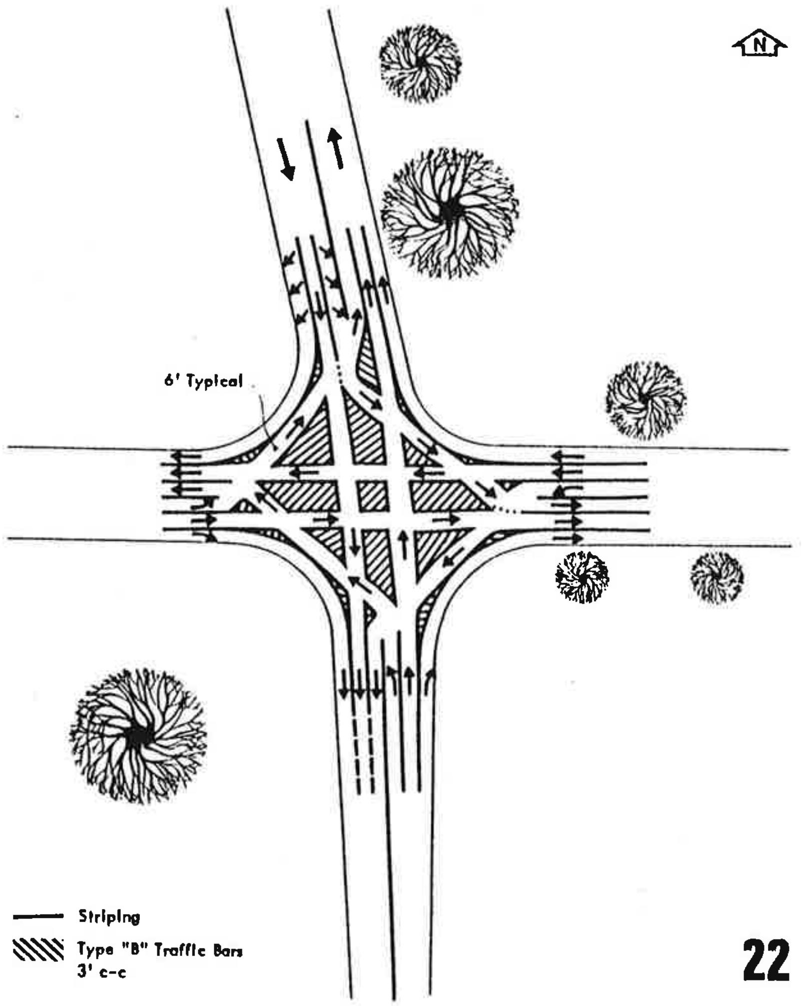
21

SCHEMATIC PLAN
BIKE TURN LANE STRIPING

of channelization as opposed to the circle described above which is self-enforcing. Nothing physically prevents the cyclist from executing an improper move such as a left turn from the lane designated straight-through. Thus, effectiveness of the scheme is heavily dependent on cyclist acceptance and voluntary compliance. In addition, this scheme does not eliminate conflicts; it only aids in identifying cycles which have potential conflicts.

More positive, self-enforcing channelization could be provided by delineating the lanes with traffic bars. Motor vehicles would have to pass over the bars which would cause some annoyance but would have the beneficial effect of slowing motor vehicle traffic. The regular motor vehicle traffic would possibly also dislodge the bars with high frequency. With use of traffic bars, bike turning lane configurations could be in the orthodox pattern as indicated on Figure 21 or in the modified pattern as indicated on Figure 22.

The modified pattern not only identifies the various conflicting bike turning movements but spreads the conflict points so that the cyclist must deal with only a single conflict movement at any given location. However, a mix of cycle and motor vehicle traffic with the modified pattern would produce severe conflicts as motor vehicles would continue to execute normal turning movements.



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MODIFIED TURN PATTERN
BIKE CHANNELIZATION

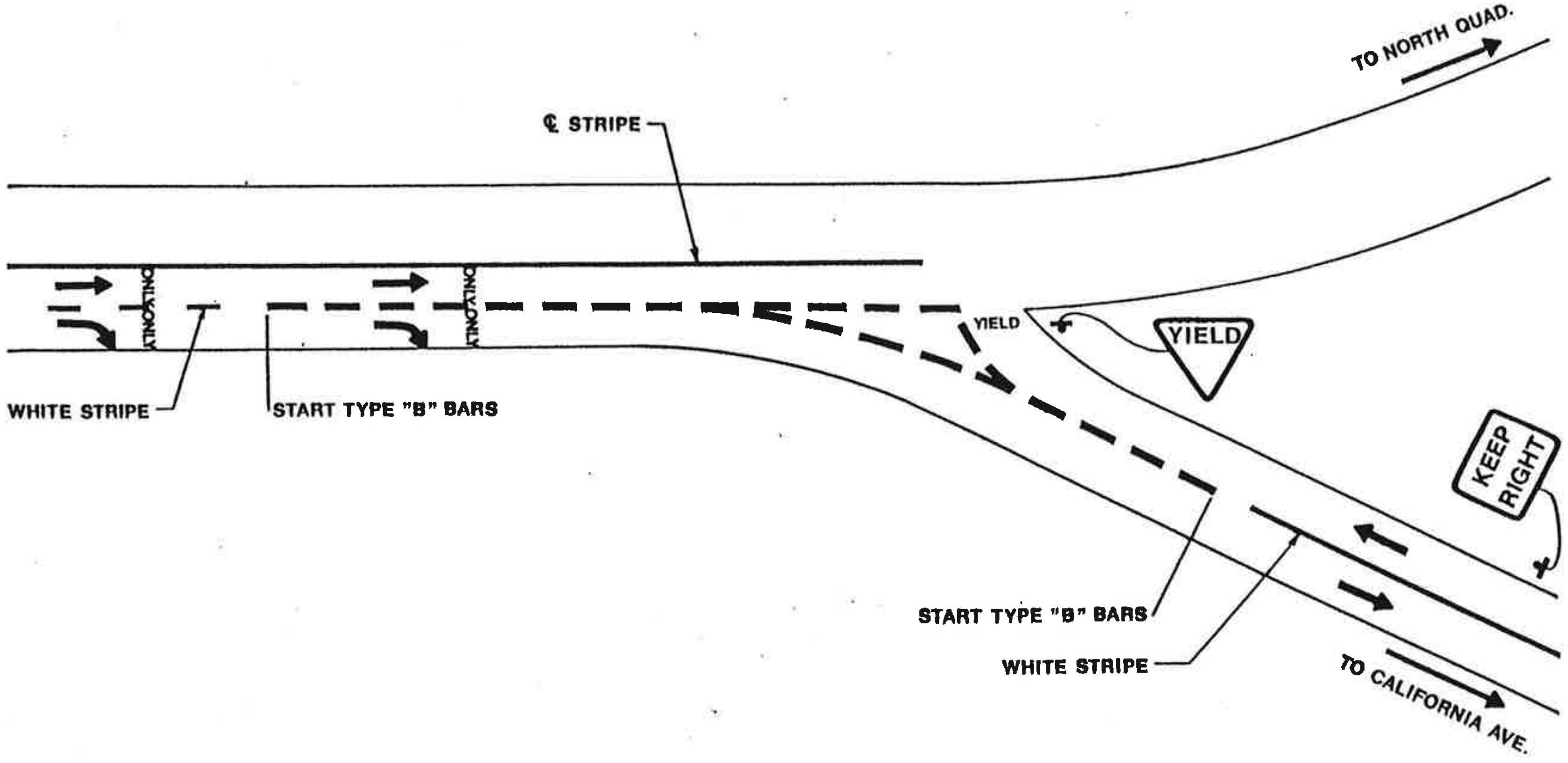
As a possible alternative to traffic bars, turning lanes in the modified pattern might be delineated by cobblestone pavement. Cobblestones might also provide an attractive and effective surface for the traffic circles proposed in the preceding sections.

Bike Path Wye

Immediately west of the California Street-North Quad intersection the main bike path to the west portion of campus forks opposite Hoagland Hall. Crossing conflicts and failure of cyclists to signal turns create a hazardous situation at this Wye. The channelization indicated on Figure 23 should improve the situation. The separation on the eastbound lanes provides positive distinction between straight-through and turning traffic, and westbound traffic from the southeast leg is controlled in its angle of entry to the main path.

LA RUE BICYCLE UNDERPASS

The bicycle underpass beneath La Rue Road was constructed because of the inherent danger in a major bicycle path crossing a divided arterial roadway at an isolated location (away from a signal-controlled intersection) as described in Chapter II, as well as to reduce delays and provide a higher level of service for both cycles and motor vehicles. Despite the direct intent of providing a



23

BICYCLE PATH Y CHANNELIZATION

safe crossing for cyclists at this location, the underpass itself has proven a safety hazard. In its four years of operation it has been the location most prone to bike-involved accidents on campus. Six accidents occurred in the underpass or on its approaches in the Fall Quarter of 1971 alone. Several factors appear to contribute to the high accident rate in the La Rue Road bicycle underpass. These include:

- Length and steepness of approach grades which result in excessive cycle speeds in the underpass.
- Impaired sight distance.
- Heavy cycle traffic volumes accentuated by platooning effects of the traffic signal at Russell Boulevard and Sycamore Lane.

Elevation of the floor of the La Rue underpass is 11 feet below surface ground level with approach gradients of 8 per cent. Thus, the grade and length of grade on the underpass climbouts exceed even the most lenient of the European standards described in Chapter 2 and indicated on Figure 7.

Under normal circumstances cyclists could control their descent on the 8 per cent approach grade to the underpass and avoid dangerous speed buildup. But, confronted by the excessive adverse grade at the opposite end of the underpass, they allow themselves to accelerate on the downgrade, building momentum to ease the climb. Average cycle speeds in the La Rue underpass are nearly twice the average on a level path, 18.7 mph versus 11.1 mph, and interviews with underpass accident victims clearly indicate that excessive speed which results from the grade profile is a major factor in the accident experience at this location.

Stopping sight distance required for cycles operating at normal cycle speeds (10-12 mph) on a level path is approximately 50 feet according to European sources and theoretical calculations. With the substantially greater speeds which are prevalent in the La Rue underpass and the increased braking required to overcome momentum on downgrades, a sight distance of more than 100 feet is needed. At the La Rue underpass, sight distance at some points may be restricted to less than 150 feet. This is ample to enable the cyclist to avoid fixed or slow moving obstructions (pedestrians, slow moving or disabled bikes) in the underpass but not sufficient for situations in which the cyclist chooses to use the opposed directional lane to avoid the obstruction and is confronted by an oncoming cyclist.

The third factor influencing accidents at the underpass is the user volume and its peaking characteristics. Counts indicate peak hour volumes of 300 to 600 cycles. These volumes are miniscule in comparison to the nominal capacity of the underpass, 4,000 to 4,500 cycles per hour. However, other considerations enter into the analysis.

Cycle traffic is sharply peaked, particularly in the morning, to coincide with University class starting times. Of the 500 to 600 cycles using the underpass in the AM peak hour, some 300 were within a 15 minute period. This peaking is compounded by the platooning effect of the traffic signal at the intersection of Sycamore Lane and Russell Boulevard through which most of the underpass users also pass. Although the quarter mile distance between the signal and underpass tends to disperse the platoons somewhat, as many as 30 to 35 cycles may use the underpass in a single minute during the peak period. This is an effective rate of 1,800 to 2,100 cycles per hour.

Conditions of substantial bunching and impaired maneuverability are observed, particularly hazardous at the high speeds common in this location. Additionally, in the AM peak periods, travel through the underpass is virtually 95 per cent campus inbound. The effective directional capacity of the underpass is approximately 2,000-2,250 cycles/hour. Thus, during peak moments the underpass actually operates very close to capacity, cyclists having scant maneuverability to pass or to avoid incidents. This also encourages use of the opposed directional lane, exposing cyclists to head-on traffic under conditions of high speed and insufficient sight distance.

Improvements - La Rue Underpass

Bicycle speed limitation in the underpass might reduce accidents but such restrictions are generally unenforceable. Placement of "SLOW" signs and pavement markings might have a small effect.

Striping the underpass for two directional lanes and a center reversible or 2-way lane would improve AM peak traffic conditions but, with the restricted sight distance, would increase the hazards of head-on collisions in the midday and afternoon hours when travel is more directionally balanced.

A third possibility would be to extend the approaches to reduce the grades and improve sight distances. This would not be a problem on the west side of the underpass but might involve utilities and necessitate retaining wall construction to the east. It would also be possible to raise the pathway surface in the underpass itself, to provide only minimal vertical clearances as presented in Chapter 2, thus additionally reducing the total grade profile.

Solutions - Future Applications

Design future bicycle underpasses with grade profiles permissible under the curves indicated in Figure 1. A 5 per cent grade should be considered maximal. This will not only reduce speeds, but will improve sight distance as well. One method of easing the cycle path grade profile is partial elevation of the motor vehicle roadway (about 4 feet) as is done in Stevenage, England and in new developments in Holland.

More open structures with angled sideslopes rather than vertical abutments would reduce the incidence of cyclists running into the walls.

Bicycle overpasses are generally less successful than underpasses unless the motor vehicle roadway can be substantially depressed. Change in elevation along the bicycle path in the case of an overpass is nearly double that which would be necessary in the case of the underpass. Overpass structures with steep gradients are likely to be avoided by cyclists if alternate at-grade routes are available, thus defeating the purpose of the structure.

BIOLETTI WAY-BIKE PATH INTERSECTION

European experience has indicated a high degree of accident exposure inherent in situations in which a two-way bike path crosses a roadway at an isolated, midblock location. Such a path crosses Bioletti Way, linking the central quadrangle and closed portion of campus to the residence halls west of Bioletti. This path would also provide the main bike-pedestrian linkage of the central campus to the Health Sciences Center when that facility is constructed. Previous high accident experience at this intersection has been reduced by removing "Stop" controls from the bike path (these had been generally ignored by the bikes) and placing the "Stops" on Bioletti.

Bioletti Way currently functions as a part of the west perimeter road system. However, with the extension of La Rue Road, the true west perimeter roadway, southward in the coming year, Bioletti Way will no longer serve a major vehicular circulation function and could be closed to all motorized traffic but service and emergency vehicles. Closure of Bioletti Way from a point just north of the entry serving Parking Lot 27 and the rear of Bainer Hall to Hutchison Drive would provide a corridor extension of the closed campus area to the residence hall area west of Bioletti Way.

Health Science Center Bike Facilities

The proposed bike-pedestrian underpass of the West Perimeter Road is probably required as much to provide a visual and psychological linkage between the Health Science Center and the central campus as it is to eliminate conflicts between motor vehicles and bikes and pedestrians. Interchanges between the Health Science Center and the central campus will be generally light during peak motor vehicle traffic hours although crossing campus would be the logical commute route to the Center for cyclists residing in central and East Davis. However, a midblock, at-grade crossing of a major road of this type is an undesirable design (viz: experience at

Bioletti) and should generally be protected by some traffic control device. Since this would disrupt the desired continuity of flow along the perimeter road, an underpass here is justified with a pathway linking to the main bike path connecting the Thille-Titus-Pierce Hall area to the central campus. Probably more important than the undercrossing beneath the La Rue extension would be a bike-pedestrian underpass crossing the relocated Hutchison Drive north of the Health Science Center, with pathways linking to Orchard Park, to the Russell Boulevard bike path and to the Sycamore Lane bike lanes in the city area. Such a facility would serve the residential areas within prime cycling range of the Center. Commute bike traffic to the Health Science Center can be anticipated primarily on this north-south orientation and would peak during the same periods as motor vehicle traffic on Hutchison Drive.

Old Davis Road Bike Paths

Linkage of the proposed bike paths along Old Davis Road serving areas south of the relocated I-80 freeway poses some problem. Connection to the existing County Road 79, which could be restricted to bicycle, service and emergency vehicle traffic upon completion of the perimeter road, would provide the most direct linkage to the central campus but would entail provision of an additional undercrossing or allowing at-grade crossing of the busy Perimeter Road-Old Davis Road intersection. Alternatively, the Old Davis Road pathway could link to the existing Putah Creek pathways which will pass beneath the Perimeter Road's Putah Creek bridge. This scheme would entail some minor out-of-direction travel and a lower level of service due to the character of the Putah Creek pathways but appears more reasonable than construction of an additional bike pedestrian undercrossing. With the linkage of the Old Davis Road path to the Putah Creek path should be included provisions preventing at-grade bicycle crossings of the Perimeter Road between the Old Davis Road Path and County Road 79.

CAMPUS PATHWAY STRIPING

Although centerlines are not marked on campus bike paths, cyclists generally keep right of the assumed centerline. However, significant numbers of cyclists, particularly those attempting to travel at high speed will, as they attempt to pass slower moving cyclists and pedestrians or take the shortest line through a curve, regularly use the area left of center normally allocated to bikes moving in the opposite direction. While this does not appear to cause a high number of accidents (4 head-on bike accidents in the Fall Quarter of 1971) the practice is disconcerting and an inconvenience to normal bike traffic. Pedestrians who somehow seem to always take their share of the pathway in the middle, racks. In any case, illegal bike parking not only affects normal pedestrians, but causes particular inconvenience to blind persons and handicapped persons confined to wheel chairs. In addition to provision of more, well-located bike racks in areas of shortage, promulgation of an ordinance defining what constitutes illegal bike parking and strict enforcement of it by campus police is needed. Enforcement could take the form of police confiscation of illegally parking bikes. This would avoid the red tape involved in issuing and processing parking tickets. Principal incentive for compliance with the parking regulations would lie in avoiding the inconvenience of reclaiming one's bike from the campus police although nominal fines to defray the cost of enforcement could be imposed.

Another element of bike parking is the theft-security problem. With the rising demand for 10-speed cycles, the increasing rate of bike thefts and involvement of professional thieves in this area is cause for considerable concern. A number of security bike racks impervious to the bolt-cutters commonly used by cycle thieves have recently become commercially available. Also available are bike lockers. Both racks and lockers have locking mechanisms integral with the unit and are available for coin-operating vending-type usage or for individual key or combination lock operation. Neither type is practical for general installation on campus since students and faculty are not likely to use coin racks under most circumstances and providing individualized locks on racks located conveniently for each person at one or several spots on campus is impossible. A few coin-operated units might be placed in the vicinity of the library and other locations on campus where there is considerable bike parking at night. Units for individual key or combination lock operation could be installed at residence halls (also at apartment complexes off campus) where nighttime thefts of ten-speed bikes are most preveland. Units at the residence halls could be rented on a quarterly or annual basis to defray the cost which is more than 10 times the cost per unit of racks currently in service. For generalized use on campus, any of the convenient type racks which facilitate locking the bike through its frame to an immobile object are desirable. Installation of racks which merely support the bike or which permit locking of only the front wheel to the rack should be discontinued and these racks should be replaced as funding permits.

Bolt cutter-proof security racks with non-integral locks (cyclist's own lock is used) are currently in development stages. None as yet have been fully tested and placed on the market and indications are that the cost per unit will be prohibitive for universal installation.

Intra-Campus Circulation

Some fear has been expressed that current levels of bike activity are at or approaching the maximum levels which can be tolerated on campus and that future campus growth will necessitate de-emphasis of the bike and its replacement or supplement in the central campus area by some sort of people-mover transit system. Allaying this fear is the fact that the channelization improvements described in the sections preceding should reduce peak period bike congestion at the key central campus intersections and enable these intersections to function satisfactorily at significantly increased bike traffic volumes. As other intersections begin to be congested, channelizations similar to those above can be implemented.

As is typical on most university campuses, tripmaking on the UCD campus exhibits vast dispersion of origin-destination patterns with some 40,000 combinations of O-D station pairs possible for intra-campus trips alone. No heavily travelled corridors of any substantial length are identifiable, making the more advanced types of line-haul transit systems (guideway systems such as monorail, skybus, etc.) relatively impractical as systems for internal circulation. Additionally, the character of intra-campus travel demand with the extreme peaks in class-breaks makes any discrete frequency system such as elephant trains useless; a continuous service system is required. This implies a moving sidewalk concept or advanced systems of this genre. However, speed of these devices is limited and even with the most advanced of these continuous service systems installed on all the sidewalks of the central campus, the bike would remain time-competitive or superior on most intra-campus trips. Large numbers of bikes will continue to be used on commute trips to campus although increasing numbers of campus commuters will be residing out of prime cycling range. Once bikes are brought to campus, they will generally be used for intra-campus circulation purposes.

This is not to question the desirability of providing distribution facilities from the Unitrans Terminal at the Memorial Union, expansion of Unitrans service to provide multiple collection-distribution points on campus, provision of other systems to ease internal campus circulation of persons who cannot or choose not to ride bikes, or provision of a line haul system which would link remote parking facilities to several points in the central campus and also function as a distributor from the Unitrans terminal. All of these systems would compliment bike circulation by enabling expansion of the area of campus closed to general auto traffic and by reducing levels of bike-pedestrian conflict. The point is that the bike, providing personalized, flexible and speedy service, will remain the primary mode for internal campus circulation; there are means to resolve bike traffic congestion currently experienced and which will facilitate smooth bike traffic circulation at volumes above existing levels; and that pedestrian circulation systems will compliment, not compete with or replace the bike on campus.

IV

THE CITY AREA

Improvements detailed for the City area relate to completing the area-wide bicycle circulation system in existing developed areas, extensions of it into planned development areas and counter measures to reverse poor accident experience at specific locations.

ACCIDENT EXPERIENCE AND REPORTING

As noted in Chapter 2, difficulty in maintaining complete bike volume records makes the task of computing annual bike accidents per bike-mile on street segments and per bike at intersections virtually impossible. Unless expressed in terms of bike-mile and per-bike units, statistics offer an incomplete picture for comparing accident incidence at specific locations to area-wide norms. However, comparison of accidents in absolute numbers and per-mile units does give some indication of overall bike safety problems and hazardous areas.

Table 3 presents total bike accidents as reported to the Davis Police Department over the last 5 years. The police records tend to be less than complete indicators of total bike accident occurrence since auto-bike collisions are the only accidents generally reported. However, police reports generally shed more light on the cause of accident than the type of reports collected at the Student Health Center, facilitating identification of problems and the design of counter measures.

Table 3

Year	Bike Accidents
1971	31
1970	43
1969	23
1968	31
1967	17

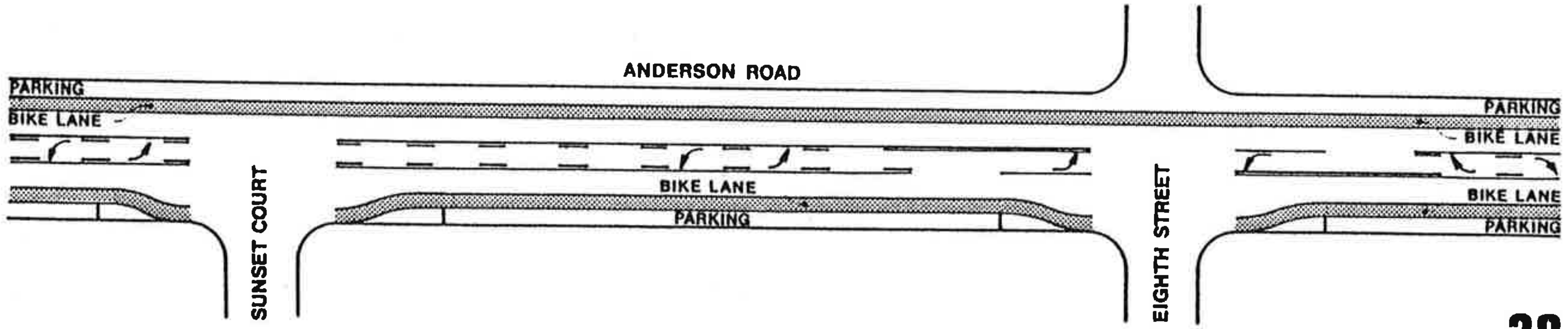
Table 4

Street Segment	Limits	Length (Miles)	Accidents 1970	1971	Total	Rate per Mile
Russell Blvd.	SR113-A St.	1.0	8	5	13	13.0
Fifth Street	A-L Streets	.8	6	4	10	12.5
Anderson Road	Russell-Covell	1.0	8	3	11	11.0
Eighth Street	Sycamore-F	1.1	6	5	11	10.0
Third Street	A-L Streets	.75	5	2	7	9.5
Eighth Street	F-Pole Line	.9	5	3	8	8.9
Fourth Street	A-L Streets	.75	2	3	5	6.7
Sycamore	Russell-Covell	1.05	1	4	5	4.8
First Street	A-G Streets	.4	0	1	1	2.5
Second Street	A-SPRR	.47	1	0	1	2.1

Removal of parking to provide space for bike lanes is not acceptable. However, findings of the concurrent traffic circulation and safety study indicate future traffic volumes on Anderson, with full development of the area north of Covell Boulevard, at a maximum might reach the 10,000 ADT level between Russell and Covell Boulevards. (This takes into account the prospect that the freeway frontage road north of Covell might be linked directly to Anderson Road rather than to Sycamore Lane.)

The Anderson Road cross-section could be modified to provide two 8-foot parking shoulders, two 6-foot bike lanes, 13-foot travel lanes in each direction and a 10-foot landscaped median with left-turn pockets at intersections. In lieu of the median, an 11-foot continuous two-way left-turn lane combined with 12.5-foot travel lanes could be provided, as shown in Figure 28. Either cross-section would provide adequate capacity at traffic volume levels well above the 10,000 ADT range projected. The median plan would be more pleasing aesthetically. The two-way left turn lane configuration would have advantages of providing better access to Anderson Road frontage properties, lower implementation cost and less permanent construction, offering flexibility in the event that unforeseen traffic increases do occur.

For these reasons, provision of bike lanes and the continuous two-way left turn lane is recommended for Anderson Road.



28

ANDERSON ROAD · TYPICAL PLAN
·TWO·WAY LEFT TURN LANE

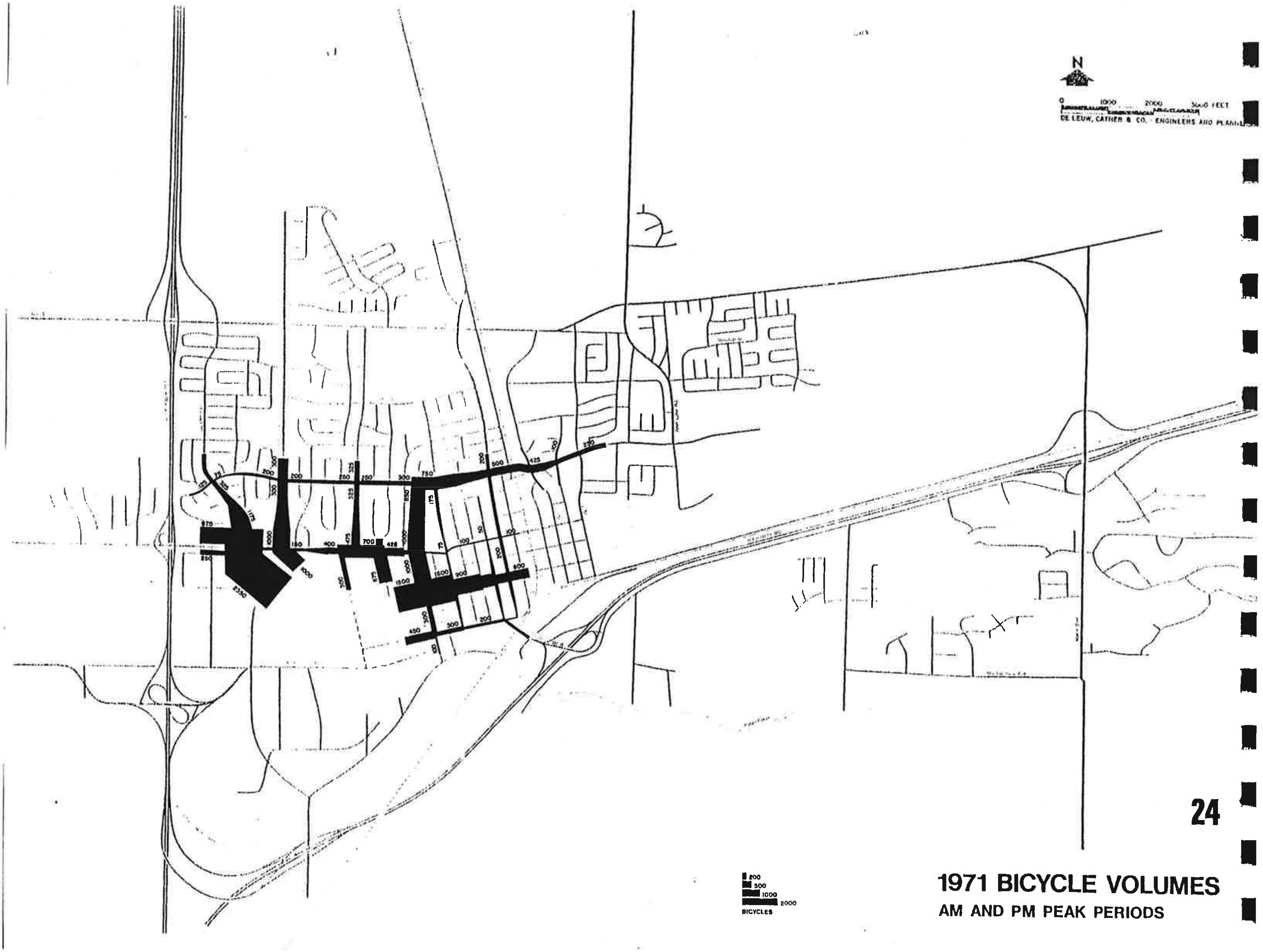
ANDERSON ROAD-RUSSELL BOULEVARD INTERSECTION

This intersection has had one of the highest two-year traffic accident rates in the study area. Detailed study of accidents at this location, presented in the companion TRAFFIC CIRCULATION AND SAFETY STUDY report, indicates no consistent pattern of collisions. However, four collisions involved automobiles striking bicycles and it is theorized that the high overall accident rate results from confusion and friction caused by the high level of unregimented bike activity at the intersection rather than from deficiencies in intersection geometrics or signalization. The diagonal movement executed by bicycles from Anderson Road southbound to the campus entrance on the southeast corner of the intersection, in which bikes occupy the left turn lane and at times cross the path of the left turning motor vehicles, is a particular source of friction, although this move has not figured directly in accidents reported in 1970 or 1971. Nearly 5500 bikes execute this movement in AM and PM peak traffic periods.

Even with bike paths provided on Anderson Road, southbound cyclists are likely to continue weaving out into the left turn lane and crossing the intersection diagonally . Bike lanes have little impact on the existing problem condition at the intersection. The wide intersecting streets and rather long signal cycle cause substantial delay to cycles executing the form of left turn prescribed in Davis code and lead to cyclists preferring the diagonal movement described above.

A scramble cycle in which all motor vehicle traffic approaches are stopped, allowing diagonal as well as single street bike and pedestrian crossing movements to be made at once, is not considered a desirable alternative for two reasons. The scramble cycle would reduce the efficiency of traffic operations, an undesirable result at this intersection of major streets. In addition, it is felt that while numbers of bikes would use the scramble cycle, many would continue to move with traffic as they do now on other phases of the signal cycle if they missed the scramble. This would defeat the purpose of the scramble cycle.

As an alternative, a bike turning lane is proposed immediately to the right of the motor vehicle left turn lane on Anderson southbound. This type of treatment, in common usage in European countries, is indicated on Figure 29. It would provide a defined space for bikes executing the diagonal movement to campus, thus providing a sense of predictability and would eliminate conflicts caused by bikes crossing the path of left turning vehicles in the turn. Protected left turn phasing would increase the security of the movement. Principal drawbacks would be the cyclists' exposure while weaving from the bike lane along the curb of Anderson to the exclusive turn lane. However, this weaving exposure would be no worse than exists currently and appropriate



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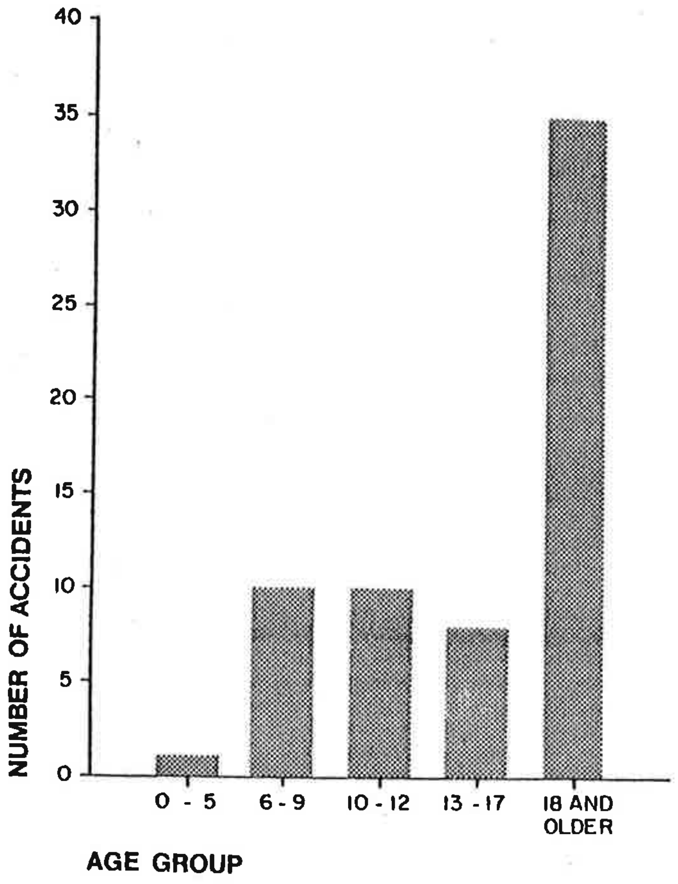
1971 BICYCLE VOLUMES

AM AND PM PEAK PERIODS



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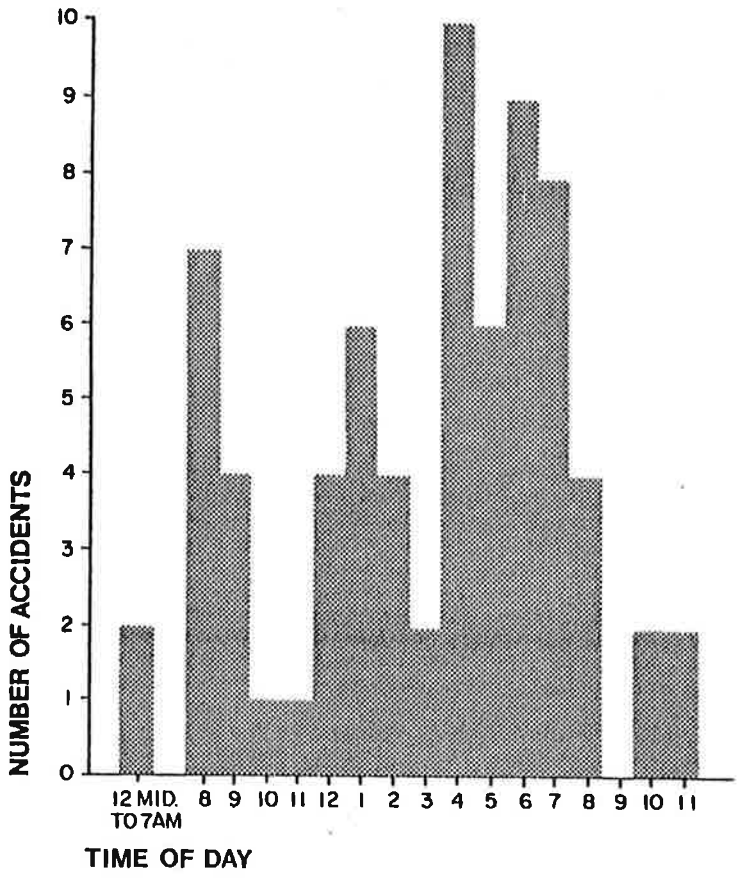
1971-72 BICYCLE ACCIDENTS
AGE DISTRIBUTION OF CYCLIST



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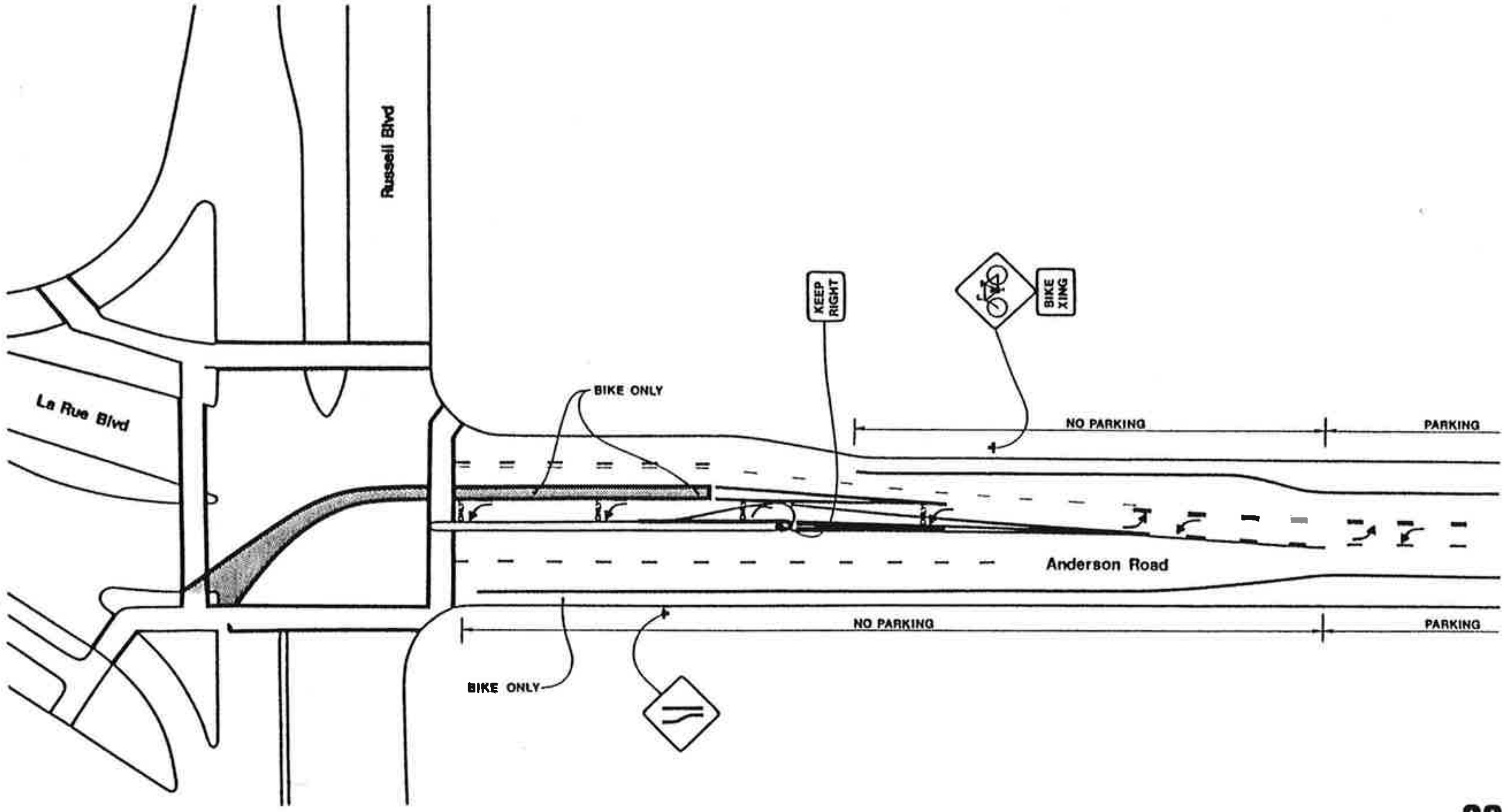
1971-72 BICYCLE ACCIDENTS
DISTRIBUTION BY TIME OF DAY



LA RUE BLVD · RUSSELL BLVD · ANDERSON ROAD
BICYCLE TURNING LANE

"Bike Crossing" signs would be placed warning motorists of this weave.

Because no such bike turning lane has as yet been installed in the United States, implementation is recommended on an experimental basis with a regular program of monitoring the result of this design.

8th Street

As indicated on Table 4, 8th Street on segments both east and west of F Street has one of the higher rates of bicycle accidents of all the streets in the city area. Eighth Street has a limited pavement width and the high traffic volumes it serves approach the capacity of the street sections in many portions of its length. As indicated on Figure 24, Eighth Street carries very heavy bike traffic volumes and bike lanes are provided over its entire length. Such a provision necessitates removal of parking at the approaches to many of the major intersections and also in the segment between B and L Streets. The high rates of bike accidents per mile, as described above, appears to result from a combination of the normal rate of bike accidents which might be expected to result at any heavily biked street plus the effects of encroachment by motor vehicles on the bike lanes at areas where capacity restriction and traffic congestion encourages this. In many locations, particularly at "T" intersections or other intersections of minor streets with Eighth Street, either in peak periods or other hours of the day, motor vehicles can be observed encroaching upon the bike lanes to avoid left-turning cars which block the single through lane while awaiting an opportunity to execute a left turn.

The situation at one such location where encroachments are prevalent, G Street, should be resolved by improvements described in the traffic circulation and safety study. These improvements would involve prohibiting left turns from Eighth Street to G Street. However, banning left turns at all intersections with Eighth Street would not be a reasonable solution to this problem. It appears that at locations where the bike lanes are particularly susceptible to encroachment by motor vehicles, more positive separation of the bike lanes from the motor vehicle traffic lane than that provided by the painted stripe is desirable. Such separation could be provided by raised traffic bars installed along the bike lane stripe.

While motor vehicle encroachment on the bike lanes is a violation of Davis traffic ordinance and susceptible to enforcement, it appears possible to provide a positive physical separation (protected lane treatment) at points most prone to encroachment. Locations most susceptible to encroachment appear to be through bike lanes opposite T intersections. At these locations, Type B traffic bars might be installed along the lanes to discourage any encroachment.

Many of the other bike collisions along Eighth Street involve bikes being struck by left-turning motor vehicles. This appears to be another result of motor vehicle traffic capacity-congestion problems on Eighth Street. Because of the heavy traffic, left-turning vehicles tend to accept gaps in the opposing traffic as they become available without checking the opposite side bike lane for bike traffic. Protected left-turn phasing at signalized intersections appears to eliminate this problem. The prohibition of left turns at G Street will also improve the conditions at that intersection. At non-signalized minor street intersections, a physical solution is not apparent. It appears essential that the City adopt public works and planning policies which will result in no further traffic increases on Eighth Street and support of Eighth Street by parallel traffic facilities such as Fifth Street and 14th Street.

Russell Boulevard and A Street

In the years 1970 and 1971, five accidents involving auto-bike collisions took place at this intersection. All five of the collisions involved bikes proceeding southbound on A Street being struck by automobiles proceeding eastbound on Russell Boulevard. It appears the amber signal indications which generally are set for motor vehicle approaches do not provide adequate warning and clearance interval for bikes crossing intersections, particularly the wider intersections of major arterials. Setting the amber phase for proper bike clearance intervals does not appear desirable as this would reduce the efficiency of operation at this major intersection and would over time tend to induce motor vehicle traffic to run the amber. An "all red" phase would be possible.

Another possibility would be separate bike signal heads with a leading amber phase timed for bikes. Such installations would display bikes on the signal lenses and be mounted with the sign "BIKE OBEY."

Another deficiency at this intersection results from the discontinuity of the two-way path along the west side of A Street which terminates at Russell Boulevard. A Street is heavily travelled by bike traffic both north and south of Russell Boulevard. However, north of Russell Boulevard, motor vehicle traffic volumes are low and no special lanes are provided for the bikes. For southbound traffic on A Street riding by the right-hand rule, the two-way bike path involves no special inconvenience and is generally used. However, northbound riders crossing from the two-way path south of Russell in order to follow the right-hand rule as they continue north on A Street would have to either wait through two signal cycles to place themselves in their proper lane or weave across traffic on A Street north of Russell. As a consequence, many of the riders instead ignore the west side path and choose to ride on the east side of A Street south of Russell where no special provisions are made. While this arrangement does not appear to create any special safety problems, it does illustrate the care required in planning the terminus of cycle facilities. Two-way usage of the west side pathway could probably be encouraged by providing a scramble cycle at the intersection of Russell and A in which northbound riders could diagonally cross the intersection while waiting for only a signal cycle. However, such a scramble cycle would reduce the efficiency of operations at this intersection.

Russell Boulevard

Russell Boulevard between State Route 113 and A Street has the highest rate of bicycle-involved accidents per mile in the city. While many of these accidents are related to specific intersection problems which are discussed subsequently, it is also becoming apparent that many accidents are resulting from the lack of bicycle facilities along the north side of Russell Boulevard. Two-way pathways in the University area along the south side of Russell Boulevard provide continuous bike linkage from State Route 113 to A Street. However, increasing numbers of bicycles are observed riding along the north side of the street in both east and west directions where there are no bicycle facilities. One remedy might be to place appropriate signing along the north side of Russell Boulevard directing bikes to use the south side path, coupled with a campaign of increased enforcement of the bicycle codes in this area. As an alternative, a bike lane might be provided along the north side of Russell Boulevard. This would necessitate elimination of northside parking, but this parking area appears to be used almost exclusively by campus commuters. Removal would enable provision of a lane for westbound bike traffic.

RUSSELL BOULEVARD-SYCAMORE LANE INTERSECTION

Comparison of Figures 24 and 25 shows this intersection has the highest crossing volumes of bike and motor vehicle traffic of all major street intersections in the City and campus area. In the AM peak hour some 550 bicycles and an equal number of motor vehicles were observed passing through the intersection.

Several problems are evident in the general vicinity. Seven collisions with bike involvement occurred here in 1970 and 1971. Most directly related to the intersection itself is the problem of signalization for bikes. Bikes are presently controlled by traffic and pedestrian signals. However, because cyclists realize the clearance interval for pedestrians is triple the time required for a bike travelling at average speed to cross the intersection, bikes continue to enter the intersection after the pedestrian signal changes from the "WALK " to the flashing "DON'T WALK" intersection clearance indication.

Cyclists crossing Russell from north to south at Sycamore, approaching the intersection from the southbound lane on Sycamore or eastbound on the two-way path north of Russell have no problem as they can see the pedestrian indicators well before they reach the intersection and are able to judge if sufficient clearance interval remains for them to cross safely. However, bikes approaching the intersection westbound on the two-way path south of Russell cannot see the pedestrian indicators until they actually reach the intersection. Thus, if the pedestrian signal is already on flashing "DON'T WALK" when the cyclist on this approach can first see it, he has no idea how much of the pedestrian clearance interval has expired and if it is safe to cross. While no accidents related to this problem were reported in 1970 or 1971, near-collisions related to it are a frequent occurrence in the afternoon hours. Special crossing signals set to indicate proper clearance intervals for bicycles would improve the situation. These would not replace but would supplement the pedestrian signals. Setting the clearance interval on the pedestrian signals for bike clearance timing would expose pedestrians.

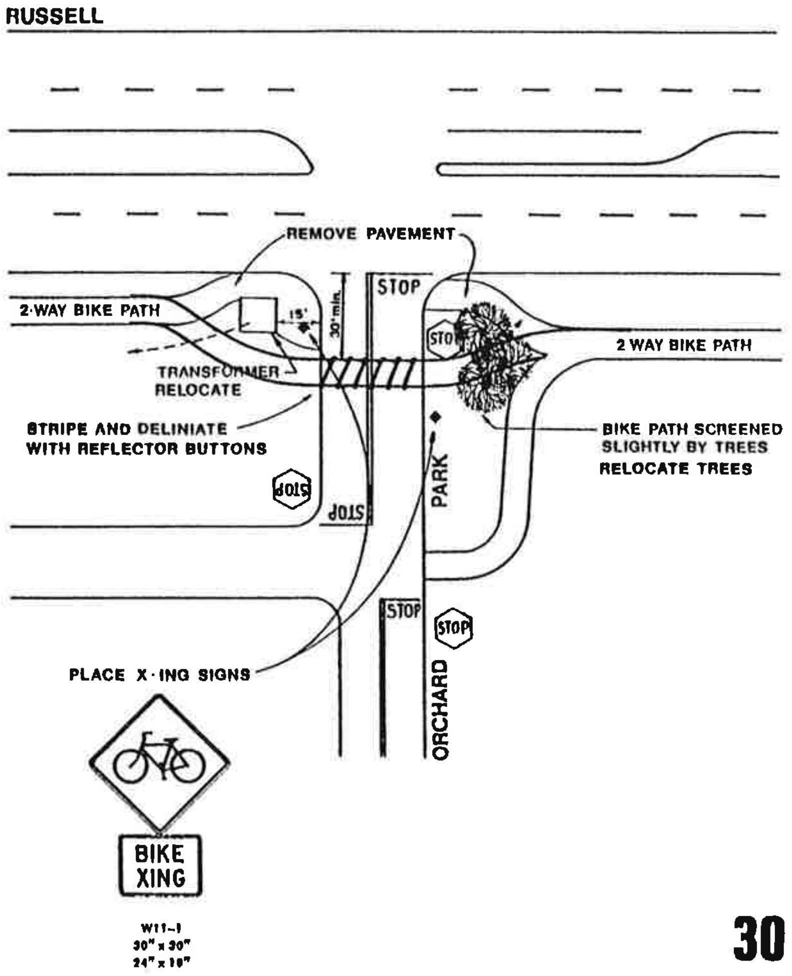
A signal modification which could improve operations at this intersection would be signal phasing for a bike-pedestrian scramble cycle. Since Sycamore Lane ends at a "T" intersection with Russell Boulevard, all southbound motor vehicle traffic on Sycamore must turn right or left, conflicting with the heavy bike-pedestrian movements crossing Russell. The scramble cycle at this location might increase the safety and efficiency of motor vehicle turns from Sycamore as most bikes and pedestrians would cross in the separate phase provided for them. However, bikes which missed the scramble might attempt to cross Russell against the turning Sycamore traffic, adding to the hazard by this unpredictable behavior.

In 1970 and 1971, three auto-bike accidents occurred at the intersection of the two-way bike path along the north side of Russell Boulevard west of Sycamore and the private driveway from Russell at the rear of the 515 Sycamore Lane property. All three bicycles were eastbound on the path; all three autos were southbound, exiting from the driveway to Russell Boulevard. This accident pattern is typical of those displayed at driveways and streets intersecting two-way bike lanes. The motorist emerging from the driveway normally looks to his left to see westbound Russell traffic in the near lane (moving left to right) which poses the most immediate concern to him (also the direction from which bikes would approach if the path were one-way) and tends to forget to check for eastbound bicycles. Complicating the situation at this particular location is a fence which obscures exiting motorists' view of eastbound cyclists on the Russell north side path and vice versa.

Removal or reducing the height of the fence would partially alleviate the problem. Other alternatives would be installing a bell warning system of the type commonly used in city center parking garages which would ring as exiting autos approached the path or installing a convex traffic mirror on the east side of the drive which would allow eastbound bikes to see the exiting car and exiting motorists to see eastbound bikes approaching from their right in the same line of sight as the westbound bikes and motor vehicles. Currently the drive is striped for entry only which should also solve the sight obstruction problem. However, problems will continue to occur when motorists ignore the striping and use this drive as an exit.

RUSSELL BOULEVARD-ORCHARD PARK DRIVE INTERSECTION

Although the problem area is actually on the UC Campus, the situation at this intersection is similar to that at the driveway to Russell near Sycamore as described above, and is presented here for clarity. Motorists entering Russell Boulevard tend to look to their left to see east-bound motor vehicle traffic approaching in the near lanes (also the direction of bike approach if the pathway along the south side of Russell Boulevard were one-way). They tend to neglect checking for westbound bikes on the path paralleling Russell which is two-way and is also slightly screened by small trees. Complicating the situation is a structure housing electrical equipment just west



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BIKE PATH MODIFICATION
RUSSELL · ORCHARD PARK

of Orchard Park Drive which severely restricts sight distance to Russell Boulevard and makes motorists emerging from Orchard Park Drive all the more anxious to look to their left, neglecting bike traffic coming from their right along the pathway.

An improvement plan for this intersection is indicated on Figure 30. Because the electrical equipment installation cannot be readily moved, the bike path is bowed to the south, crossing Orchard Park Drive away from the intersection with Russell Boulevard consistent with the European 'offset crossing' practice as discussed in Chapter 2. Traffic on the short segment of Orchard Park should be slow moving and the bike crossing would be well demarcated and sufficiently visible for safe operations.

SYCAMORE LANE

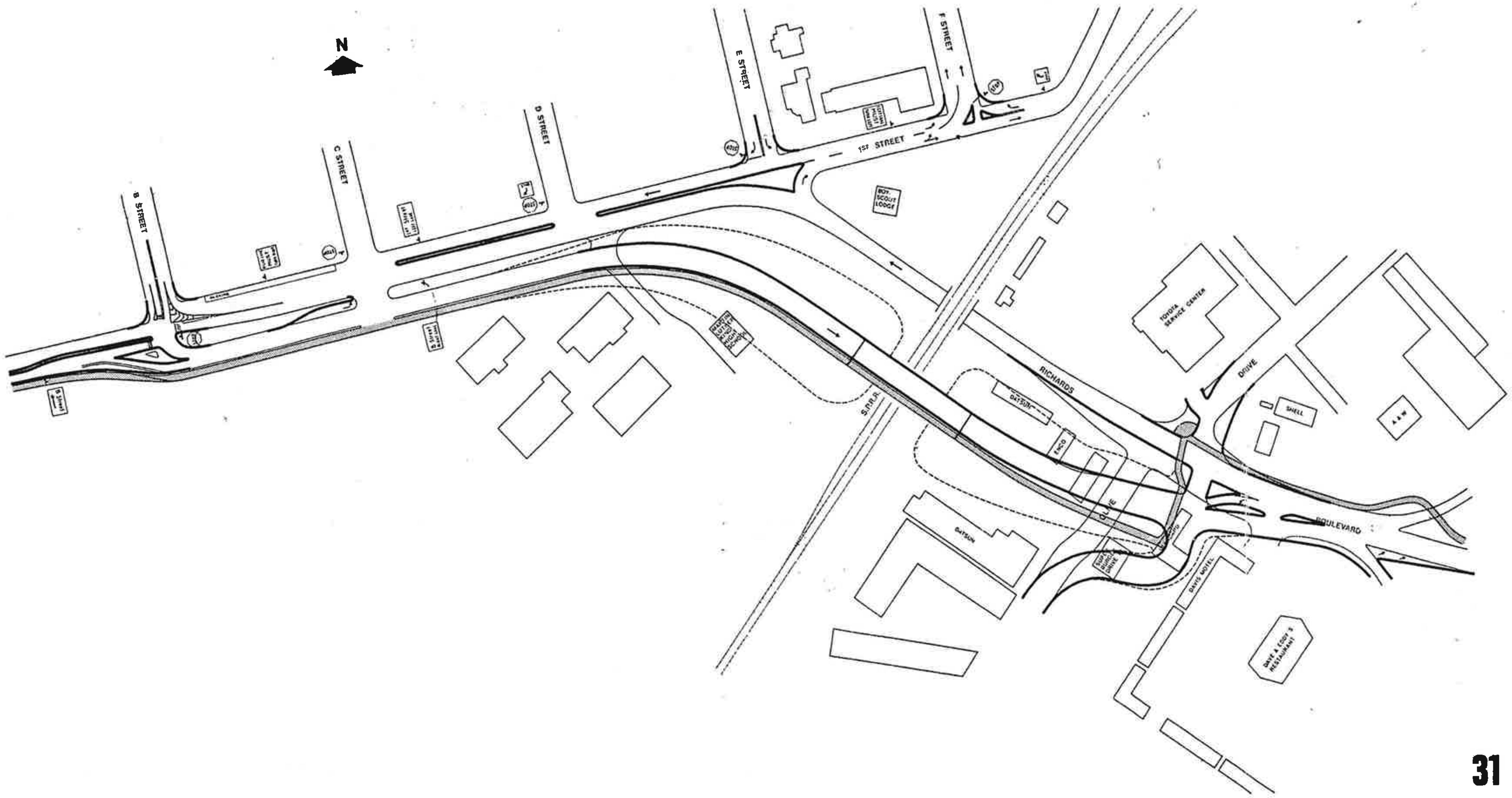
The Davis "Type B" protected lane treatment (bike lanes placed between parked cars and the curb) appears to create some problems in its application on Sycamore Lane. Removal of parking for 100 feet on intersection approaches has eliminated the initial problem of poor sight distance at these locations. However, sight distance problems remain at driveways as evidenced by one auto-bike collision at the entrance to University Mall. Another problem is that the width of the lanes (10 feet) and the barrier to street crossings posed by parked cars tend to encourage two-way travel, reducing the predictability which one-way lanes would otherwise provide. In the case of the actual installation, most cyclists' origins and destinations are in the apartment area on the west side of Sycamore in the first block north of Russell. Because this two-way bike traffic does not cross driveways or other intersections, the net result of two-way usage is probably beneficial. The lighter two-way traffic on the lane on the east side of Sycamore does cross intersections and driveways, posing more of a problem.

In the future, it appears advisable to construct Davis "Type B" protected lanes only in areas in which high parking turnover or other special conditions would interfere with operations of normal on-street lanes.

RICHARDS BOULEVARD GRADE SEPARATION

Three alternatives for improvement of the Richards Boulevard-Southern Pacific Railroad grade separation have been detailed in the companion TRAFFIC CIRCULATION AND SAFETY STUDY. In the existing underpass, only 24 feet wide with no shoulders, bikes and pedestrians must share the 12 foot travel lanes with heavy motor vehicle traffic volumes. Each improvement plan includes bike-pedestrian pathways which provide substantial improvement over the existing inadequate structure.

However, there are significant differences in quality of



31

RICHARD BLVD. GRADE SEPARATION

SCHEME A

service afforded bikes and pedestrians under the three improvement plans. In Scheme A, indicated on Figure 31, the lowest cost plan of the three, a new two-lane overpass would be constructed for southbound motor vehicle traffic and the existing underpass would carry two lanes of northbound traffic. A two-way bike-pedestrian facility would be provided along the west side of the new overpass connecting to a separate pathway along the south side of First Street leading to the UC Campus.

Two major drawbacks related to bike service are notable in this scheme. While good bike-pedestrian linkage is provided between the campus and the area south of the railroad, travel between the downtown and the area south of the tracks involves either two or three blocks of out-of-direction travel to use the new facility or use of the existing underpass, travelling in the motor vehicle traffic lane as is currently done. This latter option would be particularly hazardous for southbound trips from the downtown as these would be travelling against the direction of the one-way motor vehicle traffic. Another disadvantage of Scheme A is the grade profile on the cycle path. In order to maintain required clearance over the railroad, which itself is slightly elevated, the surface of the cycle path would at its high point be some 30 feet above surrounding ground elevations, and grade profiles within or approaching those recommended as per Figure 7 could not be achieved within the constraints of this design.

Scheme B indicated on Figure 32 involves construction of a new four-lane underpass on roughly the same alignment as the existing structure. Two-way cycle-pedestrian pathways would be provided on both sides of the new underpass.

Design constraints work to the advantage of cycle facility grade profile in the case of the underpass. Vertical clearance requirement for a vehicular roadway passing beneath the railroad is only 15 feet as opposed to 23 feet in the case of a roadway passing over the tracks, and the approximately 4 feet the railroad is raised over surrounding ground level reduces the required change in roadway elevation rather than increasing it as in the case of the overpass. In addition, with the underpass design, advantage can be taken of the lesser vertical clearance requirement on the cycle-pedestrian path, only 8.5 feet, by suspending the pathways along the side slopes to produce an ideal grade profile of 3 per cent - 300 foot approach grades (see Figure 7). A cross-section of this unique design is illustrated on Figure 33.

Scheme B provides good linkage from both the downtown and the campus to the area south of the railroad. Vehicular noise levels would be high in the underpass itself but since the enclosed area would be only some 65 feet long this would not have a severe impact on cycles and pedestrians.