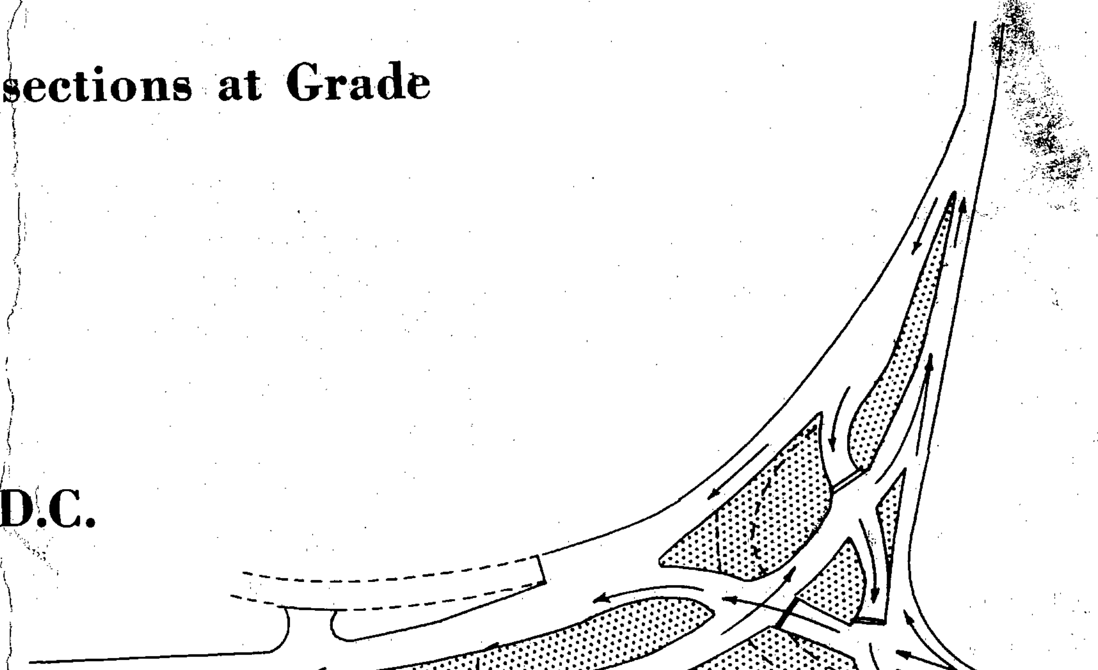
National Research Council

HIGHWAY RESEARCH BOARD SPECIAL REPORT 5

CHANNELIZATION

The Design of Highway Intersections at Grade



1952

WASHINGTON, D.C.

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CHANNELIZATION

A Cooperative Project

Committee on Channelization

Highway Research Board

Texas Engineering Experiment Station

Texas A & M College

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The Design of Highway Intersections at Grade

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WASHINGTON, D.C.

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Foreword

In the design and operation of our nation's extensive network of streets and highways, traffic and highway engineers have long recognized the intersection as the area of major conflict and congestion. The intersection at grade is the limiting factor in the operational capacity of the highway for seldom does its capacity exceed that of the approach roadways. Within the limits of the intersection occurs a disproportionately high percentage of motor vehicle accidents. Although the mileage of highways within the intersection is relatively small, 47 percent of all accidents in urban areas and 20 percent of all accidents in rural areas occur at the grade intersection (Accident Facts, 1951 Edition).

The Highway Research Board Committee on Channelization has defined channelization of intersections at grade as "the separation or regulation of conflicting traffic movements into definite paths of travel by the use of pavement markings, raised islands or other suitable means to facilitate the safe and orderly movements of both vehicles and pedestrians."

Channelization is gaining recognition among highway designers as an important tool in the control of traffic and is being employed extensively in the functional design of new highway facilities. Channelization is being applied in the redesign of "problem" intersections where accidents and congestion are creating unnecessary "bottlenecks" along otherwise adequate traffic arteries.

Although most of the important highway channelization projects were designed after 1940, the use of simple devices for the channelization of traffic dates back to the early 1920's. The basic principles of traffic movement through intersectional areas were first set forth by Mr. Guy Kelcey in his "Channelization of Motor Traffic" (ASCE Proceedings, December 1939). However, precise principles of functional channelization design have not been developed nor generally accepted and much of the current design is based upon the judgment and experience of the designer and the application of recognized principles of geometric highway design.

This publication represents the cooperative efforts of the Highway Research Board Committee on Channelization and the many State and City engineers who furnished the field data for the examples presented. More than one hundred examples were submitted to the Committee for study. Fifty-nine of these were selected as being sufficiently complete to warrant inclusion in the publication. A major contribution has been made by the Texas Engineering Experiment Station in furnishing the full-time services of a research engineer, Mr. B. F. K. Mullins, and the assistance of essential drafting and stenographic personnel who prepared the material for publication.

Progress is usually based on accumulated knowledge of principles and on the known experience of their application. The publication of these examples of highway channelization, including both good and bad design with critical review is presented in the hope that highway and traffic engineers may profit by a review of the work of others.

Grateful acknowledgment is extended to the many individuals and organizations who contributed the basic data which have been used as the basis for this publication. The name of the person submitting the material is shown with each example and especial appreciation is extended for the splendid cooperation in furnishing the information requested by the Committee.

Sincere gratitude is expressed to Dr. A. W. Melloh, Vice-Director, Texas Engineering Experiment Station, without whose support and guidance this project could not have been completed and to Mr. B. F. K. Mullins, Research Engineer, under whose direction the basic material was assembled, collated and reproduced for publication.

Appreciation is extended to Dr. H. W. Barlow, Dean of Engineering, A and M College, and Director of the Texas Engineering Experiment Station, and Dr. W. E. Street, Head, Department of Engineering Drawing who served with Dr. Melloh as the advisory group for the Texas Engineering Experiment Station on this project.

Photographs were furnished by the person or organization submitting the example and due credit is given for permission for their reproduction in this publication.

Contents

Introduction

The rapid and continued post-war increase in motor vehicle production and use, the attendant record of traffic accidents and congestion, and public clamor for some relief are forcing highway and traffic engineers to consider every possible means of attacking the mounting highway transport problem.

Freeways and expressways are providing essential relief on a limited mileage of important arteries. However, recognition must be given to the important fact that the major portion of motor vehicle traffic for years to come will move on existing streets and highways. These facilities, many of which are obsolescent, must be used to their maximum efficiency and capacity.

Important and satisfying progress is being made in many localities through the employment of restrictive traffic controls. These include one-way streets, parking prohibition and regulation traffic signal control, pavement marking, through streets, turn prohibition, regulation of transit operation, pedestrian control, truck routing and control of loading and unloading operations, and the use of traffic islands.

Recognizing the intersection as the area of major conflict and congestion, traffic and highway engineers are focusing particular attention upon these critical areas. Channelization is receiving increased recognition as an important tool in the attack on the problem of the intersection. It has been employed with success at many locations, but it has also failed at other locations where the design has been inadequate or where the basic principles of channelization have been violated.

PREVIOUS STUDIES

A review of technical literature published prior to 1939 reveals few references to intersection channelization. Since the publication of Mr. Kelcey's "Channelization of Motor Traffic," published articles relating to channelization have dealt, in general, only with the functional design of a particular intersection. Little reference is found to the operational characteristics of a completed channelized intersection and few "before" and "after" studies have been made which would reveal the effectiveness or efficiency of the design.

Several publications deal with the geometric design of the several elements of the channelized intersections, such as curbs, islands, vehicle turning radii, lane widths, speed change areas and separated turning lanes. A comprehensive bibliography on these and other references relating to highway channelization has been prepared by Mr. B. F. K. Mullins, a member of the Committee on Channelization, and published by the Texas Engineering Experiment Station as Bulletin No. 117. The title of this publication is "Annotated Bibliography on Channelization and Related Problems of Highway Traffic Engineering."

BASIS OF THIS REPORT

The Committee on Channelization recognizes that the determination of operational performance and details of functional design of the various types of intersection channelization will require a considerable amount of study and research. Standards must be developed for measuring intersection performance and criteria established which will permit the practical comparison of possible designs. Such research and evaluation represent a long-range project. In the meantime, channelized intersections are being designed and constructed.

The Committee believes that much value can be gained by presenting examples of channelized intersections which have received the test of performance under varying conditions of traffic. The report is not intended to establish principles of channelization design, but rather to present current design practice in the hope that highway and traffic engineers may profit by a review of the work of others.

Cities and states were requested to furnish examples of channelized intersections for inclusion in the report. Detailed specifications were provided to indicate the data desired. The requested data included:

Location

Type of Intersection

Physical Data

1. Geometric design. Submit plan (Scale: 1 in. - 100 ft., if available)
2. Grades. Submit profile or show important grades on plan sheet
3. Surface type: Roadways, islands, shoulders
4. Cross section (show if unusual design)
5. Traffic control devices
   a. Signs: Type, size, location
   b. Signals: Type, location, timing
   c. Markings: Type, color
   d. Lighting: Type, location
   e. Other control devices: Guide posts, reflective devices, etc.
6. Landscaping
7. Character of abutting property: Rural, business, residential
8. Transit Operations (show provisions for trolley and bus operations)
9. Right-of-way (show limits)

Traffic Data

1. Volumes: Average daily, maximum hourly, or other volume data available
2. Type: Percent passenger, percent commercial
3. Speeds: Approach - 85 percentile; Average through intersection
4. Delays
5. Accidents: Collision diagram, if available, for 12-month period before and after, or Number of fatal, personal injury and property damage only for 12-month period before and after
6. Pedestrians: Volumes; Location of crossings

Economic Data

1. Estimated cost of proposed installation
2. Estimate of monetary value and cost of traffic accidents for 12-month period before and after construction

Operational Characteristics

1. Design features which contribute to safe and unsafe operation
2. Design features which contribute to congestion
3. Comments regarding overall operation of channelized intersection

More than one hundred examples were received by the Committee. Of this number, 59 were selected as being sufficiently complete to include in the report. The examples represent rural and urban intersections in seventeen states, the Territory of Hawaii and the District of Columbia.

CRITICAL COMMENTS

The Committee recognizes that current channelization design is based, to a large degree, upon the judgment and experience of the designer in the application of the general principles of highway and traffic design to the problem of the intersection. In presenting the examples, the Committee believes that in the absence of qualifying remarks, some designs might be accepted as good practice. To prevent a misinterpretation of the examples by those readers whose experience in channelization may be limited, critical comments by two Committee members have been included with each example. Each of the two reviewers developed his comments independent of the other.

Admittedly, this critique, or review, is not intended to supersede the work of the authors. The analyses accompanying the examples should be accepted only as the considered opinion of the reviewer based upon the supporting data furnished and do not necessarily reflect the accuracy or effectiveness of the design. It must also be recognized that the reviewer did not have the designer's intimate knowledge of the local conditions which so greatly influence the ultimate design.

The critiques prepared by Committee members were submitted to the person providing the example for review and additional comments were solicited. For many of the examples, these additional comments provided important data relating to the design and operation of the intersection and have been included in the textual material.

Part I - Definitions

To reduce the misunderstanding which might develop from the misuse of the engineering terms used in the report, the Committee has adopted the definitions contained in the recently published "Highway Capacity Manual" prepared by the Highway Research Board Committee on Highway Capacity. Definitions not found in the "Highway Capacity Manual" were selected from the "Manual on Uniform Traffic Control Devices for Streets and Highways."

CHANNELIZATION DEFINED

Like the design of the channelized intersection, the definition of "channelization" is subject to considerable difference of opinion. The following definition was adopted by the Committee on Channelization as being representative of the Committee's area of investigation and research:

"Channelization of intersections at grade is the separation or regulation of conflicting traffic movements into definite paths of travel by the use of pavement markings, raised islands or other suitable means to facilitate the safe and orderly movements of both vehicles and pedestrians."

OTHER DEFINITIONS

Barrier Line. A distinctive longitudinal pavement line which, when placed in proper relation to a normal center or lane line, or to another barrier line, indicates that all traffic must keep to the right thereof.

Buffer. A structure at the approach end of a safety zone designed to deflect or stop any vehicle which collides with it.

Center Line. A line marking the center of a roadway on which traffic moves in both directions, or dividing the roadway between traffic moving in opposite directions.

Curb. A vertical or sloping member along the edge of a pavement or shoulder forming part of a gutter, strengthening or protecting the edge, and clearly defining the edge to vehicle operators. The surface of the curb facing the general direction of the pavement is called the "face."

Vertical Curb. A curb whose face is a plane surface which is either vertical or inclined at an angle not exceeding 20 degrees with the vertical. Ordinarily it is not mountable, or is mountable with difficulty, by vehicles. Also called a "straight curb" or "normal curb."

Sloped Curb. A curb whose face is a plane surface which is inclined at an angle of at least 20 degrees, but not more than 60 degrees, with the vertical. It may be mountable or nonmountable by vehicles.

Lip Curb. A curb whose face is a plane surface which is inclined at an angle of at least 60 degrees with the vertical and which is readily mountable by a vehicle.

Rolled Curb. A curb, the face of which is "S" shaped in cross section, usually so constructed as to be mountable by a vehicle.

Density. The number of vehicles occupying a unit length of the moving lanes of a roadway at a given instant. Usually expressed in vehicles per mile.

Islands.

Channelizing Island. A traffic island located in a roadway area to confine specific movements of traffic to definite channels.

Divisional Island. A traffic island so located longitudinally in a roadway as to separate traffic streams flowing in the same or opposite directions.

Loading Island. A raised safety zone especially provided at a regular streetcar stop, or at a bus stop when such is near the middle of the street, for the protection of passengers.

Pedestrian Island. A raised safety zone located in a cross walk.

Traffic Island. Any restricted area permanently located in a roadway which provides structurally for the physical separation and sorting of traffic streams.

Jiggle Bars. A series of raised transverse bars placed on the pavement to make any wheel encroachment within the area obvious to a vehicle operator without loss of control of the vehicle.

Lane Lines. A line other than a center line separating two traffic lanes.

Merging. The process by which drivers in two separate traffic streams moving in the same general direction combine or unite to form a single stream.

Prow. An elongated extension of a buffer tapered and sloped downwards toward approaching traffic so that a vehicle mounting it will drag thereon and come to a stop or reduce its speed considerably.

Separator. An area or a device (other than a painted line or area) so located longitudinally between two roadways as to separate traffic flowing in the same or opposite directions and being so designed as to discourage or prevent passage by vehicles from the lanes on one side of the separator to those on the other.

Directional Separator. A separator between traffic streams moving in opposite directions. If the directional separator is located between two roadways carrying through traffic in opposite directions, it is usually referred to as a "median".

Lane Separator. A separator between traffic streams moving in the same direction where the service rendered by the roadways on either side of the separator is essentially of the same character, as distinguished from that on a frontage roadway.

Outer Separator. A separator between a frontage roadway and the roadway of a controlled-access highway or major street.

Speed Change Area. An added width of pavement adjacent to the through traffic lanes to enable vehicles entering a roadway to accelerate to a reasonable speed before merging with through traffic or to permit vehicles leaving the roadway to decelerate to the required speed after separation from through traffic has been accomplished.

Traffic Button. A button-shaped device installed on the pavement for the purpose of helping to channelize traffic movement.

Traffic Lane. A strip of roadway intended to accommodate a single line of moving vehicles.

Parking Lane. A strip of roadway where vehicles may be legally parked but which otherwise would be available to moving traffic.

Left-Turn Lane. A lane within the normal surfaced width, reserved for left-turning vehicles.

Right-Turn-Lane. A lane within the normal surfaced width, reserved for right-turning vehicles.

Separated Turning Lanes. Added traffic lanes separated from the intersection area by an island or unpaved area. They may be wide enough for one-lane or two-lane operation.

Added Turning Lane. A special lane for turning vehicles obtained by widening the normal roadway width at intersections.

Volume. The number of vehicles moving in a specified direction or directions on a given lane or roadway that pass a given point during a specified period of time, viz., hourly, daily, yearly, etc.

Weaving. The act performed by a vehicle in moving obliquely from one lane to another, thus crossing the path of other vehicles moving in the same direction.

Part II - Types of Intersections

Considerable confusion exists in defining intersection types. Various intersections have been described as Y, T, cross, offset, skew, multiple, oblique, three-way, four-way, right-angled and multiway. To further uniformity in definition, the Committee has adopted definitions for intersection types contained in the "Highway Capacity Manual". The six basic types of intersections are shown pictorially in Figure 1.

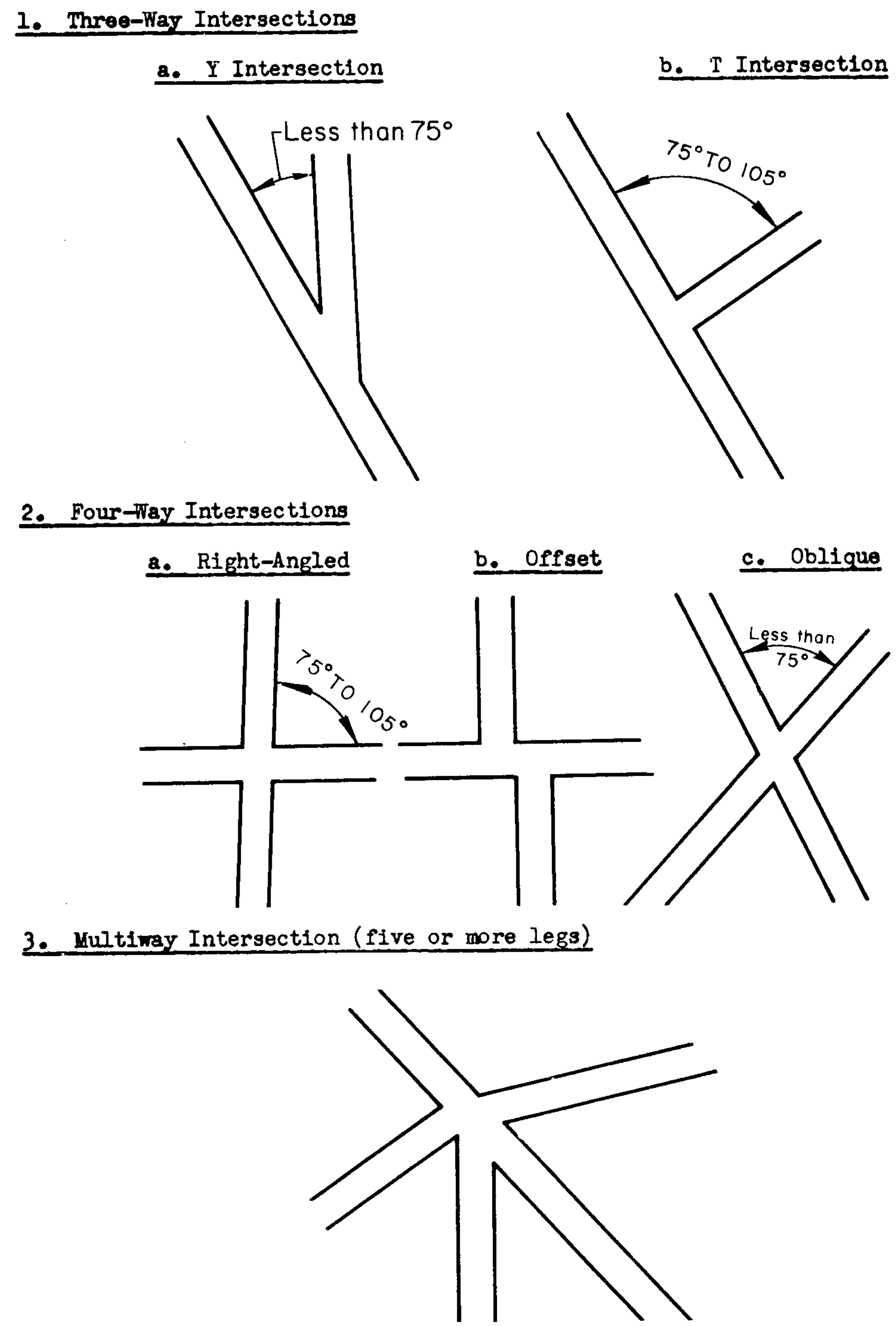


Figure 1.

Part III - Warrants for Channelization

During the preparation of this bulletin, the Committee initiated a project to investigate the warrants for the channelization of grade intersections.

In a questionnaire which was given wide circulation among City and State engineering organizations, the Committee suggested that certain "warrants for channelization are well known and are widely used in a general way." Obvious factors generally considered are as follows:

1. Excessive area
2. Improper use of area
3. Need for reference points
4. Control of speed
5. Pedestrian protection
6. Angle of conflict
7. Aid to regulations (for prohibiting a specific movement)
8. Shadowing
9. Heavy directional movements
10. Location of devices
11. Separation of conflicts

The questionnaire continued by stating that "In lieu of specific questions which might limit your reply, we would like to have you furnish us information in your own words on the warrants you use, as well as your standards, typical drawings, etc.".

Response to the questionnaire was received from the following organizations:

State Highway Departments	35
Cities	10
Bureau of Public Roads	1
District of Columbia	1
Other organizations	2
Total replies	49

Comments contained in the replies ranged all the way from enthusiasm for the establishment of definite warrants to statements that the writers were uncertain whether the establishment of such warrants is practical or even desirable. Several State Highway Departments indicated that they used the information contained in the "Policy on Intersections at Grade" as issued by the American Association of State Highway Officials. A few Highway Departments indicated that they used the AASHO Policy in conjunction with the "Highway Capacity Manual."

From the information received by the Committee, it may be concluded, therefore, that the eleven factors listed in the questionnaire are in a broad sense the warrants for channelization and their influence on the application and design of channelization depends upon physical conditions and traffic characteristics at particular intersections.

Part IV - Principles of Channelization

In the analysis of motor-vehicle movements through intersectional areas and in the development of the principles of channelization, consideration must be given to such human factors as habit, ability of drivers to make decisions, element of surprise, decision and reaction times, and conformance to natural paths of movement.

Traffic factors must be evaluated to include possible and practical capacities; turning movements; size and operating characteristics of vehicles; control of movements at points of intersection, convergence, and divergence; vehicle speeds, pedestrian movements; transit operations and accident experience.

Physical factors which control intersection design and the application of channelization include character and use of abutting property; roadway grades; surface type and cross section; sight distance; total intersectional area; angles of intersection, divergence, and convergence; areas of conflict; speed-change areas; island design; traffic control devices; and lighting.

Economic factors which are important and often controlling include the cost of the improvement and the economic effect on abutting businesses where channelization restricts or prohibits certain vehicle movements within the intersectional area.

In varying degrees these human, traffic, physical, and economic factors give character to the intersection. Although intersections have many common factors, they are not subject to class treatment, and they must be looked upon as individual problems.

The Committee fully recognizes the limitations which local conditions so often placed upon the designer. The importance of this factor was well stated by Mr. F. B. Crandall, Traffic Engineer of the Oregon State Highway Commission, when, in commenting on the examples submitted from Oregon, he wrote "I think it is in order to include both good and bad examples of channelization, for certainly we learn as much, if not more, from our mistakes as we do from our experience with those designs proved sound. I do think, however, that with the large bulk of copy to be made up of examples, some mention should be made in the report of the arbitrary controls which beset the designer working out a specific channelizing plan. Those of us who are in every day operation work are fully aware of the old bugaboo of money control which is usually traceable to such things as excessive right-of-way costs, difficult terrain, rights of access to abutting properties and others which preclude optimum design and for which compromises must be made. Certain elements of design have been fairly well established as being good practice; however, often times we are forced to digress from the established good practice by reason of aforementioned arbitrary controls."

In the design of an intersection, the engineer must consider both the objectives and the principles of channelization. The central objectives of intersection channelization are to assure orderly movement, increase capacity, improve safety and provide maximum convenience. When the design provides for orderly movement and adequate capacity, improved safety and convenience will result.

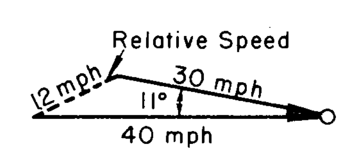
The more important principles of channelization which are presented in the following discussion must be observed if an effective design is to be achieved. The degree to which these principles are applied will depend upon traffic and physical features of the over-all design. For example, if traffic signal control is to be incorporated in the design, the angle at which traffic streams may cross without merging and weaving may be less than the right-angled crossing recommended for non-signalized intersections (Principle No. 3).

Similarly, the separation of conflict points may be undesirable and impractical if the intersection is to be controlled by traffic signals (Principle No. 8).

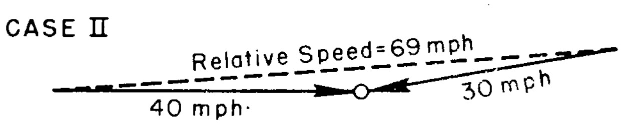
The designer must clearly understand, however, these principles of channelization. Experience will indicate the degree to which they may be modified to meet conditions at particular intersections. If, on the other hand, the principles of channelization are disregarded, the objectives of channelization will not be achieved and the resulting design will be hazardous and inefficient.

1. The relative speed and impact energy of intersecting vehicles are functions of vehicle speeds and angle of intersection.

CASE I

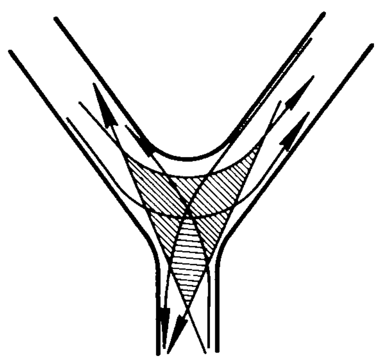


CASE II

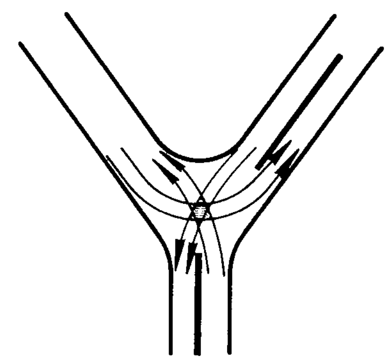


The impact energy varies as the square of the speed. The impact energy of the colliding vehicles in Case II is 33 times more than in Case I.

2. Channelization reduces the area of conflict.



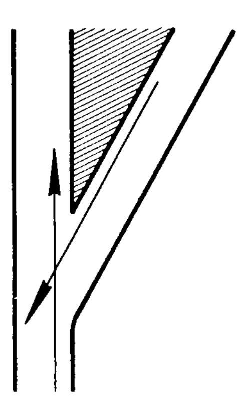
Impact area of all paved intersection

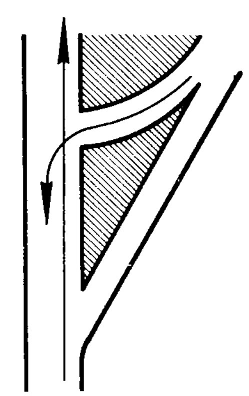


Impact area of channelized intersection

Large paved intersectional areas invite uncontrolled vehicle and pedestrian movements. The resulting confusion contributes to accidents and congestion and thus reduces the operating efficiency of the intersection.

3. When traffic streams cross without merging and weaving, the crossing should be made at or near right angles.

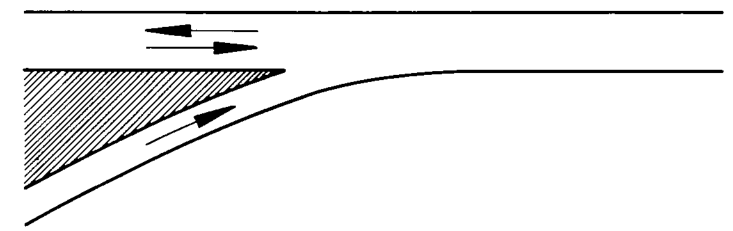




The intersection of traffic streams at or near right angles:

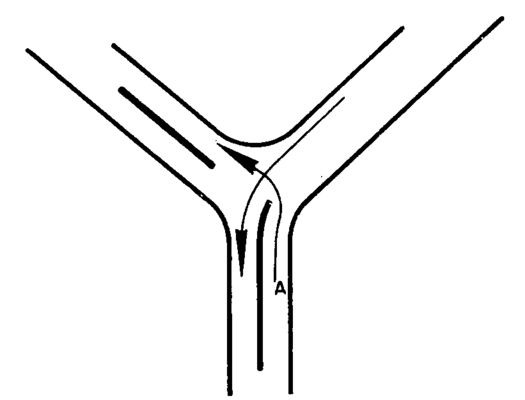
a. Reduces the angle of intersection and the impact energy.
b. Reduces the time of crossing an opposing traffic stream.
c. Reduces the size of the conflict area.
d. Provides the most favorable conditions for drivers to judge the relative position and relative speed of intersecting vehicles and permits maneuver or change of speed which may be required to avoid conflict.

4. Merge traffic streams at small angles.



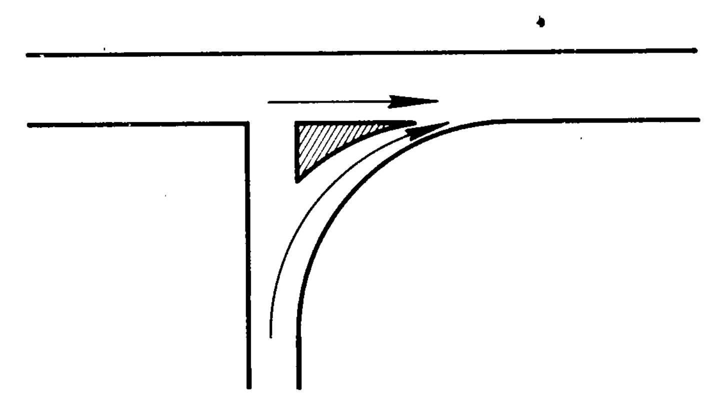
Merging at small angles (10 to 15 deg.) permits the uniting of traffic streams at minimum speed differentials. Vehicles entering a moving traffic stream at flat angles have the most favorable opportunity to select gaps in the stream which are safe for entering and merging. Vehicles entering a moving traffic stream at angles greater than 10 to 15 deg. must usually be subject to stop control. This reduces the capacity and safety of the intersection because of the greater time gap in the moving stream required for the entrance of a stop vehicle as compared for the entrance of a moving vehicle.

5. The speed of a traffic stream entering an intersection may be controlled by bending.



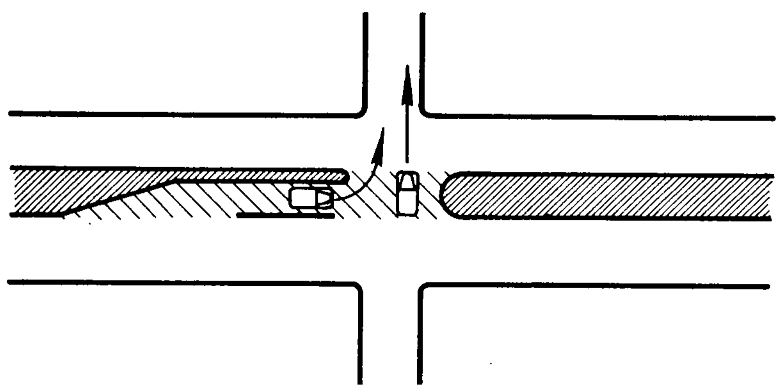
The speed of the traffic stream A may be controlled by the degree of curvature employed in the bending and by the amount of superelevation provided on the curved sections of the controlled roadway. Good practice indicates that minor flows will be bent to conform to major movements.

6. The speed of a traffic stream entering an intersection may be controlled by funneling.



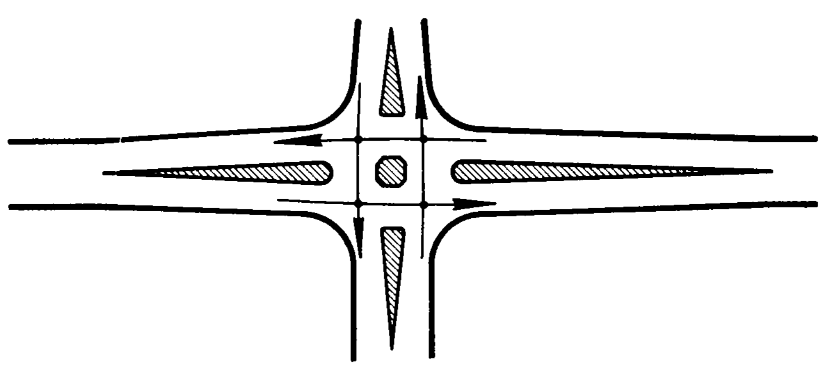
The psychological effect of a narrowing traffic lane will reduce the speed of a traffic stream. Funneling may also be employed to provide easy entrance to a traffic channel and then reduce the channel width to a single lane at the point of entrance into a moving traffic stream. This not only controls the speed of the entering vehicles, but also prevents overtaking and passing in a conflict area.

7. Channelization provides refuge (shadowing) for turning and crossing vehicles.



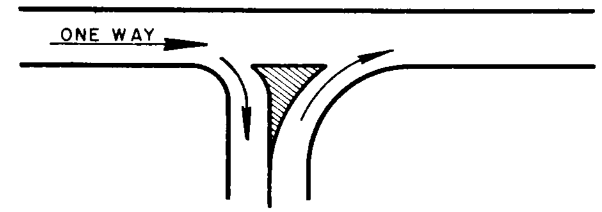
Adequate shadowing provides safe refuge for a vehicle waiting an opportunity to cross or enter an uncontrolled traffic stream. Channelization may also provide for a safer crossing of two or more traffic streams by not requiring drivers to select a safe time gap in more than one traffic stream at a time.

8. Channelization separates conflict points within an intersection.



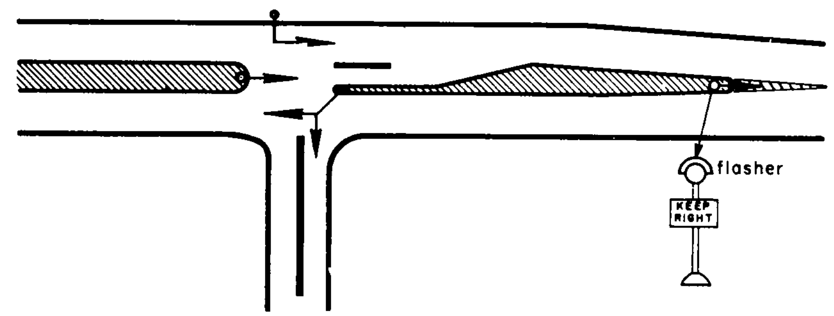
When channelization separates and clearly defines points of conflict within the intersection, drivers are exposed to only one conflict and one decision at a time.

9. Channelization blocks prohibited turns.



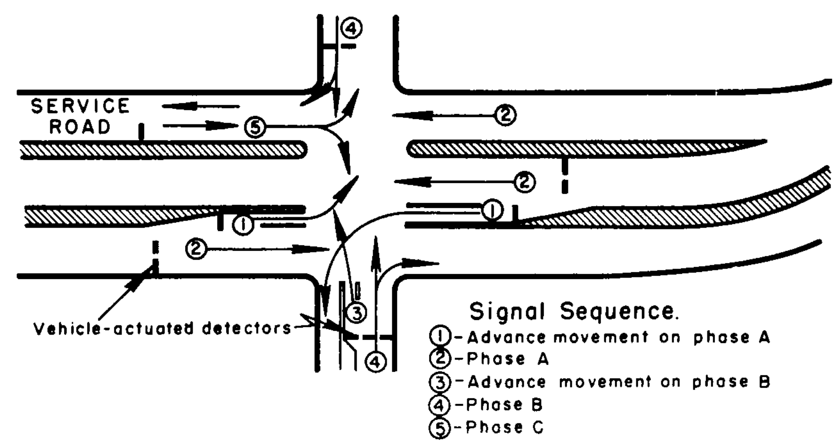
Islands may be employed to divert traffic streams in desired directions and thus encourage driver observance of such restrictions as prohibited turns and one-way movements.

10. Channelization may provide locations for the installation of essential traffic control devices.



Channelization is essential at the intersection of multilaned roadways with complex turning movements to provide locations for the proper installation of required traffic control signs and signals. Particular care should be exercised in the design of channelizing islands required for the sole purpose of providing a location for a traffic control device.

11. Channelization is required for effective signal control at intersections with complex turning movements.



Channelization must be provided at signalized intersections with complex turning movements to permit the sorting of approaching traffic which may move through the intersection during separate signal intervals. This requirement is of particular importance when traffic actuated signal controls are employed.

Part V - Examples of Channelization

Example Number

Three-Way Intersections - T Type

1 California, near San Francisco: Junipero Serra Boulevard - El Camino Real (US 101)
2 California, Marin County: Hamilton Field Entrance - US 101
3 Illinois, Chicago: Douglas Boulevard - West (Sacramento) Drive
4 Oklahoma, Henryetta : US 62 - US 266 - US 75
5 Pennsylvania, Uniontown: US 40 - Pennsylvania 112
6 Pennsylvania, Philadelphia: Parkside Avenue - Bryn Mawr Avenue
7 Pennsylvania, Philadelphia: University Avenue - Curie Avenue
8 Pennsylvania, Philadelphia: Castor Avenue - Wyoming Avenue
9 Pennsylvania, near Pittsburg: McKnight Road - Babcock Blvd.

Three-Way Intersections - Y Type

10 California, near Sacramento: Howe Avenue - Fair Oak Boulevard
11 California, near San Diago: California 94 (Federal Boulevard) - Home Avenue
12 California, near San Bernardino: Colton Avenue (US 70 and 99) - South E. St. (Calif. 26)
13 Delaware, near Dover: Wall's Corner: US 13 - Delaware 25
14 Oklahoma, Yukon: US 66 - 10th Street Cut-Off to Oklahoma City
15 Oregon, Bunker Hill: US 101 - Coos River Highway
16 Oregon, Prineville: US 28 - Oregon 27
17 Pennsylvania, Allentown: Carlisle Street - Hanover Avenue - Hamilton Street
18 Washington, Seattle: Elliott Avenue, W. - W. Mercer Place
19 Washington, near Puyallup: US 99 - Washington 5-D
52 Texas, Birdville: Texas 121 - Texas 183
56 Tennessee, Clarksville: US 79 - US 41A
57 Wyoming, Ranchester: US 87 - US 14
58 Pennsylvania, Bedford County: US 30 - Penn. 31
59 New York: US 9 - Mechanicville Road (Route 236)

Four-Way Intersections - Right-Angled Type

20 California, near San Diego: Balboa Avenue - Pacific Highway (US 101)
21 Illinois, District 1: US 52 - US 66
22 Massachusetts, Somerville: Northern Artery - Mystic Cross Avenue
23 Oregon, Portland: US 99 W (Barbur Boulevard) - Terwilliger Boulevard
24 Pennsylvania, Bucks County: Street Road - Jacksonville Road
25 Virginia, Richmond: Chamberlayne Avenue (US 1) - Lombardy Street - Lancaster Rd.

Four-Way Intersections - Oblique Type

26 California, near Riverside: Mission Boulevard (US 60 and California 19) - Bain Street
27 California, near Riverside: Mission Boulevard - Valley Way - US 60 (California 19)
28 California, near San Bernardino: California 190 - 3rd Street
29 Delaware, near Wilmington: Maryland Avenue - Boxwood Road - Middleborough Road
30 Hawaii, Honolulu: Kapiolani Boulevard - Kalakaua Avenue
31 Illinois, near Lake Zurich: US 12 - Illinois 22 and 63
32 Missouri, St. Louis County: Jennings Station Road - Kienlen Avenue - Natural Bridge Rd.
33 Missouri, St. Louis: Natural Bridge Road - Goodfellow Boulevard
34 Oregon, McMinnville: US 99 W - Oregon 18
35 Washington, Seattle: Westlake Ave., N. - Dexter Ave. - Nickerson St. - 4th Ave., N.
51 Washington, Seattle: US 99 - Linwood
55 Ohio, Akron: North Main Street - Cuyahoga Falls Avenue (Route 8)

Four-Way Intersections - Offset Type

36 Kentucky, Frankfort: Main Street - High Street - Capitol Avenue
37 Virginia, near Richmond: US 1 - Virginia 161

Multiway Intersections

38 Delaware, Wilmington: Delaware Avenue - Van Buren Street - Pennsylvania Avenue
39 District of Columbia, Washington: New York Avenue - 13th Street - H Street, N. W.
40 Hawaii, Honolulu: School-Emma-Lusitana-Iolani-Magellan Streets
41 Illinois, Chicago: 57th Street - South Shore Drive - North Circuit Drive
42 Illinois, Chicago: 51st Street - South Parkway
43 Pennsylvania, Philadelphia: Church Lane - Cobb's Creek Parkway - 70th Street
44 Pennsylvania, Philadelphia: 10th Street - 11th Street - Wagner Ave. - Somerville Ave.
45 Pennsylvania, Philadelphia: Roosevelt Boulevard - Whitaker Avenue - Adams Avenue
46 Texas, near Austin: US 290 - Texas 29 - 7th Street
47 Virginia, Falls Church: Fort Buffalo Intersection - US 50 - Virginia 338 - Virginia 613 - Wilson Boulevard
48 Washington, Seattle: Green Lake Way - N. 50th Street
49 Washington, Seattle: 16th Avenue, S. W. - W. Roxbury Street - Delridge Way
50 Washington, near Sealtle: US 99 - N. 145th St. - Washington 1-J
53 New York, New York City: Columbus Circle
54 Idaho, Lewiston: Brudge Approaches, Clearwater River

Example 1

Location

CALIFORNIA, near San Francisco
Junipero Serra Blvd. - El Camino Real (US 101)

Submitted by

J. C. Young, Traffic Engineer
Department of Public Works
Sacramento, California

Type of Intersection

3-Way, T

Date Constructed

December 15, 1948

Physical Data

5. Traffic control Devices
   b. Signals: Timing: traffic actuated
   d. Lighting: Type: not clearly indicated
   e. Guide posts, plant-mixed raised bars, reflectorized delineators

Economic Data

1. Estimated Cost of New Installation
   a. $45,000 not including preliminary engineering

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The improvements at this intersection seem to have been effective in reducing accidents."

Comments by Committee Members

1. EUGENE MAIER - The design of this intersection is an excellent example of the application of channelization to a three-way intersection in conjunction with traffic signal control. The 50 foot turning radii provided for left-turning vehicles meet the minimum requirements for commercial vehicles. Particular attention has been given to the treatment of the approach ends of the channelizing islands. This element of design is of especial importance because of the relatively high speeds on US Highway 101.

   The traffic signal controls must be considered as an essential element in the effective regulation of traffic at this intersection where the ADT approahces 15,000.

   The effectiveness of the design is relfected in the accident reduction shown in the Collision Diagram.

2. H. G. VAN RIPER - Channelization for the above described intersection is considered very effective treatment in correcting a dangerous condition and at the same time providing for a maximum of free flowing traffic with maximum protection. "Before" and "After" collision diagrams prove the effectiveness of the channelization treatment.

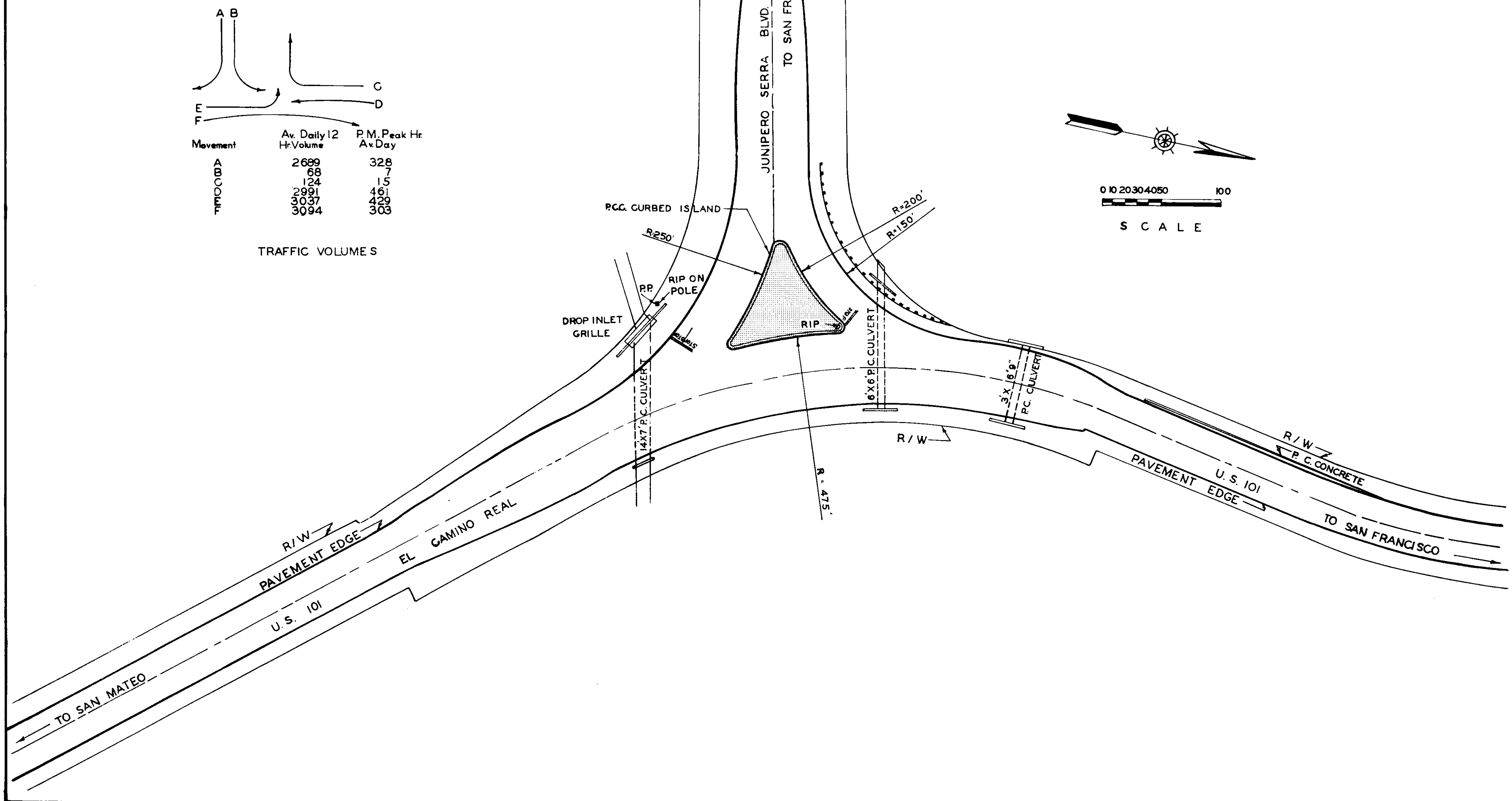
Figure 1. Intersection of El Camino Real and Junipero Serra Boulevard (US 101) looking north.

Figure 2. View of the added left-turn lane as seen from the south approach along El Camino Real.

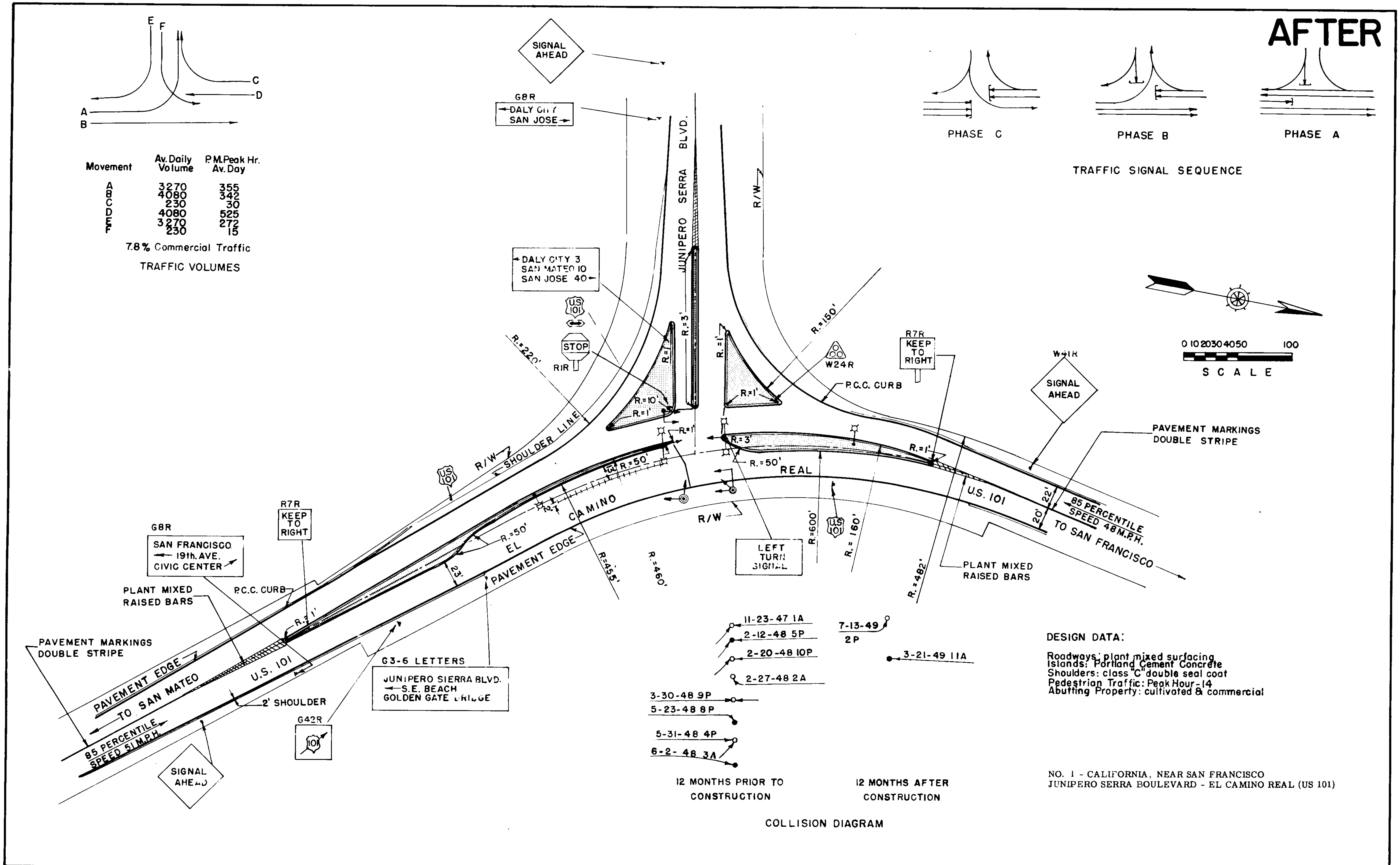
Figure 3. Approach end treatment of divisional island on Junipero Serra Boulevard.

BEFORE

NO. 1 - CALIFORNIA, NEAR SAN FRANCISCO
JUNIPERO SERRA BOULEVARD - EL CAMINO REAL (US 101)



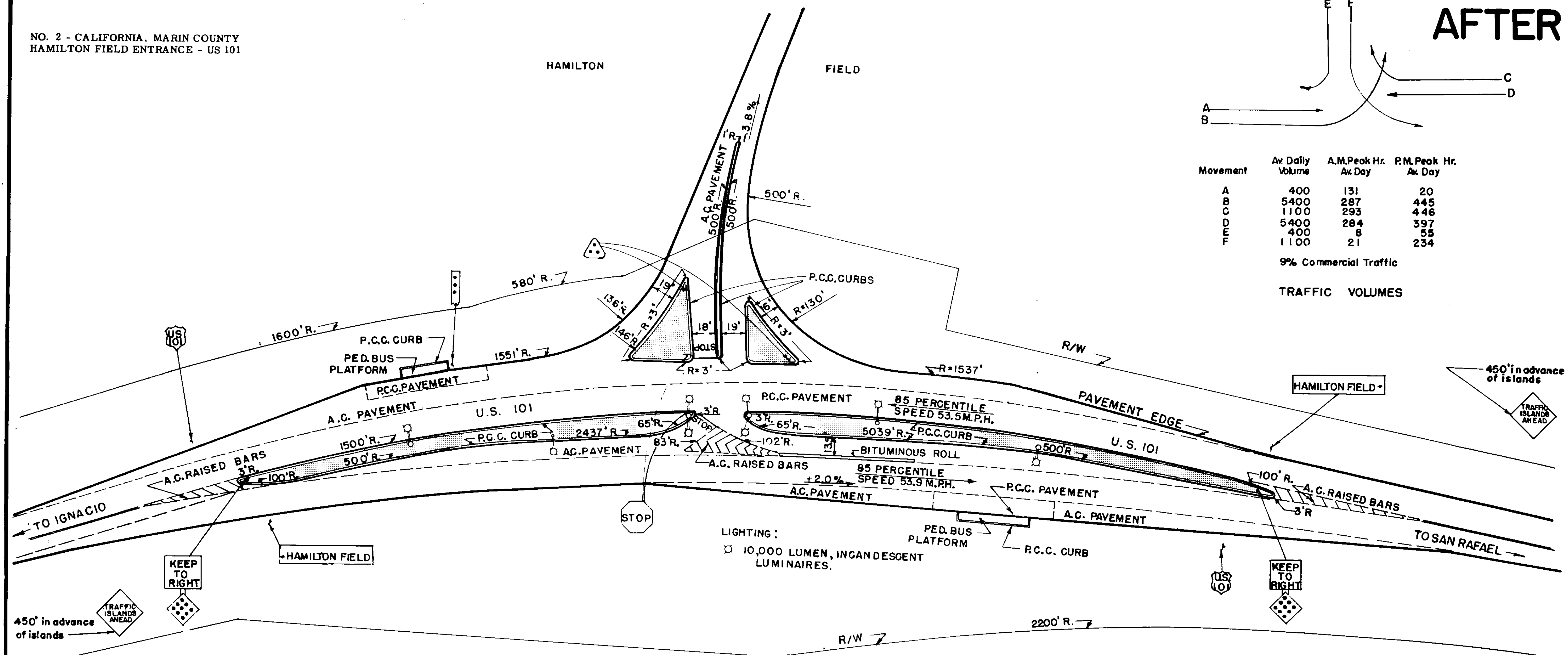
Movement	Av. Daily 12 Hr. Volume	P.M. Peak Hr. Av. Day
A	2689	328
B	68	7
C	124	15
D	2991	461
E	3037	429
F	3094	303



NO. 1 - CALIFORNIA, NEAR SAN FRANCISCO
JUNIPERO SERRA BOULEVARD - EL CAMINO REAL (US 101)

NO. 2 - CALIFORNIA, MARIN COUNTY
HAMILTON FIELD ENTRANCE - US 101

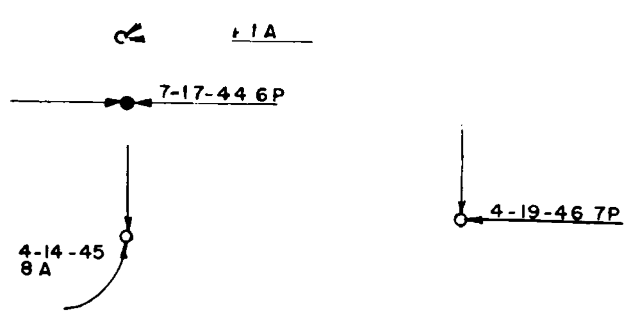
AFTER



Movement	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	400	131	20
B	5400	287	445
C	1100	293	446
D	5400	284	397
E	400	8	55
F	1100	21	234

9% Commercial Traffic

TRAFFIC VOLUMES

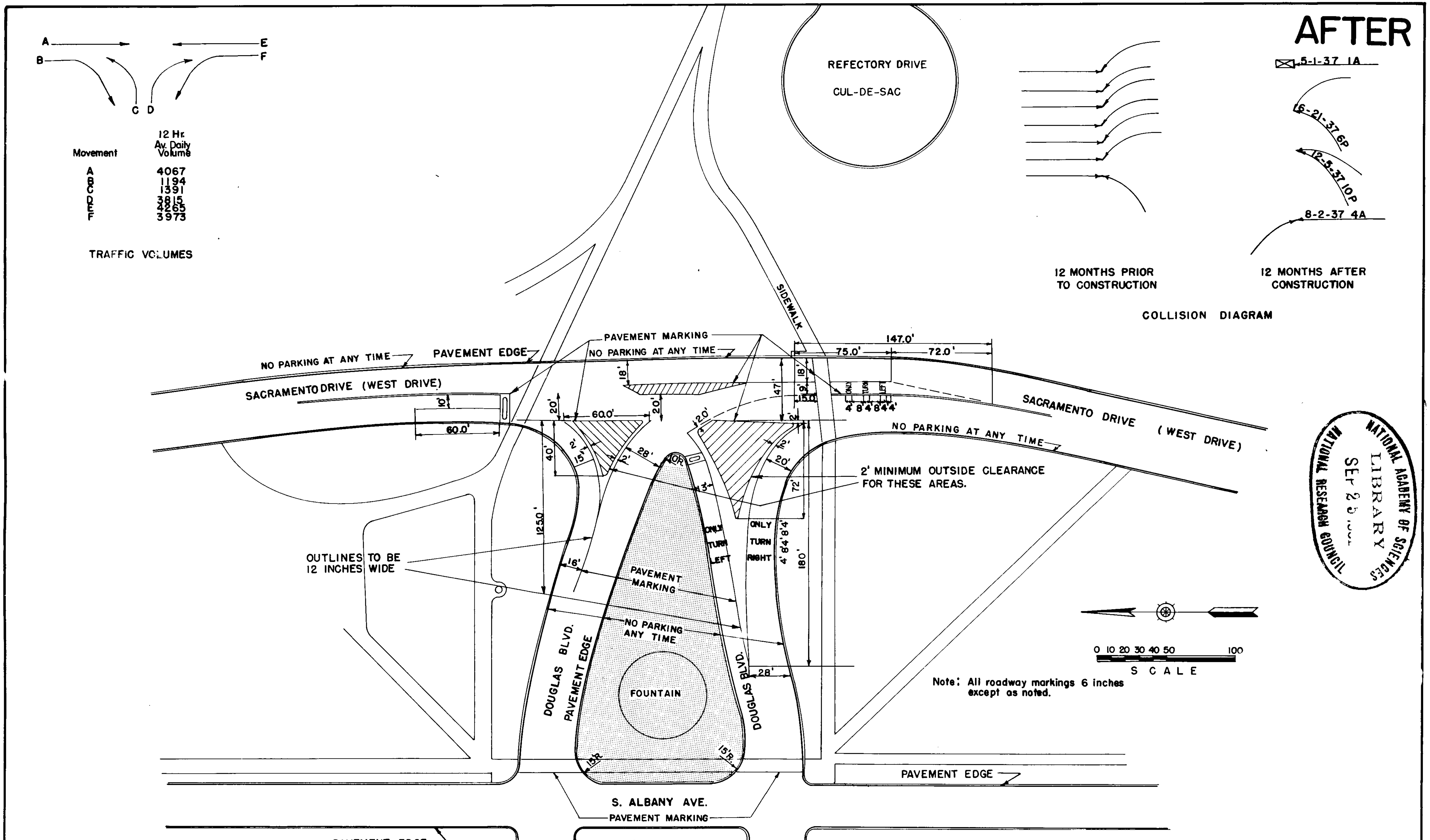


12 MONTHS PRIOR TO CONSTRUCTION

12 MONTHS AFTER CONSTRUCTION

COLLISION DIAGRAM

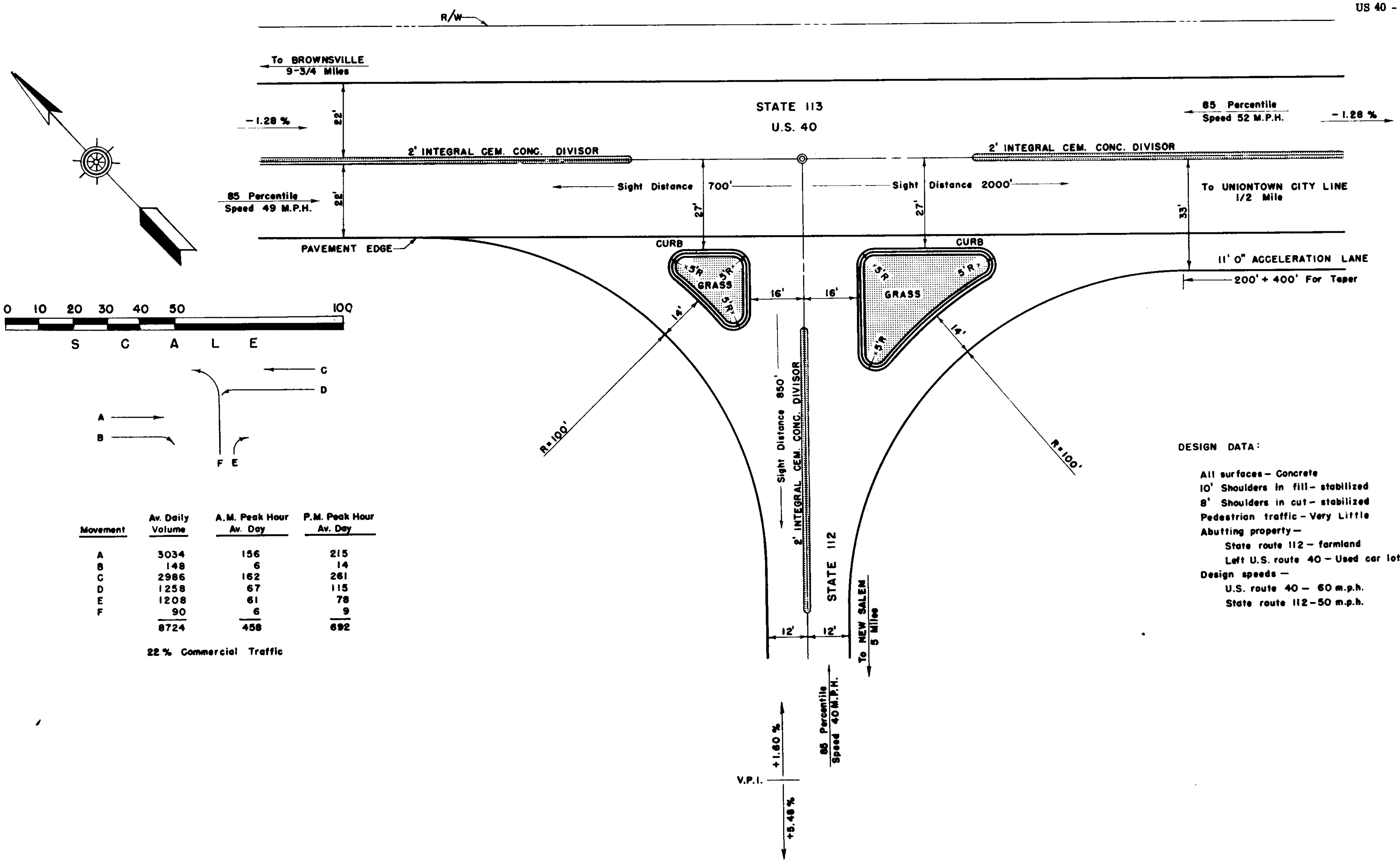
0 50 100
SCALE



NO. 3 - ILLINOIS, CHICAGO
DOUGLAS BOULEVARD - WEST DRIVE (SACRAMENTO)

AFTER

NO. 5 - PENNSYLVANIA, UNIONTOWN
US 40 - PENNSYLVANIA 112



Movement	Av. Daily Volume	A.M. Peak Hour Av. Day	P.M. Peak Hour Av. Day
A	3034	156	215
B	148	6	14
C	2986	162	261
D	1258	67	115
E	1208	61	78
F	90	6	9
	8724	458	692

22 % Commercial Traffic

DESIGN DATA:

All surfaces – Concrete
10' Shoulders in fill – stabilized
8' Shoulders in cut – stabilized
Pedestrian traffic – Very Little
Abutting property –
State route 112 – farmland
Left U.S. route 40 – Used car lot
Design speeds –
U.S. route 40 – 60 m.p.h.
State route 112 – 50 m.p.h.

Some States have found it desirable to provide curbs adjacent to the right edge of turning lanes. Drivers often will turn on radii sharper than the pavement which causes rutting at the pavement edges.

Figure 3 is not altogether clear as to the points of entrances to the parking lot adjacent to US Route 40. Considerable can be done to provide safer traffic operation on facilities of this type when the points of entrance to adjacent businesses are controlled.

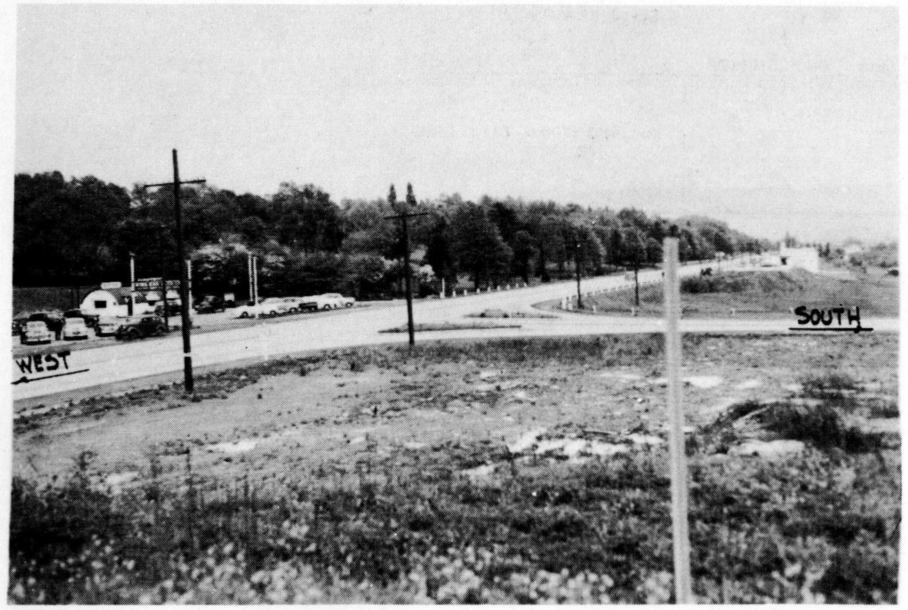


Figure 1. Channelized intersection of US 40 and Pennsylvania Route 112 before redesign.

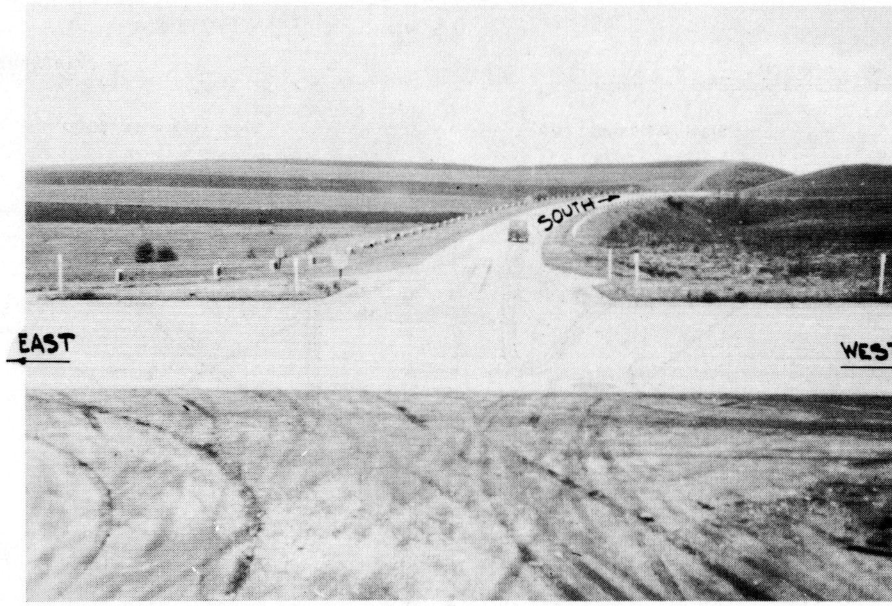


Figure 2. Note lack of contrast between the narrow median and the pavement south of the intersection.

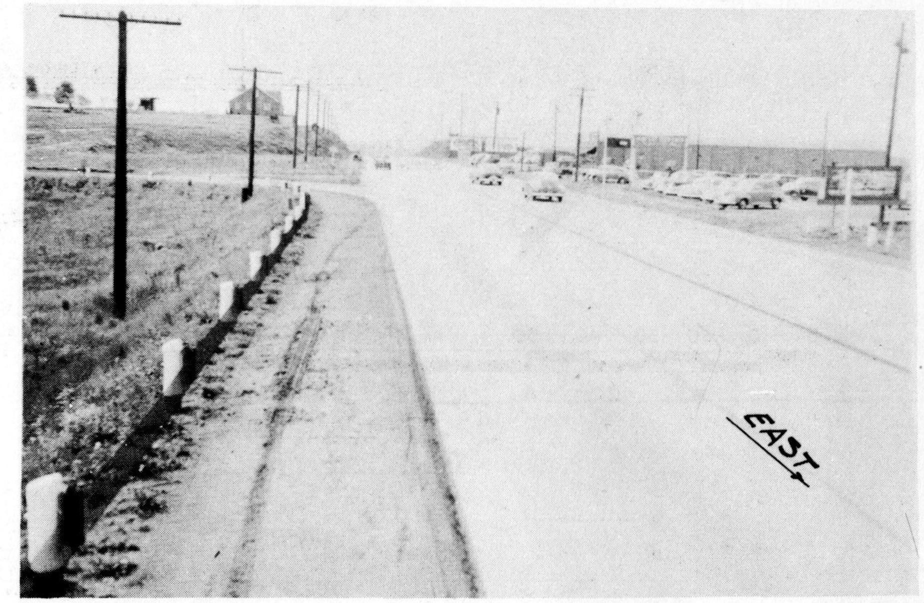


Figure 3. Narrow median on US 40 designed to prevent improper turn into separated right-turn lane.

Example 6

Location

PENNSYLVANIA, Philadelphia
Parkside Avenue - Bryn Mawr Avenue

Submitted by

Robert Mitchell, Traffic Engineer
Department of Public Safety
Philadelphia, Pennsylvania

Type of Intersection

3-Way, T

Date Constructed

May 12, 1950

Physical Data

3. Surface Type
   b. Islands: paved, as appears in "After" photograph
   c. Shoulders: not clear; seem in photograph to be curbed on Parkside but not on Bryn Mawr
5. Traffic Control Devices
   d. Lighting: Type: some indicated in photograph, but not clear as to type
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: a bus line operates on Parkside Avenue

Traffic Data

3. Speeds
   b. Legal speed at intersection: 20 mph.

Economic Data

1. Estimated Cost of New Installation
   a. $5,173

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. "This new installation increased the safety of pedestrians, as well as vehicular traffic, by giving each more protection in crossing, entering, and leaving the intersection, thus eliminating hazardous features. This was done especially by relocating telegraph pole on one of the traffic islands."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. "By channelization we have increased the flow of traffic thus eliminating hesitation and congestion within the intersection."

Comments by Committee Members

1. E. T. PERKINS - The design of this intersection is a bit confusing because of the provision of a 26-ft. channel for vehicles southbound on Parkside Avenue and turning right into Bryn Mawr Avenue and the devious counter-flow that is provided. In general, I believe that a bulbular type of island in the Bryn Mawr Avenue would give as good control and would allow moving the opening through the island in Parkside Avenue to the north so as to force a more direct crossing of the left turn into Bryn Mawr Avenue.

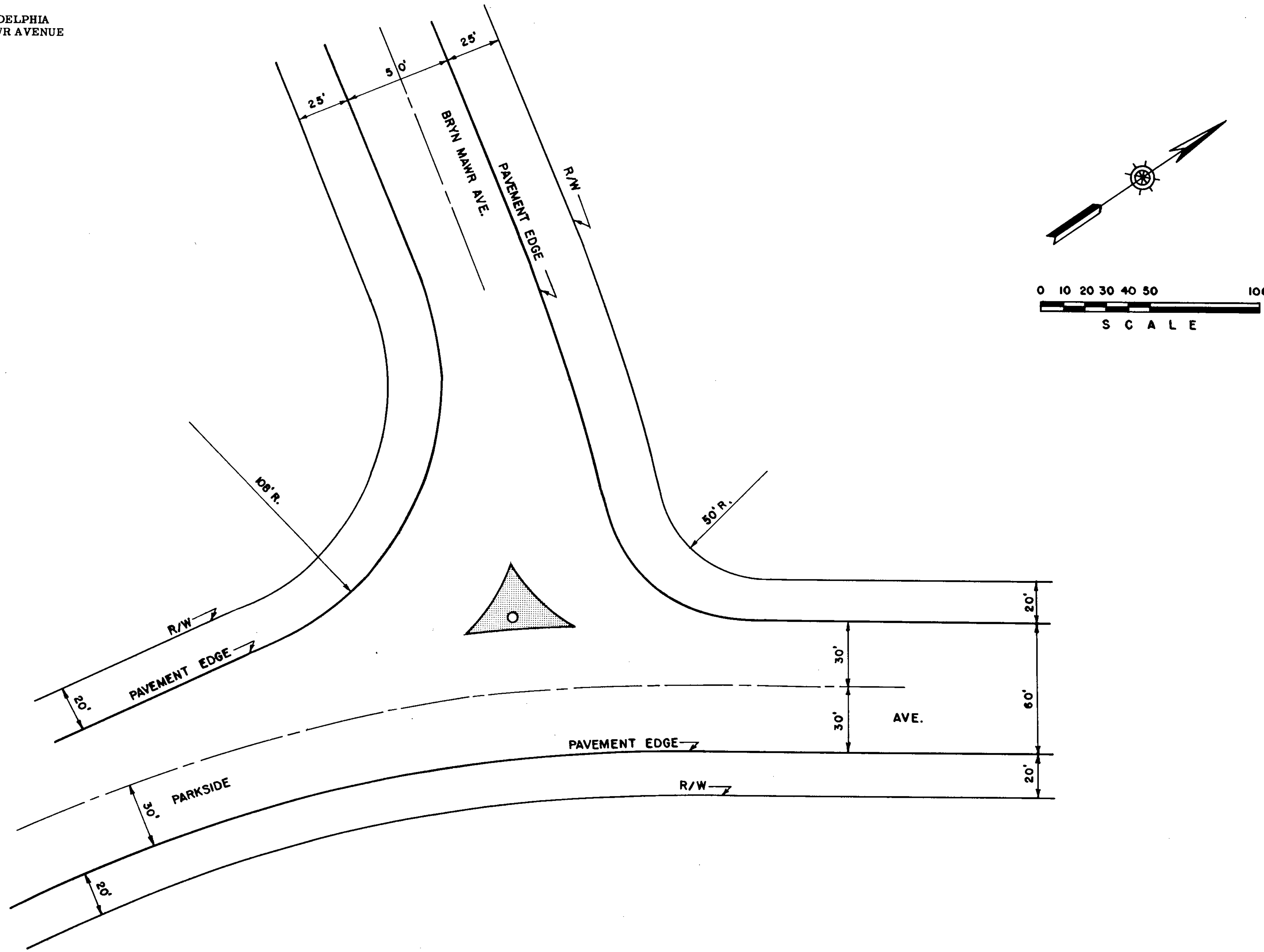
   Figure 1 gives the general, alternate layout I would suggest.

2. EDWARD G. WETZEL - The general layout of this geometric design could be considerably improved. The island on Parkside Avenue should be longer and wider. The approach paint markings are much too short. They should be two to three times the length as given on the "after" sketch. The triangular shaped island on Bryn Mawr Avenue should be increased in size, particularly extending the vertex on Bryn Mawr Avenue farther to the northwest.

   There are no indications of left-turn movements from Bryn Mawr Avenue to Parkside Avenue. If there are none to be provided for, then the "lamb chop" island on Bryn Mawr Avenue should be extended farther south on Parkside Avenue so as to prohibit any left turns through the opening in the center island on Parkside Avenue. Funneling produced by the islands in some respects appears to be in reverse. From Bryn Mawr Avenue to Parkside Avenue the throat should be narrower at the junction with Parkside Avenue and wider at the Bryn Mawr Avenue end of the "lamb chop" island. Similarly in the northeast direction on Parkside Avenue the funneling should be such that the narrowest part of the throat should be at exit rather than at the entrance to the channelization. The first island on Parkside Avenue approaching in the northeasterly direction should be wider at the north end.

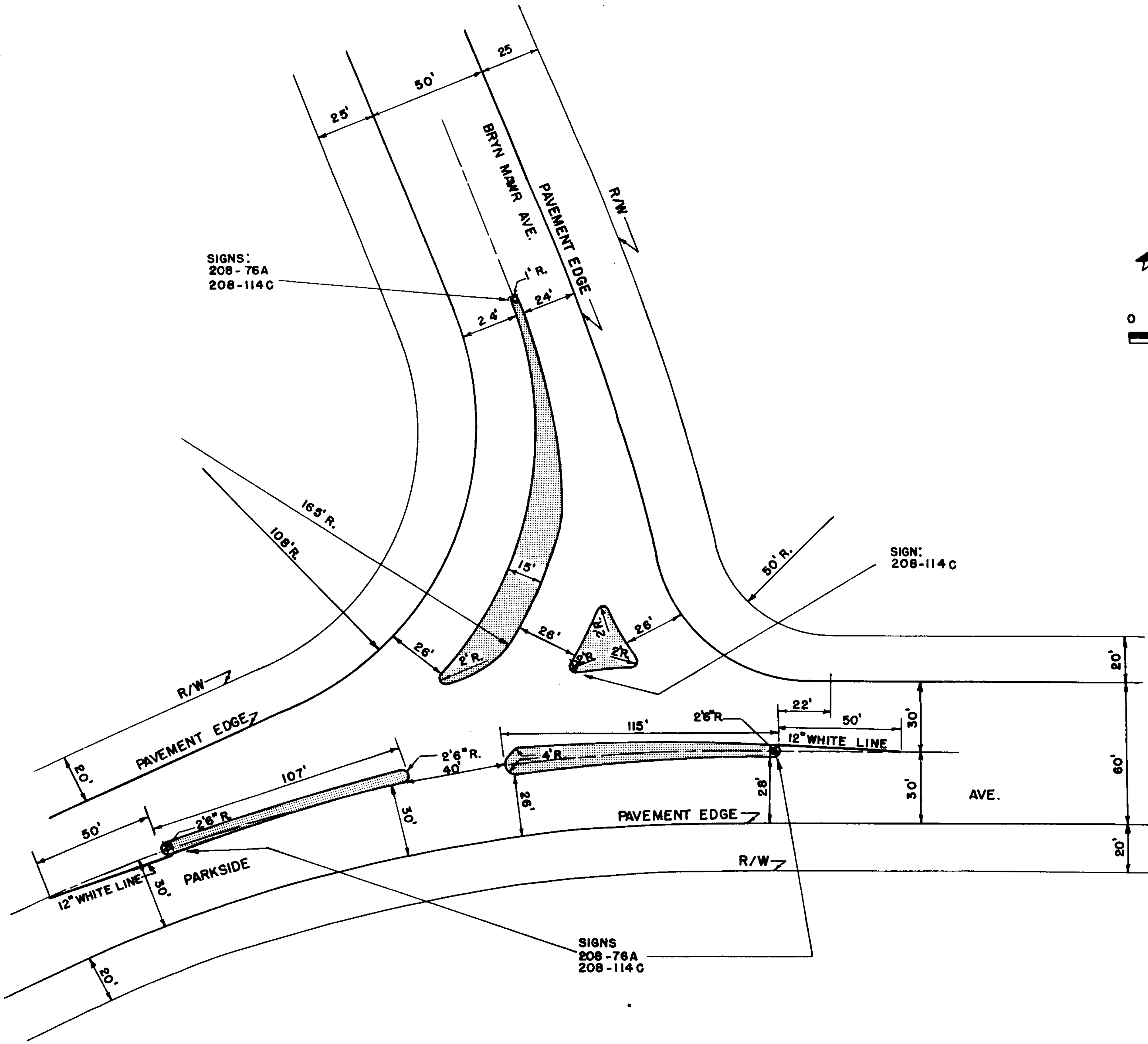
BEFORE

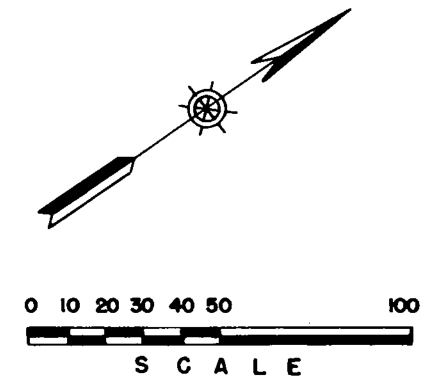
NO. 6 - PENNSYLVANIA, PHILADELPHIA
PARKSIDE AVENUE - BRYN MAWR AVENUE

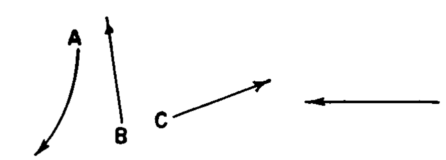


AFTER

NO. 6 - PENNSYLVANIA, PHILADEPHIA
PARKSIDE AVENUE - BRYN MAWR AVENUE







Movements	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	1548		
B	996		
C	4322		
D	4638		
TOTAL		1035	968

TRAFFIC VOLUMES

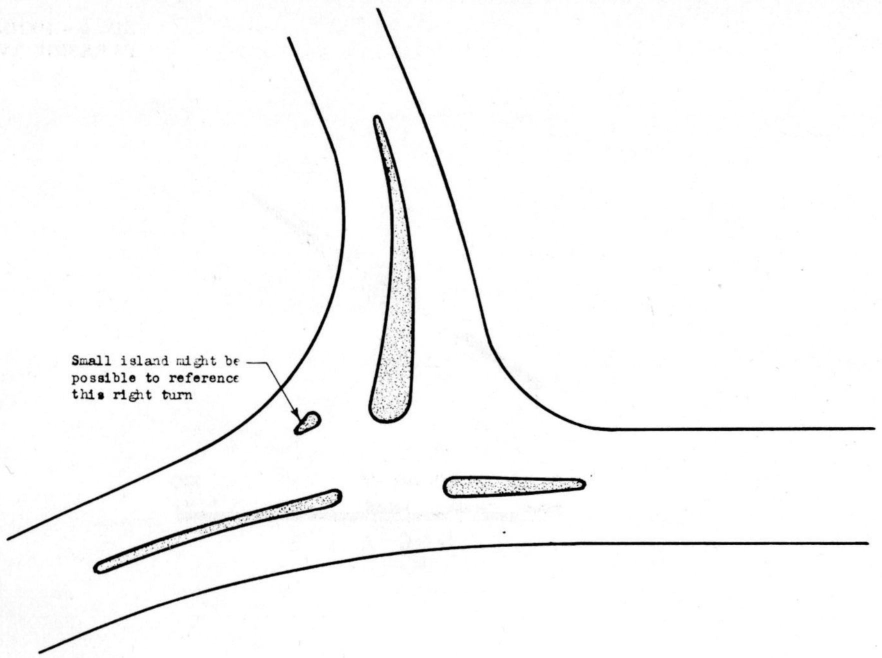


Figure 1.

Figure 2. Intersection of Bryn Mawr Avenue and Parkside Avenue before channelization.

Figure 3. Channelizing island with traffic-control signs on Bryn Mawr Avenue.

Figure 4. Good contrast is provided when concrete islands are used with asphalt pavements.

Example 7

Location

PENNSYLVANIA, Philadelphia
University Avenue - Curie Avenue

Submitted by

Robert Mitchell, Traffic Engineer
Department of Public Safety
Philadelphia, Pennsylvania

Type of Intersection

3-Way, T

Date Constructed

June 10, 1938

Physical Data

2. Sight distance at vertical curves: visibility good
5. Traffic Control Devices
   e. Guide Posts: guide posts and reflectors
7. Abutting Property
   a. Character or Land Use: cemetery, hospital
   b. Location and Importance of Entrances: none immediately in the intersection.

Traffic Data

2. Type
   b. Percent Commercial: about 28 percent commercial; greatest volume during functions at Convention Hall and Franklin Field - University of Penn. games, etc.
5. a. Collision Diagram: "Before" "After": no record available; accident record very low.

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Controls traffic flow without signals, and lessens congestion during major conventions and visitation at Philadelphia General Hospital and events at Franklin Field."

Comments by Committee Members

1. EDWARD G. WETZEL - From my interpretation of traffic data submitted I would question the advisability of the "after" channelization. I assume the traffic flow divides as follows: "A" being heaviest (more than total of other two) must split fairly evenly with about half turning east on Vintage Avenue and the other half continuing north on University Avenue. In such a case it would seem there would be some congestion around the center circular island because of its small size and the short weaving area.

   Although the information submitted with this example indicates the channelization design is satisfactory, I feel it must be due to infrequent occasions when peak traffic occurs, and also the fact that during such times the traffic is practically all passenger cars, the drivers of which expect some delay so are not "crowding" the intersection.

   I do not believe this is a good design for a three-way or "T" intersection for such traffic volumes. Instead I would recommend establishing, if there is a major and minor flow, and then favoring the major flow with a separating island and provision for left turns, while a stop sign or signal with "lamb chop" islands could be used to control the minor flow.

2. J. C. YOUNG - The traffic diagram does not show the volume of each turning movement but it looks as though through northbound traffic and both left turn traffic streams are unduly distorted. Although the intersection seems to work well with the low traffic volumes, it obviously would not work if the northbound and westbound traffic began to approach the capacity of those streets. If through northbound and left turns (westbound to southbound) were significant volumes, the weaving distance would be insufficient and a stop sign would be necessary. More capacity and less out-of-direction travel could be accomplished by a simple T-type intersection with free right turns and a stop sign against westbound traffic only. If desired, with the amount of area available, a median island parallel to the University Avenue centerline could be constructed in addition to a triangular island separating the free right turns (northbound to eastbound) from the other east and west traffic.

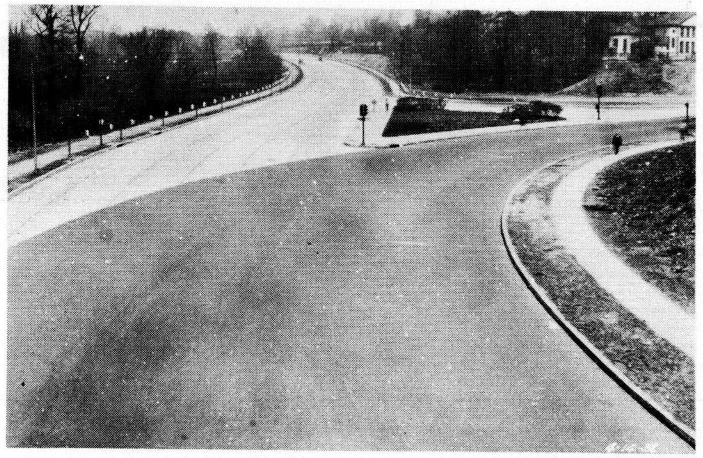


Figure 1. Intersection of University Avenue and Vintage (Curie) Avenue before redesign.

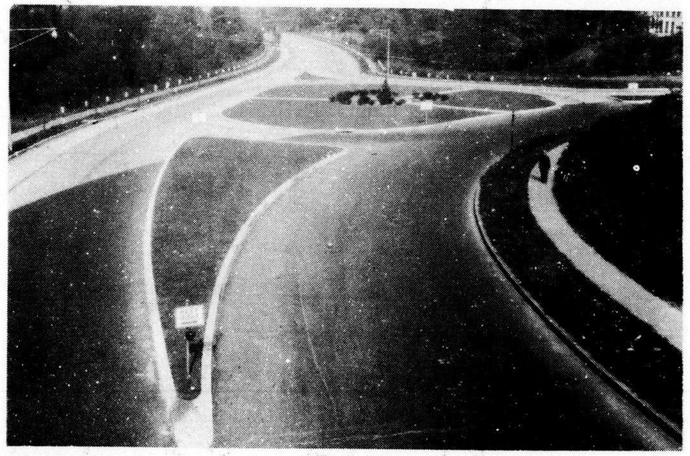
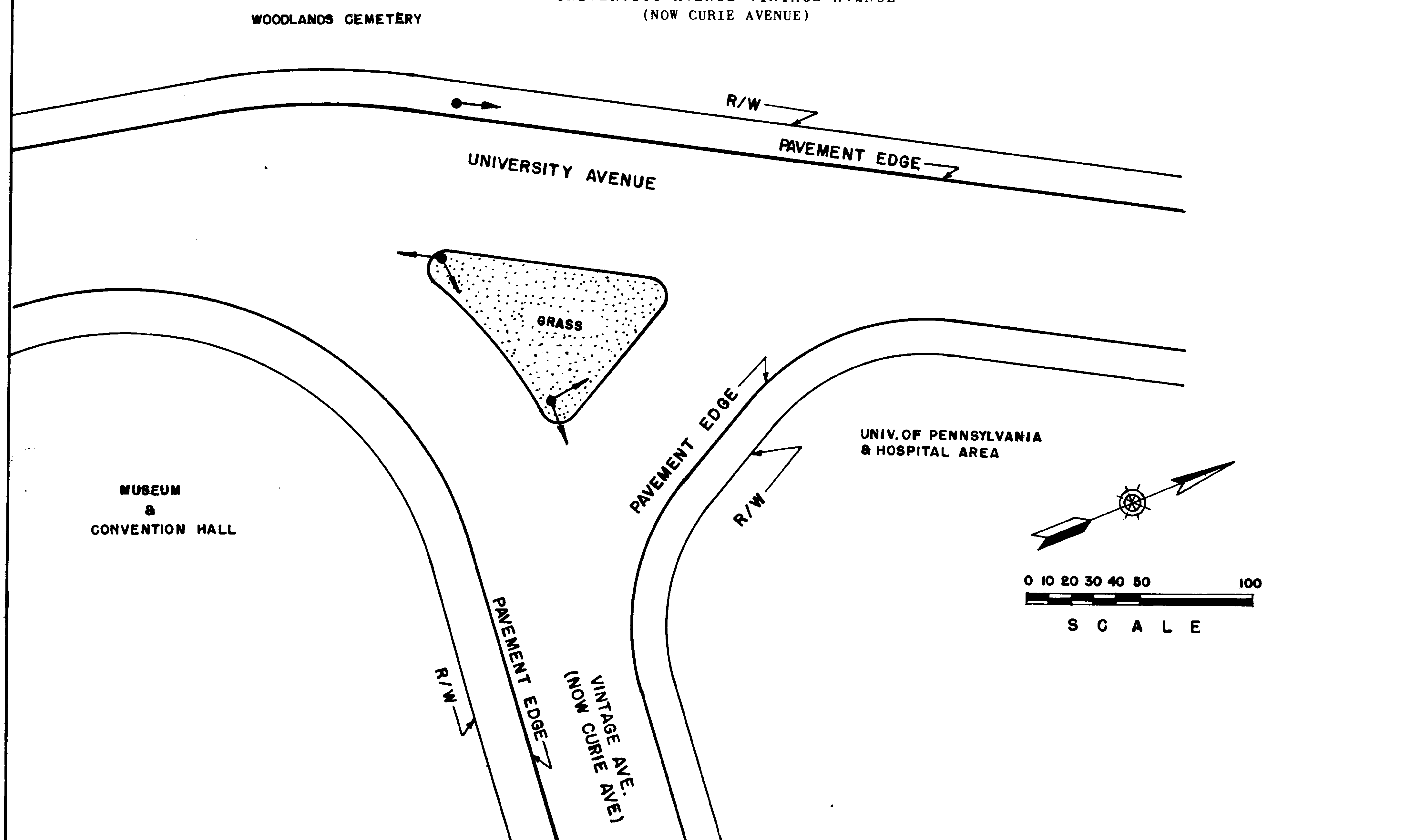
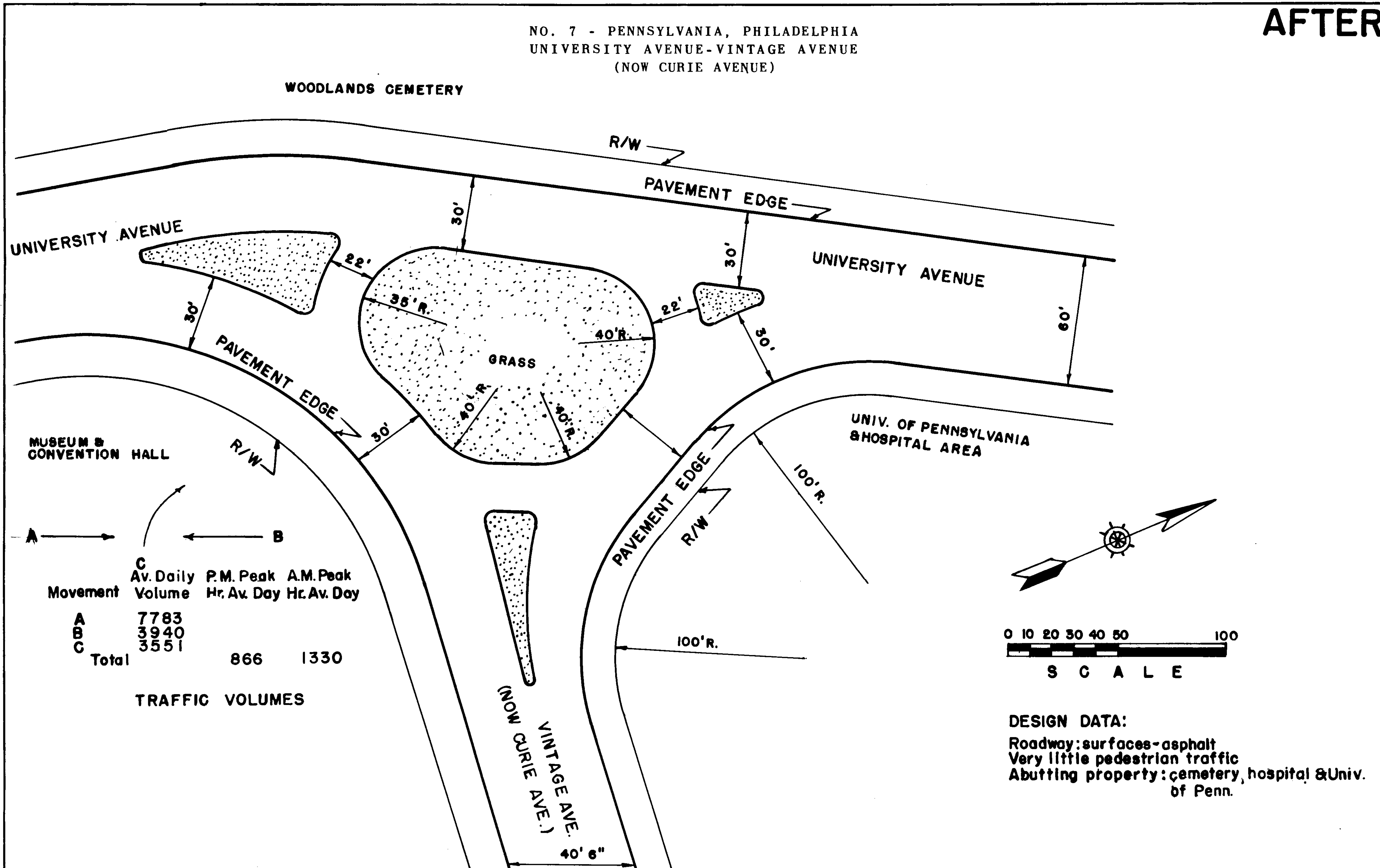


Figure 2. Channelization of 3-way T-type intersection.

BEFORE

NO. 7 - PENNSYLVANIA, PHILADELPHIA
UNIVERSITY AVENUE-VINTAGE AVENUE
(NOW CURIE AVENUE)




AFTER
NO. 7 - PENNSYLVANIA, PHILADELPHIA
UNIVERSITY AVENUE-VINTAGE AVENUE
(NOW CURIE AVENUE)
WOODLANDS CEMETERY
R/W
PAVEMENT EDGE
30'
UNIVERSITY AVENUE
UNIVERSITY AVENUE
22'
35'R.
30'
22'
40'R.
GRASS
60'
30'
30'
PAVEMENT EDGE
40'R.
40'R.
30'
UNIV. OF PENNSYLVANIA
&HOSPITAL AREA
MUSEUM & CONVENTION HALL
R/W
PAVEMENT EDGE
R/W
100'R.
A
B
C
Movement
Av. Daily Volume
P.M. Peak Hr. Av. Day
A.M. Peak Hr. Av. Day
A 7783
B 3940
C 3551
Total 866 1330
TRAFFIC VOLUMES
100'R.
0 10 20 30 40 50 100
S C A L E
VINTAGE AVE.
(NOW CURIE AVE.)
40' 6"
DESIGN DATA:
Roadway: surfaces-asphalt
Very little pedestrian traffic
Abutting property: cemetery, hospital &Univ. of Penn.

Example 8

Location

PENNSYLVANIA, Philadelphia
Castor Avenue - Wyoming Avenue

Submitted by

Robert Mitchell, Traffic Engineer
Department of Public Safety
Philadelphia, Pennsylvania

Type of Intersection

3-Way, T

Date Constructed

January 11, 1950

Physical Data

7. Abutting Property
   a. Character or Land Use: seems in photographs like outlying residential and pasture land.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: a trackless trolley route passes through this intersection in both directions along Wyoming Avenue and northeasterly along Castor Avenue from the intersection.

Traffic Data

3. Speeds
   b. Average Operating Speeds Through Intersection: not given, but the legal speed is 20 mph.
5. Accidents
   b. Fatal: none "Before" or "After", Personal Injury: one "Before" and none "After", Property Damage: none "Before" or "After", Period: 4 months

Economic Data

1. Estimated Cost of New Installation
   a. $3,875

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection:
   a. "A traffic volume count was never taken, inasmuch as there are other intersections along Castor Avenue to be improved. However, both streets are attracting increased travel daily, commercial and otherwise, including a fast trackless trolley. Operational characteristics: safe and speedy flow of traffic."

Comments by Committee Members

1. EUGENE MAIER - The comments on this intersection are limited to the channelizing islands located at the three entrances to the rotary. It appears that some improvement in the island design might have been achieved by:
   a. Locating the approach end of the islands a little to the left of the center line.
   b. Tapering the approach end of the island to a point or constructing raised bars such as are employed at the intersection presented in Example 1.

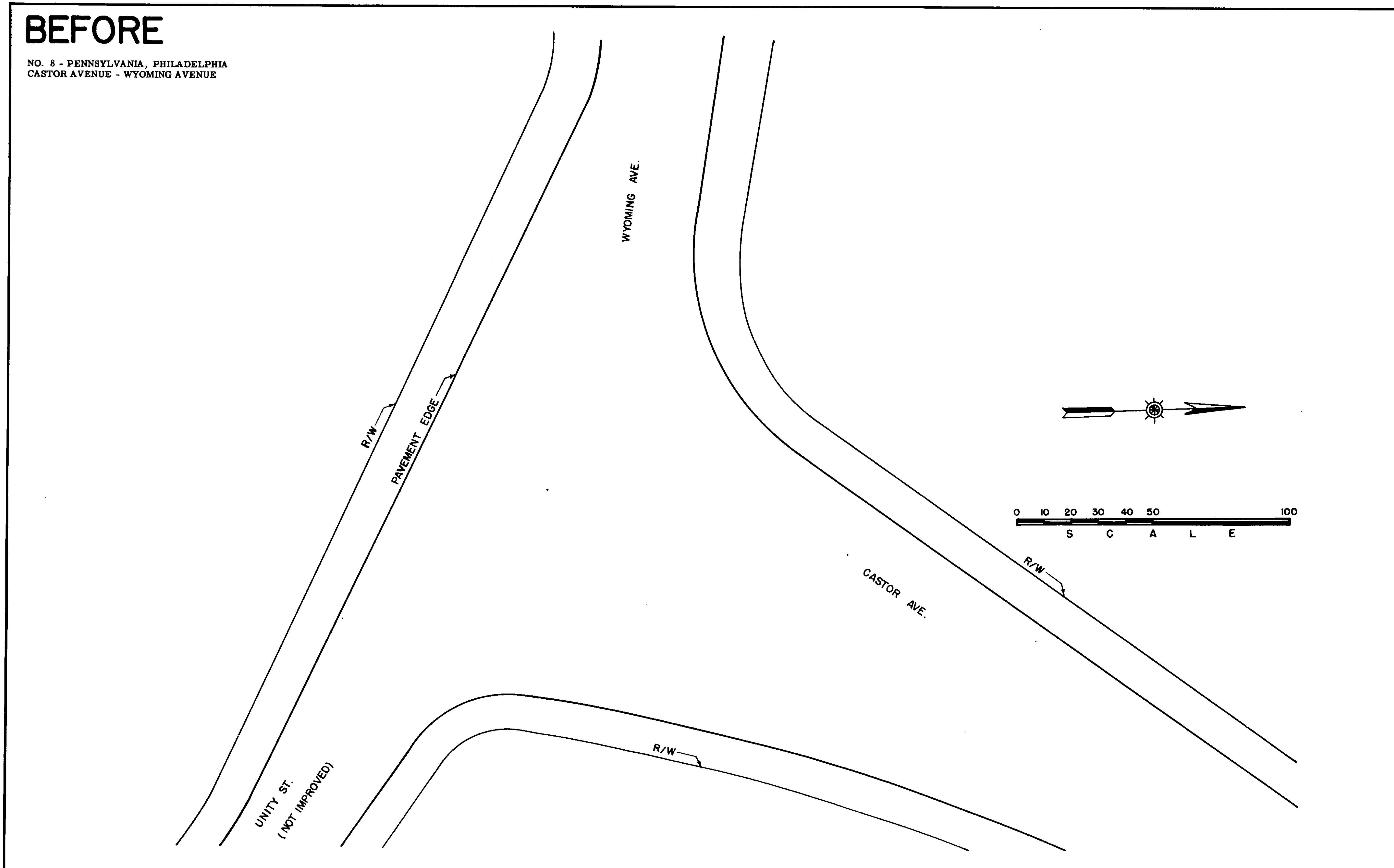
   Although the approach ends of the channelizing islands appear to have good daytime visibility and adequate lighting and signing have been provided for nighttime visibility, particular attention must be given to design of the approach end of channelizing islands to ensure safe operation during periods of inclement weather when driver visibility may be seriously restricted.

2. FRED W. HURD - In my opinion, this is a good example of channelization for a free flowing intersection with less than 1200-1800 vehicles per hour through any one crossing point. The circular central island is too small for weaving, and "stop and go" operation with three second headways would be expected at heavy crossing points. Obviously such crossings would be restricted to single lane intersecting flows. This design is particularly applicable where heavy flow reverses direction for the a. m. and p. m. traffic peaks with other approaches handling lane volumes. Furthermore, its application should be limited to low speed areas where relatively few pedestrians are encountered.

Figure 1. Free-flowing channelization design for low-speed intersection without heavy crossing flow.

BEFORE

NO. 8 - PENNSYLVANIA, PHILADELPHIA
CASTOR AVENUE - WYOMING AVENUE

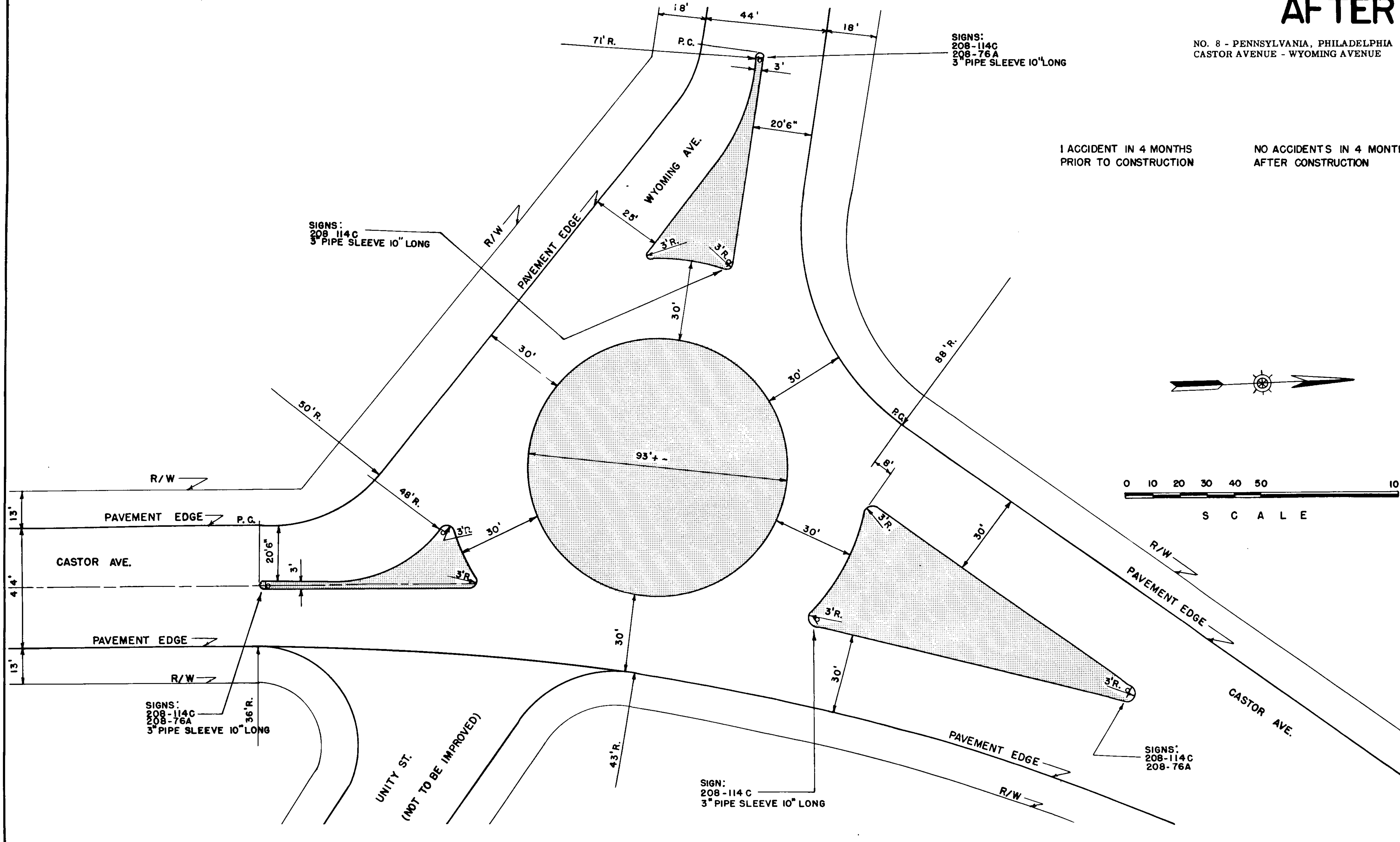


AFTER

NO. 8 - PENNSYLVANIA, PHILADELPHIA
CASTOR AVENUE - WYOMING AVENUE

1 ACCIDENT IN 4 MONTHS PRIOR TO CONSTRUCTION

NO ACCIDENTS IN 4 MONTHS AFTER CONSTRUCTION



Example 9

Location

PENNSYLVANIA, Allegheny County
near Pittsburgh
McKnight Road-Babcock Boulevard

Type of Intersection

Semi-Cloverleaf Grade Separation
with T-type Channelization

Physical Data

4. Cross Section
   a. Not shown because not unusual
5. Traffic Control Devices
   b. Signals: timing: warning signals

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The channelization is elaborate and is believed to be effective, largely because the nose of each island carries a floodlight and a sign. Without these, the layout might be confusing."

Submitted by

L. B. Duff, Director
County Works Department,
Allegheny County, Pittsburgh, Pennsylvania

Date Constructed

1945

Comments by Committee Members

1. GUY KELCEY - The channelization treatment shown appears more elaborate than need be and therefore less effective because: (a) Of the multiplicity of islands; (b) Left turn movements are channeled to intersect other movements at acute (sum of speeds) angles rather than at right angles; (c) Numerous signal lights required by the treatment may confuse traffic at night.
   The solution suggested in Figure 1 is simple, avoids the confusions, controls conflicting traffic movements and left turns cross other movements at a right angle with good visibility to right and left.

2. J. A. REDMAN - The treatment of the channelized intersections on the approaches to Babcock Boulevard would be confusing to the stranger. The 5-island set up could be reduced to two islands in the interest of simplicity. Traffic making right turns onto Babcock Boulevard should either be provided with a separate lane for blending or brought in more nearly at right angles and stopped.
   The design does reduce confusion on Babcock Boulevard which normally exists between left turn traffic entering and leaving the Boulevard, but introduces conflicts on the approaches. The latter may not be important if the approach traffic is light.

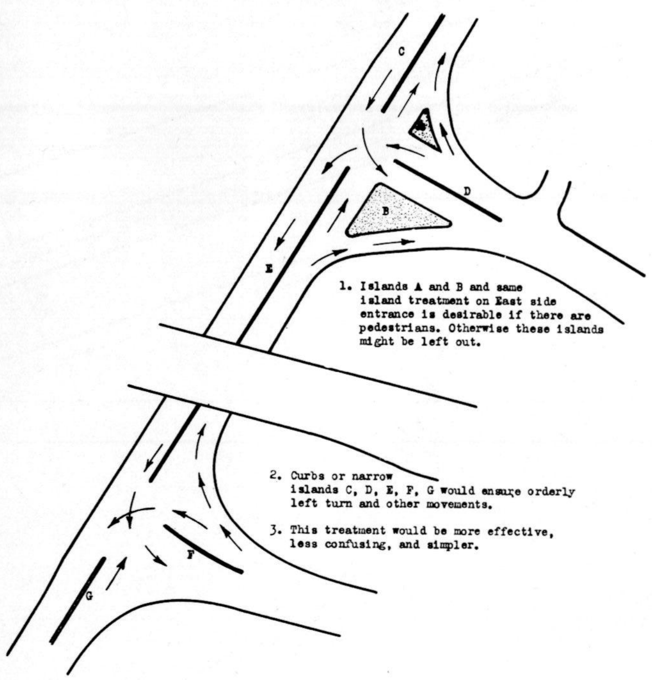


Figure 1.

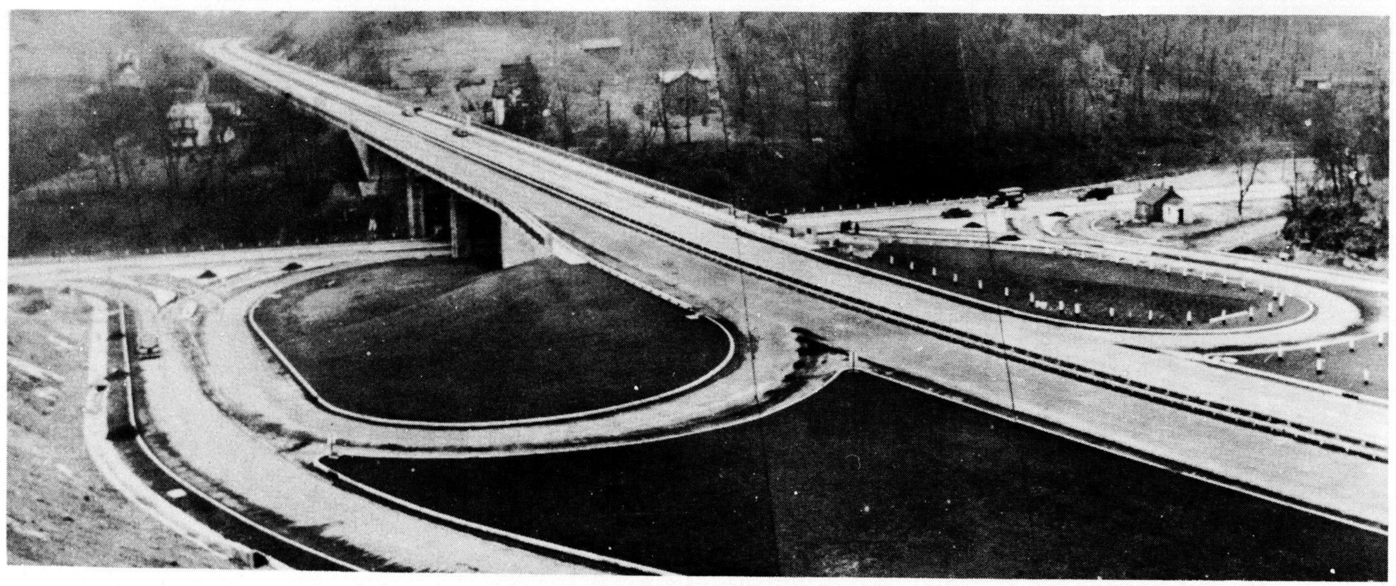
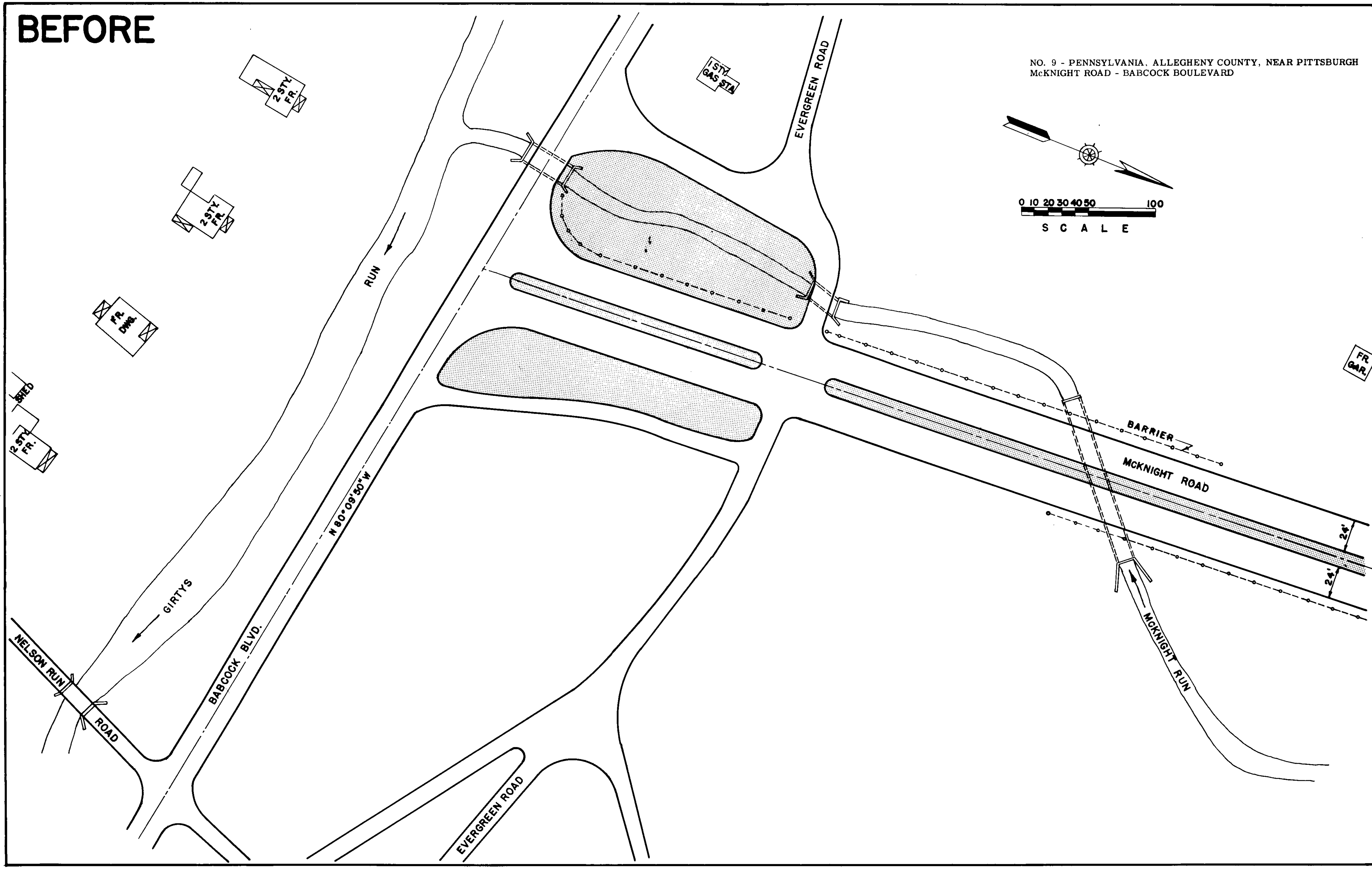
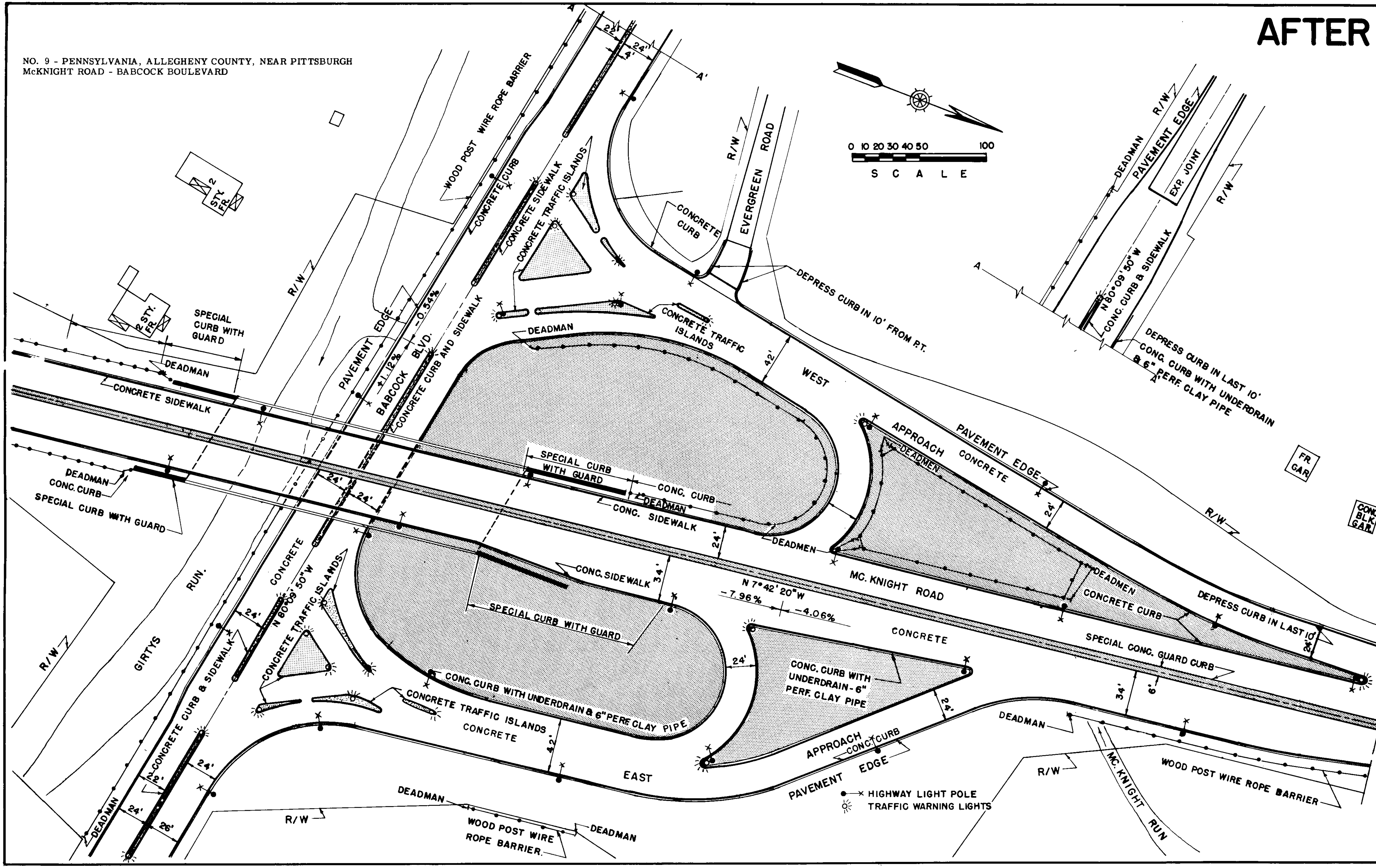


Figure 2. Channelization at interchange between McKnight Road and Babcock Boulevard.

Figure 3. Elaborate channelization with multiplicity of islands requires floodlights and numerous signs to insure effective operation.


BEFORE
NO. 9 - PENNSYLVANIA, ALLEGHENY COUNTY, NEAR PITTSBURGH
McKNIGHT ROAD - BABCOCK BOULEVARD
0 10 20 30 40 50 100
S C A L E
2 STY. FR.
2 STY. FR.
FR. DWG.
SHED
2 STY. FR.
1 STY. GAS STA.
EVERGREEN ROAD
RUN
GIRTYS
NELSON RUN
ROAD
BABCOCK BLVD.
N 80°09'50"W
EVERGREEN ROAD
BARRIER
McKNIGHT ROAD
24'
24'
McKNIGHT RUN
FR. GAR.


AFTER
NO. 9 - PENNSYLVANIA, ALLEGHENY COUNTY, NEAR PITTSBURGH
McKNIGHT ROAD - BABCOCK BOULEVARD
0 10 20 30 40 50 100
S C A L E
WOOD POST WIRE ROPE BARRIER
CONCRETE CURB
CONCRETE SIDEWALK
CONCRETE TRAFFIC ISLANDS
CONCRETE CURB
EVERGREEN ROAD
R/W
DEPRESS CURB IN 10' FROM P.T.
DEADMAN
PAVEMENT EDGE
EXP. JOINT
N 80°09'50"W
CONC. CURB & SIDEWALK
DEPRESS CURB IN LAST 10'
CONC. CURB WITH UNDERDRAIN & 6" PERF. CLAY PIPE
2 STY. FR.
SPECIAL CURB WITH GUARD
CONCRETE SIDEWALK
PAVEMENT EDGE
+1.12%
-0.54%
BABCOCK BLVD.
CONCRETE CURB AND SIDEWALK
CONCRETE TRAFFIC ISLANDS
WEST
42'
APPROACH CONCRETE
DEADMEN
PAVEMENT EDGE
FR GAR.
CONC. BLK. GAR.
CONC. CURB
CONC. SIDEWALK
SPECIAL CURB WITH GUARD
24'
MC. KNIGHT ROAD
N 7°42'20"W
-7.96%
-4.06%
CONCRETE CURB
DEPRESS CURB IN LAST 10'
CONCRETE
SPECIAL CONC. GUARD CURB
GIRTYS RUN
CONCRETE
N 80°09'50"W
CONC. SIDEWALK
34'
CONC. CURB WITH UNDERDRAIN & 6" PERF. CLAY PIPE
CONC. CURB WITH UNDERDRAIN - 6" PERF. CLAY PIPE
CONCRETE CURB & SIDEWALK
CONCRETE TRAFFIC ISLANDS
CONCRETE
EAST
APPROACH
CONC. CURB
PAVEMENT EDGE
6'
HIGHWAY LIGHT POLE
TRAFFIC WARNING LIGHTS
MC. KNIGHT RUN
WOOD POST WIRE ROPE BARRIER
WOOD POST WIRE ROPE BARRIER
DEADMAN
22'
26'

Example 10

Location

CALIFORNIA, near Sacramento
Home Avenue - Fair Oaks Boulevard
(Sac-98-A)

Submitted by

J. C. Young, Traffic Engineer
Department of Public Works
Sacramento, California

Type of Intersection

3-Way, Y

Date Constructed

March 9, 1950

Physical Data

4. Cross Section
   a. Not unusual, so not shown on plan
5. Traffic Control Devices
   b. Signals: Type: traffic actuated, timing: traffic actuated.
   e. Other Control Devices: also guard rail, and raised bars.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

1. Volumes
   a. Average Daily: shown on plan (intersection now carries 22,000 vehicles per day).
2. Type
   a. Suburban
3. Speeds
   a. Approach Speed: 85 Percentile: shown on plan as varying according to signalization during peak hours and during off-peak hours.
4. Delays
   a. "During 23 hours and 10 minuts delays are practically nil, as the eastbound movement is free-running, and the traffic actuated signals give the green to about three-fourths of the other three movements. Seldom does the wait for green exceed 15 secondgs. During 25 minutes in the morning and 25 minutes in the evening, the westbound traffic is backed up from the two-lane on the Sacramento end. The intersection of the west-bound lane of the two-lane road is 600 vehicles in 25 minutes, and this volume is attained twice a day."
5. Accidents
   a. Collission Diagram: "Before", "After", Length of Period: "Four minor accidents in 34 months prior to construction; two major accidents in two months since construction. One of the latter was caused by a driver stopping when she should have been going on on a green; the other by a driver trying to pass a truck in the channelized portion of the road, who hit the curbed island as shown in the diagram."

Economic Data

1. Estimated Cost of New Installation
   a. $42,000
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. "Insufficient data "After" to prove anything."

Operational Characteristics

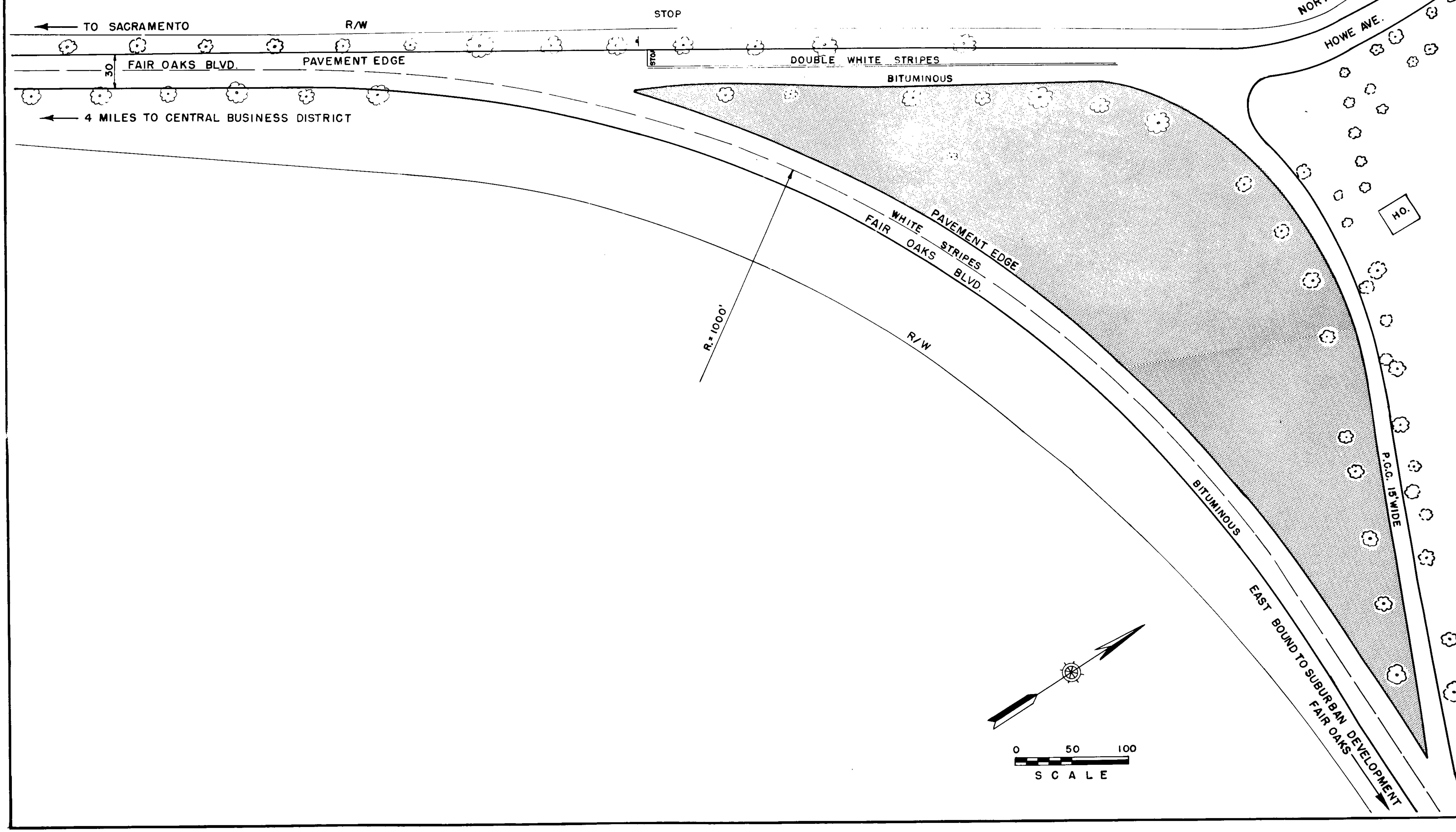
1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. "Safety: the northbound traffic from Fair Oaks Boulevard into Howe Avenue had to cross opposing westbound traffic at about a 20-degree acute angle, and due to heavy volumes and relatively high speeds this appeared to be a very hazardous move; however, there were only two accidents of this type in three years, during which average daily traffic was about 16,000 on the west leg, 4,000 on the north leg, and 12,000 on the east leg. To reduce this apparent hazard, a separate turning lane was provided, and signals were installed which give a green arrow to left-turning (northbound) traffic while holding the westbound traffic. There were two accidents in the first two months after construction, and it is going to be hard to prove that any improvement was made, because of the excellent record of the old intersection. However, the mental strain and apparent hazard has been greatly relieved."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The congestion during the westbound peaks was formerly very severe, with long lines of cars backed up on both legs from the junction. It was this congestion which created most of the pressure for the project to be constructed. The jockeying for position of the two merging streams of traffic was nerve-wracking. Since installing the signals, the right of way is split by red and green indications in proportion to the demand, which relieves the jockeying. However, the two lanes must still merge to one at the west (or south) end of the project, and there is jockeying at that location during the peak 25 min. The westbound merging capacity of the old intersection was 550 in 25 min., and the westbound capacity of the two-lane road is 600 in 25 min., so that about 50 more vehicles are now passed during the same interval of time. During the remaining 35 min. of the peak hours traffic flows freely (25 - 40 mph.). The back-up of traffic formerly lasted about 3 to 5 min. longer than it does now."
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   a. "This sample is being submitted to show that channelization is not a panacea for increasing capacity. The problem here was primarily one of capacity of the two-lane road west of the intersection, and until four lanes are provided the congestion will remain. The expenditure will be salvaged when the remainder of the highway is widened to four lanes, but as an interim project the principal accomplishments have been to relieve nervous tension on the part of drivers (1) making left turns and (2) merging."
   "This intersection carries an exceptionally large volume of vehicles for a two-lane road junction: 22,000 vehilces per day on one leg, 5700 and 16,800 on the other two legs. The intersection functions very well, but the two-lane road constituting the west leg breaks down during the peak hour and backs traffic up through the intersection."

Comments by Committee Members

1. GUY KELCEY - The channelization and signal control shown is carefully thought out, and appears to be the best treatment possible at this location short of a grade separation, which would not be justified. The two accidents which are reported during the two months following this installation appear to have been not a consequence of confusions created by

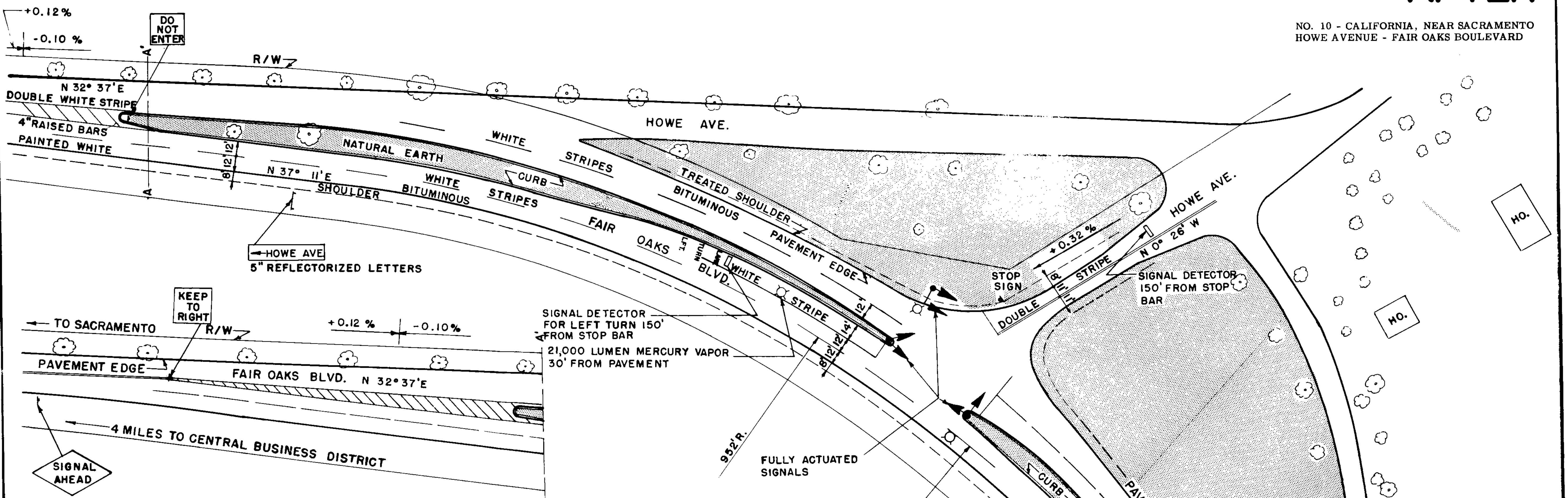
BEFORE

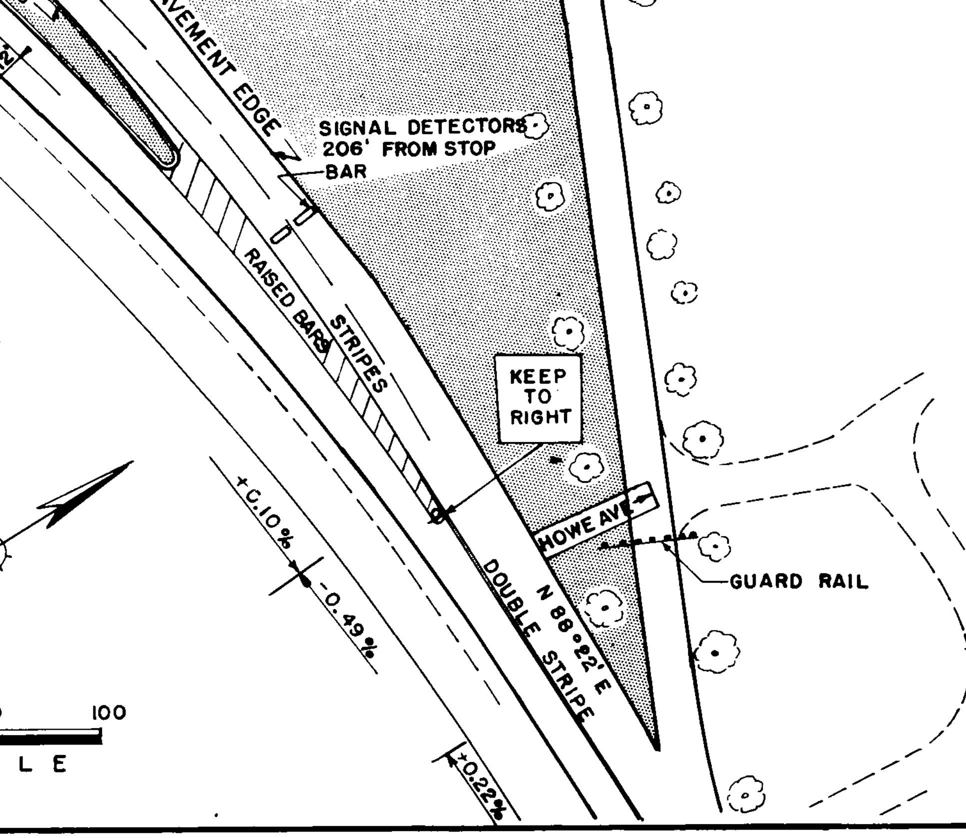
NO. 10 - CALIFORNIA, NEAR SACRAMENTO
HOWE AVENUE - FAIR OAKS BOULEVARD

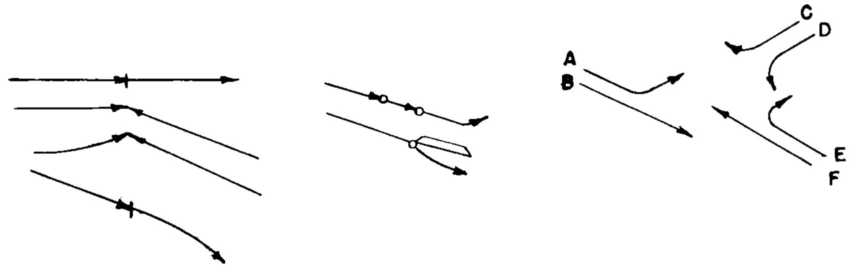


AFTER

NO. 10 - CALIFORNIA, NEAR SACRAMENTO
HOWE AVENUE - FAIR OAKS BOULEVARD







34 MONTHS PRIOR TO CONSTRUCTION

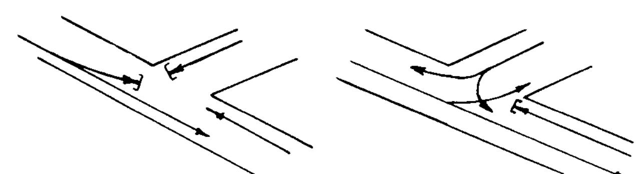
2 MONTHS AFTER CONSTRUCTION

COLLISION DIAGRAM

Movement	Av. Daily Volume	P.M. Peak Hr. Av. Day	A.M. Peak Hr. Av. Day
A	2978	366	172
B	8585	879	483
C	2491	295	386
D	121	14	0
E	120	14	0
F	7968	619	777

12% Commercial Traffic-Daily Vol.
3% Commercial Traffic-Peak Hr. Vol.

TRAFFIC VOLUMES



PHASE A PHASE B

TRAFFIC SIGNAL SEQUENCE

DESIGN DATA:

Surfaces-bituminous
8'gravel shoulders
Abutting property-outlying residential
Speeds-vary according to color of signals
20 to 30 M.P.H. in peak hours
35 to 50 M.P.H. in off peak hours

the channelization treatment, but of improper driving actions that could occur anywhere.

2. EDWARD G. WETZEL - This scheme eliminates a serious head-on conflict at westerly junction of Howe Avenue and Fair Oaks Blvd. in spite of the fact that the "Before" accident record shows only 2 such accidents. The analysis submitted with this example appears reasonable as to the effect on the motorist before channelization. However, with increasing traffic volumes and the signals since channelization, delays will undoubtedly become as serious and annoying to the motorist as "Before". In general this scheme is good and should prove of greater value when the capacity of the approaches is increased.

Figure 1. Channelized junction of local roadway (Howe Avenue) with curved section of main highway (Fair Oaks Boulevard). Note left-turn provision and well-organized wheel-track pattern shown on the pavement.

Example 11

Location

CALIFORNIA, 3 miles east of San Diego
California Route 94 (Federal Blvd.) - Home Avenue

Submitted by

J. C. Young, Traffic Engineer
Department of Public Works
Sacramento, California

Type of Intersection

3-Way, Y

Date Constructed

April, 1949

Physical Data

2. a. Grades: level
3. Surface Type
   a. Roadways: asphalt; roadways were concrete "Before". The buldge at the outer edge of the pavement on the "After" drawing is pavement that was left over from the original road which did not conform to the new alignment after widening for the channelization.
   b. Islands: probably asphalt-surfaced
   c. Shoulders: -six-foot treated shoulders. Shoulders were untreated "Before".
4. Cross Section: not pertinent
5. Traffic Control Devices
   c. Markings: color: white
7. Abutting Property
   b. Entrances: none
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

3. Speeds
   a. Approach Speed: Approach speeds were observed in 1950 for "After" and then the approach speeds for "Before" were estimated.
4. Delays: "No quantitative data are available. Except during peak hours, traffic is not appreciably delayed. Traffic volumes entering the intersection at Home and Federal are moderately heavy. It appears, without reasonable doubt, that the overall delay to vehicles is appreciably less after channelization than before."
6. Pedestrian
   a. Volumes: negligible
   b. Location of Crossings: none

Economic Data

1. Estimated Cost of New Installation
   a. From final report: $31,200
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. Property damage (estimated from Accident Reports), $1050; minor injuries, 1 x $10 equals $10; major injuries, 1 x $500 equals $500; fatalities, 1 x $15,000 equals $15,000; total $16,560.
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After".
   a. No Accidents

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The channelization apparently effectively restricts the paths of vehicles to the extent that it is unnecessary for drivers to violate the right-of-way in order to clear their vehicles at the intersection. The left turn median lane is very effective in providing protection for left turning vehicles. Prior to construction, a cutbank on the south side of the intersection restricted visibility. This bank was excavated, and the visibility was considerably improved."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Lanes for through traffic on State Sign Route 94 (Federal Boulevard) were increased from two 18 ft. lanes to four 11 ft. lanes, thereby increasing the capacity of the intersection. The median left turn lane also helps to relieve congestion at the intersection."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "This intersection functions extremely well. This is evidenced by the fact that traffic is handled during peak hours with little congestion and with a lack of accidents."

Comments by Committee Members

1. D. W. LOUTZENHEISER - A good basic plan properly used, as evidenced by speeds, volumes, and accident record. With STOP sign control only on stem road, the "After" experience indicates the high volumes that can be handled on a proper layout without other traffic control devices. Note that p. m. peak hour shows 550 vph. use median lane to make left turn across a through volume of 280 vph., with daily totals of 3,050 and 5,375, respectively.

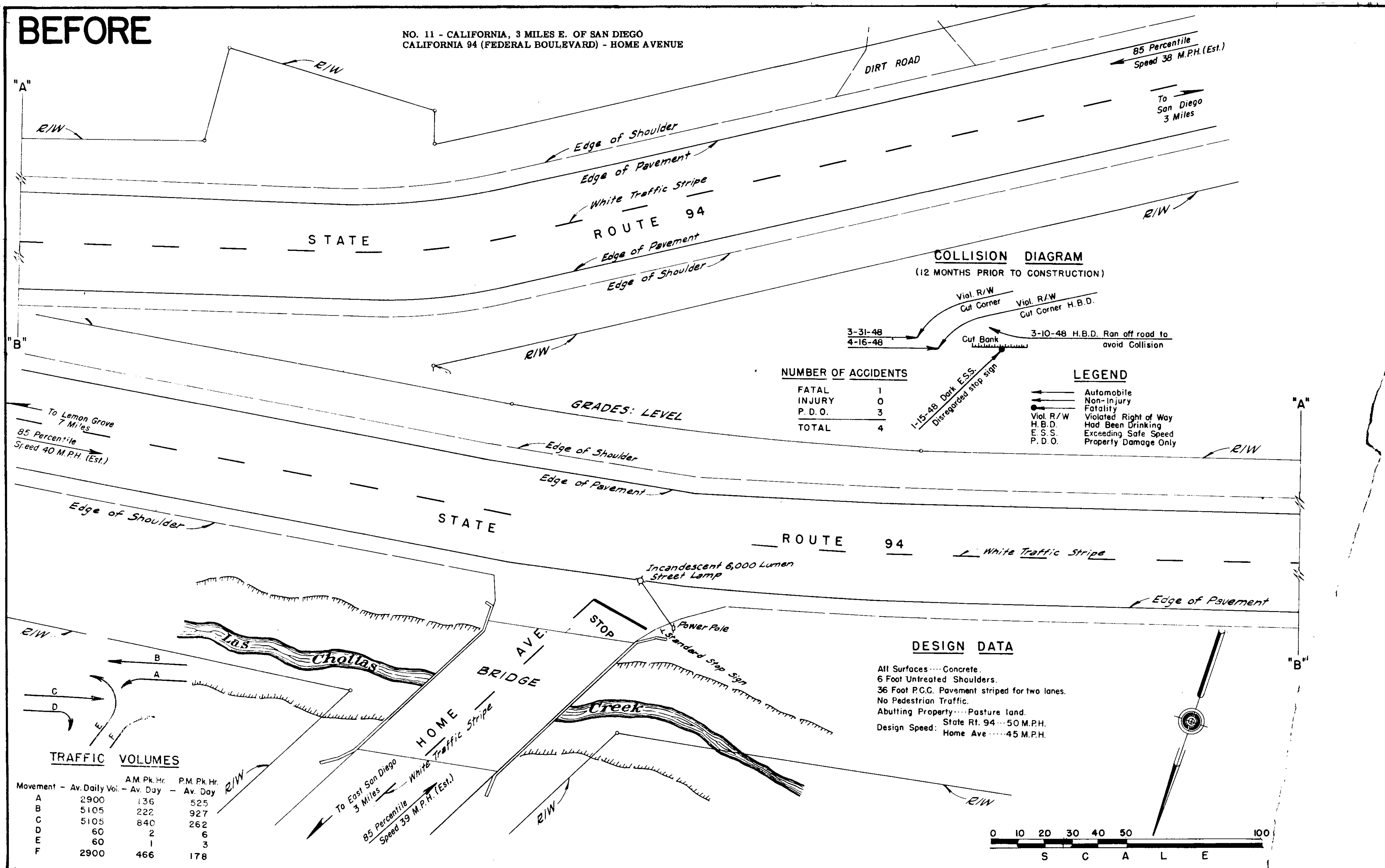
   It is to be emphasized that the narrow pavement and limited sight distances in the "Before" condition undoubtedly had much to do with the accident record. Introduction of 11-ft. lanes and widening cut slope are significant improvements, regardless of the intersection channelization.

   The designer has made good use of a curved alignment to introduce a median with desirable length and width in layout. The reverse curve entry to the median lane appears sufficiently elongated in plan, but in road view of Figure 2 and 3 it shows as questionably abrupt. Greater elongation needed to better fit vehicle paths. Approach end treatment and intersection markings are well done. Use of plant-mix roll for separator on right of median lane is a good compromise between Yes and No opinions as to use of a wider curbed separator.

2. E. T. PERKINS - In general, the redesigned intersection seems satisfactory. The only comment that I would make concerns the easterly end of the island in Route No. 94. It would seem that the opening through which vehicles turn left to enter Home Avenue could be closed up to about two-thirds of the present opening. The end of the island is so far back that a vehicle turning left could make a flat crossing in the face of westbound traffic on Route No. 94. If the opening were closed up, a more nearly direct crossing would be required and a slower turning movement would be made. This is somewhat dependent upon the legal length of vehicles allowed in California and the type of turning vehicle might have dictated the present, indicated opening. Generally, though, this opening should be kept to a minimum.

BEFORE

NO. 11 - CALIFORNIA, 3 MILES E. OF SAN DIEGO
CALIFORNIA 94 (FEDERAL BOULEVARD) - HOME AVENUE



NUMBER OF ACCIDENTS

FATAL	1
INJURY	0
P. D. O.	3
TOTAL	4

LEGEND

←	Automobile
←	Non-Injury
●←	Fatality
Viol. R/W	Violated Right of Way
H.B.D.	Had Been Drinking
E.S.S.	Exceeding Safe Speed
P. D. O.	Property Damage Only

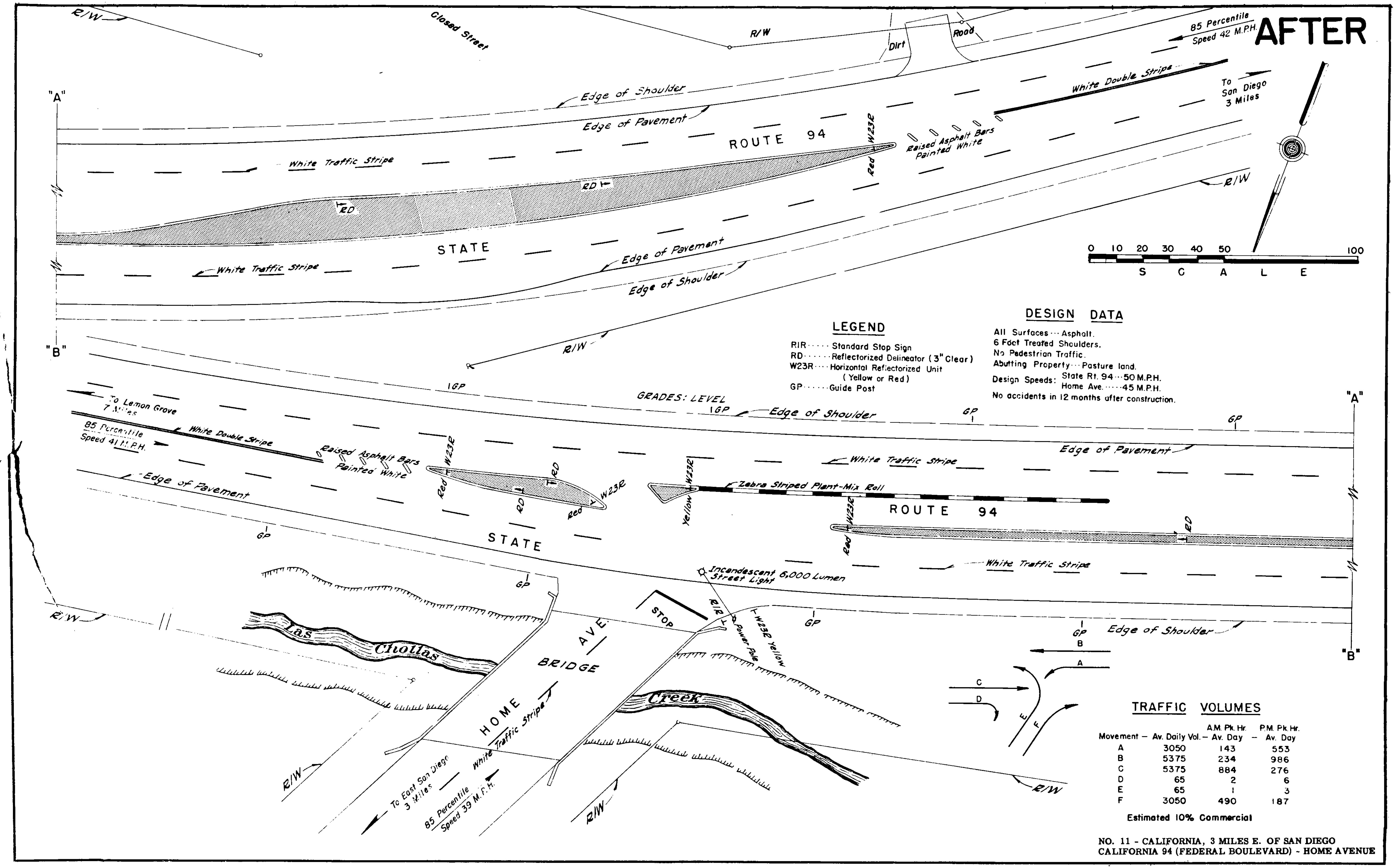
DESIGN DATA

All Surfaces····Concrete.
6 Foot Untreated Shoulders.
36 Foot P.C.C. Pavement striped for two lanes.
No Pedestrian Traffic.
Abutting Property····Pasture land.
Design Speed: State Rt. 94···50 M.P.H.; Home Ave····45 M.P.H.

TRAFFIC VOLUMES

Movement	Av. Daily Vol.	A.M. Pk. Hr. Av. Day	P.M. Pk. Hr. Av. Day
A	2900	136	525
B	5105	222	927
C	5105	840	262
D	60	2	6
E	60	1	3
F	2900	466	178

AFTER



LEGEND

R1R ······ Standard Stop Sign
RD ······ Reflectorized Delineator (3" Clear)
W23R ···· Horizontal Reflectorized Unit (Yellow or Red)
GP ······ Guide Post

DESIGN DATA

All Surfaces ··· Asphalt.
6 Foot Treated Shoulders.
No Pedestrian Traffic.
Abutting Property ··· Pasture land.
Design Speeds: State Rt. 94 ··· 50 M.P.H.
Home Ave. ····· 45 M.P.H.
No accidents in 12 months after construction.

TRAFFIC VOLUMES

Movement	Av. Daily Vol.	A.M. Pk. Hr. Av. Day	P.M. Pk. Hr. Av. Day
A	3050	143	553
B	5375	234	986
C	5375	884	276
D	65	2	6
E	65	1	3
F	3050	490	187

Estimated 10% Commercial

NO. 11 - CALIFORNIA, 3 MILES E. OF SAN DIEGO
CALIFORNIA 94 (FEDERAL BOULEVARD) - HOME AVENUE

Figure 1. Intersection of California Route 94 and Home Avenue near San Diego before channelization.

Figure 2. Intersection after channelization. Highway widened and curbed median added. Four vehicles in protected median lane, awaiting opportunity to turn left.

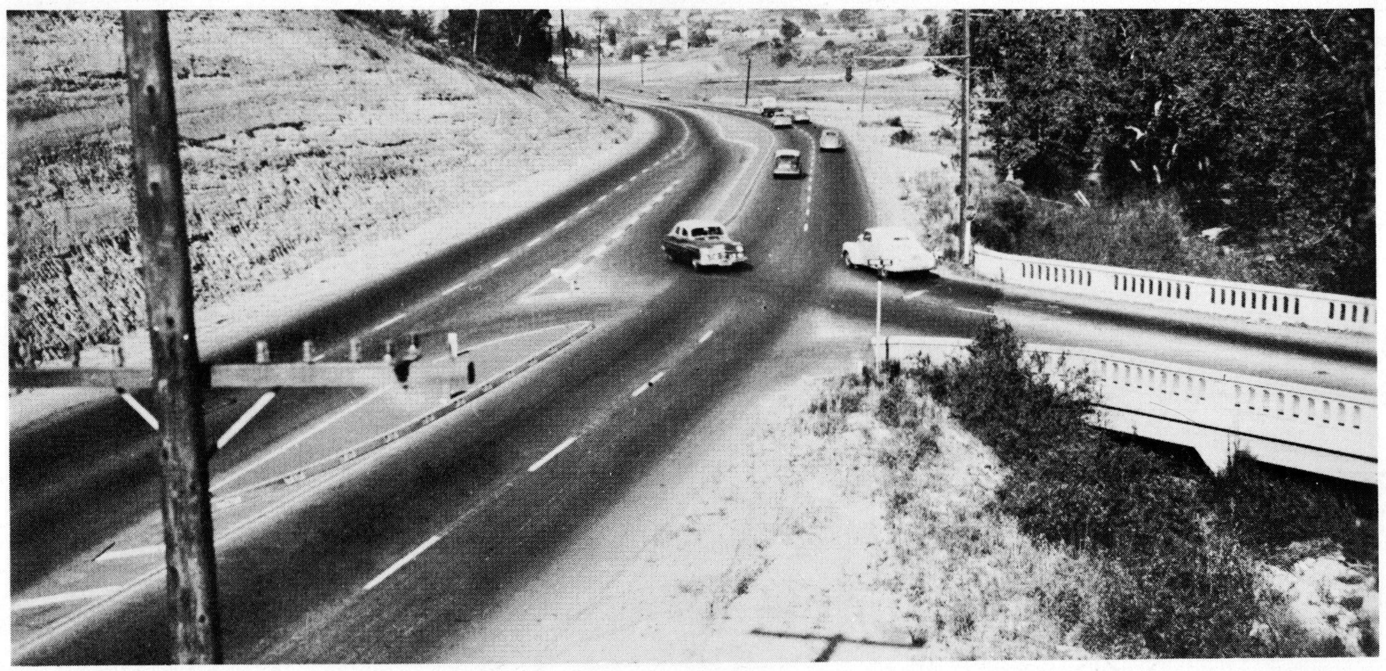


Figure 3. View of channelized intersection to the west showing curbed triangular island and raised-roll separator. Note reflecting curb and approach-end jiggle bars at left. Stop-sign controls traffic entering from right.

Example 12

Location

CALIFORNIA, 2 miles south of
San Bernardino
Colton Avenue (US 70 and 99) - South E St.
(California 26)

Submitted by

J. C. Young, Traffic Engineer
Department of Public Works
Sacramento, California

Type of Intersection

3-Way, Y

Date Constructed

January 7, 1949

Physical Data

3. Surface Type
   c. Shoulders: bituminous pavement and earth
5. Traffic Control Devices
   e. Other Control Devices: Guide Posts: raised plant-mix bars,
   Reflectorized Delineators: 2" red reflectors in curb and 3" yellow reflectors on post
6. Landscaping
   a. None indicated clearly

Operational Characteristics

1. Design Features Which Contribute to Safe Operation: to Unsafe Operation
   a. "Before redesign, this intersection was a branch type intersection with a free right turn provided for westbound traffic turning north onto South E Street. Colton Avenue was a three-lane highway with double striping in place, so that eastbound traffic was restricted to the south lane, and westbound traffic to the north lane. This left the middle lane for traffic entering the highway from E Street. The movement of traffic off of E Street onto Colton Avenue was very hazardous, particularly during peak hours. Eastbound traffic off of E Street was required to make a boulevard stop before entering Colton Avenue.

   After redesign Colton Avenue was constructed as a four-lane, divided highway, and the approach on South E. Street was channelized to provide four channels for traffic entering and leaving from Colton Avenue. The movement of traffic within the intersection is now accomplished with greater ease and safety. Eastbound traffic on Colton Avenue desiring to turn left onto south E Street has been provided a deceleration lane, southbound traffic on south E Street, turning left onto Colton Avenue, has been provided an acceleration lane. The basic design of the intersection, which contributes to the accident hazard, has not been changed, i. e.: the manner in which eastbound traffic off of E Street enters onto Colton Avenue."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion: see comments above
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The accident record shows an increase in accidents for the first year following reconstruction. There has been no outstanding pattern of accident-types developed; however, the increase in rear-end collisions on Colton Avenue is noticeable."

Comments by Committee Members

1. J. A. REDMAN - The new design should improve the capacity and operating speeds for Colton Avenue traffic. The information submitted does not show 85 percentile speeds for the intersection before redesigning, but they likely were lower on account of the 10 ft. width lanes. There appears to be insufficient allowance in width of Colton Avenue for shying distance from parked trucks (where parking is permitted) if this design should be applied where full four lanes of traffic were moving at 50 mph. For the volumes experienced at this location it appears to have adequate width. The right turn lane from "E" street has insufficient width to accommodate 50 ft. semitrailers.

   The increased accident rate may be due to a combination of higher traffic volumes and speeds than those experienced on the original intersection.

   The left turning traffic from Colton Avenue onto "E" street would interfere with the left turning traffic from "E" onto Colton if both were waiting for west bound Colton Avenue traffic and started up simultaneously. Insufficient descriptive accident data are given to determine the points of collision and circumstances. However, the above described movements should result in accidents due to the former movement hiding the latter. If possible to handle the former movement farther west this situation would be remedied.

2. J. L. SHOTWELL - The design of this intersection deserves a "well done". The lengthening of the taper on the west approach to the median lane might help to decrease the number of rear end collisions on Colton Avenue.

Figure 1. Intersection of Colton Avenue (US 70 and US 99) and South E Street (California 26) before channelization.

Figure 2. Intersection after channelization.

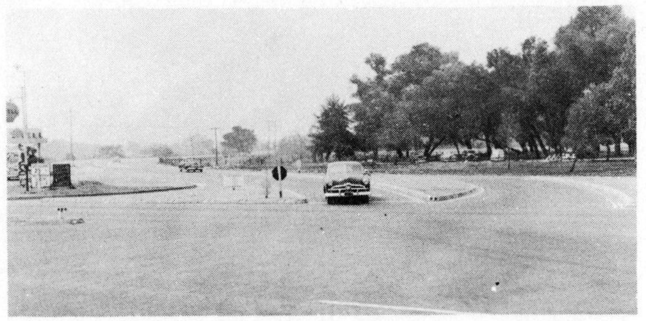
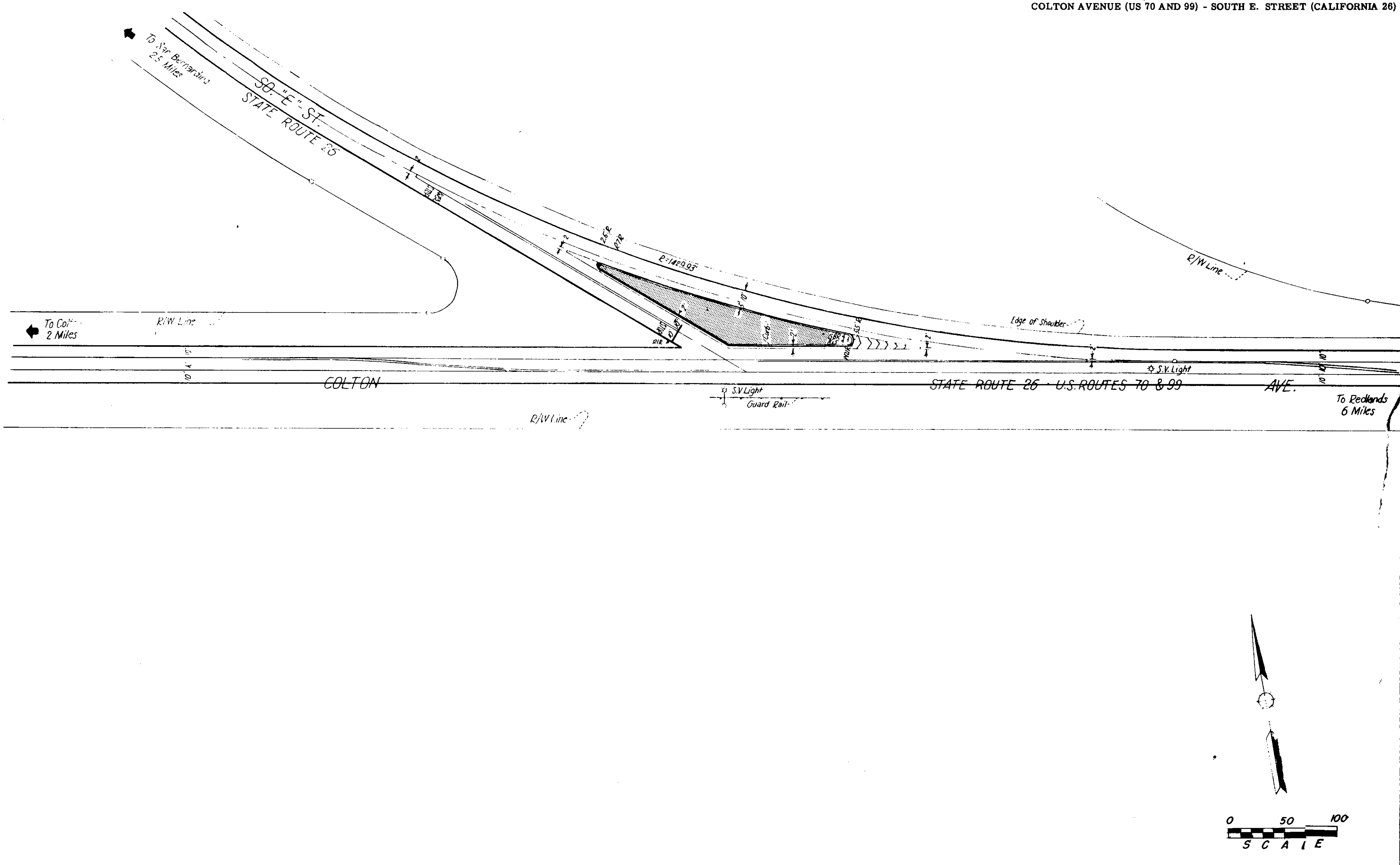


Figure 3. Channelizing islands with reflecting curbs.

Figure 4. Separated left turn lane on Colton Avenue.

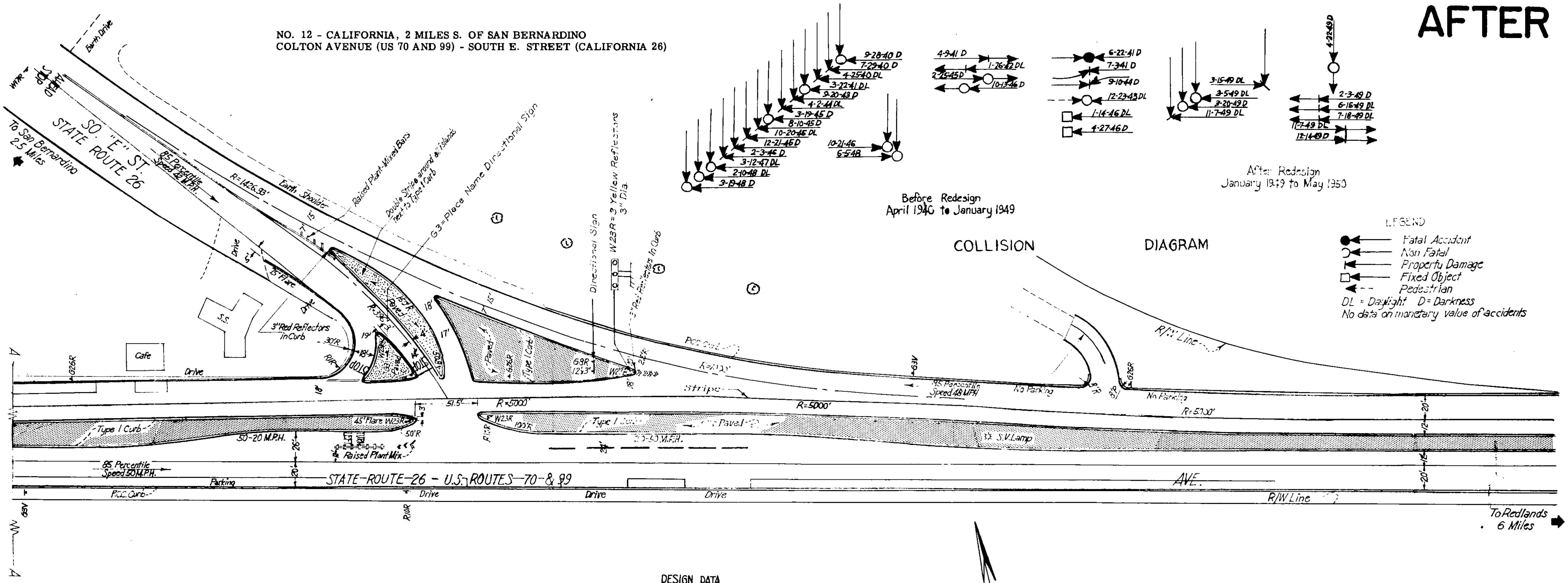
BEFORE

NO. 12 - CALIFORNIA, 2 MILES S. OF SAN BERNARDINO
COLTON AVENUE (US 70 AND 99) - SOUTH E. STREET (CALIFORNIA 26)



AFTER

NO. 12 - CALIFORNIA, 2 MILES S. OF SAN BERNARDINO
COLTON AVENUE (US 70 AND 99) - SOUTH E. STREET (CALIFORNIA 26)

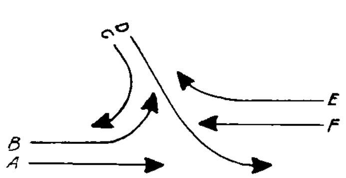


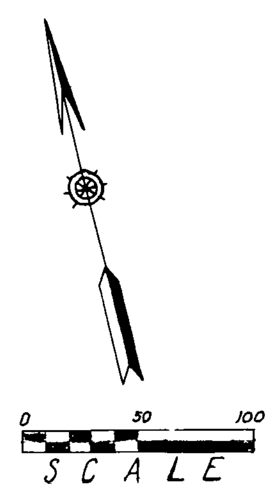
DESIGN DATA

All Surfacing - Bituminous Pavement
Variable Outside Shoulder - Bituminous Paved
No Pedestrian Traffic
Abutting Property - Commercial Buildings
Design Speed - 50 M.P.H.
No Cost Data Available

No Bus Stops

All pavement markings - White Traffic Lacquer

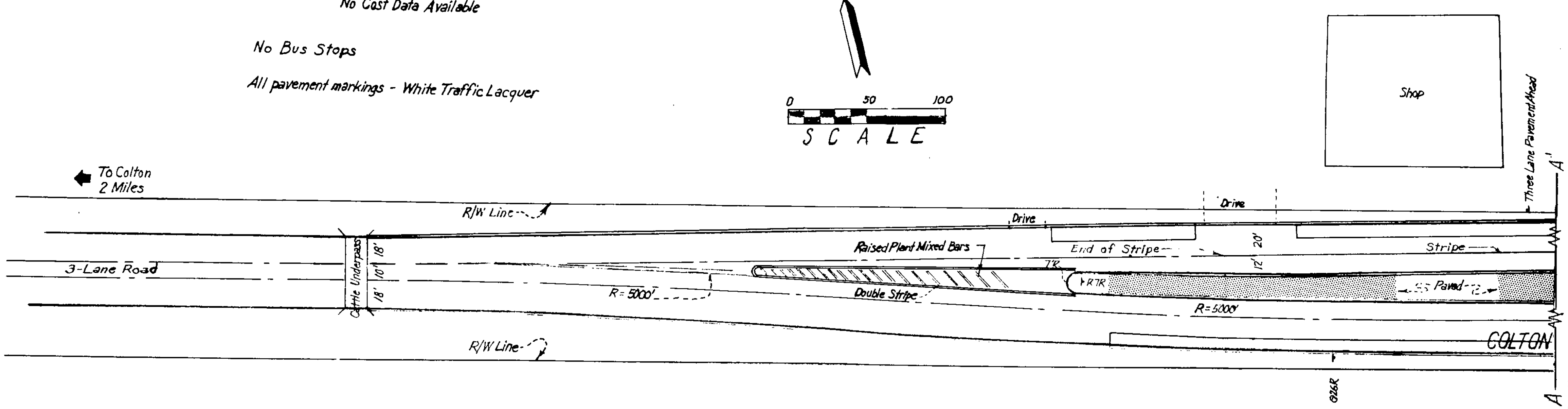




Movement	A	B	C	D	E	F
Average Daily Volume	3938	306	150	1969	1862	4275
AM Peak Hour Average Day	243	20	12	124	129	272
PM Peak Hour Average Day	277	20	8	136	116	293

17% Commercial Traffic

TRAFFIC VOLUME



Example 13

Location

DELAWARE, South of Dover.
Wall's Corner, US 13 -
Delaware Rd. 25

Submitted by

William J. Miller, Jr.,
Traffic and Planning Engineer
State Highway Dept., 152 South State Street,
Dover, Delaware

Type of Intersection

3-Way, Y

Date Constructed

Fall, 1949

Physical Data

3. Surface Type
   b. Islands: grass
6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: adjacent properties are farms with one exception
   b. Location and Importance of Entracnes: the entrance off Road 25 is for an agricultural machine warehouse.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

1. Volumes
   e. Pedestrian: very little pedestrian activity
4. Delays
   a. None
5. Accidents
   b. Fatal: no accidents for 12 month "Before": three accidents in similar period "After", all property damage only.

Economic Data

1. Estimated Cost of New Installation
   a. $5,600
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. None
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $665

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. "The particular problem which we attempted to solve at this location was the one presented when vehicles leaving Route 25 had poor sight distance looking back towards southbound US 13 traffic. Moving the people into Route 13, by way of the existing channelization, gave them better sight distance for US 13 traffic, and also reduced the area of conflict in which it was possible for them to have an accident.

      After construction, there were three accidents compared with a year previous to construction. The accidents were minor, resulting in total property damage of $665, with no personal injuries. The accidents which occurred were not caused by the new type of intersection but were the type of accidents which could have occurred on any other location along this same highway."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "There is very little congestion in this rural section."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The intersection has been working very well and effectively."

Comments by Committee Members

1. E. T. PERKINS - The original layout contained the undesirable flat crossing which is conducive of the head-on type of collision.

   The redesign contains the desirable, nearly right-angle crossing for Route 25 vehicles destined westbound on Route US 13. Advanced signing on Route 25 has been well worked out and should be a distinct aid to traffic flow.

   It is, apparently, intended that traffic from the Private Road will be allowed to turn left into Route 25 as previously permitted. With the small amount of traffic using the opening to turn left from Route US 13 into Route 25, I believe that all traffic leaving the side road should go through the opening in the island. This plan may be in force at the present time, but it is not apparent from the information provided.

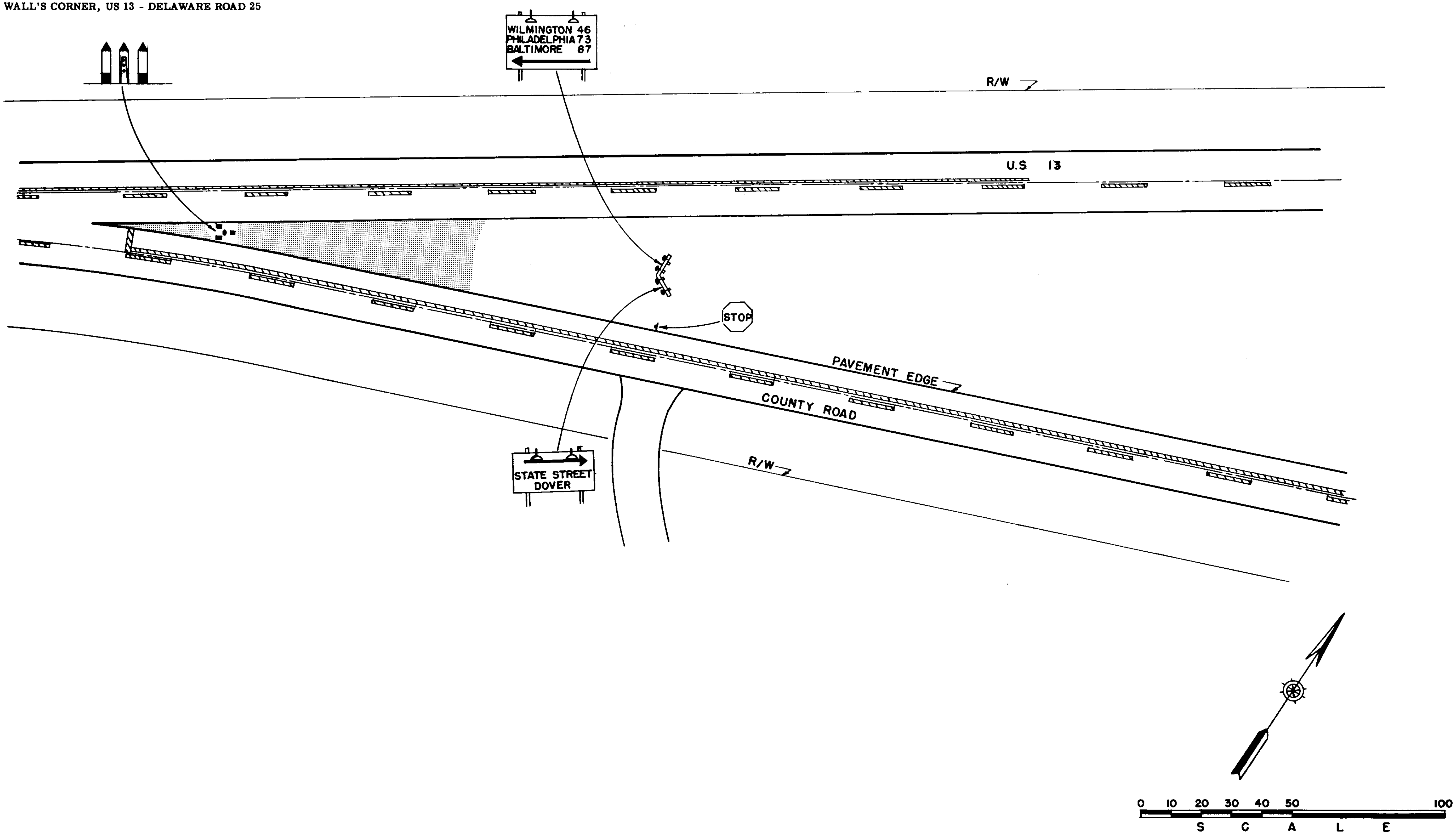
   It seems possible to introduce funneling and shadowing into the islands along Route 25. The recommended general outline of the edge of islands has been indicated in Figure 1. With an 85 percentile speed of 53 mph. for westbound traffic on Route US 13, all possible protection should be provided for vehicles in the opening in the island. Vehicles turning left from the opening into Route 25 could be given some shadowing as a protection against vehicles entering at high speed from Route US 13.

2. H. G. VAN RIPER - The layout permits a left turn onto County Road 25 for traffic leaving the private drive. It is believed that this movement should be prohibited, as traffic entering US 13 from County Road 25 invites a head-on collision. Accordingly, it is suggested that a "no left turn" sign be erected at the exit from the private drive.

   It is also suggested that the barrier line on US 13 be cut back to the west to allow for movements off of US 13 into and out of the opening in the traffic island opposite the private drive.

BEFORE

NO. 13 - DELAWARE, SOUTH OF DOVER
WALL'S CORNER, US 13 - DELAWARE ROAD 25



NO. 13 - DELAWARE, SOUTH OF DOVER
WALL'S CORNER; US 13 - DELAWARE ROAD 25

AFTER

DESIGN DATA:

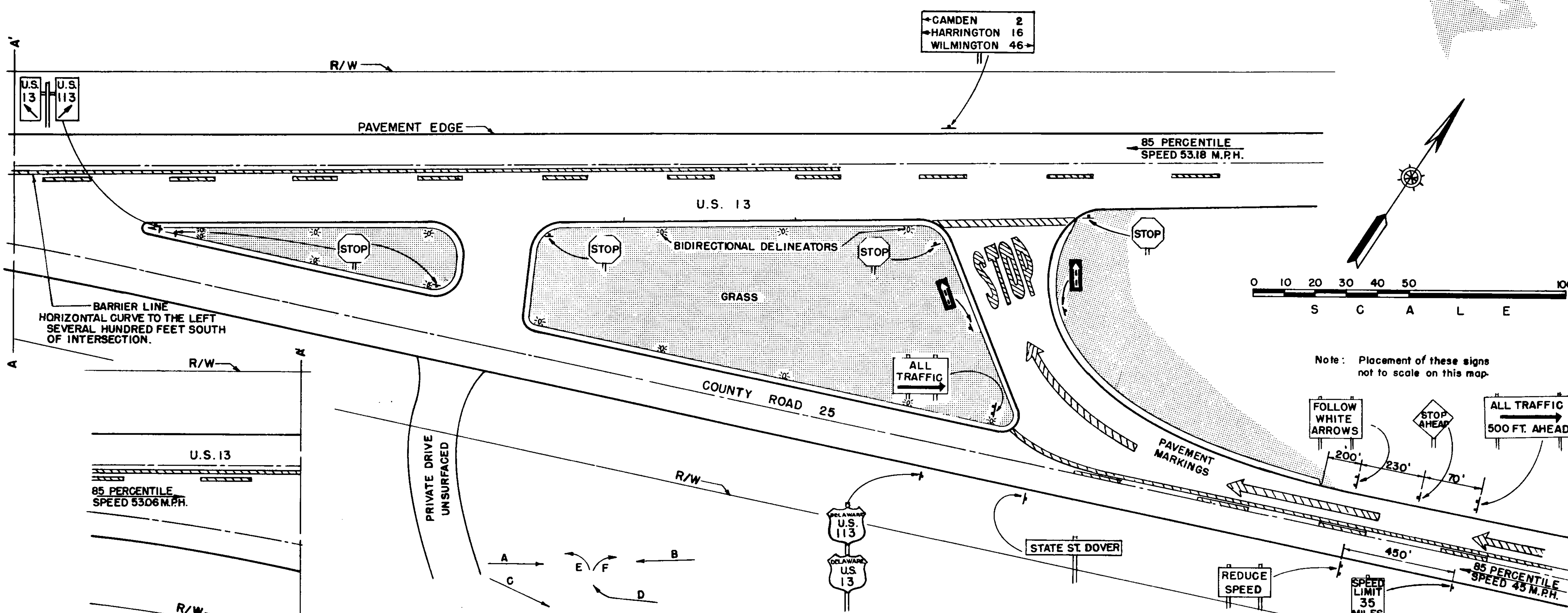
U.S. 13-bituminous concrete
County No. 25-concrete
10' graded & drained earth shoulders
No pedestrian traffic
Abutting property- farm land
Design Speeds: U.S. 13-50 M.P.H.
County Rd 25- 50 M.P.H.

1-14-50 6P
12-9-49 11P
3-26-50 11A

Total Damage $ 665

12 MONTHS PRIOR TO CONSTRUCTION — 12 MONTHS AFTER CONSTRUCTION

COLLISION DIAGRAM



Movement	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	2860	188	243
B	3140	216	277
C	718	72	54
D	782	59	83
E	754	77	80
F	28	—	—

28% Commercial Traffic

TRAFFIC VOLUMES

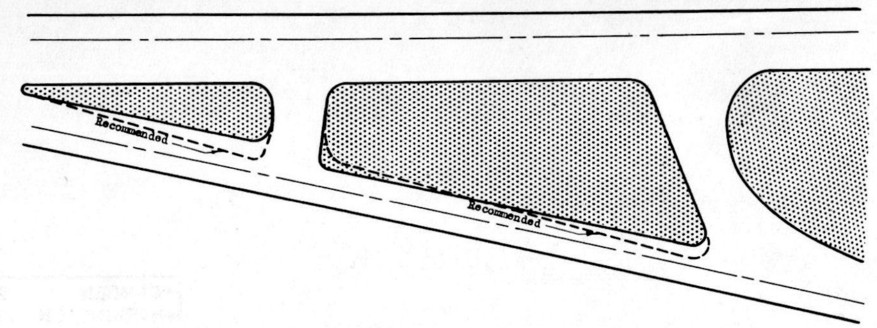


Figure 1.

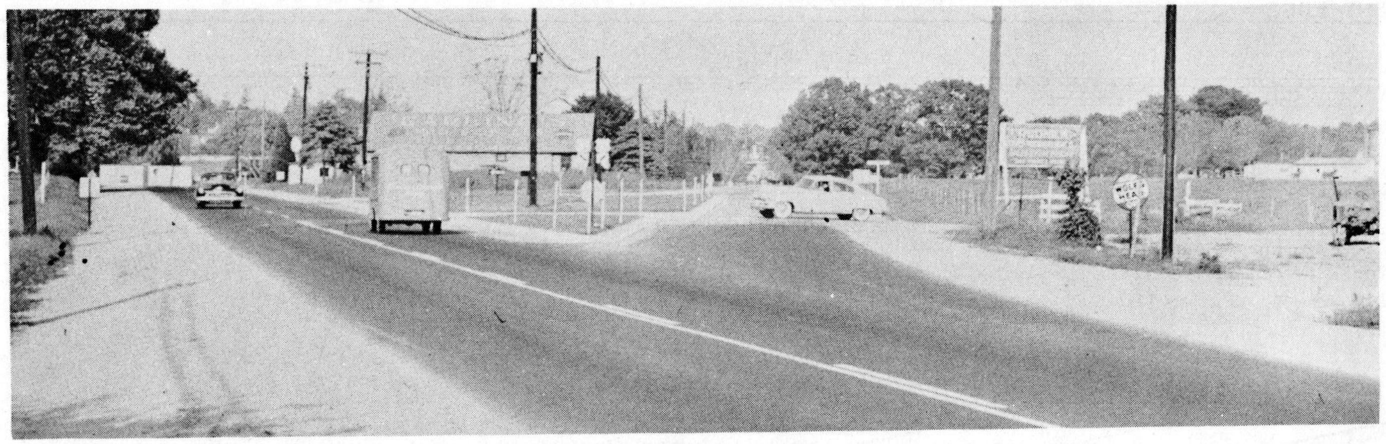


Figure 2. Intersection of US 13 and Delaware Road 25 near Dover. This view is to the east into Delaware Road 25.

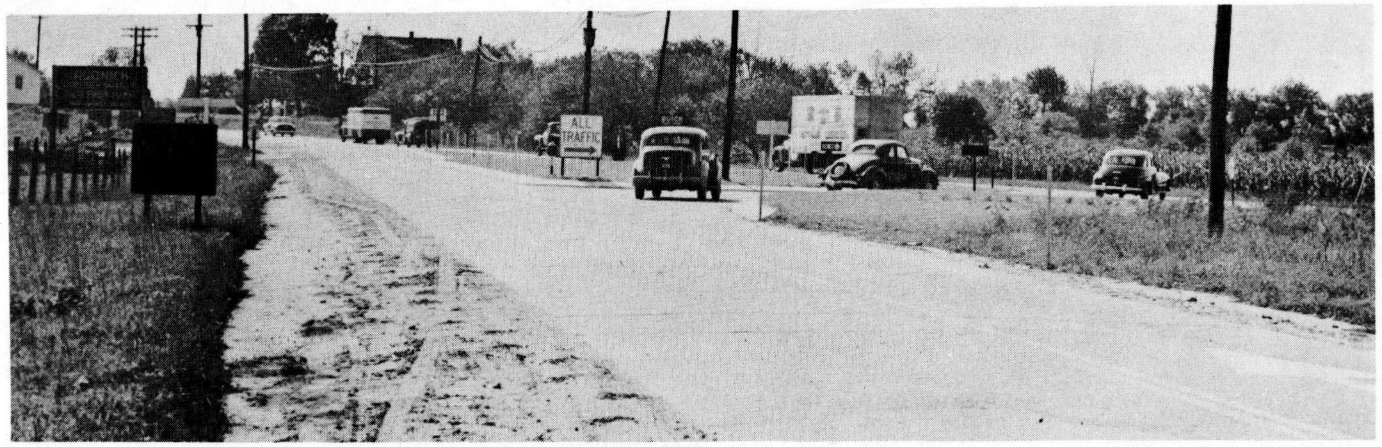


Figure 3. Looking west on Delaware Road 25.

Example 14

Location

OKLAHOMA, Yukon, Canadian County
US 66 - 10th St. Cutoff to Oklahoma City

Submitted by

Stoner K. McLelland, Chief Engineer,
Department of Highways,
Capitol Offices Bldg., Oklahoma City 5,
Oklahoma

Type of Intersection

3-Way, Y

Date Constructed

1949

Physical Data

4. Cross Section
   a. Typical cross section of concrete dividing strip shown on plan
5. Traffic Control Devices
   a. Signs: Type: AASHO standard route markings. destination boards and informational signs (reflectorized) are used, but locations not indicated.
   b. Signals: Type: none
   c. Markings: Type: center stripe and barrier lines. Color: black
   d. Lighting: Type: none
   e. Other Control Devices: Guide Posts: none; Reflectorized Delineators: none
6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: pasture land and farm properties; filling station on one corner.

Traffic Data

3. Speeds
   a. Legal speeds are shown on plan; no others given; no speed studies available
4. Delays
   a. None except on minor movements

Comments by Committee Members

1. EUGENE MAIER - In the channelization of the US 66 - 10th Street Cutoff intersection, the classical "tear drop" design for a 3-way, T-type intersection has been employed. A distinguishing feature of this design is the separation of conflicts.

   Suggested changes in the design of this intersection include:

   a. Speed change areas should be provided for vehicles entering and leaving both the eastbound and westbound roadways of US 66. Acceleration and deceleration is accomplished in the through roadways on US 66. The need for adequate speed change areas would appear particularly essential at this intersection where speeds are relatively high and the percentage of commercial traffic is above normal.
   b. This design does not provide for the installation of traffic signal controls which may be required. Where speeds are high and where traffic volumes are heavy, channelization alone cannot improve the safety or assure the maximum capacity of the intersection. Channelization designs should provide for the ultimate installation of traffic signal controls as an intermediate step preceding separation of grades. The "tear drop" design is not suited for practical signalization and traffic actuated controls could be installed only after extensive redesign.
   c. Sloped curbs are recommended in the design of the channelizing and divisional islands in this example.

2. J. C. YOUNG - Because of the incomplete data furnished with the example, I cannot tell what the volumes of the various movements are. If the left-turning volume westbound to southbound is very small, then very little has been accomplished by forcing them around a U-turn and into the free right turn lane eastbound. If it is a significant volume, the conflict with the major left turn (northbound to westbound) still occurs and it may have been accomplished better at one open intersection. The latter solution would also facilitate ultimate signalization of the intersection if the volumes increase.

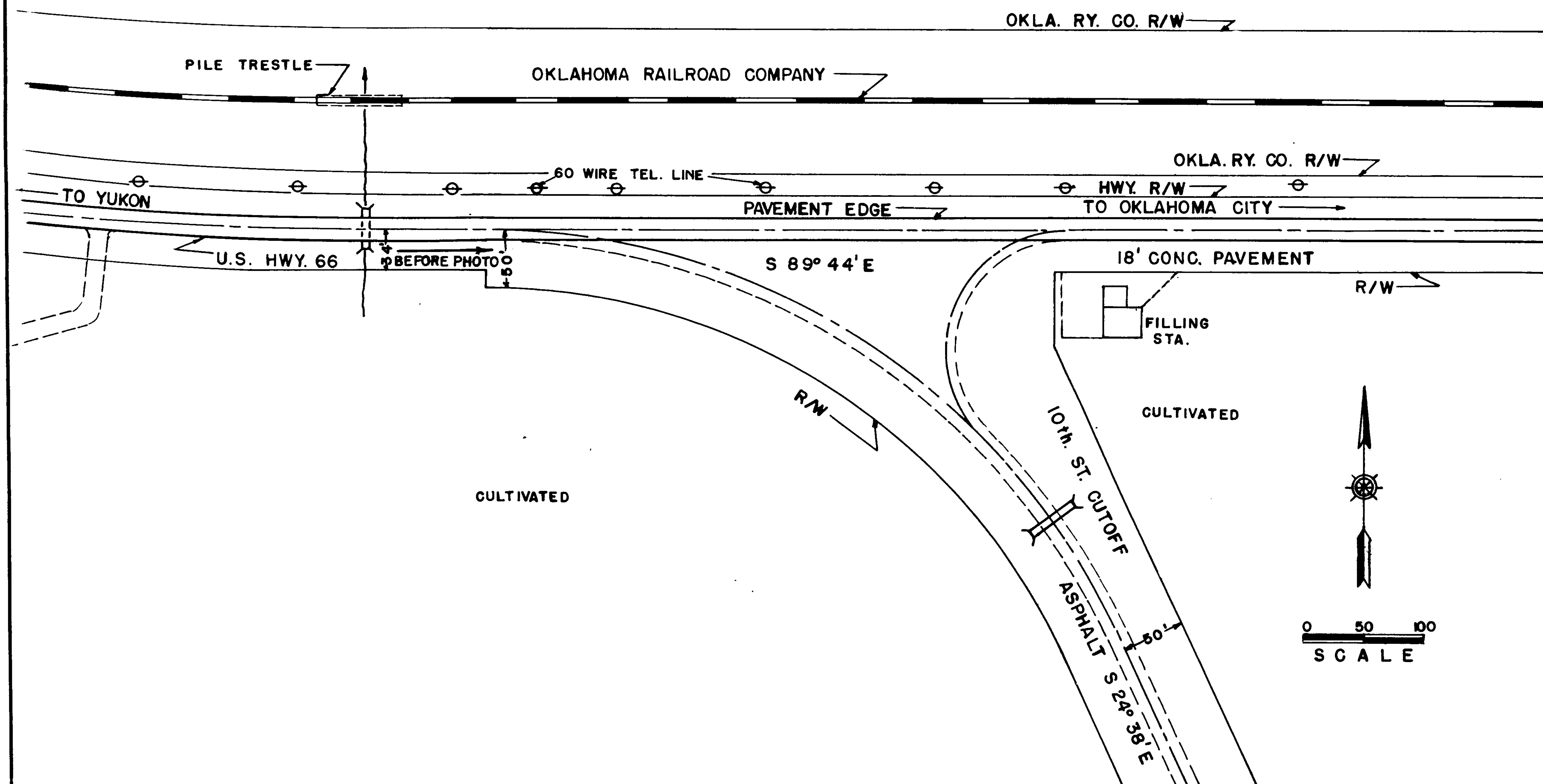
   It is our policy that curbs should be set back, preferably 8 ft. on the right and at least 2 ft. on the left, from through lanes. In locations such as this, a semi-mountable, or slope-faced curb is used.

   It is hard to see why the nose of the island should be paved with six in. of concrete. Not only is this expensive, but such a positive barrier in the transition area from undivided to a divided road is a hazard to traffic. We would use bituminous jiggle bars in a similar location.

   I am sending a sketch (Fig. 1) of what appears to be about the same type of problem with about the same traffic volumes at an intersection with US 40 at Davis, California. The acceleration lane is very useful during peak hours and is used considerably throughout the day. I believe this design to be simpler and more satisfactory in operation than the one used in Oklahoma.

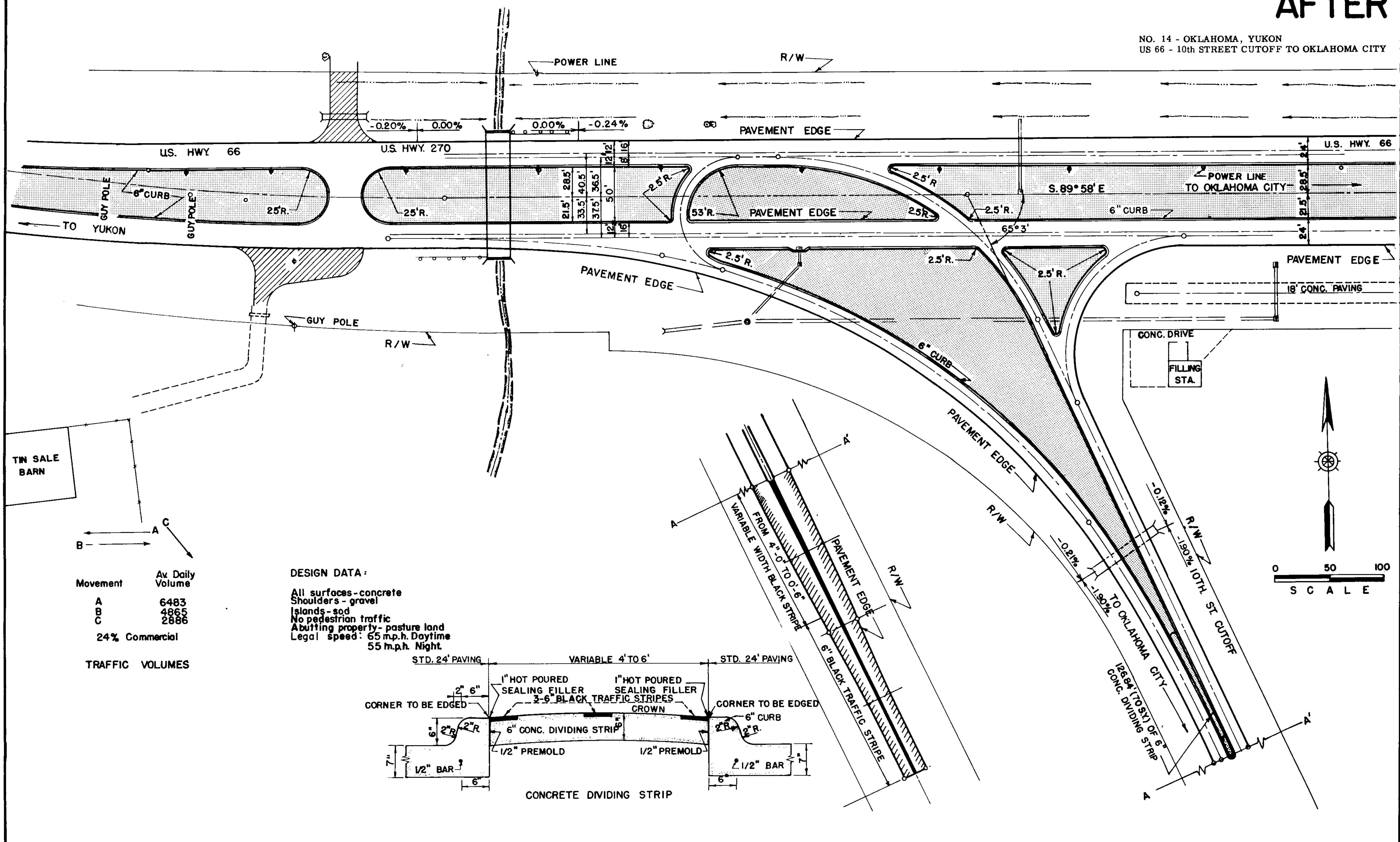
BEFORE

NO. 14 - OKLAHOMA, YUKON US 66 -10th
STREET CUTOFF TO OKLAHOMA CITY



AFTER

NO. 14 - OKLAHOMA, YUKON
US 66 - 10th STREET CUTOFF TO OKLAHOMA CITY



Movement	Av. Daily Volume
A	6483
B	4865
C	2886

24% Commercial

TRAFFIC VOLUMES

DESIGN DATA:

All surfaces - concrete
Shoulders - gravel
Islands - sod
No pedestrian traffic
Abutting property - pasture land
Legal speed: 65 m.p.h. Daytime
55 m.p.h. Night

CONCRETE DIVIDING STRIP

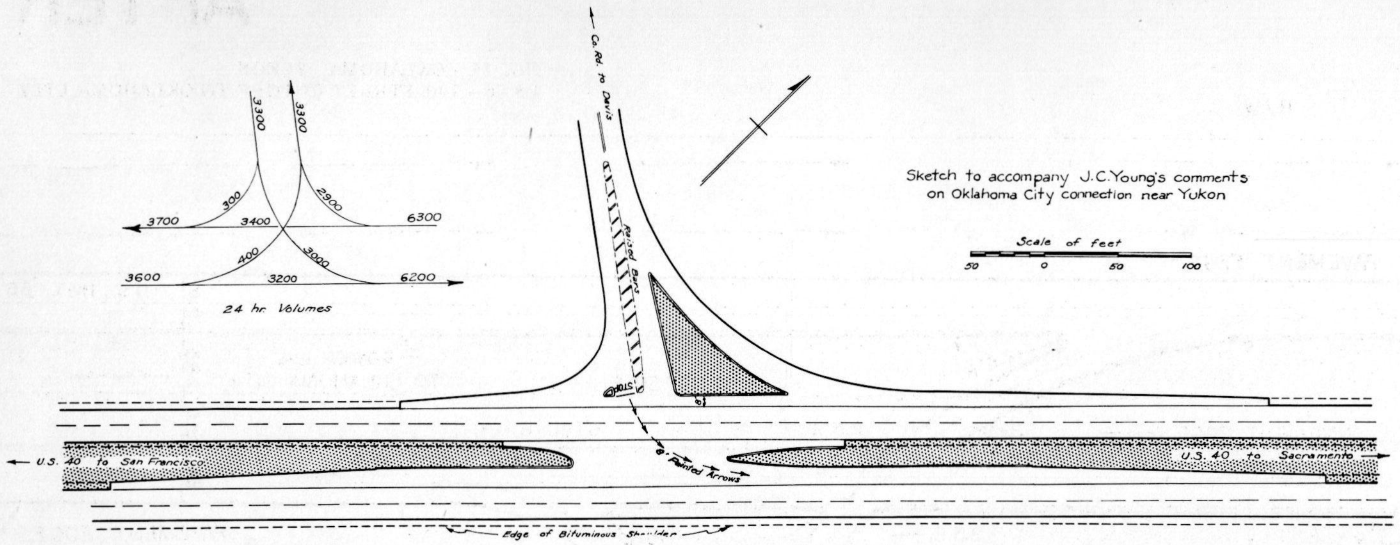


Figure 1.

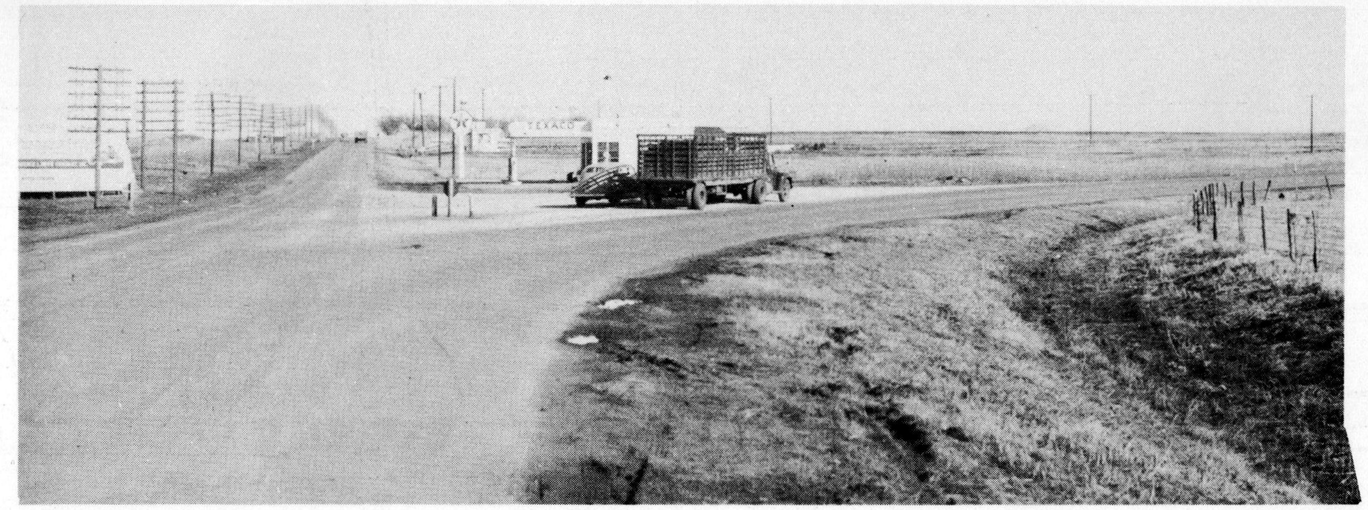


Figure 2. Intersection of US 66 and 10th Street Cutoff before reconstruction.

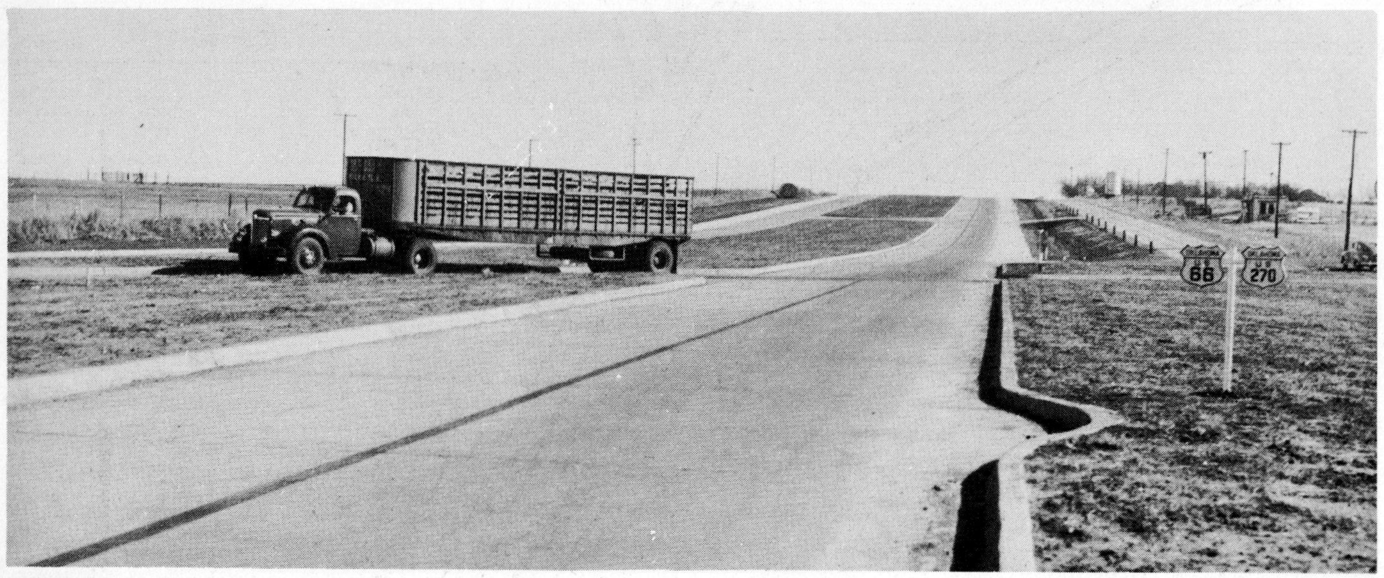


Figure 3. West along US 66 from east lane of 10th Street Cutoff. Note the use of 6-in. vertical curbs with channelizing islands.

Figure 4. East lane of 10th Street Cutoff entering US 66 subject to stop control.

Example 15

Location

OREGON, Bunker Hill
US 101-Coos River Highway

Submitted by

R. H. Baldock, State Highway Engineer,
Oregon State Highway Department,
Salem, Oregon

Type of Intersection

3-Way, Y

Physical Data

3. Surface Type
   b. Islands: grass
   c. Shoulders: oiled rock footpath shown on plan
5. Traffic Control Devices
   e. Other Control Devices: Guide Posts: Benjamen Island lights

Traffic Data

2. Type
   b. Percent Commercial: 20 percent
6. Pedestrian
   a. Volumes: not appreciable

Economic Data

1. Estimated Cost of New Installation
   a. $77,000
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. $7,900
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $100

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "There are several features which tend to give safer operation. Here the elimination of a large area of conflict by strategic location of islands is the main safe operating feature. One-way channelization within the area also gives very good operating conditions. The elimination of some stop signs and a more advantageous positioning of others is another favorable possibility for safe operation. Decreasing confusion from the ability to place directional signs in the most efficient spots has also contributed to the overall safety of the intersection.

      Obstacles contained within the inherent design of the intersection such as traffic separators, traffic islands and light fixture standards all tend to contribute to unsafe operating conditions."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The relief of congestion was accomplished mainly by placing large island areas within the intersection. The one-way channelization to handle larger traffic volumes at a higher speed and the elimination of some stop signs also reduced congestion."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Prior to channelization, this intersection was of the standard "T" type, with the Coast Highway (US 101) making the right angle turn. The one-way channelization has enabled traffic on US 101 to move faster, and it has given them a higher degree of safety in making this turning movement. It has also allowed traffic on the Coos River Highway to move more freely because of the merging lane constructed for westbound traffic on US 101 and westbound traffic on Coos River Highway.

Comments by Committee Members

1. D. W. LOUTZENHEISER - This is the basic "channelized Y" plan, modified as necessary for superimposed cross streeets. Introduction of median separates heavy flow into one-way streams, one of which is placed under STOP control at central crossing point. The 20-ft. and 22-ft. pavement widths are too narrow for double lane flow and wider than necessary for single lane with passing. With curbs on each side a 24-ft. to 26-ft. width would be desirable.

   There is undue width in the central portion of Mullen Street within the Y. This should be used only for minor northbound flow and extra width invites improper southbound movements.

   While not pin-pointed, the accident data show that the major improvement was the increase in pavement width along US 101, from 22 ft. to 60 ft.

2. H. G. VAN RIPER - Channelization treatment has some unsafe operating conditions - (a) westbound traffic on Coos River Highway desiring to make left turn onto US 101 southbound would not have sufficient weaving distance on approaching Center Street; furthermore, the movement would be hazardous to cross eastbound traffic on Coos River Highway: (b) westbound traffic on US 101 desiring to go north on Center Street would have insufficient weaving movement.

   Snow and icy conditions would cause hazardous operation through the traffic islands.

   Suggest that light be provided at the toe of the traffic island separating eastbound traffic on Coos River Highway from southbound traffic on US 101.

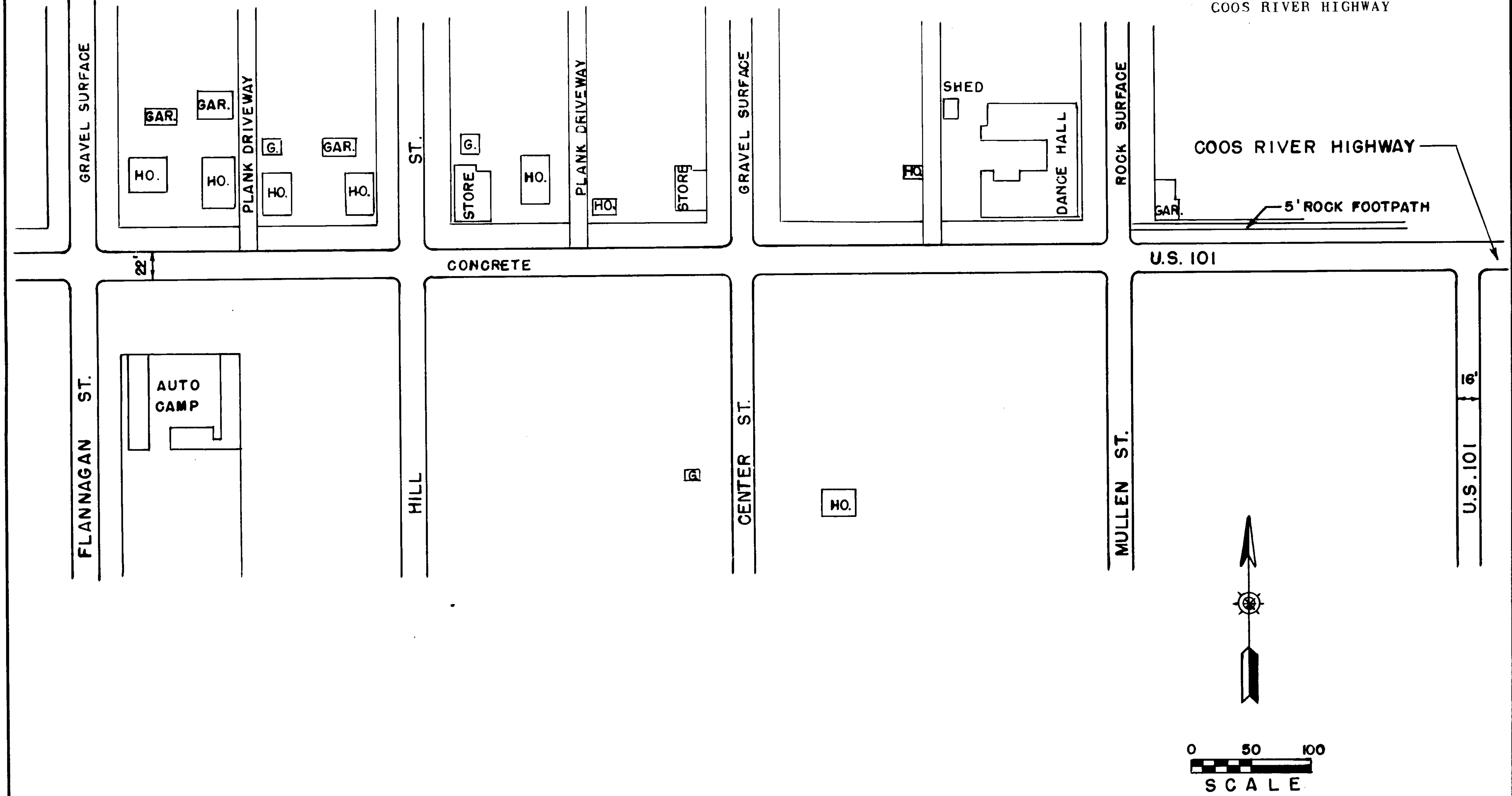
   "After" accident record indicates that intersection treatment has contributed to safe operation through the elimination of conflicts.

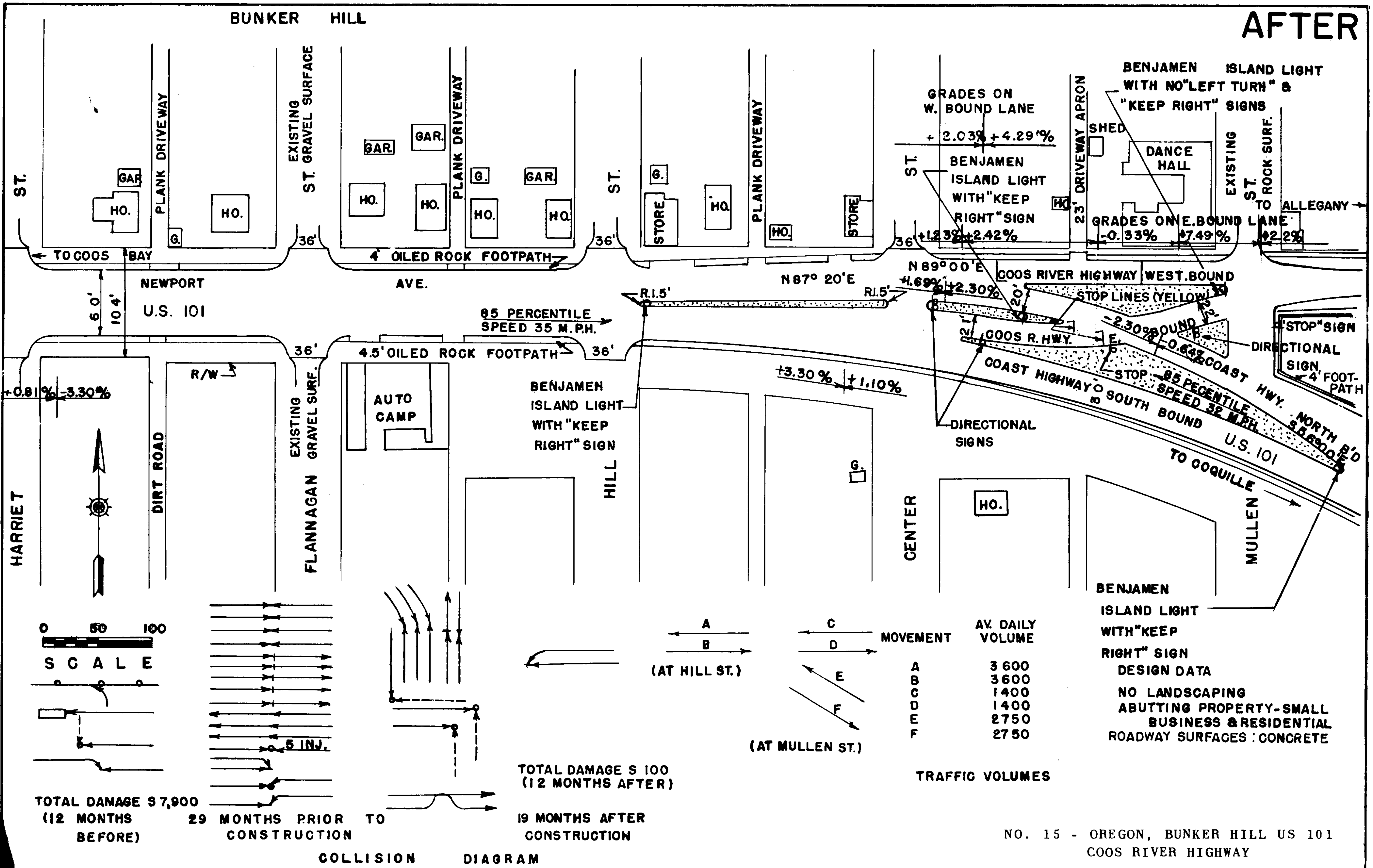
Additional Comment by F. B. Crandall, Traffic Engineer, Oregon State Highway Commission

Reference Mr. Loutzenheiser comment, it is probably true that here in Oregon we tend to work with a maximum design vehicle of rather generous proportions. With the 72,000 lb. gross log truck semi, which we deal with, I do not believe that a confined throat width of 17 or 18 ft. is quite ample enough even for normal one-way traffic with by-pass relief in case of vehicle breakdown. This is particularly true where the vehicle in question is on any sort of curve. The big percentage of our accidents involving log trucks are a type wherein the loaded log truck is making turning movement and the sweep of the overhang rakes a parked vehicle or one moving in flanking lane.

BEFORE

NO. 15 - OREGON, BUNKER HILL US 101
COOS RIVER HIGHWAY





NO. 15 - OREGON, BUNKER HILL US 101
COOS RIVER HIGHWAY

Figure 1. Aerial view of channelized intersection of US 101 and Coos River Highway. Bunker Hill, Oregon.

Example 16

Location

OREGON, Prineville
US 28 - Oregon 27

Submitted by

R. H. Baldock, State Highway Engineer
Oregon State Highway Department,
Salem, Oregon

Type of Intersection

3-Way, Y

Physical Data

1. a. "Before" Plan: no previous intersection at this exact location, hence no "Before" plan would be comparable with the "After" plan.
3. Surface Type
   a. Roadways: oil mat
   b. Islands: grass
   c. Shoulders: not given except where footpaths
5. Traffic Control Devices
   b. Signals: Type: none

Traffic Data

2. Type
   b. Percent Commercial: 20 %
6. Pedestrian
   a. Volumes not appreciable
   b. Location of Crossings: not indicated, but footpaths shown

Economic Data

1. Estimated Cost of New Installation
   a. $49,000 including sign lighting and mercury vapor illumination.
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $300

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The main features leading to safe operation are the long, one-way channels and the very large areas separating these channels. The construction of a footpath for pedestrians, especially grade school children, also increased safe vehicle operation. The mercury vapor lighting installation, as shown on the plans, gives added safety at night. Since this was a new project with no intersection at this point prior to construction, confusion as to direction was a major cause of unsafe operating condition. This was due mainly to unfamiliarity with the intersection, which was increased at night because of its remote geographic position with respect to the city of Prineville. Within the intersection there is a point of conflict in the area where the mercury vapor illumination was installed. Vehicles entering from the Madras leg of the intersection did so at a fairly high rate of speed, with the result that vehicles were "overshooting" the stop sign."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The over-all operation of the intersection has been very good as is shown by the fact that only three accidents have occurred in the twelve months after construction. The long one-way channels have proven efficient in moving the traffic through the intersection. Although volumes of traffic are not large, the channelization has provided a large degree of safety to the school children, and at the same time it has enabled the traffic to move at a reasonable rate of speed."

Comments by Committee Members

1. E. T. PERKINS - Photograph, Figure 1, indicates a wide travel lane each side of the island in the Redmond leg of the intersection. It would seem that the island should be raised and plainly visible curbing provided. Low planting would accentuate the existance of the island which appears inconspicuously in the photograph. The island could be made to define and further restrict the entrance and exit lanes.

   Photograph, Figure 2, indicates a wide area in front of the island. The One-Way - Do Not Enter sign is dwarfed by the Route sign and does not stand out at first glance. Here, again, a raised curb further restricting and defining the entrance and exit lanes would add to smoothness of separation.

   The entrance to the intersection shown in Photograph 3 again reveals the need for better definition of the island and travel lanes. Too much reliance seems to be placed on signs and not sufficient physical construction to definitely outline the islands and travel lanes.

   In general, the design of the intersection is good, but it would seem that entrances and exits adjacent to end islands could be funneled and better operation would result from the construction of raised curbing.

2. J. C. YOUNG - It would be my thought that with such small traffic volumes there would be a great temptation for people to take shortcuts up the wrong way of the one-way channels. With larger traffic volumes, the percentage of people doing so would be less but the probable consequences would be more serious. Since the only conflict of any appreciable volumes at an ordinary grade intersection would have been movement E and movement G, and since this conflict still exists, it is hard to see why all this rrom, mileage, and potential confusion was introduced into the design.

   A brightly painted no-passing stripe might help to keep people to the right of the island noses.

Additional Comment by F. B. Crandall, Traffic Engineer, Oregon State Highway Commission

From a practical standpoint I think that this volume warrant as a determinant of the degree of channelization, if any, must be treated on a regional basis. Within a region or state I believe that within the limitations of money controls, so long as we maintain balanced treatment over the system, we should make the fullest use of channelization where such can give any measure of improvement with respect to traffic operation. US 28 and ORE 27 at Prineville, is admittedly a low volume intersection; however, it is a relatively important highway junction in the state and particularly in Eastern Oregon. Again, thinking of the high right-of-way costs which so often plague the designer, in this particular instance the junction is on the fringe of an urban area which may develop with the years and more or less engulf the junction. Personally, under circumstances such as these, I would rather be on the ground first, so to speak, at a time when we can "protect" this junction for the future by acquiring ample area before the property values become excessive. It is very easy to let go of unneeded right-of-way, but very difficult to acquire it sometimes.

With reference to Mr. Perkins' comment, the contract has been let for curbing and landscaping at the Prineville Junction.

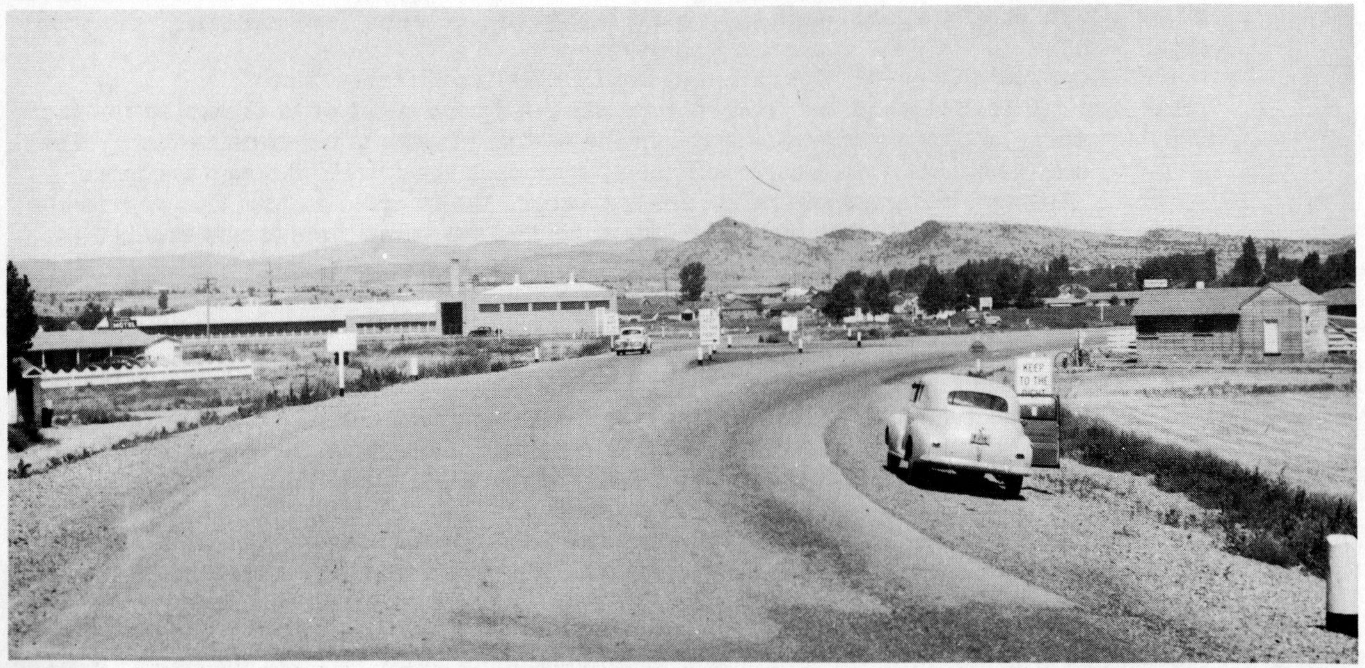


Figure 1. Intersection of US 28 and Oregon 27 west of Prineville, looking north from Redmond leg. Note the temptation to shortcut up wrong lane and the size of signs used to control this wrong-way tendency.

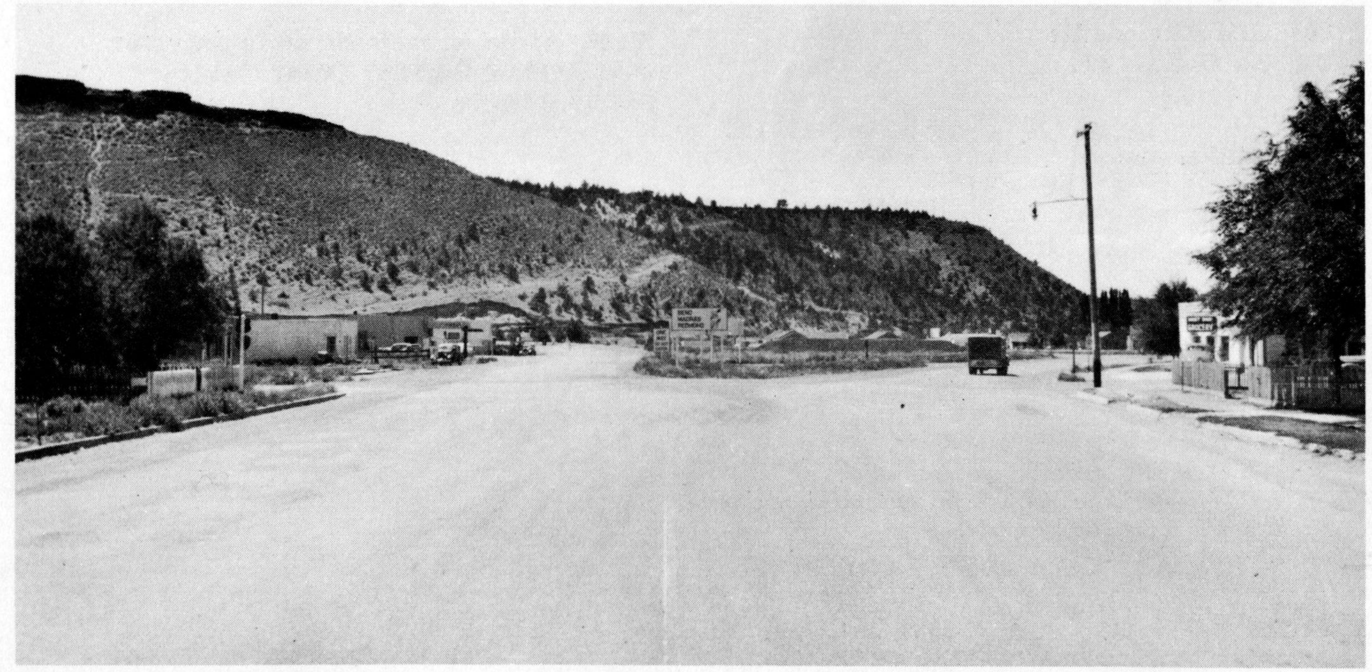
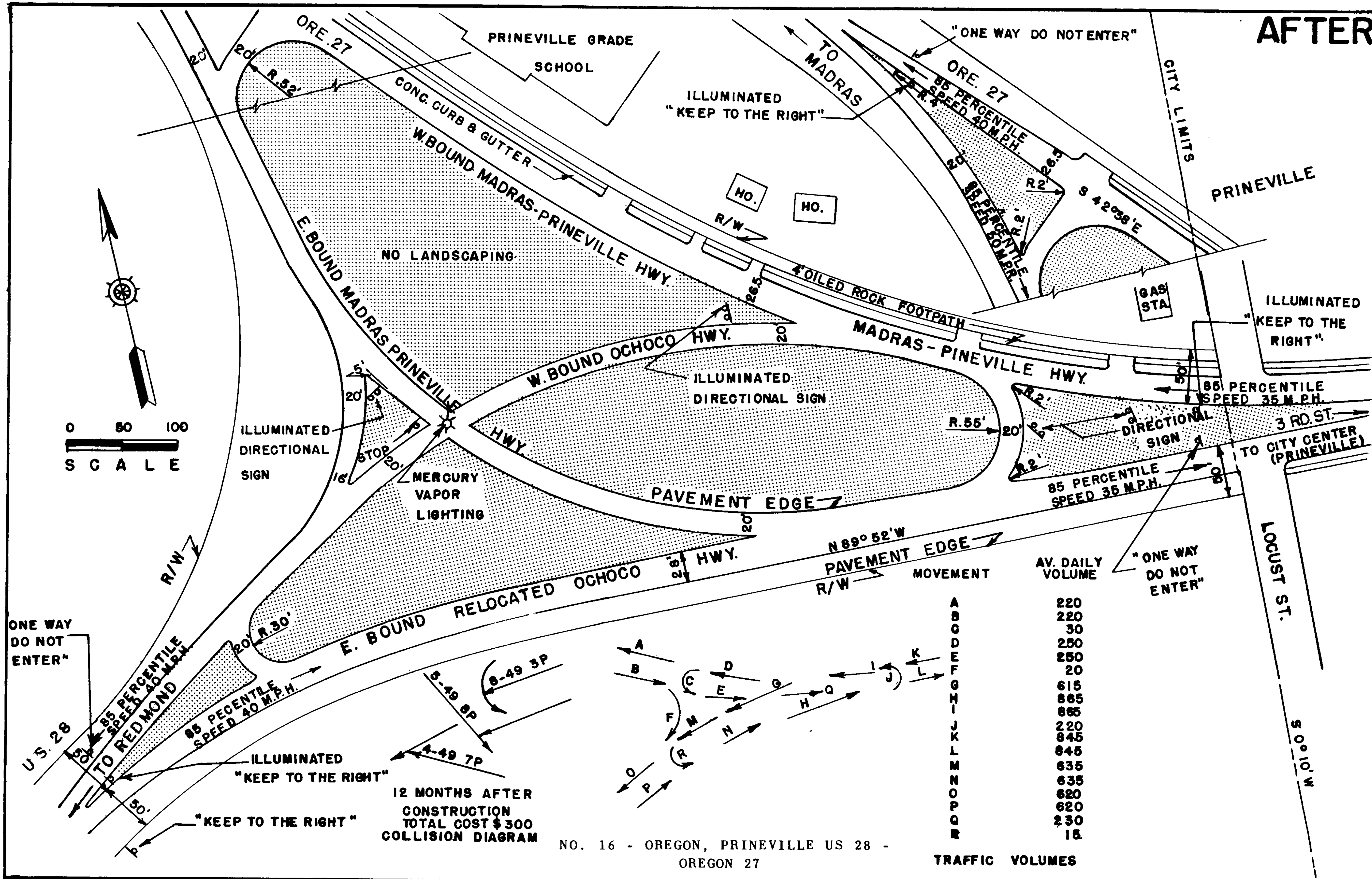


Figure 2. Looking west toward channelized intersection from a point near Locust Street.



NO. 16 - OREGON, PRINEVILLE US 28 - OREGON 27

Example 17

Location

PENNSYLVANIA, Allentown
Carlisle St. - Hanover Avenue - Hamilton Street

Submitted by

G. E. Handwerk, District 5, Planning Eng., Pennsylvania Department of Highways, Allentown, Pennsylvania

Type of Intersection

3-Way, Y

Date Constructed

February, 1950

Physical Data

2. a. Grades: shown on plan - obtained from profiles
3. Surface Type
   c. Shoulders: none
5. Traffic Control Devices
   b. Signals: Type: standard corner post type, Timing: Fixed time controller is equipped with flasher which flashes red on E. Hamilton and Carlisle and yellow on W. Hamilton and Hanover.
   c. Markings: Type: two crosswalks painted for trolley passengers.
6. Landscaping
   a. None

Traffic Data

1. Volumes
   e. Pedestrian: The traffic count sheet for trucks (not included in this publication) showed more uniform distribution for trucks throughout the day than that for passenger cars or pedestrians.
4. Delays
   a. "Difficult for cross traffic to get out on main road before signals were erected. No delays since signals were installed."

Economic Data

1. Estimated Cost of New Installation
   a. $4,000.00

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "This channelized intersection offers more orderly flow of traffic by segregating pedestrians and vehicles, and also it controls movement of traffic with minimum conflicts and increased safety."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Traffic becomes very diffused, if the intersection is very wide and much of the area in a wide intersection is unused as well as not required. The average motorist requires a guide through a wide intersection."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "This particular intersection. since channelized, has a general illumination of the entire area. Standard no parking signs are erected along the curb adjacent to the island to prohibit parking for the entire length of the island. Stop signs have been removed since the attached pictures have been taken. It is now controlled by traffic signals."

Comments by Committee Members

1. EUGENE MAIER - The channelization of the Carlisle-Hanover-Hamilton intersection is an excellent example of the introduction of a simple channelizing island in an existing intersection for the purpose of: (a) Reducing the size of an intersection by eliminating large unused areas; (b) Reducing or eliminating major conflicts; (c) Defining vehicular and pedestrian paths through complex intersection; (d) Permitting effective traffic signal control.

   Outstanding features of design of this intersection include: (a) The flashing amber light at the west end of the island which separates the eastbound traffic on Hanover and Hamilton; (b) The direct lighting of each point of the island which supplements the general lighting provided for the intersection; (c) Channelization of pedestrian movements through the use of chain barriers; (d) Lights installed on the ends of the traffic blocks at the north end of Carlisle Street.

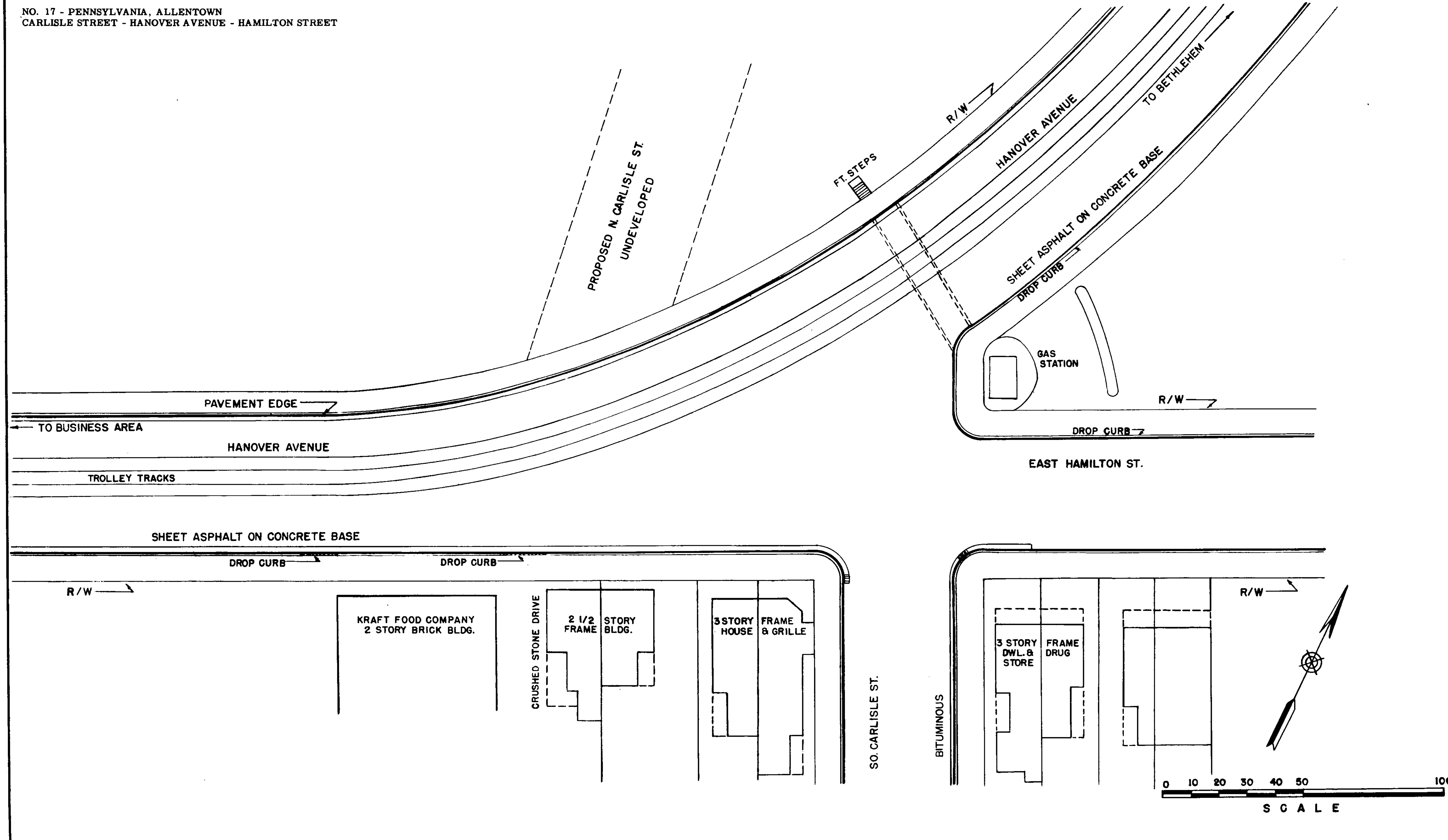
2. EDWARD G. WETZEL - The comparatively simple channelizing island treatment appears to be a satisfactory solution for this intersection. I heartily recommend the method here of handling the westbound traffic from E. Hamilton Street intersecting at right angle with Hanover Avenue.

   With respect to the traffic signals system I note all but northbound on S. Carlisle St. and westbound on E. Hamilton St. have two signal indications while these two have only one. I would recommend two signal indications for all approaching traffic, one on right and other on left.

   It appears this signal system is designed to be flexible enough to handle variable volumes through the several approaches. It seems adequate for the pedestrians also. This is highly desirable.

BEFORE

NO. 17 - PENNSYLVANIA, ALLENTOWN
CARLISLE STREET - HANOVER AVENUE - HAMILTON STREET



AFTER

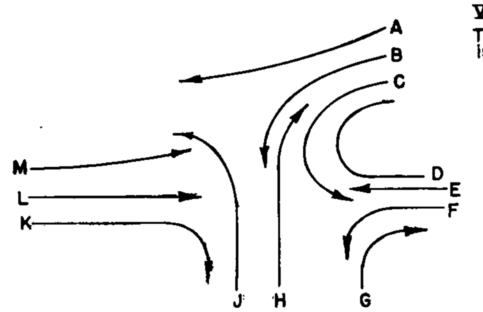
NO. 17 - PENNSYLVANIA, ALLENTOWN
CARLISLE STREET - HANOVER AVENUE - HAMILTON STREET

Lights

R = Red
A = Amber
G = Green

I	R —	A —	G —	G —	G —	G
II	R —	A —	G —	G —	G —	G
III	R —	A —	G —	G —	G —	G
IV	R —	A —	G —	G —	G —	G
V	R —	A —	G —	G —	G —	G
VI	G —	G —	R —	A —	G —	G
VII	G —	G —	G —	G —	R —	A
Time in sec.	32"	3"	15"	3"	12"	3"

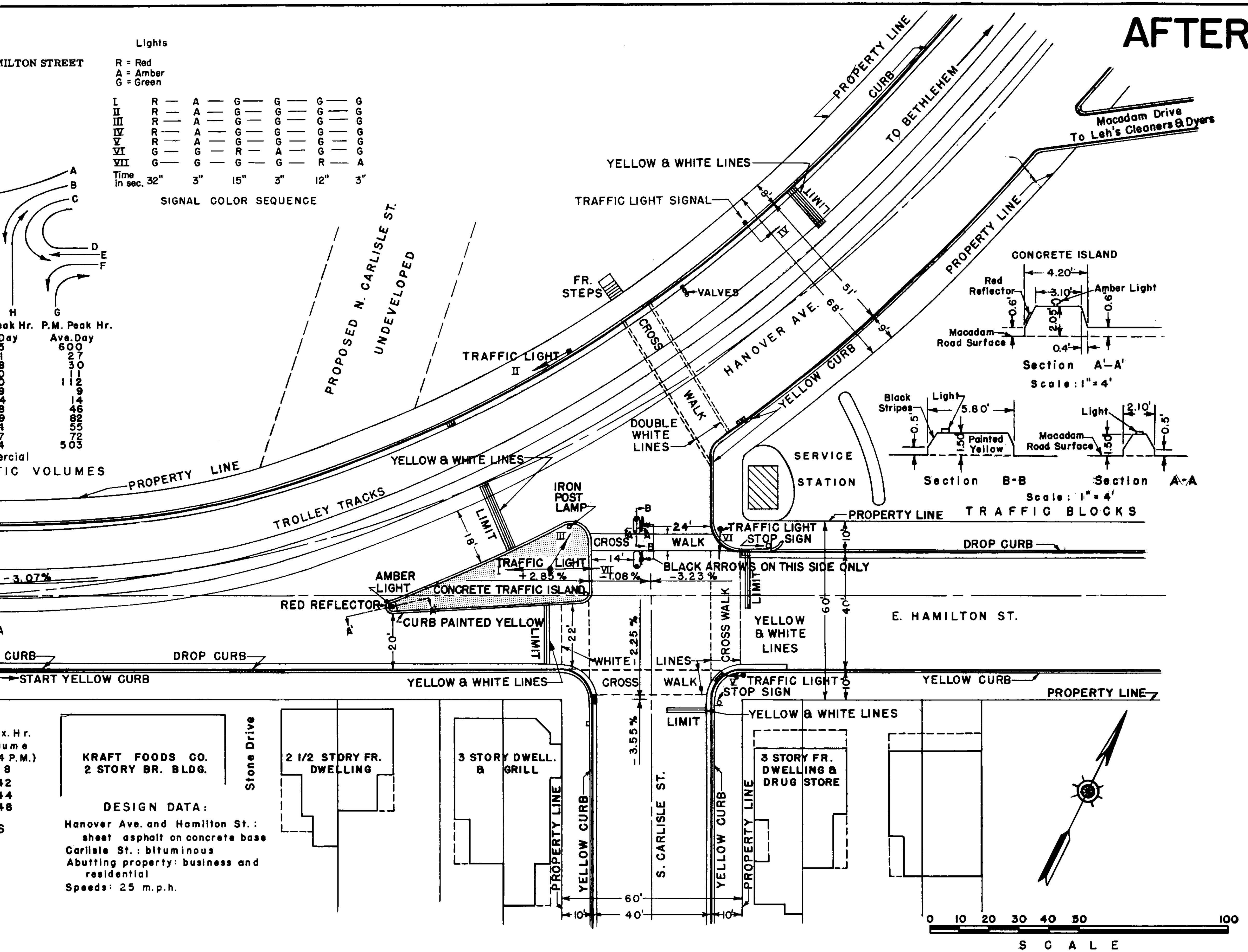
SIGNAL COLOR SEQUENCE



Movement	Ave. 12 Hr. Volume	A.M. Peak Hr. Ave. Day	P.M. Peak Hr. Ave. Day
A	4207	405	600
B	230	21	27
C	289	48	30
D	57	10	11
E	401	30	112
F	60	9	9
G	159	34	14
H	324	38	46
J	373	29	82
K	426	64	55
L	523	67	72
M	3713	384	503

30 % Commercial

VEHICULAR TRAFFIC VOLUMES



	Ave. 12 Hr. Volume	Max. Hr. Volume (3-4 P.M.)
N. Crosswalk (Hanover)	389	18
S. " (Carlisle)	1410	242
E. " (E. Hamilton)	994	144
W. " (W. Hamilton)	716	148

PEDESTRIAN TRAFFIC VOLUMES

DESIGN DATA:

Hanover Ave. and Hamilton St.: sheet asphalt on concrete base
Carlisle St.: bituminous
Abutting property: business and residential
Speeds: 25 m.p.h.

Figure 1. Channelization of the intersection of Carlisle Street, Hanover Avenue, and Hamilton Street in Allentown, Pennsylvania.

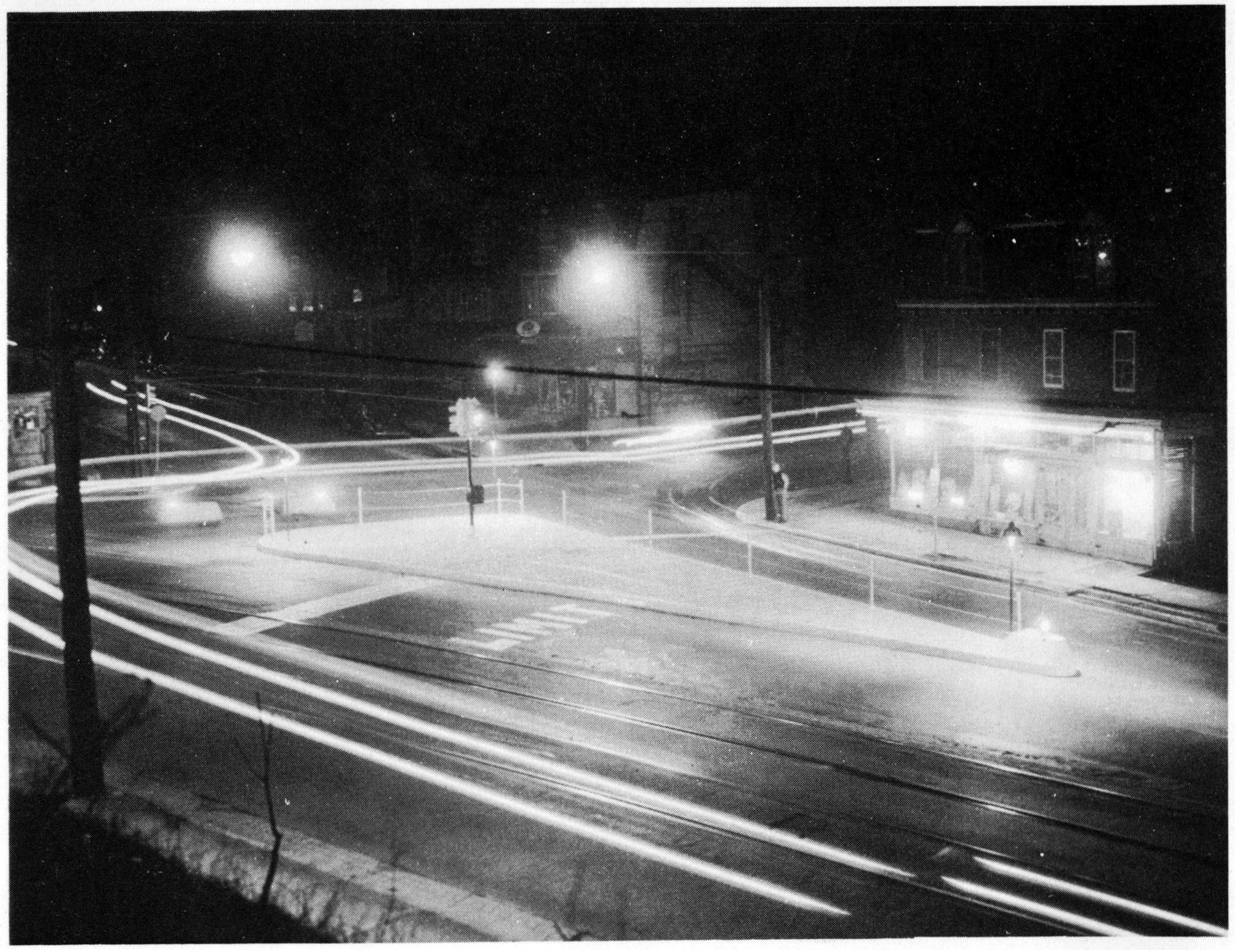


Figure 2. An excellent example of effective illumination for channelizing islands.

Example 18

Location

WASHINGTON, Seattle
Elliott Avenue W. - W. Mercer Place

Submitted by

J. W. A. Bollong, Traffic Engineer,
400 County-City Building,
Seattle, Washington

Type of Intersection

3-Way, Y

Date Constructed

Signal in operation November 28, 1948

Physical Data

3. Surface Type
   a. Roadways: Concrete
   b. Islands: none
4. Cross Section
   a. Standard
5. Traffic Control Devices
   b. Signals: Timing: signal sequence shown
   d. Lighting: Type: mercury vapor safety lighting on Elliott Avenue. W.
7. Abutting Property
   a. Character or Land Use: commercial
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: Bus Route proceeds straight through, both directions, on Elliott Avenue, W.
   b. Location of Passenger Stops and Zones: Far-side stops, just beyond the crosswalk past Roy St. southbound, and beyond Sand St. northbound.

Traffic Data

1. Volume
   e. Pedestrian: negligible
3. Speeds
   a. Arterial speed limit 30 mph.
6. Pedestrian
   a. Volume: negligible

Economic Data

1. Estimated Cost of New Installation
   a. $1,505.46 ($1,147.00 and $258.46)

Operational Characteristics

1. Design Features Which Contribute to Safe Operation:
   a. Left turn protection provided by stopping northbound traffic.
2. Design Features Which Relieve Congestion:
   a. The shadowing island eliminates congestion caused by southbound traffic being stopped by cars waiting to make the left turn.
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. The installation has reduced congestion considerably and reduced the number of accidents.
   b. The signal was turned on after the island was completed. A trial was made of a paint island and signal previously, but it was found that a physical barrier was necessary to clear through traffic from the left turn lane.

Comments by Committee Members

1. FRED W. HURD - (a) Shows how left turn lane may be established on existing pavement wide enough to permit it; (b) Note how Mercer Place approach is "bent" to right angles; (c) Tear drop in Mercer approach would separate left turns and serve as additional reference points for both movements; (d) Raised island ahead of left turn lane on Elliott would shield the left turn lane, channelize left turns from Mercer and aid pedestrians (if any); (e) Signal apparently operates two phase but this design is particularly applicable to three phase timing when warranted - Actuated equipment preferred.

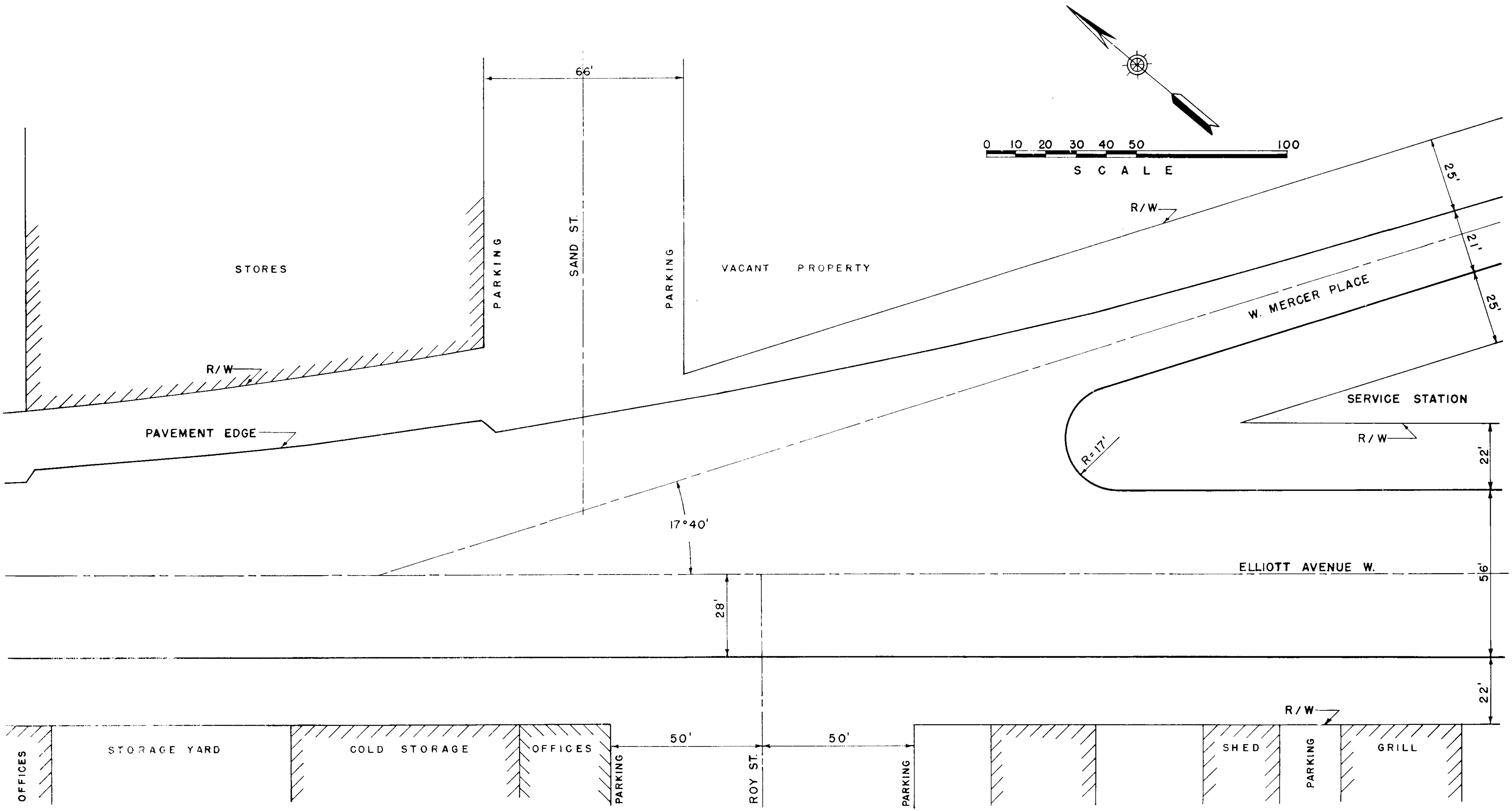
2. EDWARD G. WETZEL - This channelization scheme appears satisfactory for the left-turn volumes (from Elliott Avenue to Mercer Place) indicated. I would suspect that during winter snows particularly, the delineation is difficult. Having already made the transition from paint lines to buttons and found the geometry apparently satisfactory, the next stage should be raised islands so designed to permit left turn vehicles more "shadowing" and thus more safety. This would probably require widening Elliott Avenue on north side the equivalent of the width of a speed change lane.

Additional Comment by J. W. A. Bollong

A tear-drop paint island exists at W. Mercer Place at entry, as mentioned in comment 1. (c) by Fred Hurd. This was not shown on our original sketch, but is shown in photograph, Figure 1.

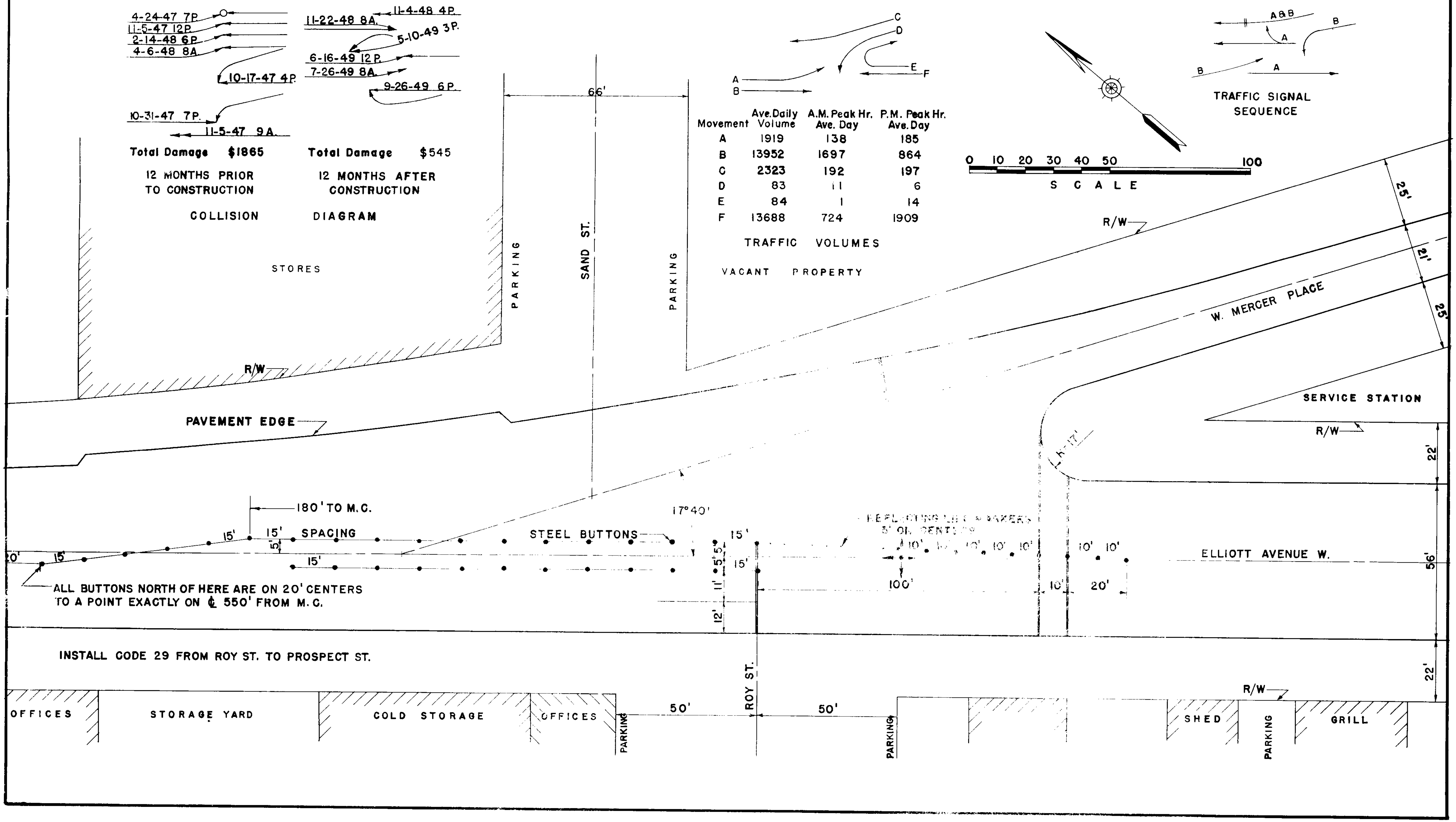
BEFORE

NO. 18 - WASHINGTON, SEATTLE
ELLIOTT AVENUE, W. - W. MERCER PLACE



AFTER

NO. 18 - WASHINGTON, SEATTLE
ELLIOTT AVENUE, W. - W. MERCER PLACE



Movement	Ave. Daily Volume	A.M. Peak Hr. Ave. Day	P.M. Peak Hr. Ave. Day
A	1919	138	185
B	13952	1697	864
C	2323	192	197
D	83	11	6
E	84	1	14
F	13688	724	1909

TRAFFIC VOLUMES

Figure 1. Intersection of Elliott Avenue, W. and West Mercer Place, Seattle, looking northwest along Elliott Avenue.

Example 19

Location

WASHINGTON, 8 mi. N. of Puyallup
US 99 - S. S. H. 5-D (Washington 5-D)

Submitted by

H. C. Higgins, Traffic Engineer,
Washington Department of Highways,
Olympia, Washington

Type of Intersection

3-Way, Y

Date Constructed

Opened to traffic December, 1948

Physical Data

5. Traffic Control Devices
   b. Signals: Type: none

Economic Data

1. Estimated Cost of New Installation
   a. $4,150

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. See comments on several channelized intersections given under the US 99-145th St. - S. S. H. 1-J Washington example.

Comments by Committee Members

1. GUY KELCEY - Without looking at the "After" layout I examined the "Before" and prepared my own solution (Figure 1). The result was very close to the treatment adopted as shown on the "After" sheet. In my own solution I brought the south end of the "Left Turn" channeling curb about 75 ft. farther to the north to swing the left turn across the high speed, northbound traffic at as close to a right angle as possible. Wheel tracks on the photo of the present installation show this left turn now crosses the northbound movement at a fairly sharp acute angle and probably at high speed. I believe the left turn from Secondary State Highway 5D to southbound on US 99 (6 vehicles per day) should be prohibited at this point and this small movement provided for by a turn-through farther to the south if possible.

2. E. T. PERKINS - It would seem that the southerly end of the island in US 99 was ended too soon. A flat crossing is permitted in the face of a considerable northbound volume on US 99. It also seems confusing to have the small island between SSH 5-D and US 99 directly in front of the left turning vehicle. I believe that islands should, almost without exception, be so placed as to require a right turn around them. There appears to be a sufficient width of right-of-way between the two roads to locate the cross over to the south of the triangular shaped island. Figure 2 gives the general layout I would suggest. The whole island in Route US 99 could be moved bodily to the south so as to give the same degree of shadowing as now provided. The northerly end of the island could be adjusted to fit conditions.

Additional Comments by Rex G. Still, Traffic Engineer, Washington Department of Highways

Due to make the left turn from a right curve on US 99, the vehicle operator does not actually make such an acute angle when crossing the northbound US 99 lane, as is indicated on the plan. A review of the "before" and "after" accident study indicated on the plan shows that the accidents at this intersection have been greatly decreased by this channelization project.

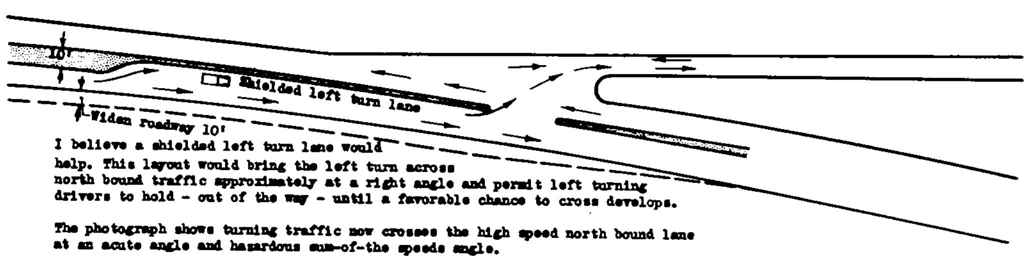


Figure 1.

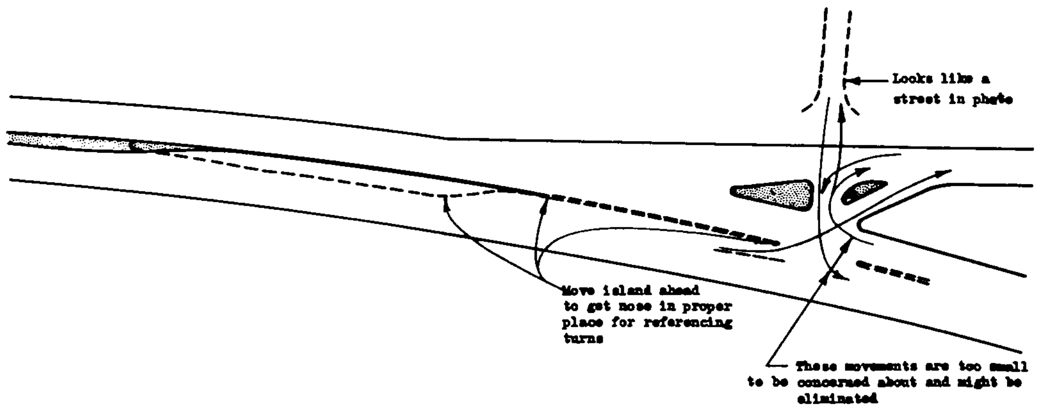
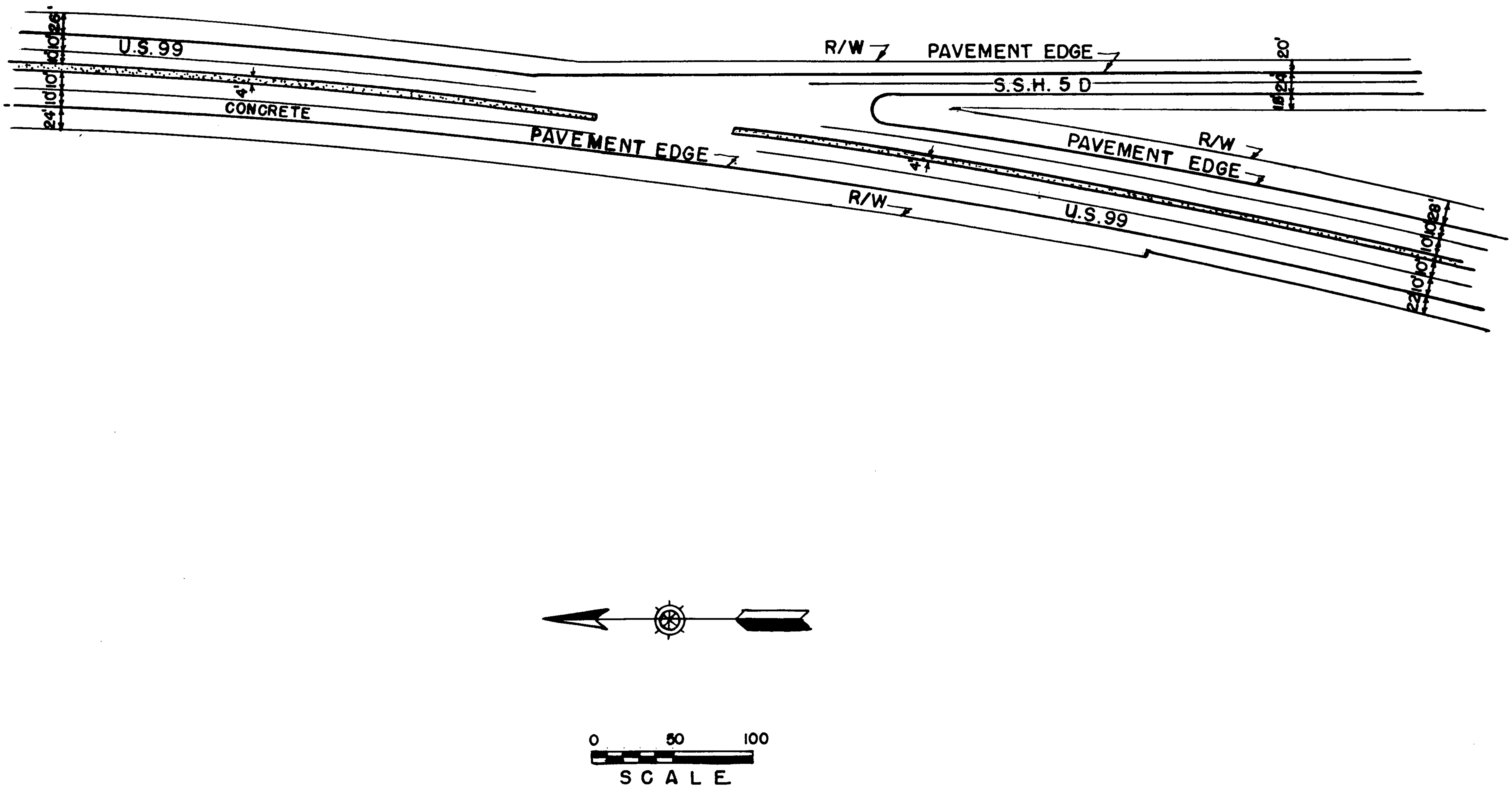


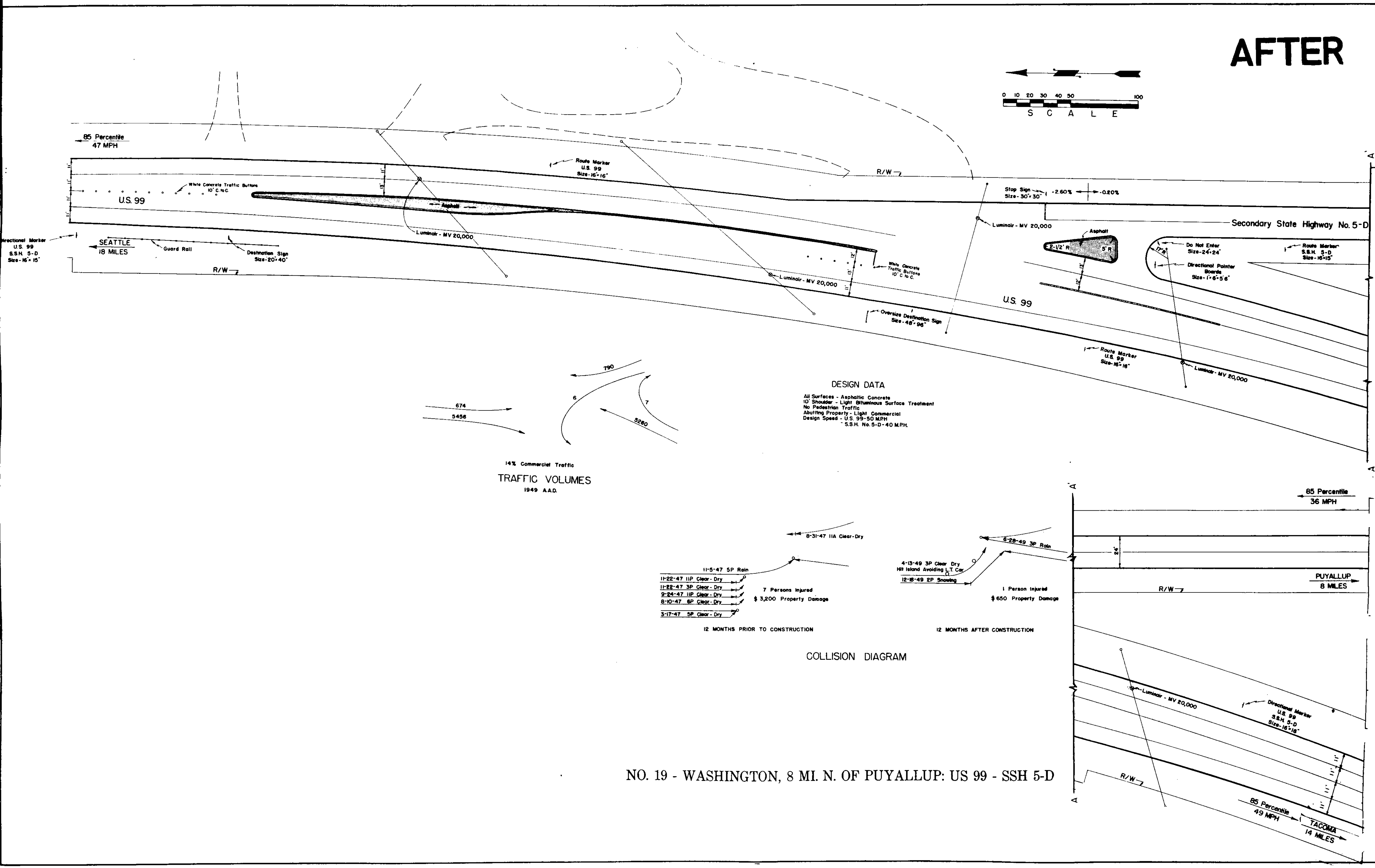
Figure 2.

BEFORE

NO. 19 - WASHINGTON, 8 MI. FROM
PUYALLUP US 99 (PSH 1) - SSH 5-D



AFTER



NO. 19 - WASHINGTON, 8 MI. N. OF PUYALLUP: US 99 - SSH 5-D

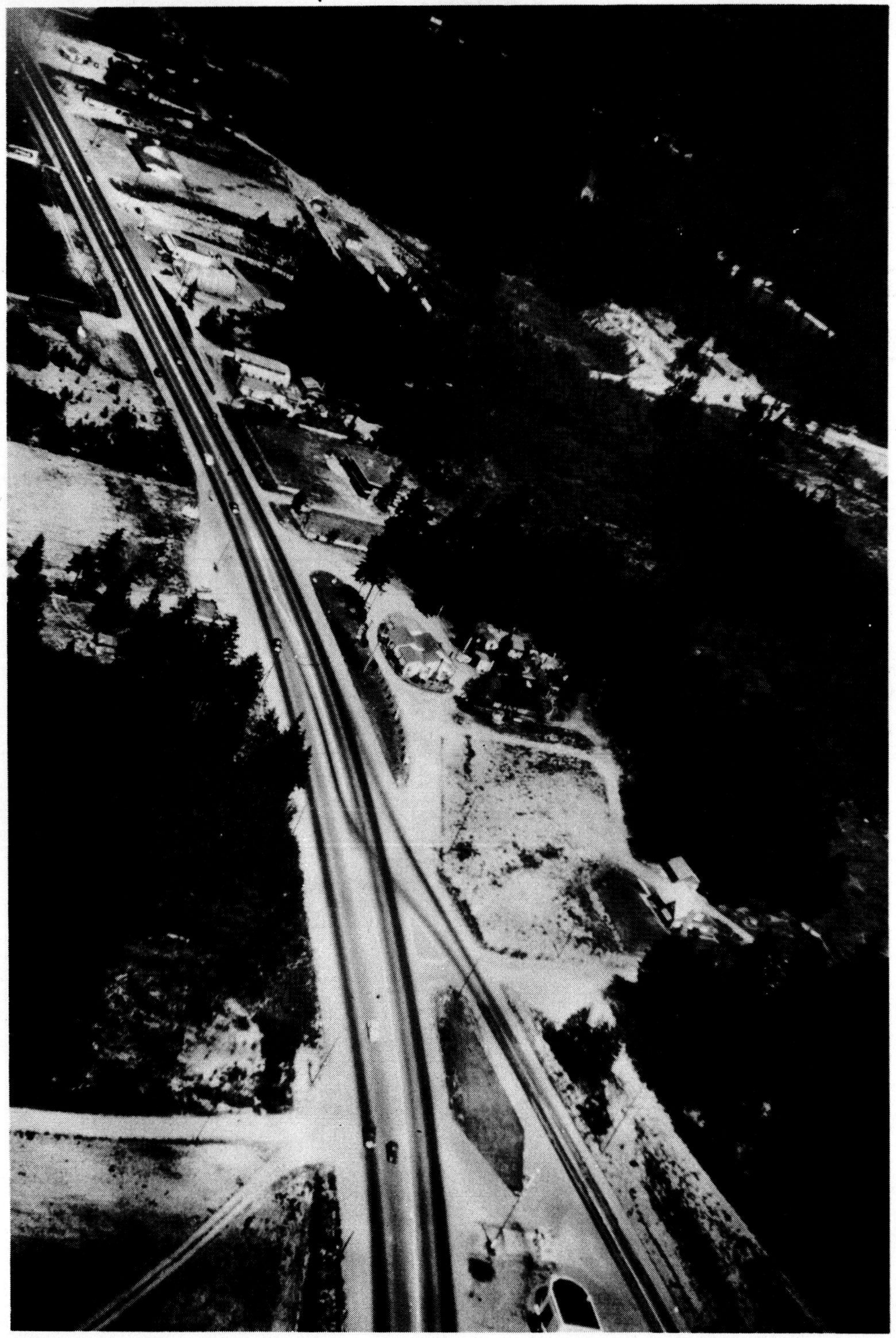


Figure 3. Channelization of Y-type intersection of 4-lane US 99 with 2-lane secondary road, State Highway 5-D, near Puyallup, Washington.

Example 20

Location

CALIFORNIA, 7 mi. N.W. of San Diego
Balboa Avenue - Pacific Highway (US 101)

Submitted by

J. C. Young, Traffic Engineer,
Department of Public Works,
Sacramento, California

Type of Intersection

4-Way, Right-Angled

Date Constructed

September, 1948

Physical Data

2. a. Grades: level
4. Cross Section: not unusual
6. Landscaping
   a. None
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: "Buses are routed on Balboa with near side and far side stops for both west and eastbound buses. Loading zones for westbound buses are located 80 ft. from the curb returns to clear service station driveways. Then near side loading zone for eastbound buses is located west of the beginning of the free right turn and the far side loading zone is opposite the near side zone for westbound buses."
   b. "Near and far side stops are desired by the transit company because Pacific Highway is the bus zone boundary, and because such an arrangement of stops precludes unnecessary hazardous pedestrian crossings of heavy traffic on Pacific Highway."

Traffic Data

3. Speeds
   a. Approach Speed: 80 Percentile: on Pacific Highway: 52 mph. from north, 44 mph. from south, on Balboa Avenue: 27 mph. from east, 31 mph. from west, Average Design: Pacific Highway, 60 mph., Balboa Avenue, 40 mph. (Approach speeds measured in 1946, "Before", were 48 from north and 47 from south on Pacific Highway, and no record was indicated for Balboa at that time. The "After" data was taken in 1950).
4. Delays
   a. "No quantitative data are available. Except during peak hours, traffic is not appreciably delayed.

      Traffic volumes are relatively heavy through the Balboa and Pacific Highway intersection. In one half-hour afternoon peak period, it was observed that all of the drivers approaching the intersection were able to clear the intersection without waiting for more than one complete signal cycle."

Economic Data

1. Estimated Cost of New Installation
   a. From final report: Channelization, $21,000; Signalization, $11,300; Total, $32,900.
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. Property damage (estimated from Accident Reports), $8,360; minor injuries, 13 x $10 equals $130; major injuries, 8 x $500 equals $4,000; Total, $12,490.
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. Property damage (estimated from Accident Reports), $5,845; minor injuries 11 x $10 equals $110; major injuries, 1 x $500 equals $500; total $6,455.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The left turn median lane and the 2-phase signal system with 1-phase split to accommodate left turn movement have contributed to the relatively safe operation of this intersection. On Pacific Highway in advance of the intersection are SIGNAL AHEAD signs with yellow flashing lights which operate during times the A phase change and the B phase are in effect. The 2-phase signal system does not fully protect vehicles making left turns from Pacific to Balboa."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The left turn median lane and the east to southbound right turn lane considerably relieve congestion. During the afternoon peak period, the left turn median lane may not be adequate in length because vehicles tend to block the through traffic lane adjacent to the median south of the left turn median lane. It is our opinion, however, that if the left turn median lane were much longer, it might be used by through vehicles which in turn would block the left turn vehicles during the split phase."
3. Comments Regarding the Over-all Operation of the Channelized Intersection
   a. "Signalization and channelization appear to function very satisfactorily considering the large amount of peak hour left-turning traffic. This is evidenced by the reduction in number and severity of accidents."

Comments by Committee Members

1. D. W. LOUTZENHEISER - The layout and traffic control revision rate a "well done." The dimensional treatment, curbed islands, plant-mix roll, bullet-nose median, together with the four-corner plus suspended signal installation, signs and markings are good examples of intersection modernization.

   The length of the median lane is deficient during the afternoon peak periods; see photos and notes. The indicated ratio of left versus through traffic favors lengthening the lane. With additional pavement marking the indicated concern regarding through movements within the median lane does not seem in order.

   The approach speeds on Pacific Highway are surprisingly high and may account for the continuing accident experience. The split-phase signal control for left-turn movements is considered appropriate for the volume pattern, but it is inconsistent with a high approach speed condition. While signal-phase is not fully explained it appears that further adjustment either in it or in the approach speeds would be in order to reduce left-turn accidents.

   Use of a STOP sign at a traffic signal control intersection seems unnecessary and must be confusing to strangers. The stop message is not needed during the red phase and is superseded during the green phase. (See page 20, "Manual on Uniform Traffic Control Devices".)

2. EDWARD G. WETZEL - Considerable improvement was made in the operation of this in-

BEFORE

NO. 20 - CALIFORNIA, 7 MILES N. W. OF SAN DIEGO
BALBOA AVENUE - PACIFIC HIGHWAY (US 101)

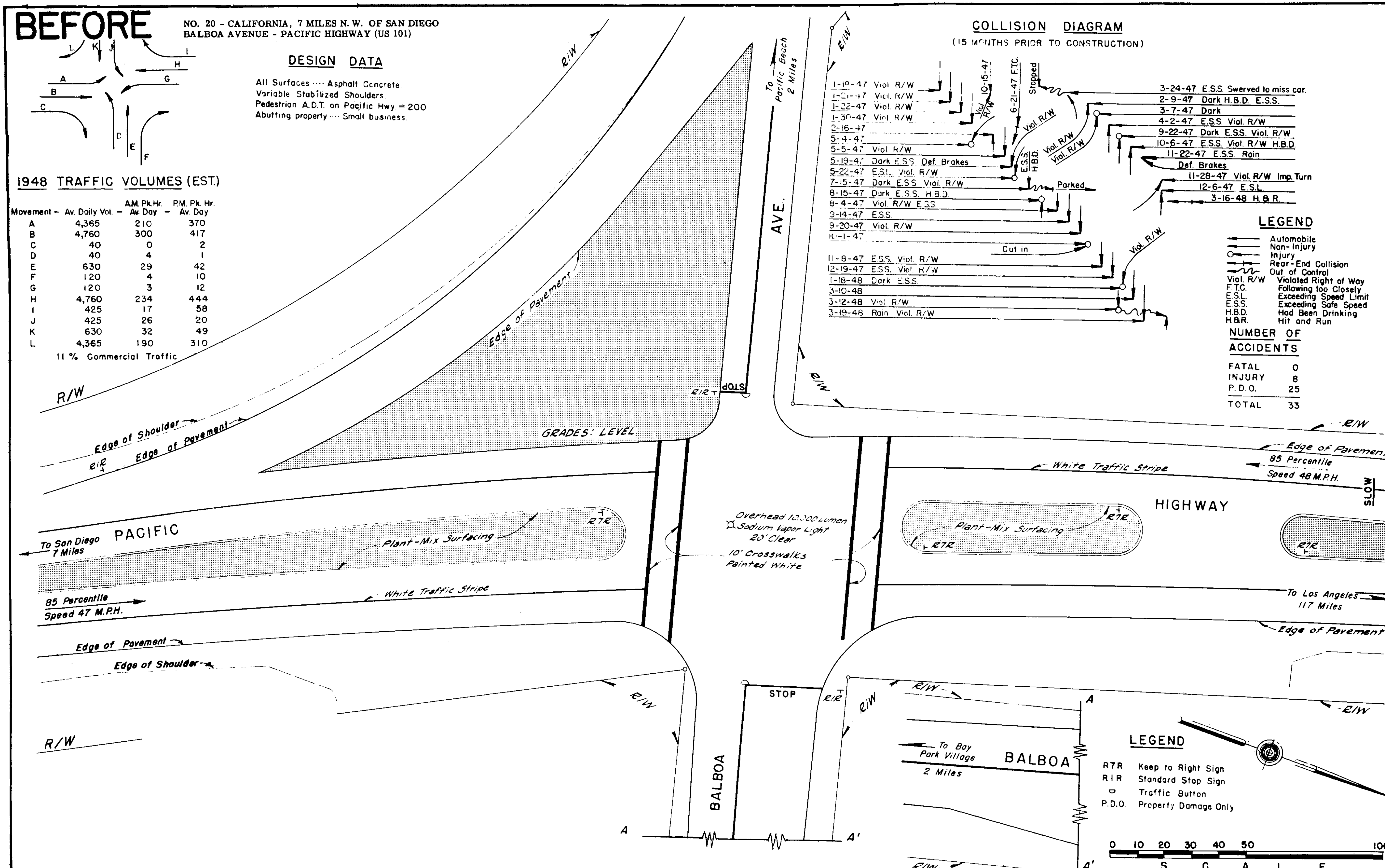
DESIGN DATA

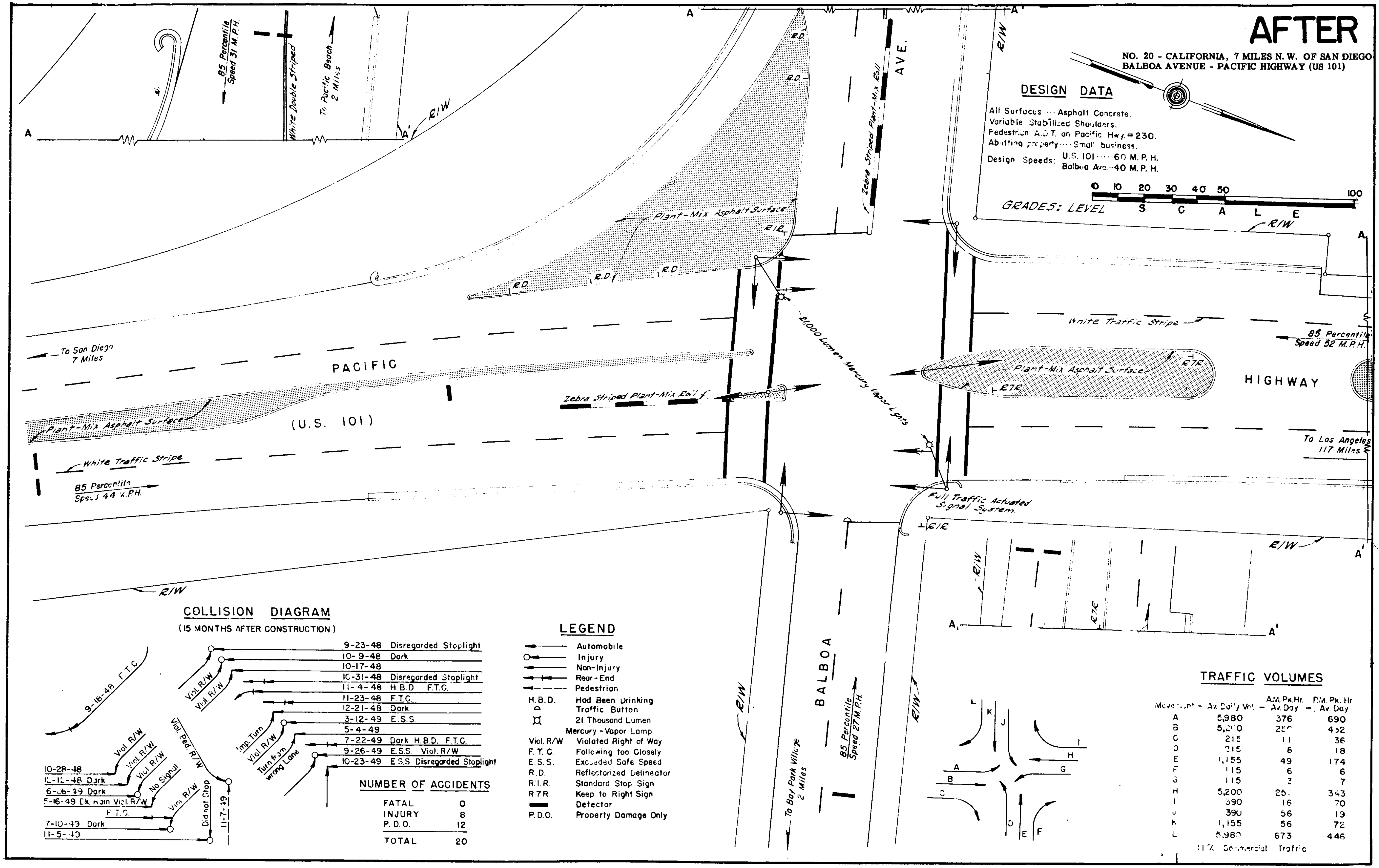
All Surfaces ···· Asphalt Concrete.
Variable Stabilized Shoulders.
Pedestrian A.D.T. on Pacific Hwy. = 200
Abutting property ···· Small business.

1948 TRAFFIC VOLUMES (EST.)

Movement	Av. Daily Vol.	A.M. Pk. Hr. Av. Day	P.M. Pk. Hr. Av. Day
A	4,365	210	370
B	4,760	300	417
C	40	0	2
D	40	4	1
E	630	29	42
F	120	4	10
G	120	3	12
H	4,760	234	444
I	425	17	58
J	425	26	20
K	630	32	49
L	4,365	190	310

11 % Commercial Traffic





COLLISION DIAGRAM

(15 MONTHS AFTER CONSTRUCTION)

9-23-48 Disregarded Stoplight
10-9-48 Dark
10-17-48
10-31-48 Disregarded Stoplight
11-4-48 H.B.D. F.T.C.
11-23-48 F.T.C.
12-21-48 Dark
3-12-49 E.S.S.
5-4-49
7-22-49 Dark H.B.D. F.T.C.
9-26-49 E.S.S. Viol. R/W
10-23-49 E.S.S. Disregarded Stoplight
9-18-48 F.T.C.
Viol. R/W
Viol. R/W
Viol. Ped. R/W
Imp. Turn
Viol. R/W
Turn from wrong Lane
10-28-48
12-12-48 Dark
6-26-49 Dark
5-16-49 Dk. Rain Viol. R/W
F.T.C.
7-10-49 Dark
11-5-49
Viol. R/W
Viol. R/W
Viol. R/W
No Signal
Viol. R/W
Did not Stop
11-7-49

LEGEND

(arrow)	Automobile
(circle)	Injury
(arrow)	Non-Injury
(arrow)	Rear-End
(dashed arrow)	Pedestrian
H.B.D.	Had Been Drinking
D	Traffic Button
¤	21 Thousand Lumen Mercury-Vapor Lamp
Viol. R/W	Violated Right of Way
F.T.C.	Following too Closely
E.S.S.	Exceeded Safe Speed
R.D.	Reflectorized Delineator
R.I.R.	Standard Stop Sign
R7R	Keep to Right Sign
▬	Detector
P.D.O.	Property Damage Only

NUMBER OF ACCIDENTS

FATAL	0
INJURY	8
P.D.O.	12
TOTAL	20

TRAFFIC VOLUMES

Movement	Av. Daily Vol.	A.M. Pk. Hr. Av. Day	P.M. Pk. Hr. Av. Day
A	5,980	376	690
B	5,2[illegible]0	25[illegible]	432
C	215	11	36
D	215	6	18
E	1,155	49	174
F	115	6	6
G	115	3	7
H	5,200	25[illegible]	343
I	390	16	70
J	390	56	19
K	1,155	56	72
L	5,980	673	446

11% Commercial Traffic

tersection with the provision of the left-turn lane from Pacific Highway west on Balboa Avenue and installation of 2-phase traffic actuated signal system as shown in the "Before" and "After" sketches.

Contrary to the opinion expressed in the analysis submitted with the original data, it is believed the left-turn lane should be at least 100 ft. longer and appropriate signs and markings on the approach to more clearly delineate the left-turn lane. The signal detector should be relocated accordingly to take into consideration the approach speeds and the left-turn volumes.

The accident record as shown by the collision diagrams suggests the need for a change in the traffic signal operation. Most of the accidents appear as a result of the left-turn vehicles (from Pacific Highway to Balboa Avenue) not having sufficient time clearance, or the indication of a separate left-turn movement is not apparent to the through traffic on Pacific Highway. It is believed a 3-phase operation of the signals with a longer left-turn lane would help to reduce the accidents. Consideration should also be given to a left-turn lane of appropriate length to handle the much smaller left turn from Pacific Highway to the east on Balboa Avenue. This would delineate turning from Pacific Highway and under 3-phase signal operation should work much better than the present operation.

Additional Comments by J. C. Young, Traffic Engineer, California Division of Highways

Reference the comment of Mr. Loutzenheiser, it is a policy to place STOP signs facing the side road at signalized intersections.

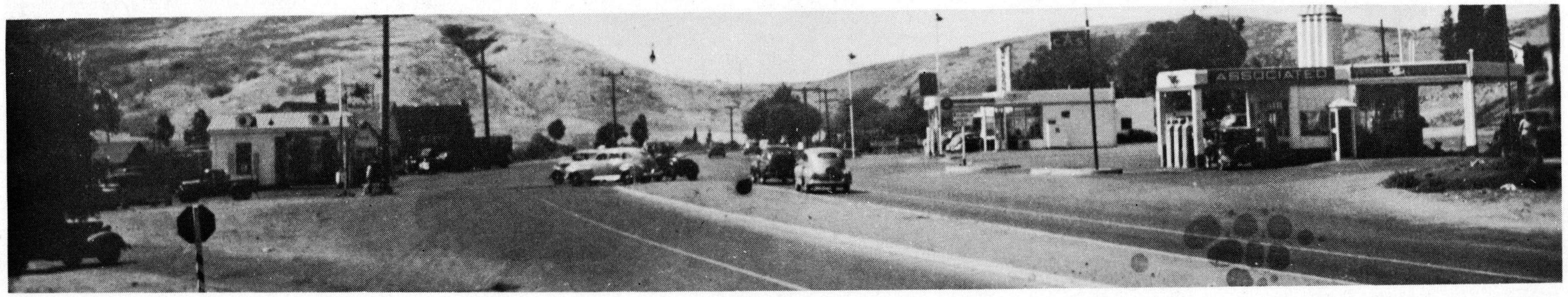


Figure 1. Intersection of Balboa Avenue and Pacific Highway (US 101) northwest of San Diego, California, before channelization.

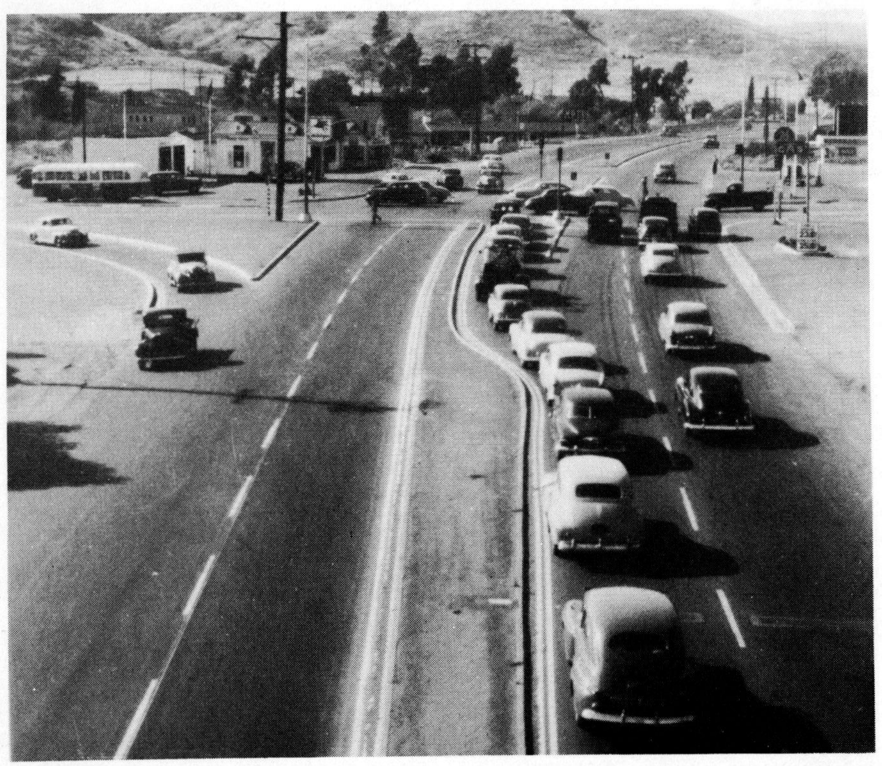


Figure 2. Intersection after channelization with details of separated left-turn lane.

Figure 3. Double line next to reflecting curb improves visibility of median curbs.

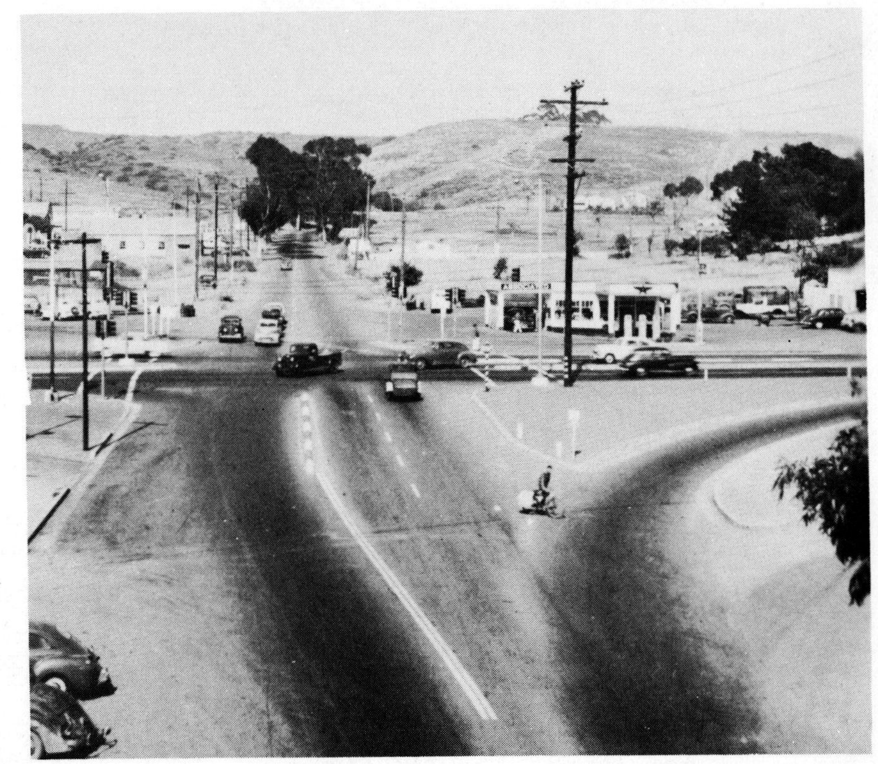


Figure 4. View of Balboa and Pacific intersection looking east.

Example 21

Location

ILLINOIS, District 1
US 52 - US 66

Submitted by

Harry H. Harrison, Traffic Engineer,
Illinois Division of Highways,
Springfield, Illinois

Type of Intersection

4-Way, Right-Angled

Date Constructed

May 23, 1941

Physical Data

5. Traffic Control Devices
   a. Signs: Type: "No special signs are used as far as the channelization is concerned. Standard pre-warning signs are in place on all approaches to the intersection."
   b. Signals: Timing: the signals are speed-control actuated.
   c. Markings: Type: no special markings are used for the channelization
   d. Lighting: Type: none
   e. Other Control Devices: Guide Posts: none
7. Abutting Property
   a. Character or Land Use: filling stations on three corners.
8. Transit Operations
   b. Location of Passenger Stops and Zones: none except "through" buses

Traffic Data

1. Volumes
   a. Average Daily: the yearly 24-hr. average for 1947 is shown as plan
   c. PM Peak Hour: "The peak hour at the intersection is from 4:00 to 5:00 PM on an average week day. A count taken on Thursday, May 11, 1950, during that hour illustrates the type and volume of traffic on a typical week day."
   e. Pedestrian: negligible
2. Type
   b. Percent Commercial: "On the one hour peak count on May 11, 1950, the commercial traffic was 18 percent of the total traffic."
3. Speeds
   a. Approach Speed: 85 Percentile: "Approach speeds and operating speeds through the intersection were comparatively high on US 66. In May, 1950, the signals were changed to provide a speed type of control."
4. Delays
   a. "There are no undue delays at the intersection, because the flow of traffic is controlled by traffic signals."
5. Accidents
   a. "Reduction of accidents is due mostly to the presence of traffic signals rather than the channelization. The first year signals were installed, the number of accidents was not reduced as much as might be expected."
6. Pedestrian
   a. Volumes: negligible

Economic Data

1. Estimated Cost of New Installation
   a. $19,450. "This includes the cost for the entire reconstruction of the intersection as well as the channelization. Traffic signals not included."
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. "Estimate is difficult to make because of entire reconstruction of intersection."

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:

   "One of the principal advantages of the channelization at an intersection with traffic signals is that it allows the signals to be placed closer to the center of the intersection. This enables vehicles to stop at the proper place by the signal instead of pulling ahead of it as is the case if the intersection has wide rounded corners."

   "In such a channelization, the lane for the right-turning vehicle is designed to be just wide enough to permit right turns to be made without difficulty, yet not too wide to encourage vehilces on the other road to make left turns into it. In spite of that, some vehicles do attempt such a left turn, and that situation may be potentially more dangerous with channelization than without."

   "The islands do afford some protection for vehicles that are stopped at the traffic signal. However, anything that is placed in the middle of a highway has a tendency to be hit. Therefore the islands must be designed to accomplish the desired traffic movement without providing an undue hazard. The size and shape of the island should be such as to encourage safe traffic movements and discourage unsafe ones."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion

   "In addition to encouraging safe traffic movements, channelization should also provide for a free and natural movement of traffic. Unless this is accomplished, confusion results, and this confusion many times causes congestion. The size and shape of the island must be such as to invite the motorist to do the right thing."

   "Because channelization allows traffic signals to be placed closer to the intersection, congestion is reduced. The reason for this is that the distance on which vehicles must travel across the intersection is less, and more vehicles can cross on a green light."

   "Channelization allows for a separation of opposing flows of traffic as well as control over the direction of each flow. It aids the mass movement of vehicles by grouping those contemplating or executing the same traffic movement. Such traffic movements can be made in a more natural manner with less exposure to hazard."

   "Each intersection must be studied individually in order to design the most effective type of channelization. Proper signs and markings must also be used. Channelization is not a "cure-all", but is an additional means of obtaining a free and safe movement of traffic."

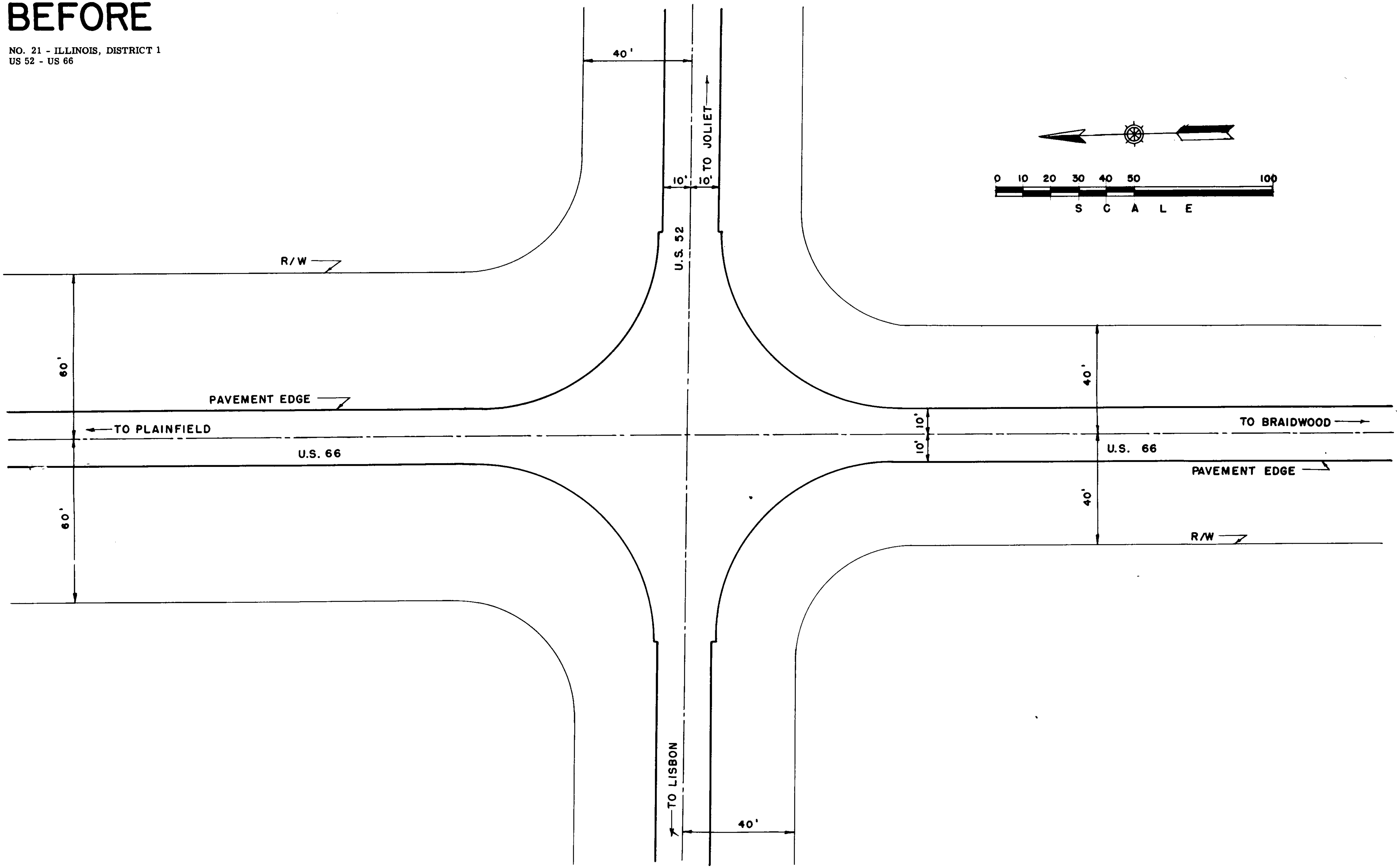
Comments by Committee Members

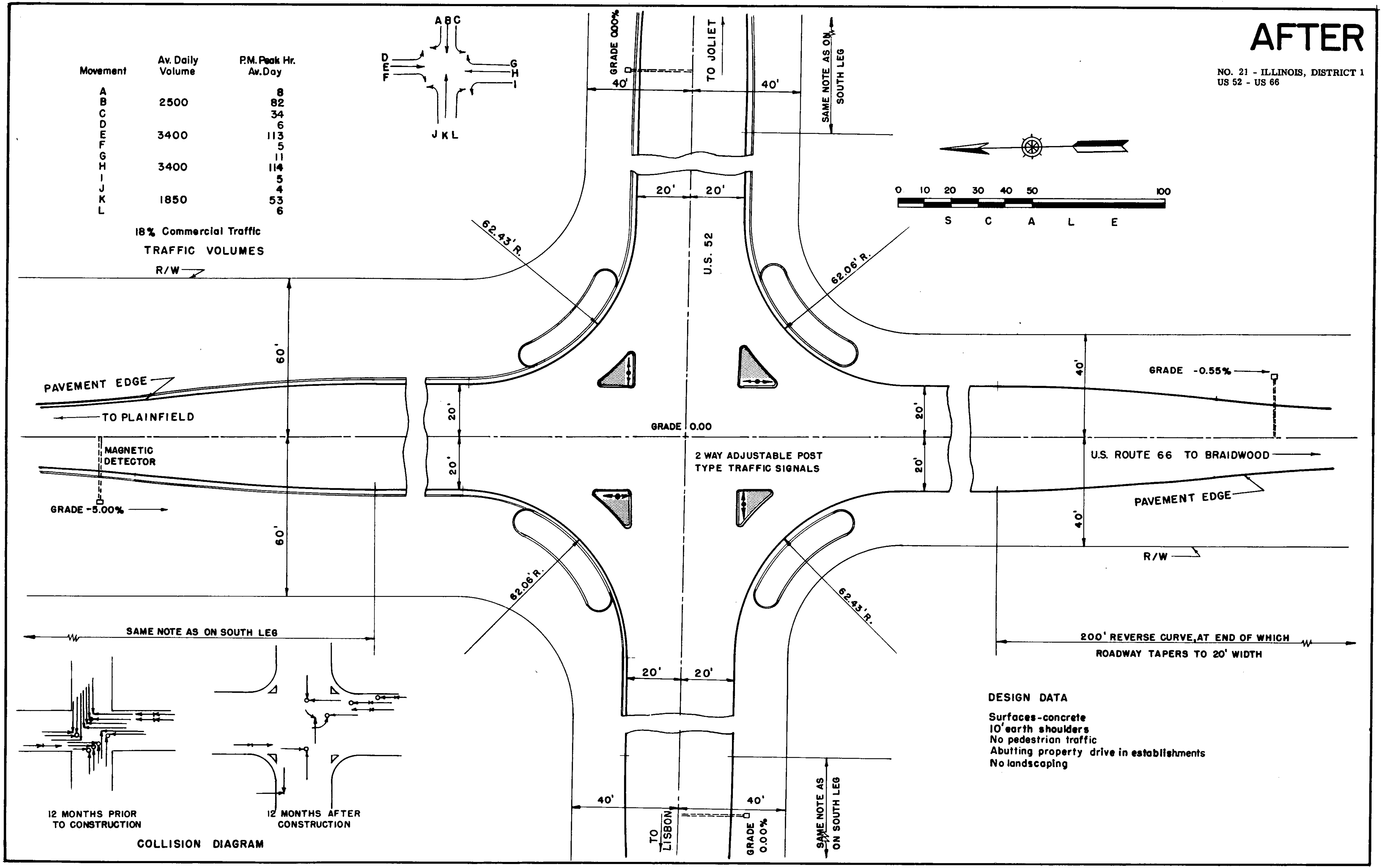
1. EUGENE MAIER - The major functions of the channelization at the intersection of US 52 and US 66 are to provide a location for the installation of the traffic control signals and to reduce the paved area of the intersection.

   Two improvements in the design of this intersection are suggested:

BEFORE

NO. 21 - ILLINOIS, DISTRICT 1
US 52 - US 66




AFTER
NO. 21 - ILLINOIS, DISTRICT 1
US 52 - US 66
Movement
Av. Daily Volume
P.M. Peak Hr. Av. Day
A 8
B 2500 82
C 34
D 6
E 3400 113
F 5
G 11
H 3400 114
I 5
J 4
K 1850 53
L 6
18% Commercial Traffic
TRAFFIC VOLUMES
A B C
D
E
F
G
H
I
J K L
R/W
GRADE 0.00%
TO JOLIET
40'
40'
SAME NOTE AS ON SOUTH LEG
20'
20'
62.43' R.
62.06' R.
U.S. 52
0 10 20 30 40 50 100
S C A L E
PAVEMENT EDGE
60'
TO PLAINFIELD
MAGNETIC DETECTOR
GRADE -5.00%
20'
20'
GRADE 0.00
2 WAY ADJUSTABLE POST TYPE TRAFFIC SIGNALS
20'
20'
40'
40'
GRADE -0.55%
U.S. ROUTE 66 TO BRAIDWOOD
PAVEMENT EDGE
R/W
60'
62.06' R.
62.43' R.
SAME NOTE AS ON SOUTH LEG
200' REVERSE CURVE, AT END OF WHICH ROADWAY TAPERS TO 20' WIDTH
20'
20'
DESIGN DATA
Surfaces-concrete
10' earth shoulders
No pedestrian traffic
Abutting property drive in establishments
No landscaping
40'
40'
TO LISBON
GRADE 0.00%
SAME NOTE AS ON SOUTH LEG
12 MONTHS PRIOR TO CONSTRUCTION
12 MONTHS AFTER CONSTRUCTION
COLLISION DIAGRAM

a. The construction of a narrow (12 in.) mountable separator along the center line of approaching roadways and extending away from the intersection for a distance of approximately 150 ft. These separators would discourage left turns into the separated right turn lanes which are reported to occur at the intersection.

b. The surfacing of the islands with asphalt or concrete. The maintenance of planting on the small islands in this example is not practical.

2. JAMES L. SHOTWELL - The reconstruction of this intersection provided separate lanes for right turning vehicles which should increase the capacity and safety of the intersection.

The width of the right turning lanes appears to be wider than necessary. Width of 12 to 14 ft. should be adequate and permit the enlarging of the islands. The appearance of the triangular islands could be improved if tangents were substituted for the curves on the sides adjacent to the turning lanes. This could be accomplished by widening the entrance throats slightly.

It should be helpful if 12-ft. traffic lanes could be used and short tear drop islands placed on the centerline on all roadways. These islands should be long enough to prevent improper left turning.

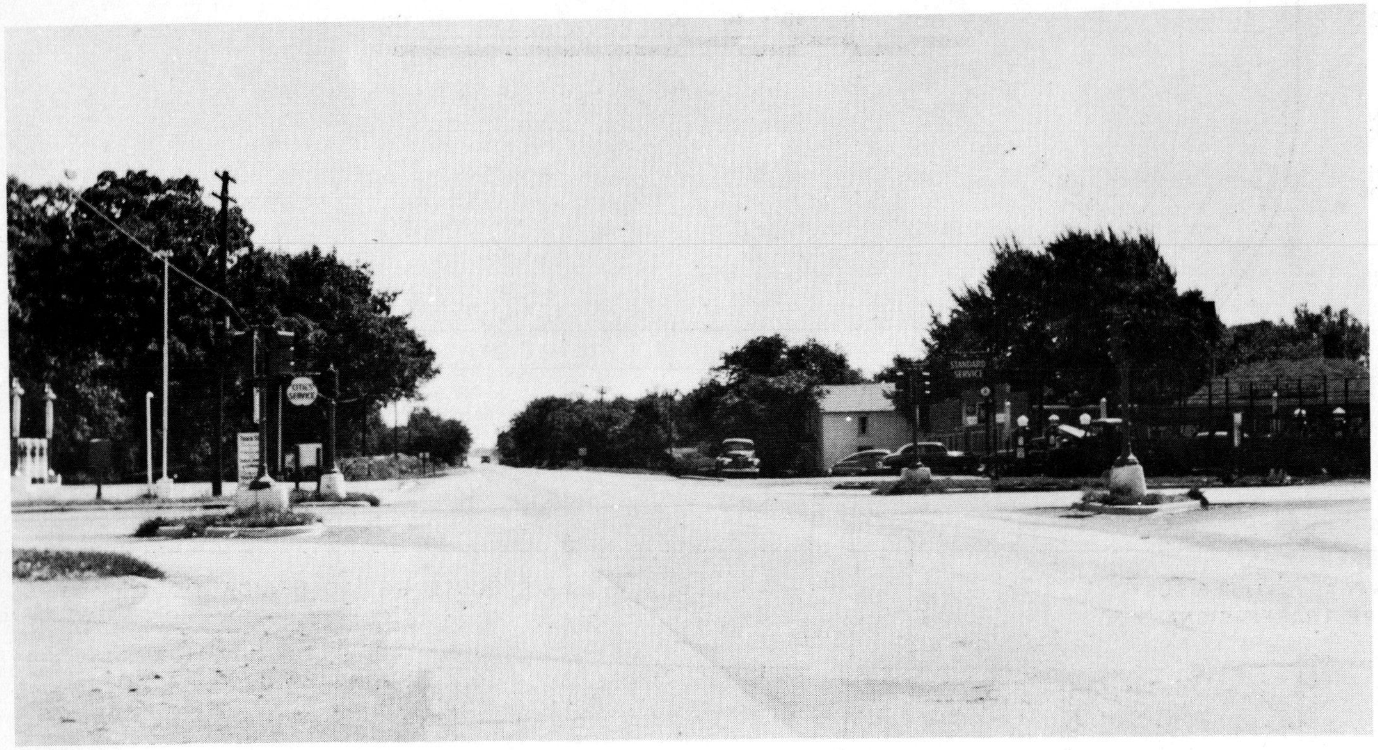


Figure 1. Channelization of 4-way right-angled intersection of US 52 and US 66, Illinois District 1.

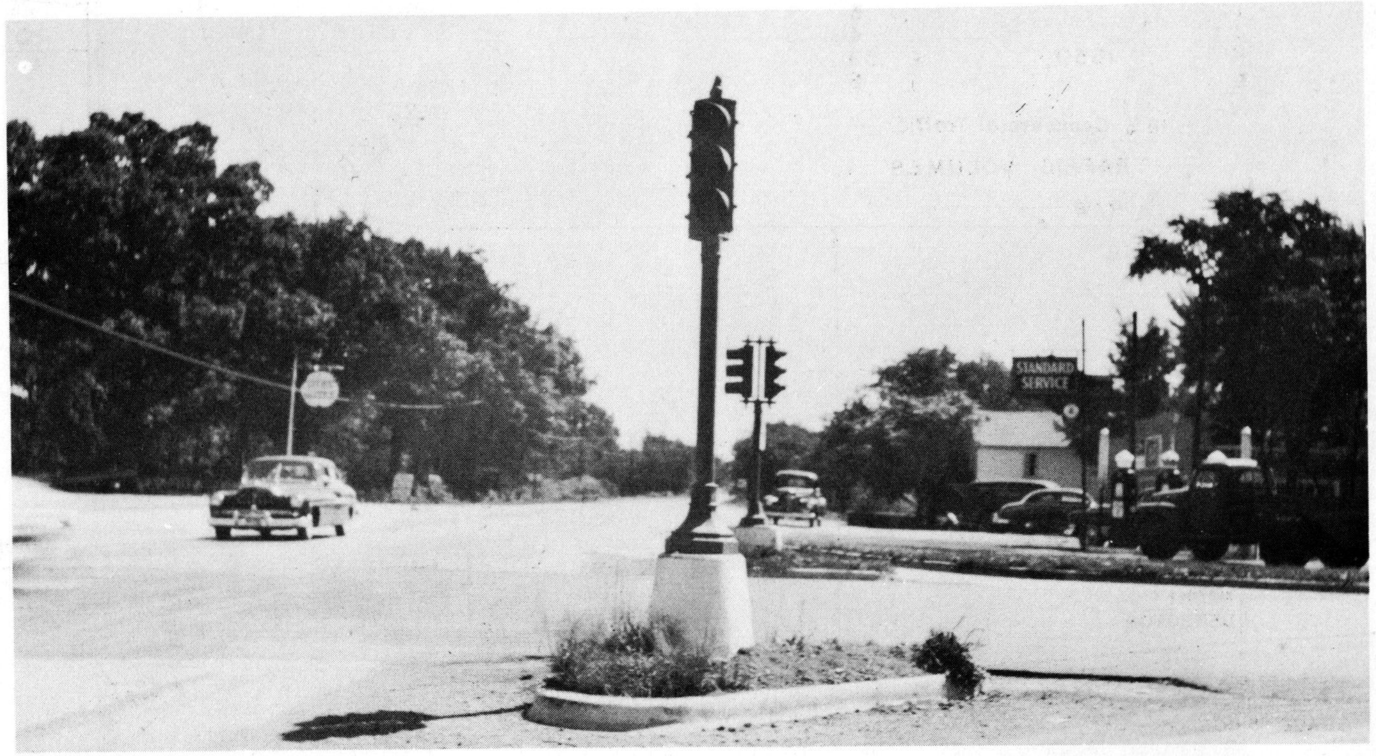


Figure 2. Channelizing island at southwest corner of intersection. Note that the maintenance of planting on small channelizing islands is not practical.

Example 22

Location

MASSACHUSETTS, Somerville
Northern Artery-Mystic Cross Avenue

Submitted by

Edgar F. Copell, Executive Assistant
Traffic and Maintenance Division
Department of Public Works, 100 Nashua St.,
Boston 14, Massachusetts

Type of Intersection

4-Way, Right-Angled

Date Constructed

October 22, 1948

Physical Data

1. b. "After": "Construction included the building of two traffic islands with signs, installation of signals, and the painting of white lines."
3. Surface Type
   b. Islands: bituminous concrete
   c. Shoulders: none
4. Cross Section
   a. Standard
5. Traffic Control Devices
   a. Signs: Type: shown on plan, detailed description of each sign is given but no included here
   b. Signals: Timing: sequence shown on plan; letters do not correspond with traffic volume designation
   c. Markings: Type: "White reflectorized four inches wide and four inches apart."
      1. On Northern Artery from large island west - special center lines consisting of two sets of two solid lines spaced 2 ft. apart. Also cross lines spaced 17 ft. apart and at a 45 degree angle to the double lines.
      2. Four lane lines (15 ft. paint - 25 ft. skip) on Northern Artery south. Making six lanes curb to curb. (Note: These were painted after picture was taken.)
      3. Two solid center lines extending on Mystic Avenue from the small island northerly.
      4. Stop lines (2 ft. paint - 6 in. skip). One painted across the Northern Artery (West) from the nose of the small island to the double center lines.
      5. Solid line for right turns 10 ft. off curb and extending from a point opposite the center of the small island around the northwest corner of the intersection and northerly on Mystic Avenue.
   d. Lighting: Type: "The intersection is well lighted by illuminated signs, etc., at the two gasoline stations. In addition, there are three vertical street lights as shown".
   e. Other Control Devices: Guide Posts: "Standard stop-sign facing west-bound traffic on Northern Artery (east side). Reflectorized cluster on small island and reflectorized "Keep Right" signs on both ends of large island."
7. Abutting Property
   a. Character or Land Use: "This is a city intersection in a business district. However, on the northwest side of the intersection, there is a ball-field surrounded by a retaining wall and a 30 ft. wire fence. This field is now under the control of the Metropolitan District Commission of the Commonwealth.

      On the northeast corner there is a gasoline station and on the southeast corner a yellow brick building containing a restaurant.

      The southwest corner contains a gasoline station and beyond that, westerly, a brick building."
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: "The streetcar line passes directly through the intersection and runs from Sullivan Square, Boston, to Elm Street in Medford."

Traffic Data

1. Volumes
   a. Average Daily: "Neither A.M. counts nor pedestrian counts available. Other count data shown on prints of 'All Traffic', 4:30 to 5:30 P.M. Peak', and "Trucks - Busses."
3. Speeds
   b. Average Operating Speeds Through Intersection: "Speeds observed with radar equipment."
4. Delays
   a. "Parking is now prohibited on the south side of the Artery from 4 to 6 P.M. This has assisted in preventing peak hour delay. The traffic control signal contains a program type controller and the cycle is extended from 70 to 90 seconds in the peak hours from 6 A.M. to 9 A.M. and from 4 P.M. to 7 P.M. This has prevented excessive delay in periods of heavy traffic volume."
5. Accidents
   a. Collision Diagram: Shows a 62.5 percent decrease in accidents during the year after construction as compared with the year before.
6. Pedestrian
   a. Volumes: "No counts available. Pedestrian volumes not heavy. Those wishing to cross the Northern Artery (south) have considerable protection at the islands."

Economic Data

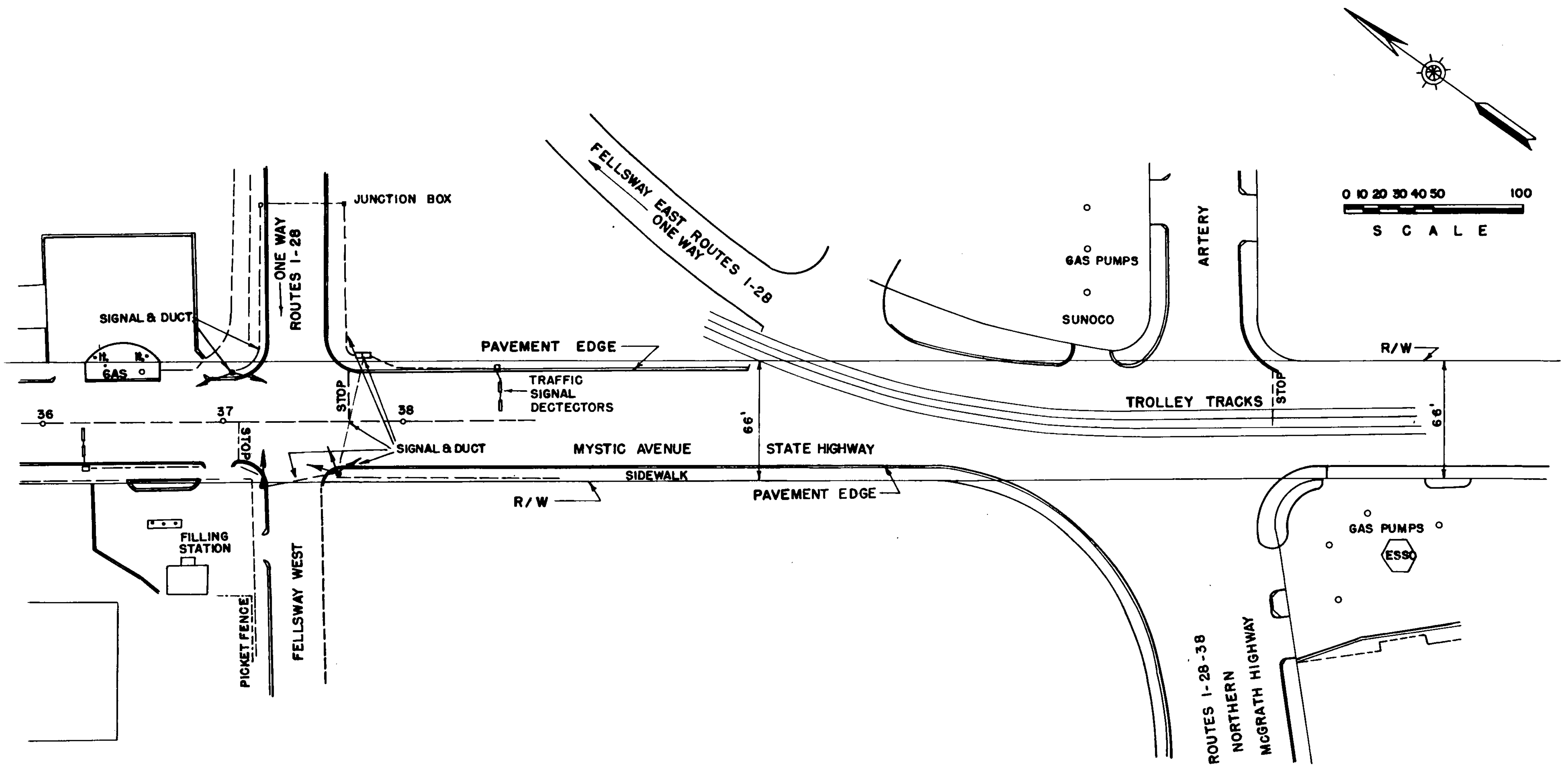
1. Estimated Cost of New Installation
   a. Signals - bid price $5,662.50 Islands - (built by Maintenance Division) $1,289.00 - Total $6,951.50.
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. "Note: assumed arbitrary values for each accident, i.e., Prevention and Control: $70 per accident; Damage per Vehicle: $60; Medical Care and time lost per injury: $350; October 23, 1947 to October 22, 1948; 8 Accidents, 16 Vehicles, and 15 Injured - Total: $6,770 per year October 23, 1948 to October 22, 1949; 3 Accidents, 6 Vehicles, and 5 Injured - Total: $2320 per year."

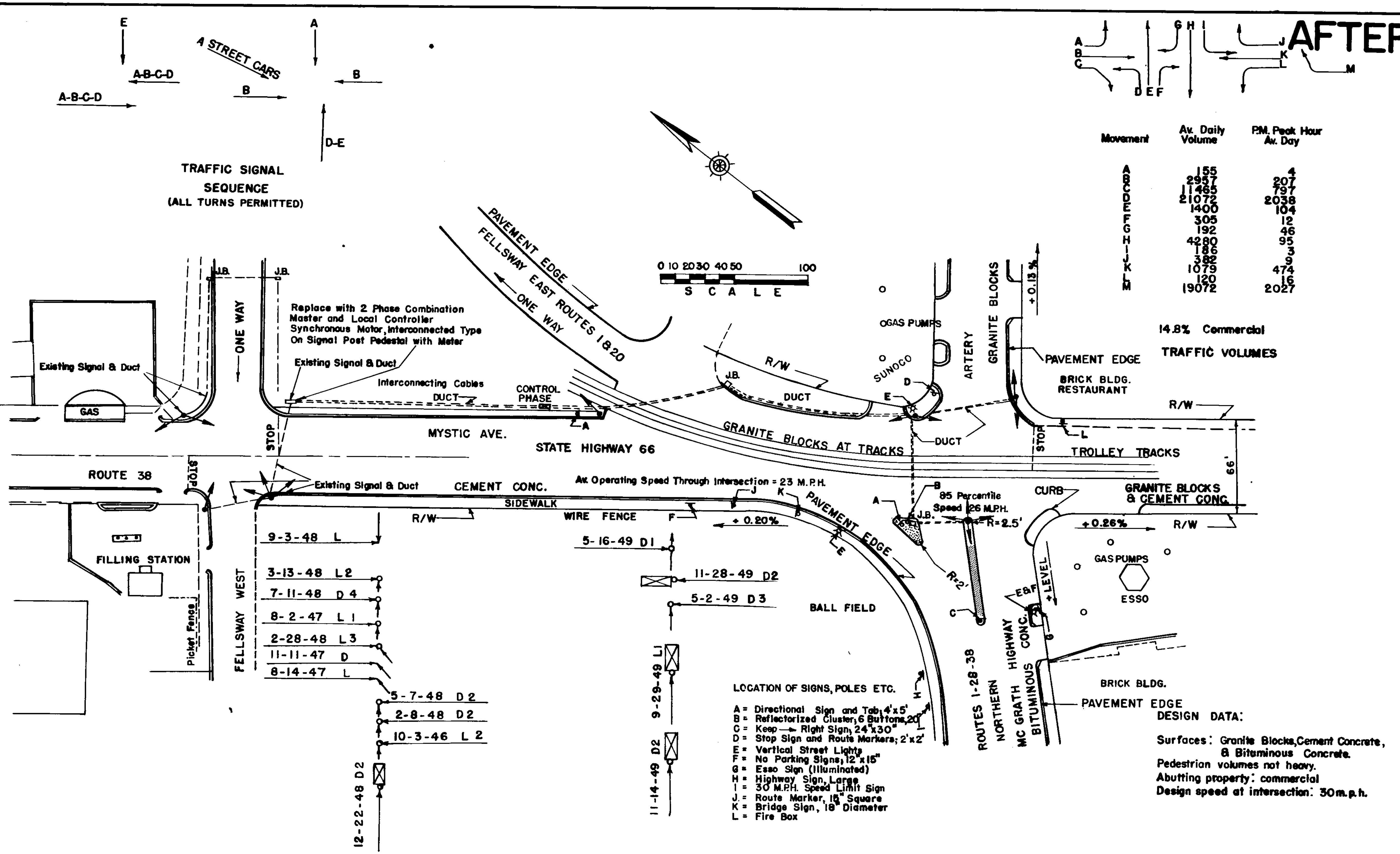
Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The channelization of traffic by the construction of two traffic islands has contributed much toward safety. Many accidents occurred prior to construction and even at times when the intersection was officer-controlled because motorists were not confined to the correct lanes. Channelization has been efficiently accomplished by these physi-

BEFORE

NO. 22 - MASSACHUSETTS, SOMERVILLE
NORTHERN ARTERY - MYSTIC CROSS AVENUE





TRAFFIC VOLUMES

14.8% Commercial

Movement	Av. Daily Volume	P.M. Peak Hour Av. Day
A	155	4
B	2957	207
C	11465	797
D	21072	2038
E	1400	104
F	305	12
G	192	46
H	4280	95
I	186	3
J	382	9
K	1079	474
L	120	16
M	19072	2027

LOCATION OF SIGNS, POLES ETC.

A = Directional Sign and Tab, 4'x5'
B = Reflectorized Cluster, 6 Buttons, 20"
C = Keep → Right Sign, 24"x30"
D = Stop Sign and Route Markers; 2'x2'
E = Vertical Street Lights
F = No Parking Signs, 12"x15"
G = Esso Sign (Illuminated)
H = Highway Sign, Large
I = 30 M.P.H. Speed Limit Sign
J = Route Marker, 15" Square
K = Bridge Sign, 18" Diameter
L = Fire Box

DESIGN DATA:

Surfaces: Granite Blocks, Cement Concrete, & Bituminous Concrete.
Pedestrian volumes not heavy.
Abutting property: commercial
Design speed at intersection: 30 m.p.h.

ESTIMATE OF MONETARY VALUE OF ACCIDENTS

$ 6770	$ 2,320
14 MONTHS PRIOR TO CONSTRUCTION	14 MONTHS AFTER CONSTRUCTION

COLLISION DIAGRAM

NO. 22 - MASSACHUSETTS, SOMERVILLE
NORTHERN ARTERY - MYSTIC CROSS AVENUE

cal separations. . . . . It (the intersection) shows a 62.5 percent decrease in accidents during the year after construction as compared with the year before."

2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The Northern Artery carries a large column of traffic and includes in peak hours many persons who are en route to or from their daily work in Boston. In addition, of course, it is a Federal Route (No. 1) which is the main north and south artery on the east coast. State Routes 28 and 38 also pass through this intersection.

      The efficiency of the traffic control signals in peak hours has been mentioned above. The continuous right turn for eastbound traffic on Mystic Avenue is one major factor in relieving congestion.

      Also the provision of a one-way artery for northbound Route No. 1 traffic after it has left the intersection, has greatly facilitated traffic."

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "In summary - it has been found that after the initial minor difficulties inherent in every new installation had been corrected and peak hour motorists had become familiar with the signal and islands, the construction has proved well worth while reducing accidents and facilitating traffic."

Comments by Committee Members

1. NORMAN KENNEDY - This channelization has apparently been successful in reducing the area of conflict. Perhaps its major contribution to the decrease in the number and cost of accidents has been in its provision of locations for traffic control devices, particularly signals.

2. D. W. LOUTZENHEISER - The addition of the two islands and described marking, signing, and traffic signal controls all rate a "well done." The proximity of the one-way Fellsway East roadway complicates the situation, especially the trolley tracks crossing at an acute angle. It appears that much of movement 'D' must swing right to become movement 'M' into Fellsway East. It is not evident how the southbound streetcar movements are controlled to avoid interruptions to the NW flow. A surprisingly high peak-hour flow is handled by this rather confined intersection area.

Figure 1. View of intersection of Northern Artery and Mystic Cross Avenue, Somerville, Massachusetts, after channelization showing median and triangular islands added to channelize open area at a four-way crossing under traffic-signal control.

Figure 2. View along Mystic Cross Avenue showing channelizing islands at right in the photograph.

Example 23

Location

OREGON, Portland
US 99W (Barbur Boulevard) -
Terwilliger Boulevard

Submitted by

R. H. Baldock, State Highway Engineer,
Oregon State Highway Department
Salem, Oregon

Type of Intersection

4-Way, Right-Angled

Date Constructed

December 15, 1948

Physical Data

2. b. Sight distance at vertical curves: described as "limited".
3. Surface Type
   a. Roadways: concrete on Barbur Blvd., and black-top on Terwilliger Blvd.
   b. Islands: asphaltic concrete; one painted island
   c. Shoulders: curbs and sidewalk mostly; 8 ft. blacktop on Barbur
5. Traffic Control Devices
   d. Lighting: Type: advance warning flasher beacons, floodlights, street lights, and illuminated nosing.
   e. Other Control Devices: Guide Posts: none
7. Abutting Property
   a. Character or Land Use: service station on one corner; otherwise undeveloped though adjacent to residential

Traffic Data

2. Type
   b. Percent Commercial: 18 percent
3. Speeds
   a. Approach Speed: 85 percentile: 44 mph. from the east, and 39.5 mph. from the west on Barbur Boulevard
5. Accidents
   a. Collision Diagram: "Before": shown on plan, "After": shown on plan, Length of Period: not given except in damage record.
6. Pedestrian
   a. Volumes: not appreciable

Economic Data

1. Estimated Cost of New Installation
   a. Cost of reconstruction and improvement, exclusive of the traffic signals and illumination was approximately $30,000. This includes purchase of right-of-way at SW Terwilliger and the cost of covering the existing concrete with an asphalt surface "in order to provide correct alignment through portions that were widened. It has been found that drivers tend to follow the edge of the concrete unless this is done."
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. $5,600
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $6,000.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The main feature leading to safe operation is the elimination of large areas of conflict within the intersection. Also contributing to a more safe operation is the change from a flashing beacon to a traffic signal installation, more advantageous positioning of signs, and island illumination. Noteworthy of the above mentioned features are the advance warning devices. Because of the limited sight distance, advance warning flashing beacons were installed on both sides of the Terwilliger intersection. The light to the west of Terwilliger is a continual flasher in conjunction with an illuminated "Traffic Signal Ahead" sign. The advance warning to the north of Terwilliger is on the north side of the Miles Street intersection. Miles Street is the next adjacent cross street to Terwilliger that is signalized, and it is not shown on the plans attached to this report. The light north of the Miles intersection is used in conjunction with a sign "Prepare to Stop When This Light Flahses." This light is regulated on the basis of a 40 mph. speed.
   b. Although traffic island, separators, etc. all contribute toward safer operation, they introduce an obstacle hazard making proper illumination mandatory."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The relief of congestion was accomplished by placing a large island within the intersection, with through channelization for the main traffic flow. The rotary movement given to the cross street traffic and the elimination of left turns are other factors reducing not only area of conflict but also congestion."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Prior to channelization, this intersection was of the standard four-way type involving a heavy left turn movement with a large number of left turn accidents resulting. The installation of the split traffic circle very nearly eliminated the left turn accidents, and in all accidents of the after period it has greatly reduced the angle of conflict.
      Long range plans call for grade separation at this intersection and the widening of SW Barbur Boulevard to six lanes in order to accommodate the anticipated future demand."

Comments by Committee Members

1. GUY KELCEY - This is an excellent treatment of a 4-lane, main artery and a secondary road which carries a moderate traffic load and which is on a grade ranging from 5.3 percent to 7 percent. Traffic movements on the main artery are carried directly through. Turning and secondary movementsare deflected. Some tendency for main movement traffic to turn left directly might be reduced by narrowing the crossing openings in the islands on the main roadway to 20 or 25 ft.

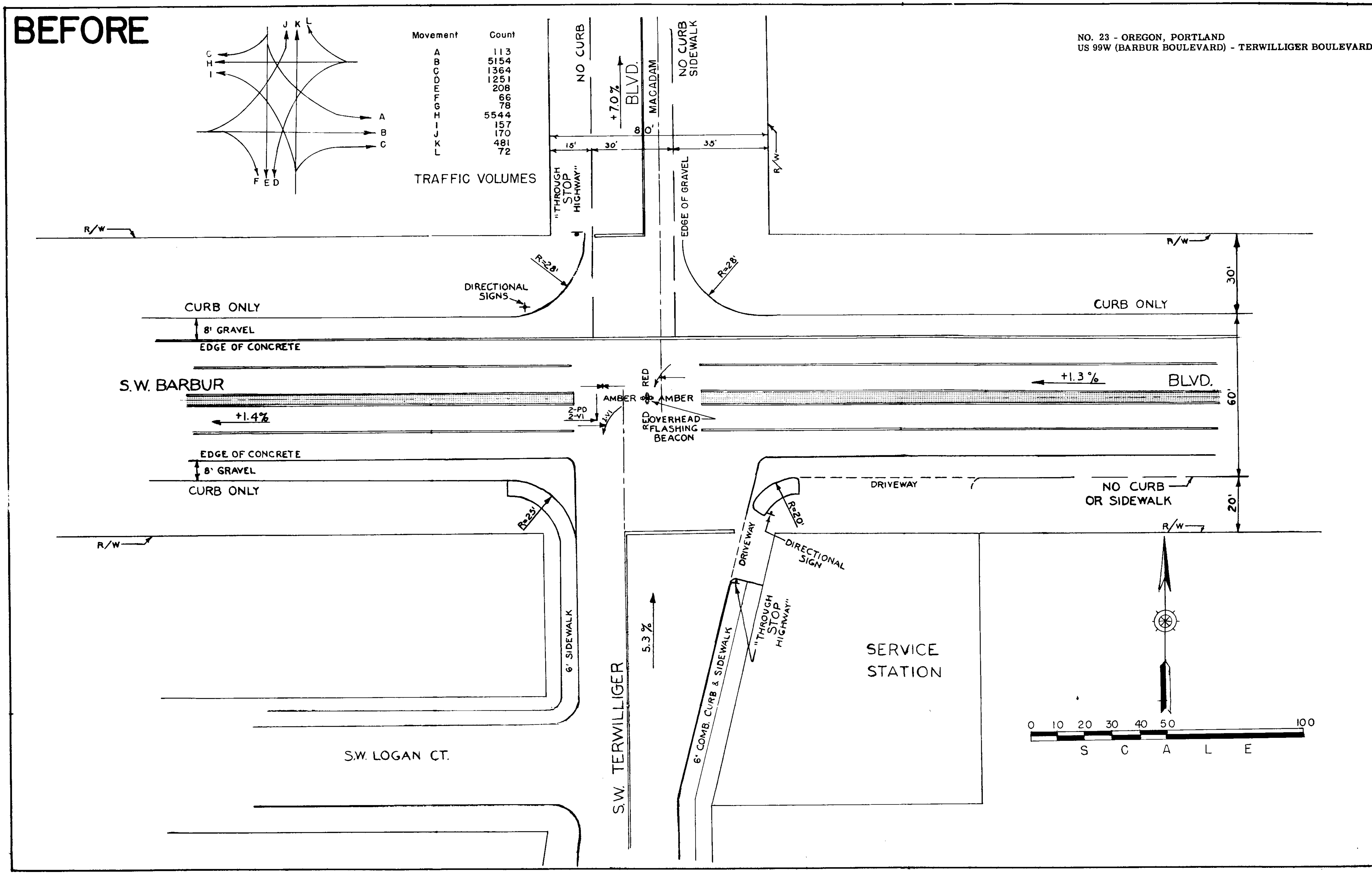
2. JAMES L. SHOTWELL - This intersection of a split rotary type appears to have been well designed. Perhaps there might be a slight advantage in tapering the inside edges of the rotary to eliminate the shoulder area at the exit end. This would provide a better opportunity for right turning traffic to enter Barbur Boulevard.
   This type of design works well when most of the traffic consists of repeat users but is often confusing to the stranger.

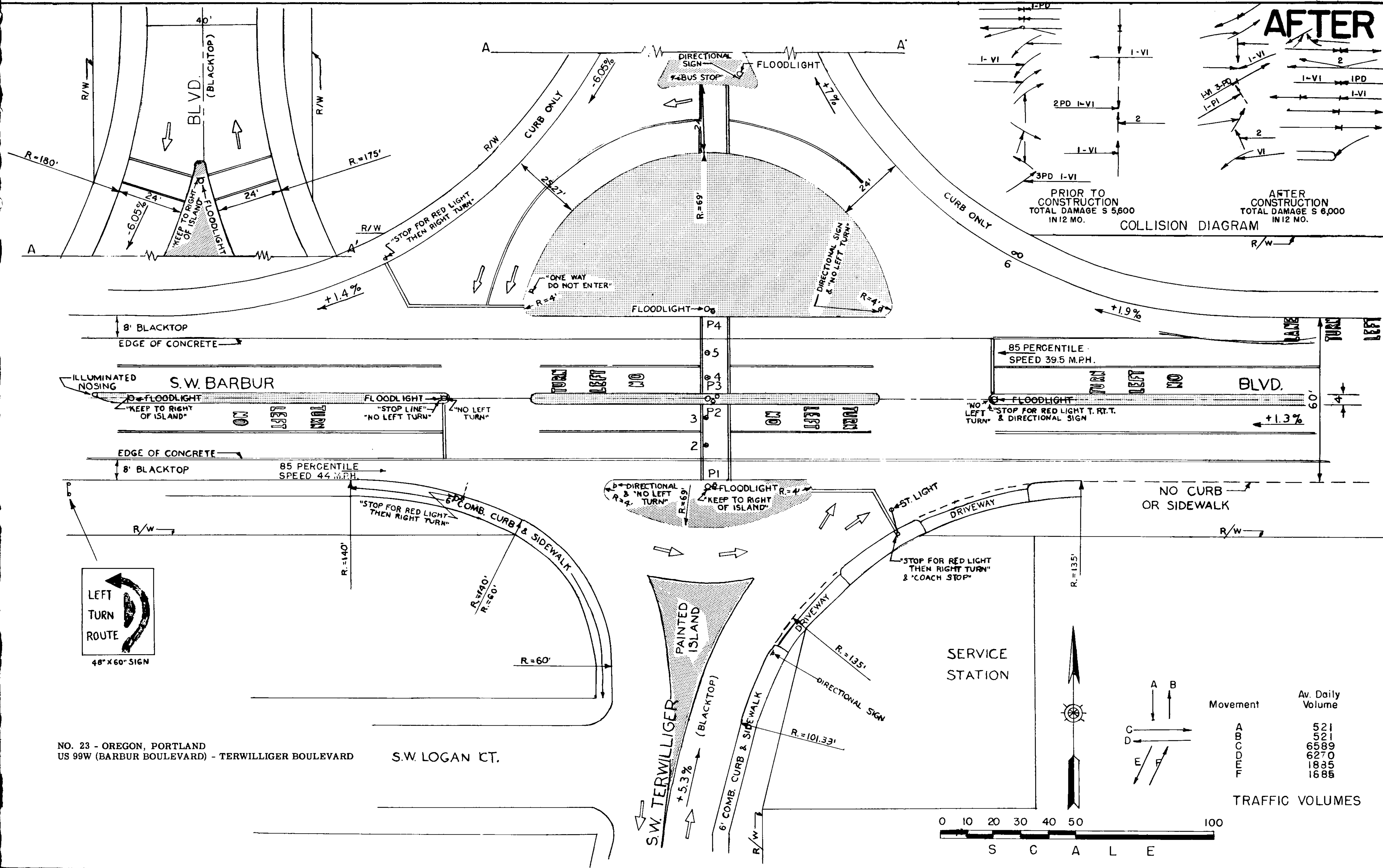
BEFORE

NO. 23 - OREGON, PORTLAND
US 99W (BARBUR BOULEVARD) - TERWILLIGER BOULEVARD

Movement	Count
A	113
B	5154
C	1364
D	1251
E	208
F	66
G	78
H	5544
I	157
J	170
K	481
L	72

TRAFFIC VOLUMES





Movement	Av. Daily Volume
A	521
B	521
C	6589
D	6270
E	1835
F	1685

NO. 23 - OREGON, PORTLAND
US 99W (BARBUR BOULEVARD) - TERWILLIGER BOULEVARD

Figure 1. Aerial view of Barbur Boulevard with the Terwilliger intersection in the lower left-hand corner before reconstruction.

Figure 2. Split-circle treatment of main and secondary highway in which through traffic continues directly and left turns from main highway and cross traffic are deflected to right around islands. Satisfactory results are reported.

Figure 3. Details of channelizing island and traffic-control devices.

Example 24

Location

PENNSYLVANIA, Bucks County
Street Road (T. R. 132) -
Jacksonville Road (T. R. 332)

Submitted by

D. C. Stackpole, District 6,
Pennsylvania Department of Highways
Ardmore, Pennsylvania

Type of Intersection

4-Way, Right-Angled

Date Constructed

1943

Physical Data

2. a. Grades: one shown on plan; "no grades of any consequence were or are present."
4. Cross Section not given, since not of unusual design
5. Traffic Control Devices: "Before redesign, no traffic control was deemed necessary. Both routes were located in a rural section and did not carry a sufficient amount of traffic to warrant any restrictive measures. After construction of Brewster Aircraft Plant, traffic conditions warranted placement of Pennsylvania Department of Highways Standard - R-1."
   a. Signs: Type: Penn. Dept. of Hwys. Standard R-1, W-5 (cross road signs) and W-13 ("Slow" signs).
   b. Signals: Type: none
   e. Other Control Devices: Guide Posts: none
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: Normal bus operation is every 20 min. with route north on Jacksonville Road past the intersection or turning left at the intersection into the Naval Air Development Center; thence back by an easterly and southerly route through the intersection and south on Jacksonville Road.

Traffic Data

1. Volumes
   a. P. M. Peak Hour: peak hour is 4:00 to 5:00 P. M.
   e. Pedestrian: shown on plan: 26 total for four hours.
2. Type
   b. Percent Commercial: shown on plan
3. Speeds
   a. Approach Speed - 85 Percentile: average is shown on plan, rather than 85 Percentile.
   c. Average Operating Speeds Through Intersection: shown on plan.
4. Delays
   a. "Most delays are incurred between the hours of 4:30 to 5:30 P. M. Traffic leaving the north and south throat of T. R. 332 has considerable trouble in crossing T. R. 132. Naval Air Development Center employees leave the base at this time."
5. Accidents
   a. Collision Diagram: covering 40 months after construction, from 1946 to 1950.
   b. During this period there were nine accidents, all property damage.
6. Pedestrian
   a. Volumes; shown on plan: 26 total for four hours.
   b. Location of Crossings: crossings are made from the southeastern island, across T. R. 332. No painted crosswalks have been designated.

Economic Data

1. Estimated Cost of New Installation
   a. "Jacksonville Road was reconstructed during the years 1941, 1942. Upon completion, Street Road was reconstructed and the traffic islands were installed. The approximate cost of rebuilding the intersection considering islands, pavement 100 ft. from intersection on Jacksonville Road was $5,000. Pavement on Street Road was not considered due to its proposed rebuilding."
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before".
   a. "A search of accident records revealed no information prior to reconstruction or within 12-month period thereafter. It is our opinion that the records for the years previously mentioned, in section on Traffic Data, will point out the dangers present since reconstruction. Estimated damages in this period are $2700.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "This intersection was designed approximately 1940 or 1941. At this time design standards concerning turning radii required by large tractor trailers were in all probability adequate. Due to construction of the Brewster Aircraft and later occupation by Naval Development Station, channels provided for right turns and distances between islands were proved too narrow. This in turn restricted the free flow of traffic and was almost a prohibitive area in which tractor trailers carrying plane parts could turn. The large radii at the intersection increased area for small trucks to travel, but are not properly designed to allow turns into Naval Station with any degree of safety."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "The same conditions that tend to make this an unsafe intersection also contribute to congestion."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "During the period since this intersection has been designed, over-all operation has proved to be most unsatisfactory. The only solution to be found is removal of all islands, reducing curb radii, thereby reducing area of intersection."

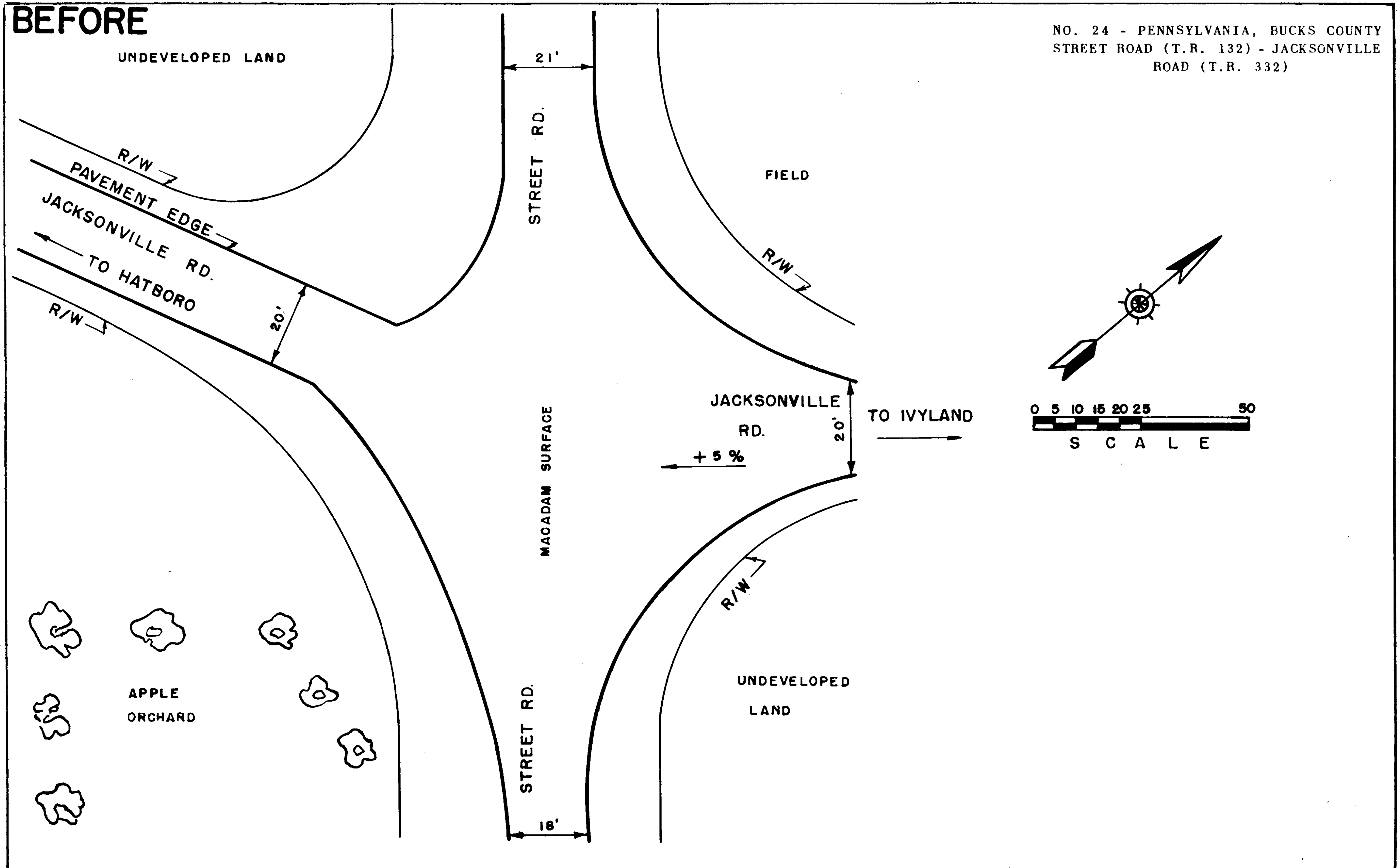
Comments by Committee Members

1. GUY KELCEY - Usage of this intersection by buses, tractor trailers and indicated heavy loadings, developed by the Naval Air Development Station from 4:30 to 5:30, are reported to have resulted in congestion. Cramped turning movements are also reported.

   The basic difficulty appears to lie in inadequate pavement space at this intersection of two, two-lane roadways. The solution appears to lie in a redesign of the intersection to provide adequate room for suitable channelization which should then include a pair of islands or low curb strips in opposite throats of one of the roadways. This would provide sufficient radius for and control left turns. If needed, islands to facilitate right turns could then be provided for and installed.

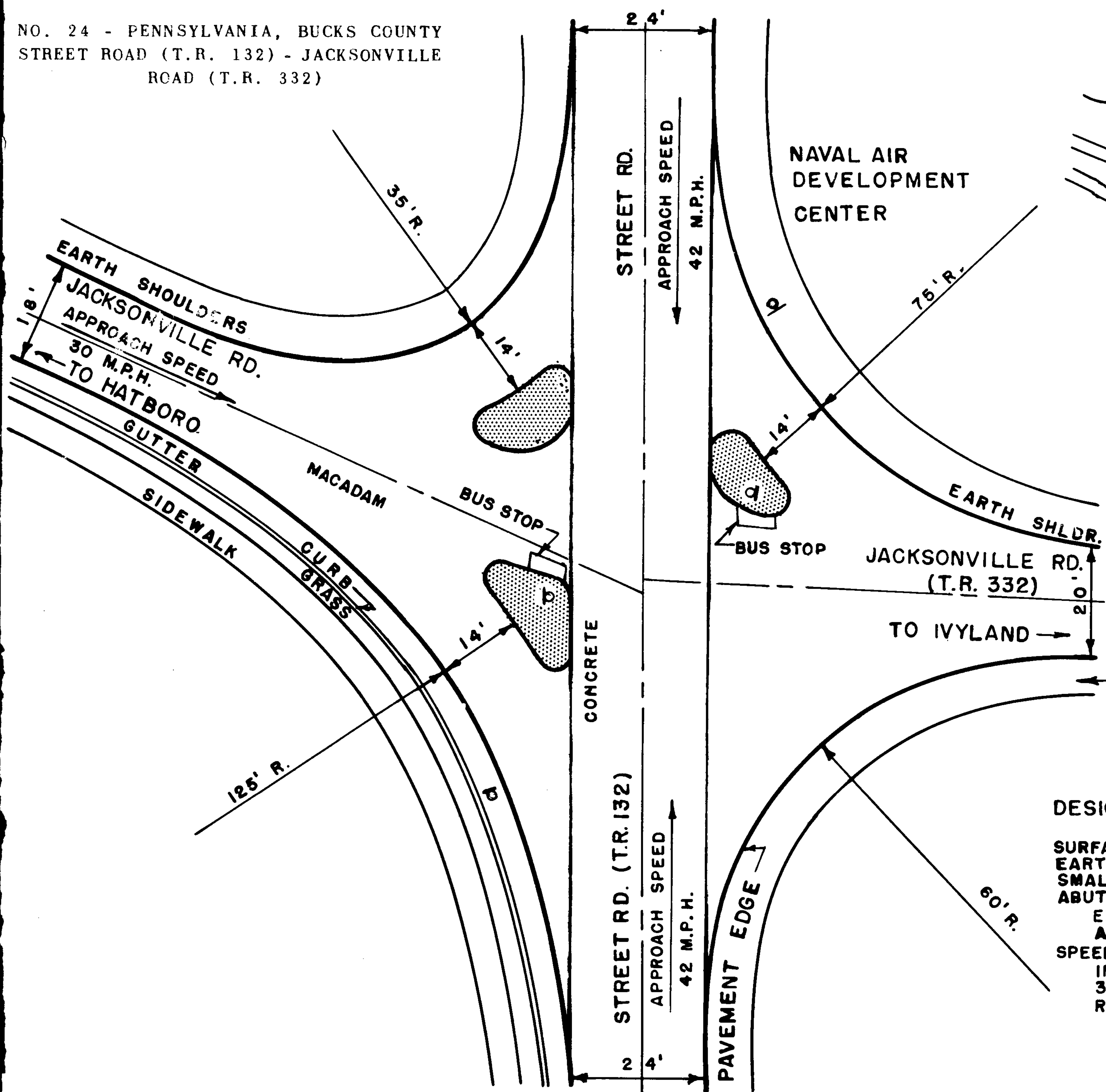
BEFORE

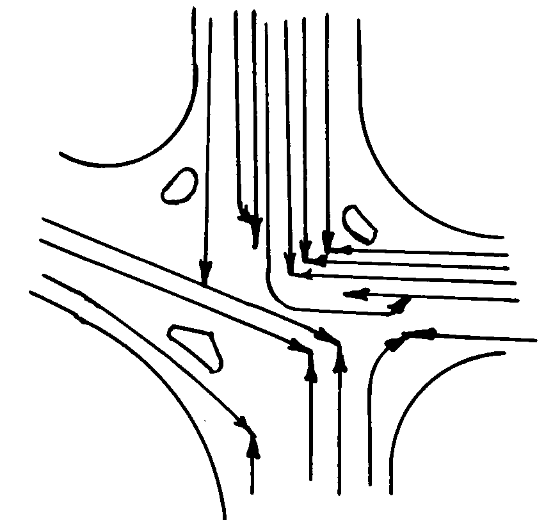
NO. 24 - PENNSYLVANIA, BUCKS COUNTY
STREET ROAD (T.R. 132) - JACKSONVILLE
ROAD (T.R. 332)



NO. 24 - PENNSYLVANIA, BUCKS COUNTY
STREET ROAD (T.R. 132) - JACKSONVILLE
ROAD (T.R. 332)

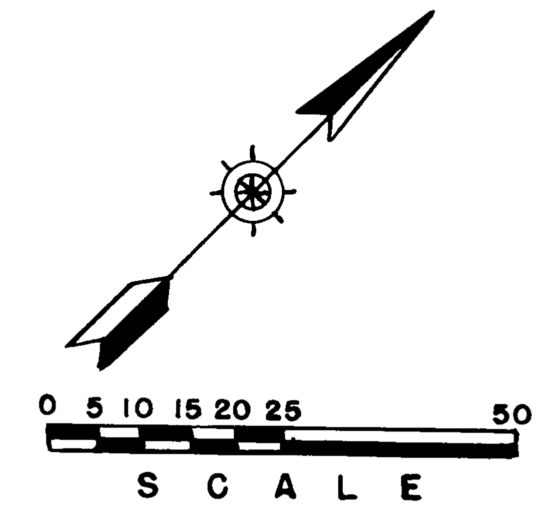
AFTER

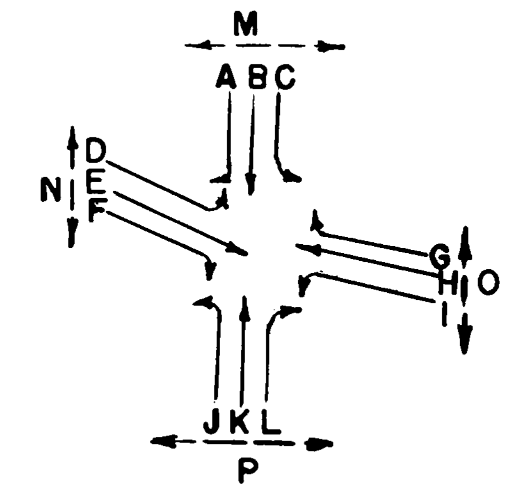




TOTAL DAMAGE $2,700
40 MONTHS AFTER
CONSTRUCTION

COLLISION DIAGRAM





DESIGN DATA:

SURFACES-CONCRETE & MACADAM
EARTH SHOULDERS
SMALL PEDESTRIAN TRAFFIC
ABUTTING PROPERTY-UNDEVELOPED.
EXCEPTION N.W. CORNER, NAVAL AIR DEVELOPMENT CENTER
SPEEDS: AV. OPER. SPEED THROUGH INTERS. ON STREET ROAD IS 35 M.P.H.; ON JACKSONVILLE RD. IS 10 M.P.H.

MOVEMENT	AV. 4HR. DAILY VOLUME	P.M. PEAK HR. AV. DAY
A	221	149
B	285	163
C	57	20
D	145	39
E	206	61
F	147	35
G	105	55
H	292	150
I	74	51
J	136	38
K	247	81
L	47	11
M	5	2
N	13	7
O	1	1
P	7	4

16% COMMERCIAL TRAFFIC

TRAFFIC VOLUMES

2. J. C. YOUNG - The peak hour volume shown here is so low that it is hard to believe that trouble was experienced due to congestion alone, although it is easy to see that large semi-trailers would have difficulty making either right or left turns. The proposed remedy suggested by the original submitter of this example involves removing the islands, which is obviously necessary, and reducing the curb radii. Far from being reduced, the curb radii should stay at least what they are and as is obvious from Photograph No. 1, tapers must be added on all four legs. I am enclosing a print showing the standard county road connection for two-lane highways in California (Fig. 2), which is used for very low traffic volumes on the entering road. It will be noted that considerably more room is allowed for turns than this channelization example would give, even with the islands removed.

Figure 1. Channelized intersection of Street Road and Jacksonville Road, Bucks County, Pennsylvania. Channelization does not control left turns. Right-turn movements are restricted by short radii and narrow channel widths.

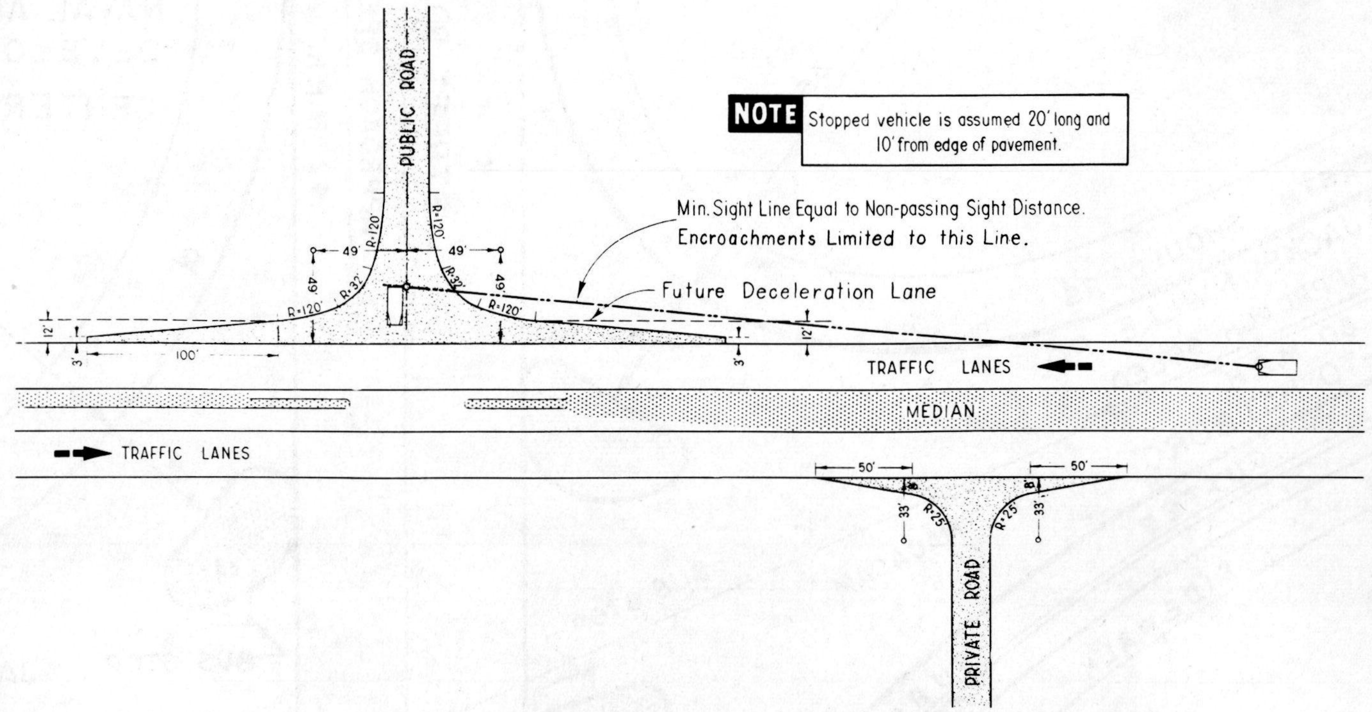


Figure 2. Channelization for intersection of a major highway and minor road, as recommended by the California Department of Highways. This design is used on 2-lane and divided highways.

Example 25

Location

VIRGINIA, Richmond
Chamberlayne Avenue (US 1) -
Lombardy Street - Lancaster Road

Submitted by

Virginia Department of Highways,
Richmond, Virginia
Division of Traffic and Planning
Through W. F. Smith, Urban Engineer

Type of Intersection

4-Way, Right-Angled

Date Constructed

Fall, 1948 (?)

Physical Data

4. Cross Section
   a. Not Unusual
5. Traffic Control Devices
   a. Signs: Size 2 ft. by 2 ft.
   e. Other Control Devices: Reflectorized delineators

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "Mr. Gould stated that Lancaster Street had been posted for one-way traffic in order to prevent vehicles from entering from the east. He further stated that the most objectionable feature was the location and extent of the driveways."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "It is our observation that the channelization functions satisfactory and is a considerable improvement for the majority of traffic."

Comments by Committee Members

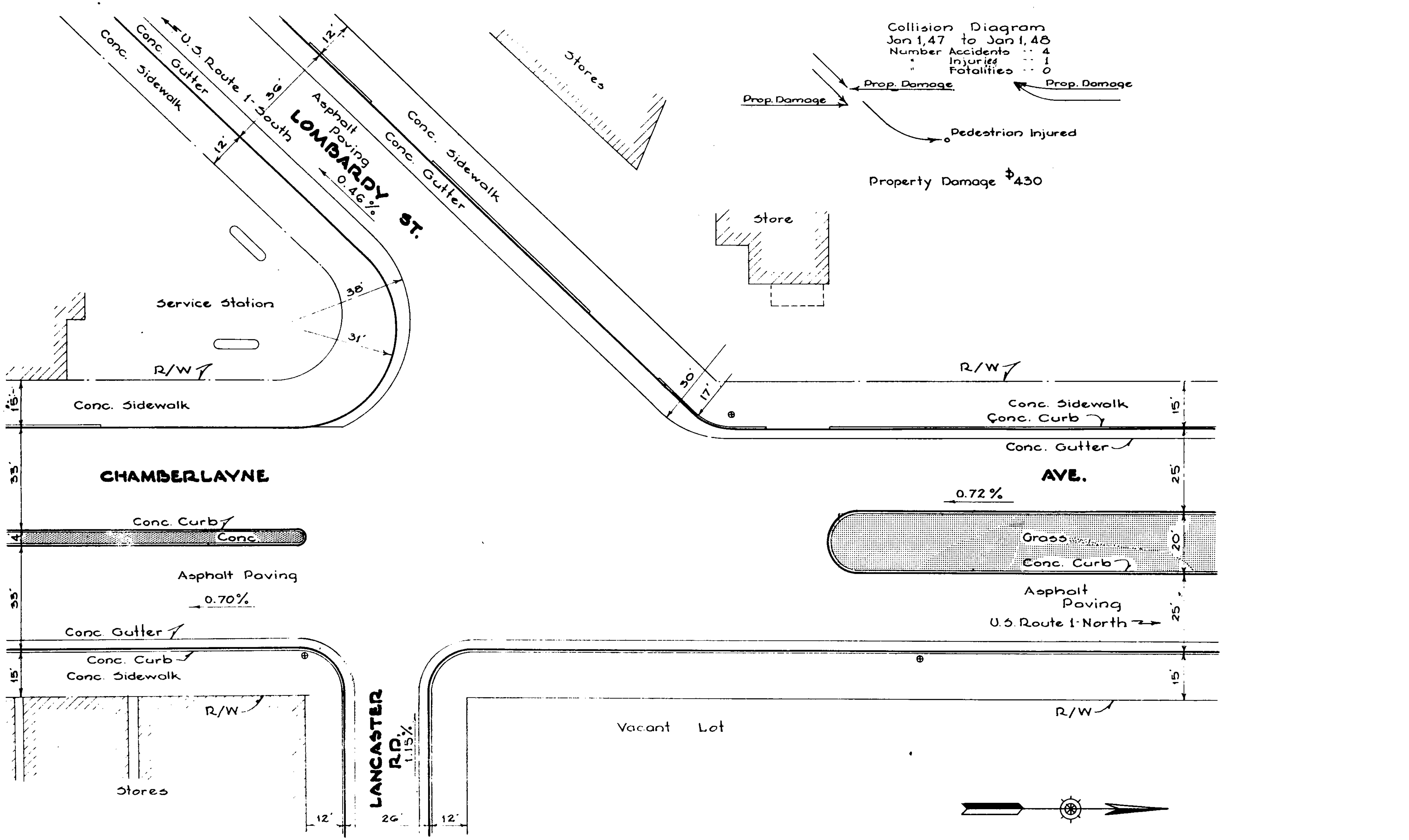
1. NORMAN KENNEDY - The two islands added to this intersection serve two functions: (1) to reduce the area of conflict and (2) to provide locations for the installation of traffic signals. Pedestrian movement through A intersection should be safer. (It is noticed that the photograph shows a "jaywalker".)

2. EUGENE MAIER - The value of the channelizing islands introduced into the Chamberlayne-Lombardy-Lancaster intersection appears to be in the reduction of the unnecessarily large paved area, the prohibition of northbound traffic on Chamberlayne turning left into Lombardy, and to provide for locations for the installation of traffic signal controls.
   The establishment of the one-way regulation on Lancaster Road, the prohibition of left turns from Chamberlayne to Lombardy, the channelizing of traffic movements by means of the islands within the intersection, and the traffic control signals all contribute to the elimination of major conflicts and promote orderly traffic movements through the intersectional area.

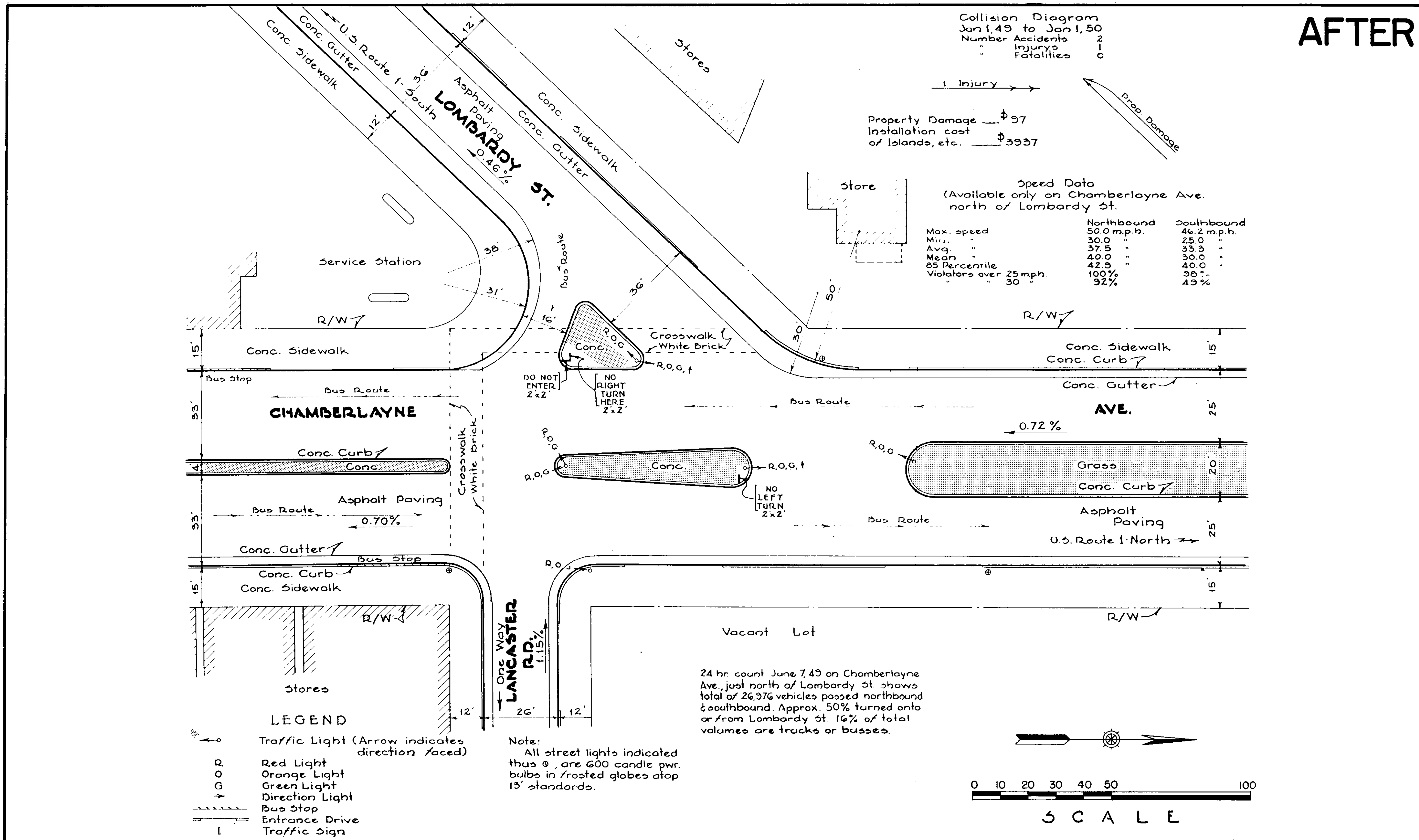
Figure 1. Channelized intersection of Chamberlayne Avenue (US 1), Lombardy Street, and Lancaster Road in Richmond, Virginia.

BEFORE

NO. 25 - VIRGINIA, RICHMOND,
CHAMBERLAYNE AVENUE (US 1) - LOMBARDY STREET - LANCASTER ROAD



Note
All street lights indicated thus ⊕, are 600 candle pwr. bulbs in frosted globes atop 13' standards.



NO. 25 - VIRGINIA, RICHMOND
CHAMBERLAYNE AVENUE (US 1) - LOMBARDY STREET - LANCASTER ROAD

Example 26

Location

CALIFORNIA, 9 mi. west of Riverside
Mission Boulevard - Bain Street -
US 60 and California 19

Submitted by

J. C. Young, Traffic Engineer,
Department of Public Works
Sacramento, California

Type of Intersection

4-Way, Oblique

Date Constructed

January 5, 1950

Physical Data

2. b. Sight distance at vertical curves: unrestricted
3. Surface Type
   b. Silands: Grass, with curbs
5. Traffic Control Devices
   b. Signals: Type: none
   d. Lighting: Type: none
6. Landscaping
   a. Native growth
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

3. Speeds
   a. Approach Speed: 85 percentile: 55 mph. on US 60 and California 19, 40 mph. on Mission Boulevard
   b. Average Design: 60 mph.
4. Delays
   a. None to main line, insignificant to cross traffic
5. Accidents
   b. Both before and after accidents were property damage only

Economic Data

1. Estimated Cost of New Installation
   a. Cost not separated from cost of other work in same contract

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The Mission Boulevard which is the south leg of this intersection serves several small communities which are located to the south of Route 19. All traffic from these communities to Ontario and the Los Angeles metropolitan area to the west enter Route 19 at this intersection.

      The northbound approach was composed of a 300-ft. radius curve and a pavement width of 20 ft. A turning radius of 50 ft. was provided for eastbound traffic turning right onto Mission Boulevard. There were no acceleration or deceleration lanes in the intersection.

      Eastbound traffic turning right could not execute the movement without crossing into the opposing northbound traffic lanes. All movements off of and onto Route 19 were made without the benefit of acceleration or deceleration lanes, although the volumes of traffic warranted the provision of these lanes."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. "The intersection was reconstructed in order to provide a free turning lane for eastbound traffic which was turning right onto Mission Boulevard and an acceleration lane for northbound traffic which was turning left onto Route 19.

      The improvement permits greater ease of movement for traffic entering and leaving the highway from the west."

Comments by Committee Members

1. FRED W. HURD - (a) Lack of channelization within cross-over area probably causes little trouble because cross flow is so light. Bringing crossroad in at right angles is good. (b) Curb cut in divider favors left turn from Mission Boulevard at the cost of other cross-over movements. Volume probably justifies this. (c) AASHO Policy shows that truck could keep right of center of cross-over and still turn into acceleration lane from stop. Apparently purpose of left turn acceleration lane is to permit this turn without stop in cross-over. (d) Cross-over is too long - Cross-over can not be traversed by more than one (or two) vehicles at a time in orderly fashion - 55 ft. and 65 ft. lanes permit storage of left turns off of E-W road until cross-over clears. (e) 65 ft. and 55 ft. lanes cannot be termed acceleration or deceleration lanes on 60 mph. road.

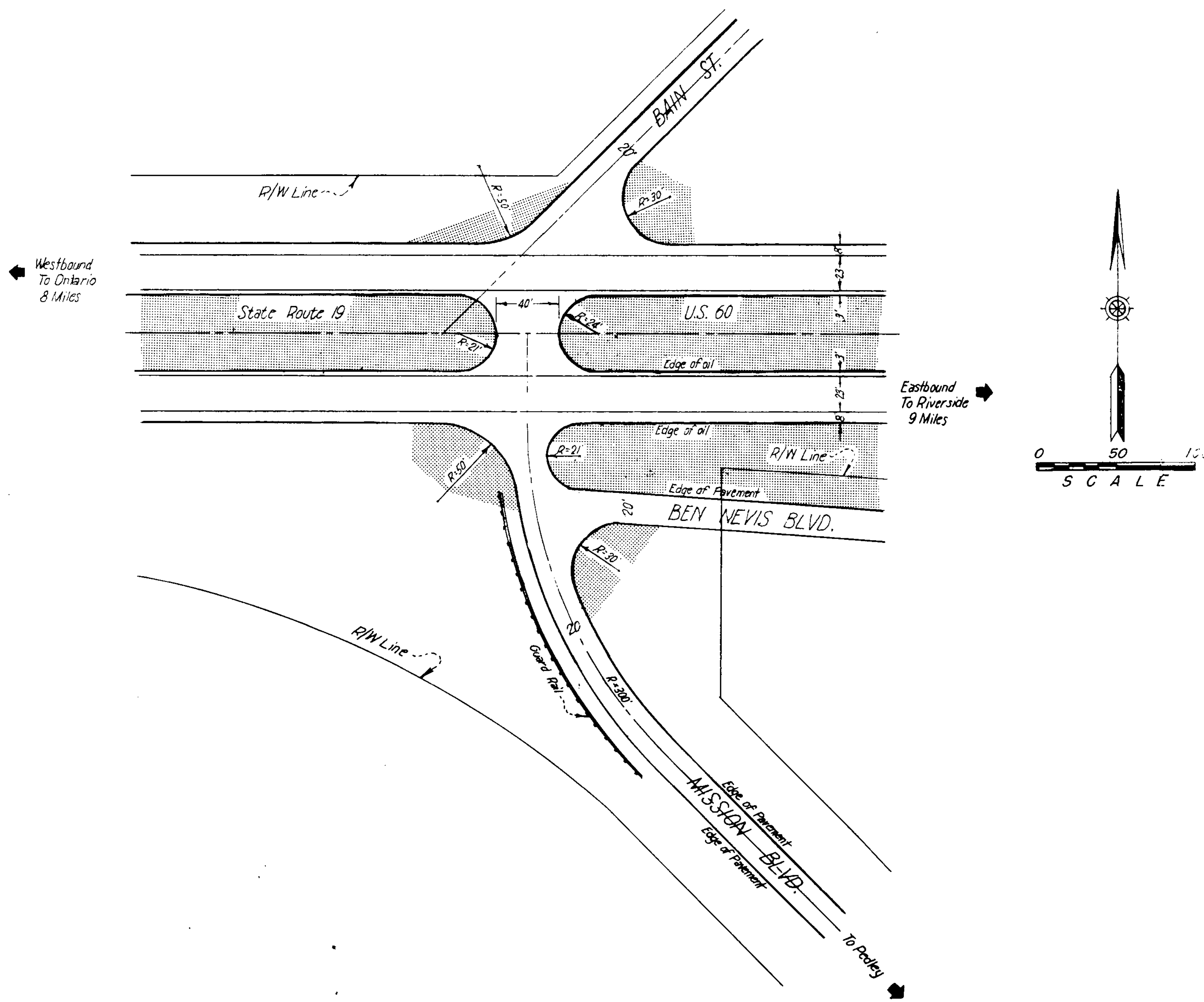
2. E. T. PERKINS - The intersection seems to be well designed and constructed. So far as I can determine, the various traffic flows have been well thought out and properly designed for.

Additional Comment by J. C. Young

The short median curb returns in three quadrants are not considered to be speed change lanes but are merely the result of moving the curbs outside of the shoulder area. In our more recent channelization, we have come to realize that the curbs should not encroach upon shoulders. It is our observation that shoulders are needed, and are used in the vicinity of intersections as much or probably more than they are throughout the balance of the highway, and therefore it seems illogical to block them off by channelizing curbs. For very light turning volumes off the main highway this type of refuge is very useful because one or two vehicles can decelerate on the through lane to approximately 20 mph. and then get off, thereby causing congestion in the main lane of very few seconds duration; whereas, if they are compelled to decelerate to nothing and then wait for a break, while making their left turn, the potential hazard to following vehicles in the through lanes is multiplied several times.

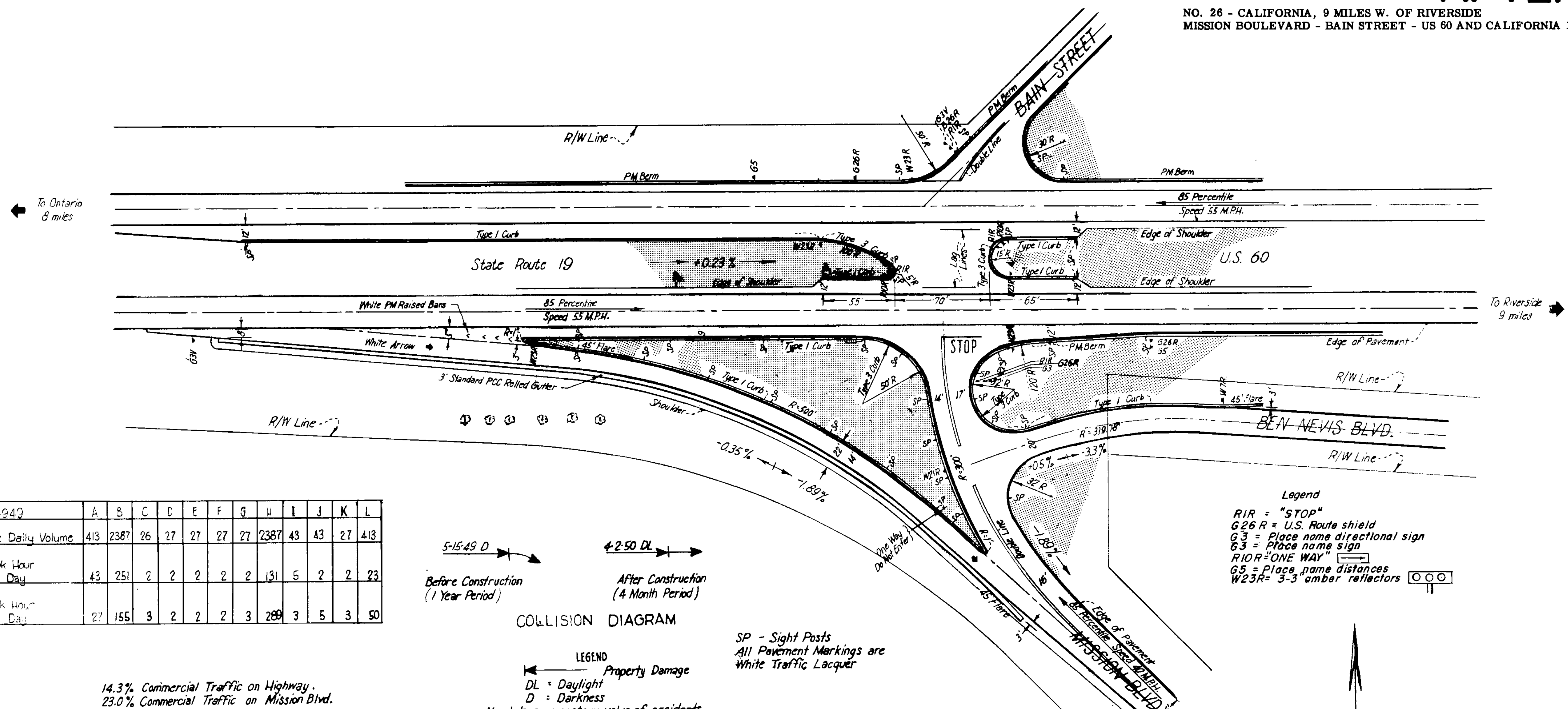
BEFORE

NO. 26 - CALIFORNIA, 9 MILES W. OF RIVERSIDE
MISSION BOULEVARD - BAIN STREET - US 60 AND CALIFORNIA 19



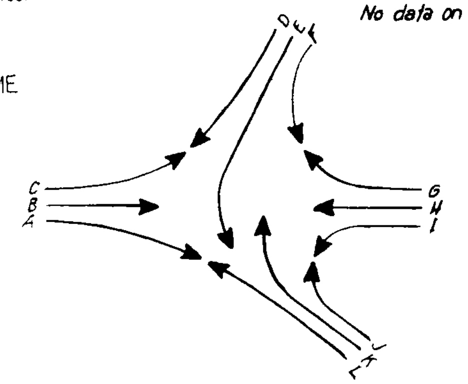
AFTER

NO. 26 - CALIFORNIA, 9 MILES W. OF RIVERSIDE
MISSION BOULEVARD - BAIN STREET - US 60 AND CALIFORNIA 19



1949	A	B	C	D	E	F	G	H	I	J	K	L
Average Daily Volume	413	2387	26	27	27	27	27	2387	43	43	27	413
AM Peak Hour Average Day	43	251	2	2	2	2	2	131	5	2	2	23
PM Peak Hour Average Day	27	155	3	2	2	2	3	289	3	5	3	50

14.3% Commercial Traffic on Highway.
23.0% Commercial Traffic on Mission Blvd.



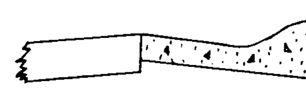
TRAFFIC VOLUME

5-15-49 D — Before Construction (1 Year Period)

4-2-50 DL — After Construction (4 Month Period)

COLLISION DIAGRAM

LEGEND
Property Damage
DL = Daylight
D = Darkness
No data on monetary value of accidents



Cross Section: Rolled Gutter

DESIGN DATA:
All Surfaces - Bituminous Pavement
8' Bituminous Outside Shoulders
5' Inside Shoulders with 3" Bituminous Pavement
No Pedestrain Traffic
Abutting Property - Farm Land
Design Speed : 60 M.P.H.
Estimated Cost : $ 18,000

Figure 1. Intersection of Mission Boulevard, Bain Street, US 60, and California 19 before channelization.

Figure 2. Northbound approach of Mission Boulevard to State Route 19 at Bain Street.

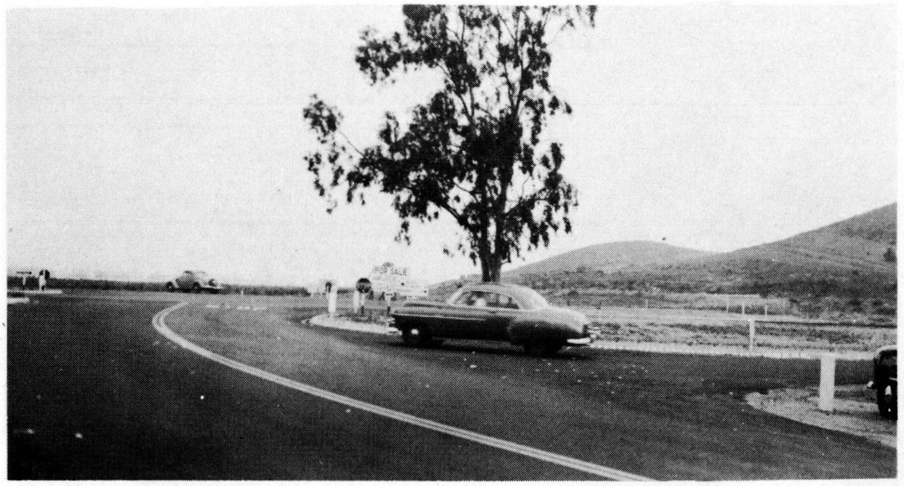


Figure 3. Looking north on Mission Boulevard: Car entering Mission Boulevard from Ben Nevis Boulevard.

Example 27

Location

CALIFORNIA, 3 mi. N.W. of Riverside
Mission Boulevard-Valley Way -
US 60 and California 19

Submitted by

J. C. Young, Traffic Engineer,
Department of Public Works,
Sacramento, California

Type of Intersection

4-Way, Oblique

Date Constructed

January 5, 1950

Physical Data

2. b. Sight distance at vertical curves: Unrestricted
6. Landscaping
   a. Native growth
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none, except school bus routes.

Traffic Data

3. Speeds
   b. Average Design: 60 mph. on US 60
4. Delays
   a. Insignificant

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. See comment regarding Over-all Operation.
2. Design Features Which Relieve Congestion: Which Contribute to Congestion:
   a. See comment regarding Over-all Operation.
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "This intersection is a five-way intersection; however, the old Mission Boulevard was parallel to and approximately 23 ft. south of Route 19 westerly from the intersection. It was difficult for eastbound traffic on Route 19 to make the U-turn and proceed westerly on the old Mission Boulevard. Since this movement was often made by school buses, criticism of the intersection was severe. Other movements involving traffic on the south leg were less difficult, but the design features were below the standard for which the highway was constructed.

   The Old Mission Boulevard connection was relocated to the south of its original position so as to permit the construction of a three-centered curve. A free right turn was constructed for eastbound traffic entering Route 19 from the Old Mission Boulevard and the south leg of Valley Way, and a deceleration lane provided for westbound traffic on Route 19 turning south or left.

   This installation has been in operation for almost five months. There have been three accidents during this period, all of which have occurred in the westbound lane. Observation of traffic movements indicates that the improvement has facilitated the movement of traffic within the intersection. It was noted, however, that the speed of eastbound traffic entering Route 19 from the Old Mission Bouleavrd was relatively high. The 85 percentile speed was found to be 39 mph. To date there have been no accidents involving this traffic; however, this speed is considered to be excessive for the intersection."

Comments by Committee Members

1. J. A. REDMAN - The main highway 85 percentile speeds indicate the intersection is working quite well. The five-way intersection has, in effect, been reduced to a four-way highway intersection.

   The use of abrupt changes in width of the median is not pleasing in appearance and the lengths of the acceleration and deceleration lanes for three movements are inadequate to serve that purpose. The length of the lane for right turning traffic from Valley Way eastерly bound would provide more merging distance if moved westerly.

2. H. G. VAN RIPER - This layout represents an effective treatment to correct an unsatisfactory turning movement. It appears desirable to erect a "slow speed" sign for traffic on Mission Boulevard entering the intersection.

Figure 1. Intersection of Mission Boulevard, Valley Way, US 60, and California 19 before reconstruction.

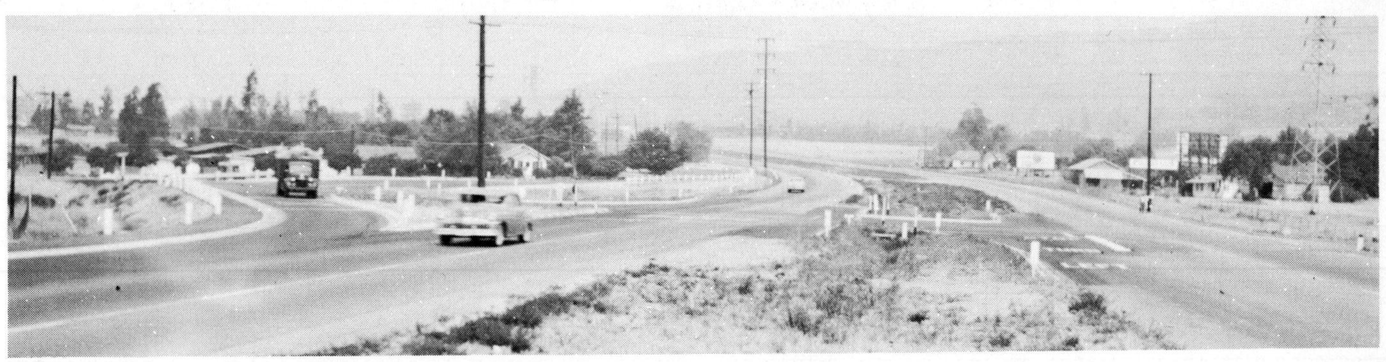
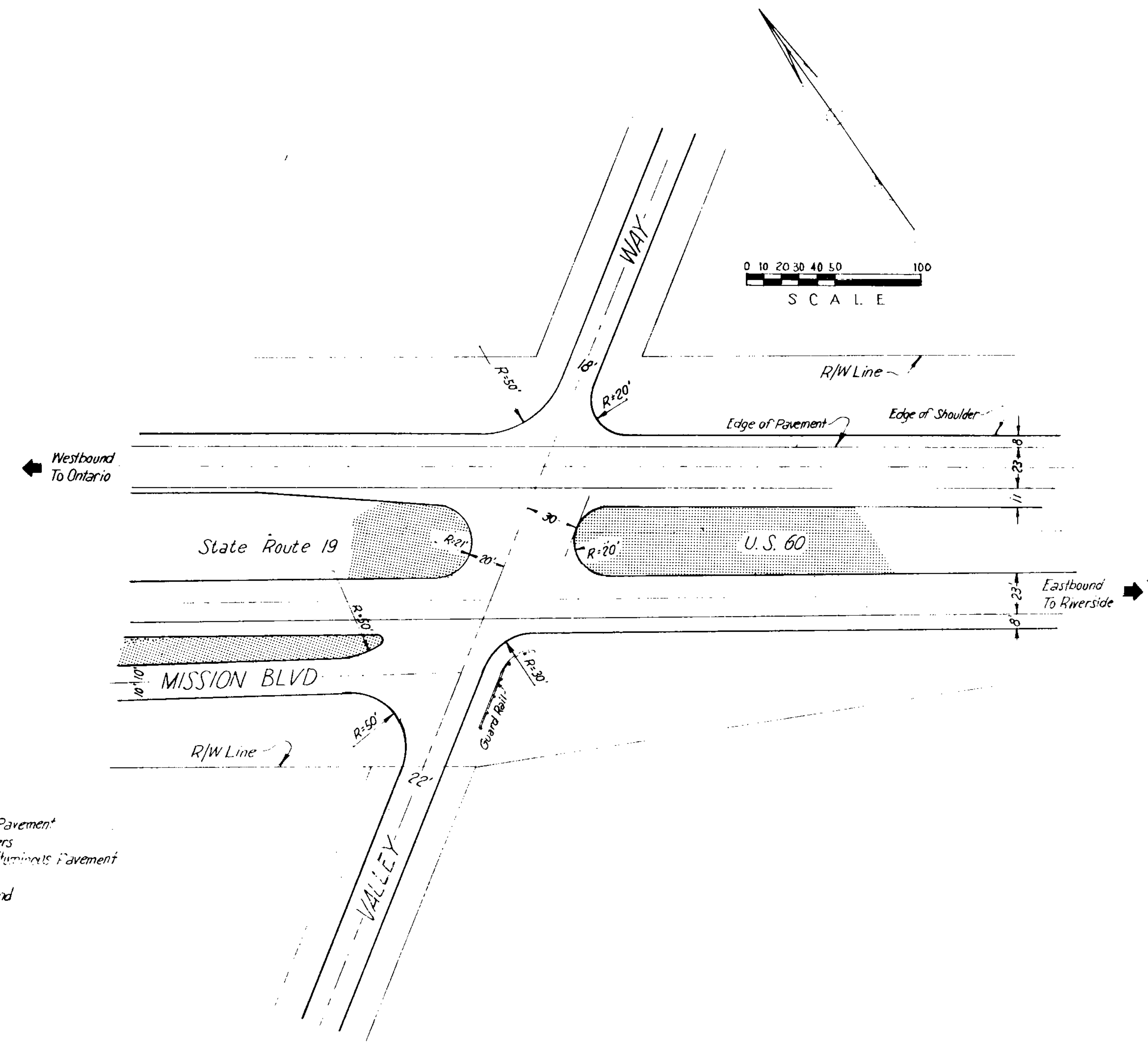


Figure 2. Valley Way intersection after channelization, looking west.

BEFORE

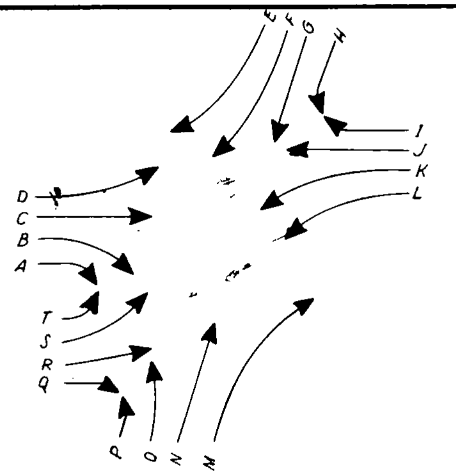
NO. 27 - CALIFORNIA, 3 MILES N.W. OF RIVERSIDE
MISSION BOULEVARD - VALLEY WAY - US 60 (CALIFORNIA 19)



DESIGN DATA

All Surfaces are Bituminous Pavement
8' Bituminous Outside Shoulders
5' Inside Shoulders with 3' Bituminous Pavement
No Pedestrian Traffic
Abutting Property - Farm Land
Design Speed - 60 M.P.H.

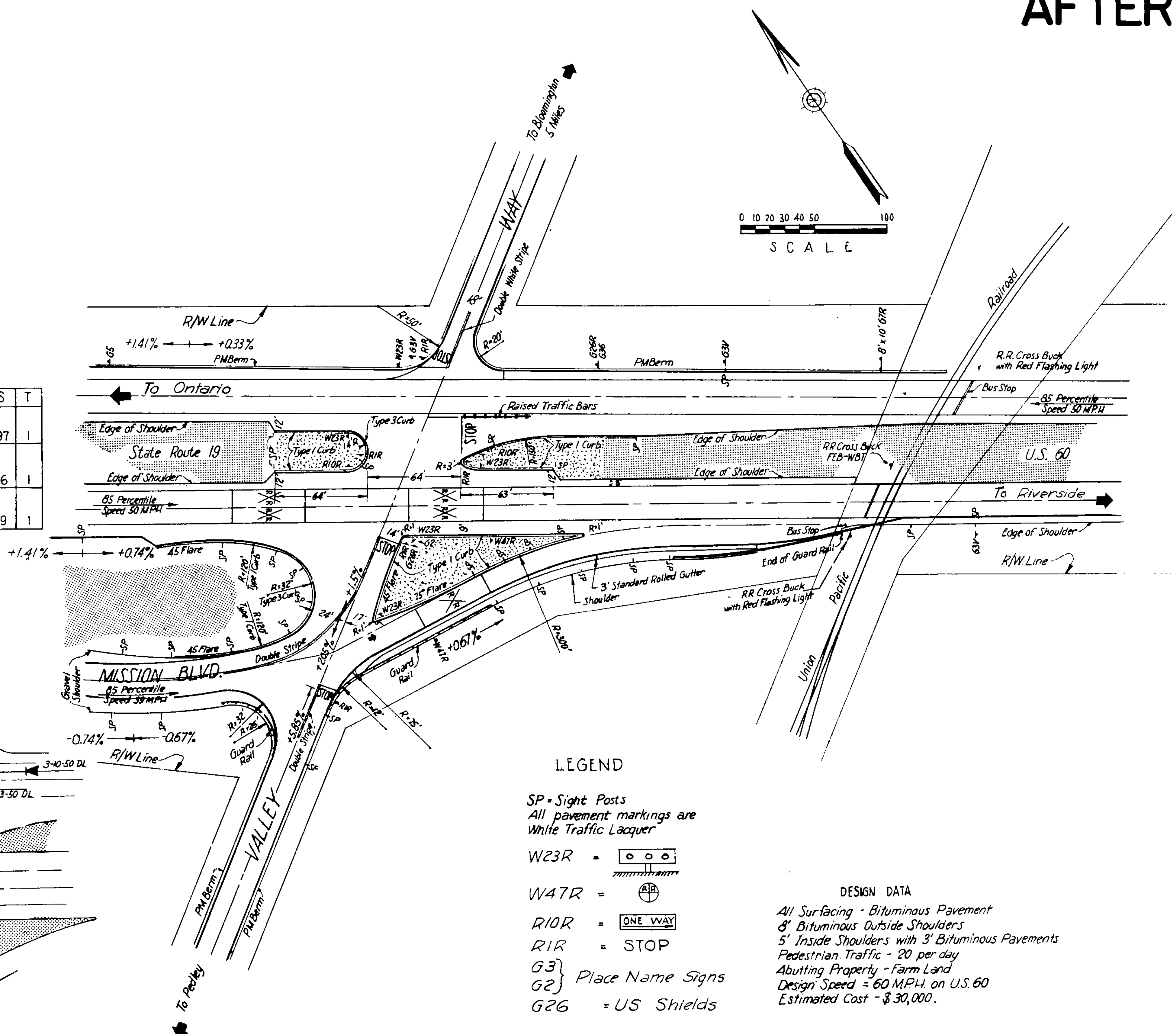
AFTER



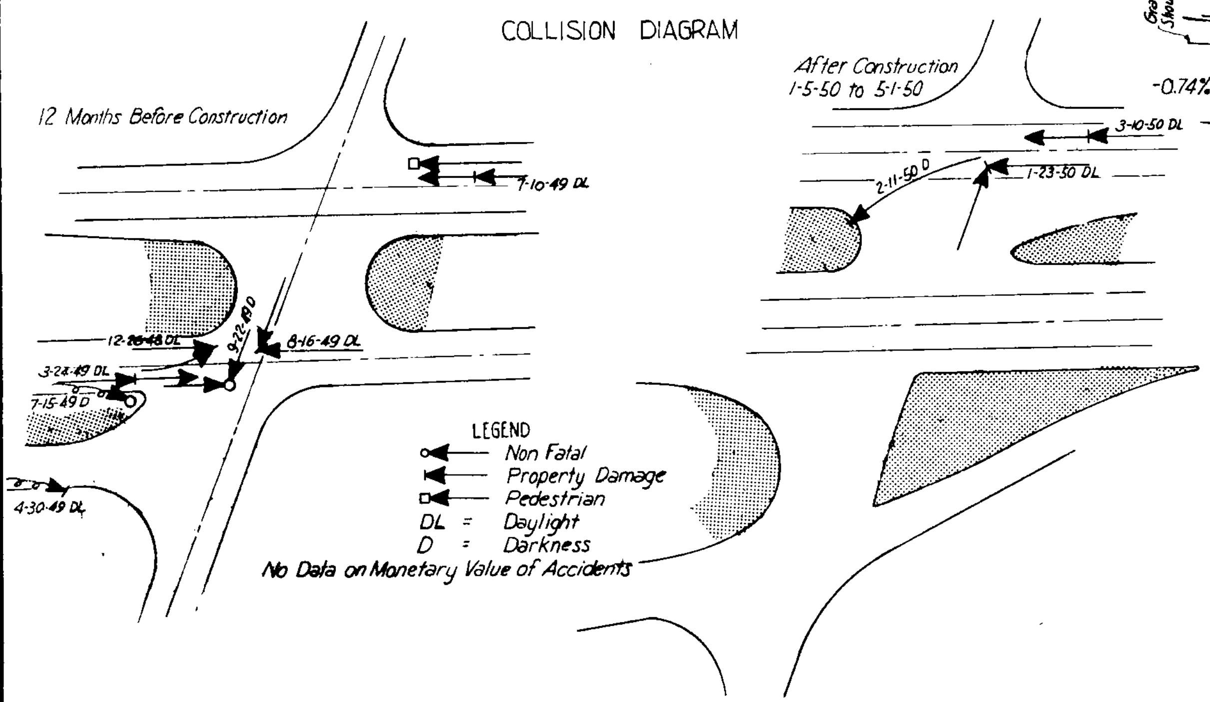
TRAFFIC VOLUME

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Average Daily Volume	7	7	2676	61	94	251	31	336	396	2356	853	16	30	24	1	9	7	930	97	1
AM Peak Hour Average Day	1	1	206	5	3	18	2	25	28	148	36	1	2	2	1	1	1	68	6	1
PM Peak Hour Average Day	1	1	182	4	11	18	2	24	30	201	93	1	2	1	1	1	1	68	9	1

14.5 % Commercial Traffic on Highway
23.1 % Commercial Traffic on Mission



COLLISION DIAGRAM



LEGEND

SP = Sight Posts
All pavement markings are White Traffic Lacquer

W23R = [o o o]

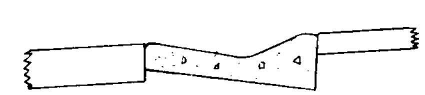
W47R = (RR)

R10R = ONE WAY

R1R = STOP

G3, G2 } Place Name Signs

G26 = US Shields



SECTION ROLLED GUTTER

DESIGN DATA

All Surfacing - Bituminous Pavement
8' Bituminous Outside Shoulders
5' Inside Shoulders with 3' Bituminous Pavements
Pedestrian Traffic - 20 per day
Abutting Property - Farm Land
Design Speed = 60 M.P.H. on U.S. 60
Estimated Cost - $ 30,000.

NO. 27 - CALIFORNIA, 3 MILES N. W. OF RIVERSIDE
MISSION BOULEVARD - VALLEY WAY - US 60 (CALIFORNIA 19)

Example 28

Location

CALIFORNIA, 6 mi. E. of San Bernardino
California 190 - 3rd Street

Submitted by

J. C. Young, Traffic Engineer,
Department of Public Works
Sacramento, California

Type of Intersection

4-Way, Oblique

Date Constructed

May 20, 1949

Physical Data

1. a. "Before" plan not shown but statement given, (under comments Regarding Over-all Operation).
3. Surface Type
   c. Shoulders: Oiled, with plant-mix berm
5. e. Other Control Devices: Raised plant-mix bars, Guide Posts: shown on plan, Reflectorized Delineators: Reflectorized sight posts, also yellow reflectors.

Traffic Data

5. Accidents
   a. No recorded accidents "Before" or "After" for one year period each.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. Not specified; see comment following
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. See comment on median lanes, deceleration lanes, and free right-turning lanes, following
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Before redesign, the existing route was a narrow two-lane road with two right angle turns approximately one-quarter mile apart. Southbound traffic on Route 190 made a boulevard stop before making a left turn onto Third Street. After redesign Route 190 was constructed on new location, intersecting old Route 190 at three locations, the middle intersection being at a point approximately one-half way between the two former right angle turns.

   Through this intersection, median lanes were constructed on Route 190, which separated north and southbound traffic and provided deceleration lanes for left turning traffic off of Route 190. A free right turning lane was provided for eastbound traffic on Third Street, which turned south onto Route 190.

   The reconstruction of this portion of highway has greatly facilitated the movement of through traffic on Route 190.

   There were no accidents at this intersection during the year period before construction and there have been none since reconstruction."

Comments by Committee Members

1. GUY KELCEY - The channelization shown appears to be as satisfactory as possible for this acute angle intersection. It would have been better if, in the redesign of the route, the secondary roadway could have been brought across Route 190 at a right angle.

2. EUGENE MAIER - The intersection of California 190 and 3rd Street is an excellent example of channelization of a 4-way oblique rural highway intersection. Outstanding features of the design include: (a) Free-flowing separated right-turn lanes with adequate accelerating areas; (b) Added left-turn lanes with adequate decelerating areas for vehicles turning left from the major roadway. An alternate design would be separated left turn lanes as used at the intersection in Example 1; (c) Good treatment of the approach ends of channelizing islands; (d) Funneling of separated turning lanes.

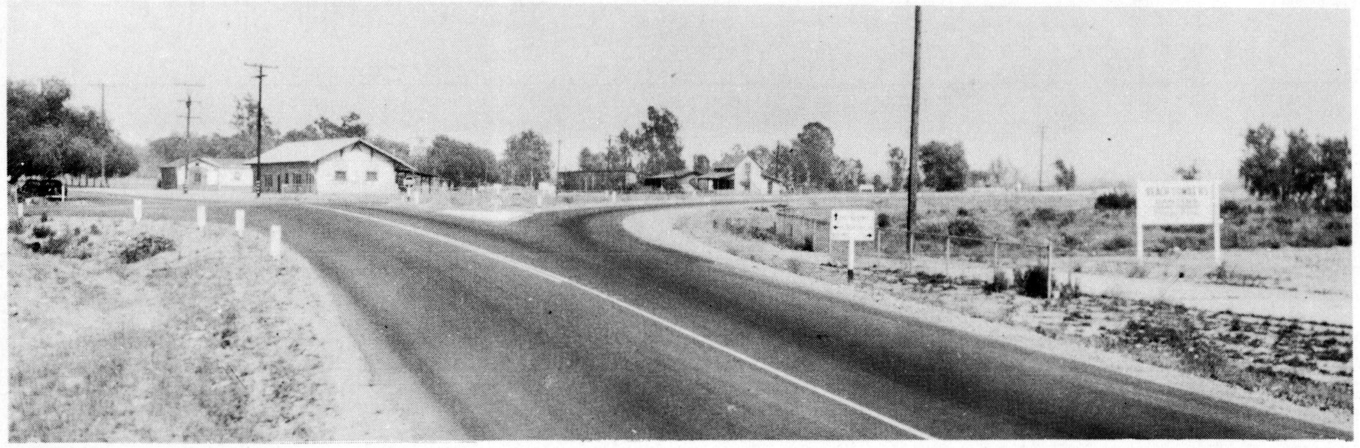


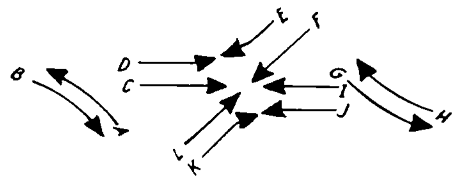
Figure 1. Intersection of California 190 and 3rd Street looking east. Note the separated right-turn lane and the treatment of the approach end of the channelizing island.

Figure 2. Looking north on US 190, showing the deceleration area and the added left-turn lane

AFTER

NO. 28 - CALIFORNIA, 6 MILES E. OF SAN BERNARDINO
CALIFORNIA 190 - 3rd STREET

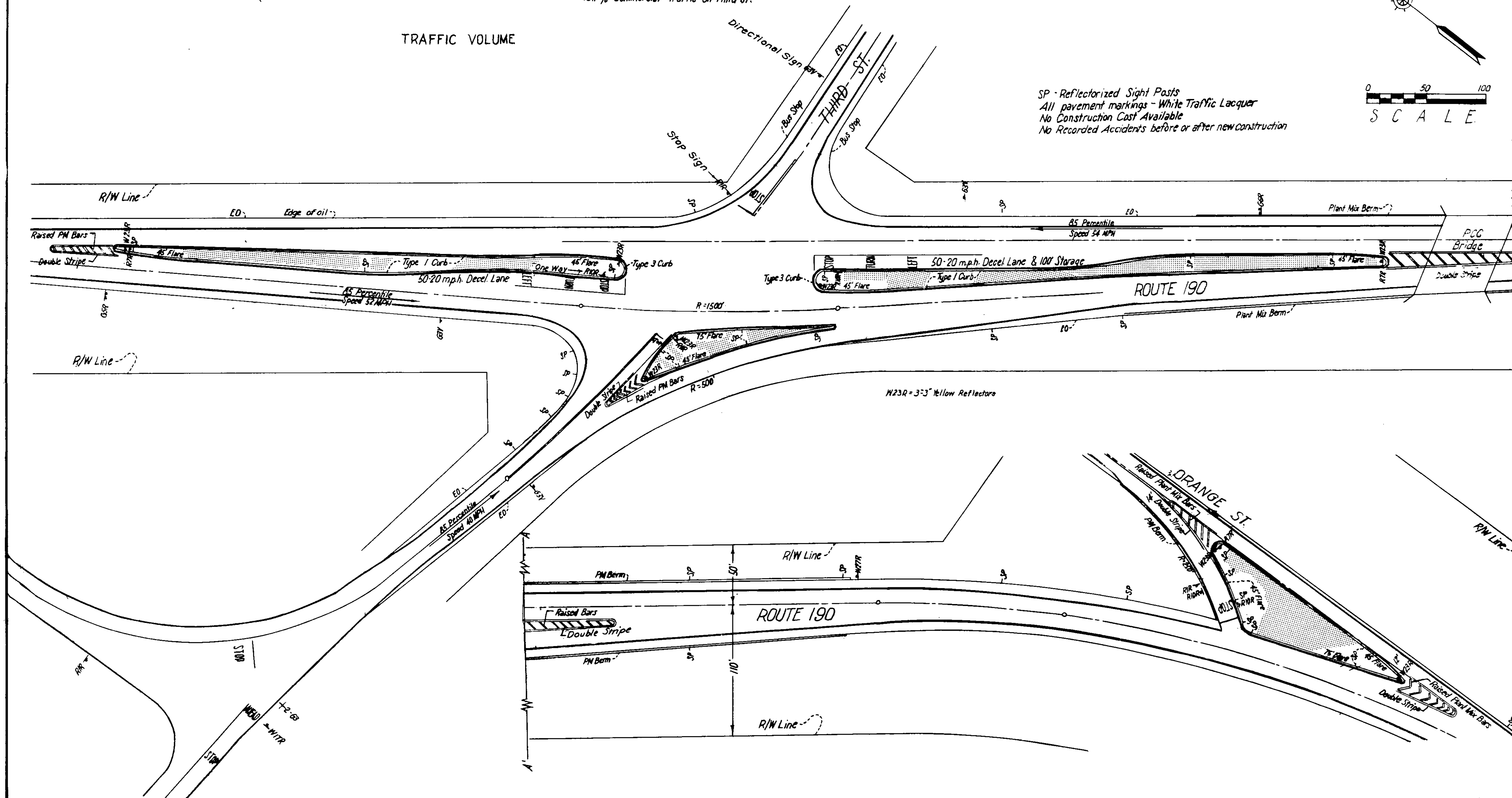
	A	B	C	D	E	F	G	H	I	J	K	L
Average Daily Volume	61	51	1052	46	67	196	201	131	680	622	742	190
AM Peak Hour - Average Day	3	5	75	1	5	9	13	9	63	51	44	12
PM Peak Hour - Average Day	7	3	86	6	5	22	19	11	40	43	71	17



TRAFFIC VOLUME

11.8 % Commercial Traffic on Highway
13.1 % Commercial Traffic on Third St.

SP - Reflectorized Sight Posts
All pavement markings - White Traffic Lacquer
No Construction Cost Available
No Recorded Accidents before or after new construction



Example 29

Location

DELAWARE, Southwest of Wilmington
Maryland Avenue - Boxwood Road - Middleborough Road

Submitted by

William J. Miller, Jr.
Traffic and Planning Engineer,
State Hwy. Dept., 152 South State Street,
Dover, Delaware

Type of Intersection

4-Way, Oblique

Date Constructed

1946

Physical Data

3. Surface Type
   c. Shoulders: mostly sidewalks
5. Traffic Control Devices
   b. Signals: Type: A four way, three color, isolated, fixed time signal system is in operation at this intersection, with a continuous green arrow for Western Maryland Ave. traffic turning into Boxwood Road. Timing: A 42-sec. signal is used with 28 sec. green for Maryland Avenue and 12 sec. green for Boxwood Road.
   e. Other Control Devices: Attention is called to the wire pedestrian fence located on the sidewalk on the northwest corner of the intersection. This fence is intended to make pedestrians cross at right angles to the right turning traffic leaving Maryland Avenue and entering Boxwood Road. It has been in since the job was completed and has been working very well.
7. Abutting Property
   a. Character or Land Use: Abutting Properties are generally suburban homes except for the trolley turn indicated on the sketch and south of the gas station is a neighborhood theater.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: Trackless trolleys use Maryland Avenue. Buses use Boxwood Road during peak hours only.
   b. Location of Passenger Stops and Zones: The trolley turn is also used as the one bus stop in the area.

Traffic Data

5. Accidents
   b. Fatal, Personal Injury, Property Damage: Both accidents "After" appear to be property damage only.

Economic Data

1. Estimated Cost of New Installation
   a. $2,500

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. "A heavy right turning movement from Mayland Avenue is favored at this intersection with the design as used here. Boxwood Road traffic is controlled reasonably well."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. "There is little congestion in this area."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The intersection has been operating very well."

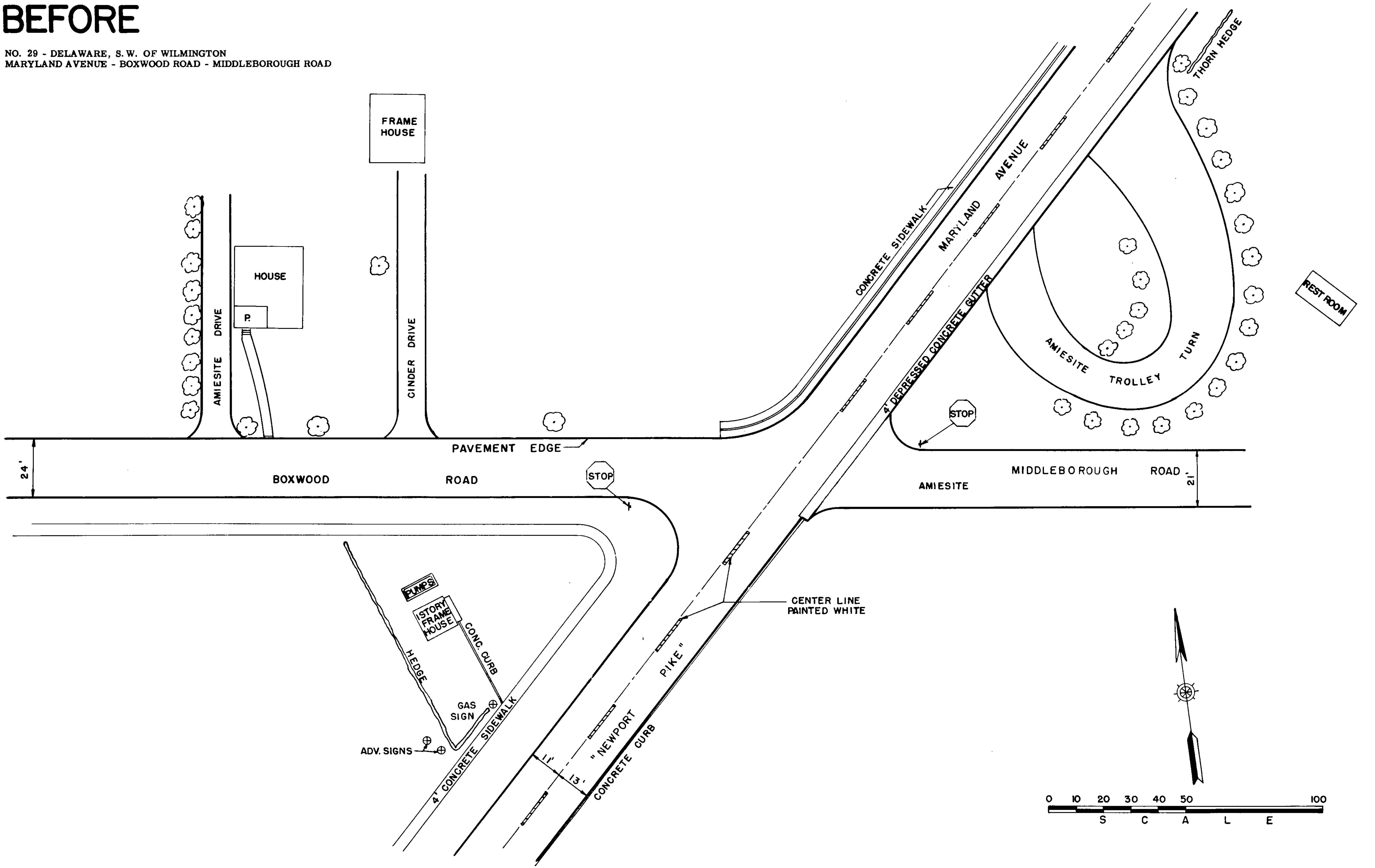
Comments by Committee Members

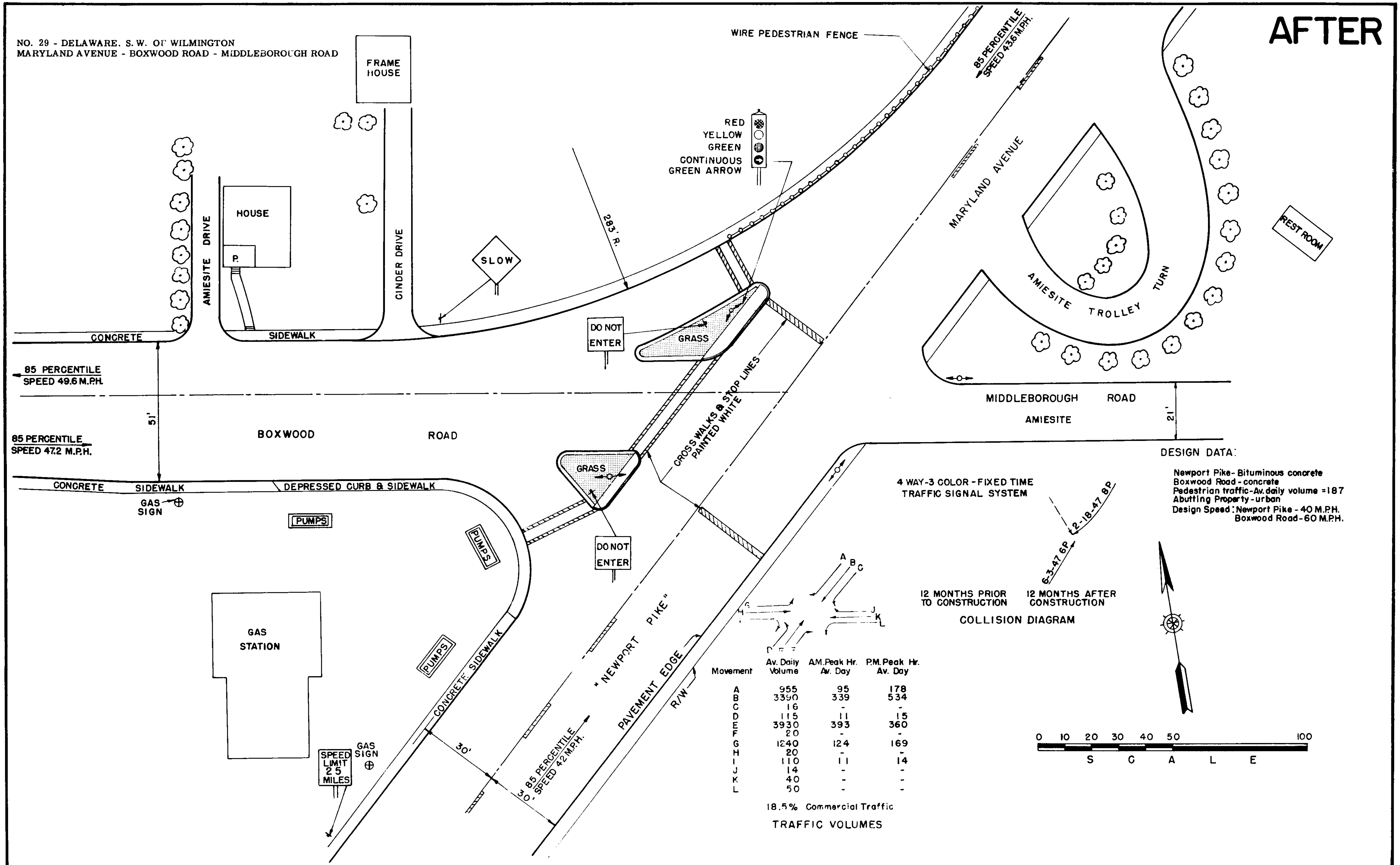
1. D. W. LOUTZENHEISER - Pavement widening provided ample capacity under traffic signal control. Two islands well located and shaped to guide turning vehicles and offer pedestrian refuge. Addition of a narrow median on Boxwood Road appears advantageous; at least a prominent centerline stripe is in order.

2. EUGENE MAIER - The channelization of the Maryland-Boxwood-Middleborough intersection is an example of intersection redesign to provide separated right turning lanes to accommodate a major traffic movement in connection with the installation of traffic control signals.
   An important element in the redesign of the intersection is the wire fence along the west side of Maryland Avenue which channelizes pedestrians to the established pedestrian crossings.
   Although there is no evidence that the eastbound traffic on Boxwood Road turning left into Maryland Avenue uses the one-way separated right turn lane, a suggested addition to the design would be the construction of a narrow (12 in.) mountable separator along the center line of Boxwood for a distance of approximately 150 ft. west of the marked crosswalk.

BEFORE

NO. 29 - DELAWARE, S.W. OF WILMINGTON
MARYLAND AVENUE - BOXWOOD ROAD - MIDDLEBOROUGH ROAD





Movement	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	955	95	178
B	3390	339	534
C	16	-	-
D	115	11	15
E	3930	393	360
F	20	-	-
G	1240	124	169
H	20	-	-
I	110	11	14
J	14	-	-
K	40	-	-
L	50	-	-

18.5% Commercial Traffic

TRAFFIC VOLUMES

Figure 1. Channelized intersection of Maryland Avenue, Boxwood Road, and Middleborough Road. Note the pedestrian barrier fence at the left of the intersection.

Example 30

Location

HAWAII,* Honolulu
Kapiolani Boulevard - Kalakaua Avenue

Submitted by

George Houghtailing, Planning Engineer,
City of Honolulu, Territory of Hawaii

Type of Intersection

4-Way, Oblique

Date Constructed

Proposed; not yet built

Physical Data

1. d. "After": photograph of model shown.
5. Traffic Control Devices
   b. Signals: Type: 3-Phase fully actuated.
7. Abutting Property
   a. Character or Land Use: apparently business and some residential.

Economic Data

1. Estimated Cost of New Installation
   a. $350,000 for reinforced concrete overpass, including acquisition of right-of-way and engineering

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. This intersection, over a period of years, has been a major problem in traffic congestion and delay in the City of Honolulu.

Traffic Volume

The total 24-hr. volume of traffic passing through this intersection is approximately 46,000 cars. The following traffic movements through the intersection have been observed:
1. Kapiolani straight-through movement - 16,100 cars
2. Kapiolani to Kalakaua right-turn movement - 7,980 cars
3. Kalakaua to Kapiolani left-turn movement - 8,120 cars
4. Kalakaua towards King Street - 4,910 cars
5. Kalakaua towards Waikiki - 5,720 cars

Traffic Control

Presently this intersection is controlled by three-phase fully actutated traffic light signals. The total cycle for the three-phase system amounts to 100 sec. distributed as follows:
1. Favoring Kapiolani Boulevard - 35 sec. green, yellow caution lights 3 sec.
2. Favoring Kalakaua-Kapiolani left turn - 30 sec. green, yellow caution light 3 sec.
3. Kalakaua towards Waikiki - 26 sec. green, yellow caution light 3 sec.

When the design of this intersection was discussed at a meeting of the Public Works Committee of the Board of Supervisors, the committee felt that in order for the public to appreciate fully the proposed design for an over-head structure at this intersection, a scale model be constructed for review by them and the citizens intersected. It was suggested that the Commission call for bids for the construction of this model overpass. Two bids were received, ranging from approximately $350 to $500. After further discussion of the matter with the Board it was suggested that the model overpass be constructed by the Building Department if there were men available to do this type of work.

An aerial photograph blown up to a scale of one-eight of an inch to a foot was used as a basic map for this model. This aerial photograph showed all of the existing buildings and other features within the intersection. The overpass proper, namely, the bridge over the intersection, will have a length of 114 ft. by 56 ft. in width. The total length of the ramps is 700 or 350 on both sides. The clearance at the center of the crown of the bridge will be 19 ft. and tapering off to the abutment with a clearance of 15 ft.

It required approximately 380 man hours by the Commission's staff to construct the model. Based on the number of working hours, the total cost of the construction of the overpass is estimated at $600, including the cost of materials and maps, an additional $150, or a total of $750.

The scale model of this project has created a great deal of interest on exhibition in the City and County lobby and in the Bishop First National Bank. Much can be said in favor of constructing scale models of important engineering projects for review by laymen who are not adaptable to reading blueprints. Models of important engineering and planning projects have been of utmost value in selling the project to communities and interested citizens.

Comments by Committee Members

1. EUGENE MAIER - The design of the proposed grade separation for the intersection of Kapiolani Boulevard and Kalakaua Avenue in the City of Honolulu includes few elements of channelization design and this example has been included primarily to demonstrate the value of scale models in the presentation of street and highway designs.

   In the development of designs for the channelization of intersections, engineers will find the use of scale models of considerable value. The models will be of particular value in the development of complex or controversial designs and for the acceptance of these designs in localities where channelization has had limited application.

   The model shown here is an outstanding example of the employment of this device for the "selling" to the public of a controversial project. More simple models can be constructed to demonstrate proposed designs for the channelization of intersections at grade.

2. E. T. PERKINS - The use of a scale model in this instance should serve to acquaint the owners of highly developed, adjacent property of the effect of the proposed improvement. It is, apparently, an area of high real estate values. The clarity and detail with which the model has been constructed are commendable.

   With the heavy cross flow that is indicated on the traffic diagram, the greatest benefit to traffic at this location would result from a separation of the cross movements. Without available space for interchange ramps, I believe the plan, as proposed, is a reasonable one and is well designed.

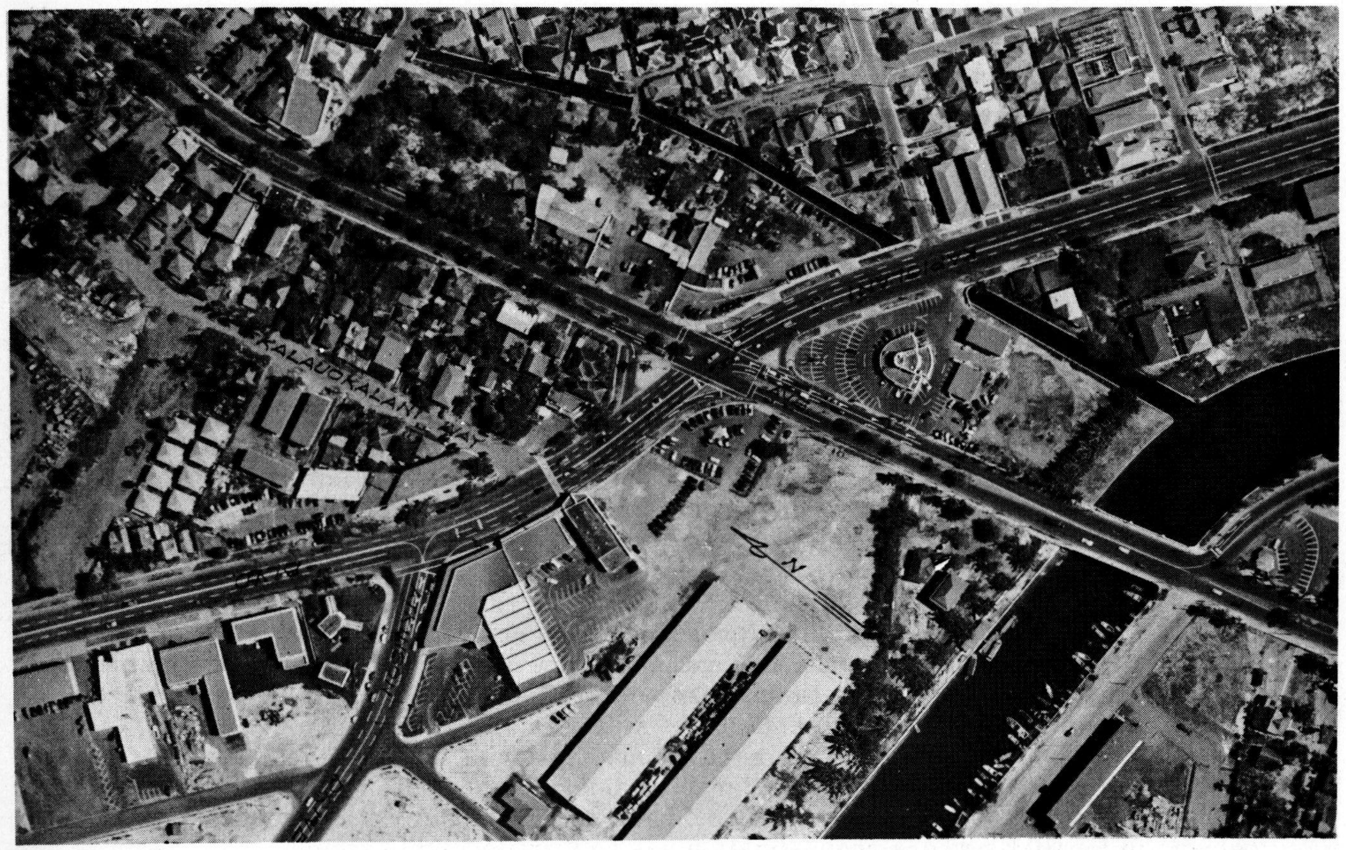


Figure 1. Existing intersection of Kapiolana Boulevard and Kalakaua Avenue, Honolulu.

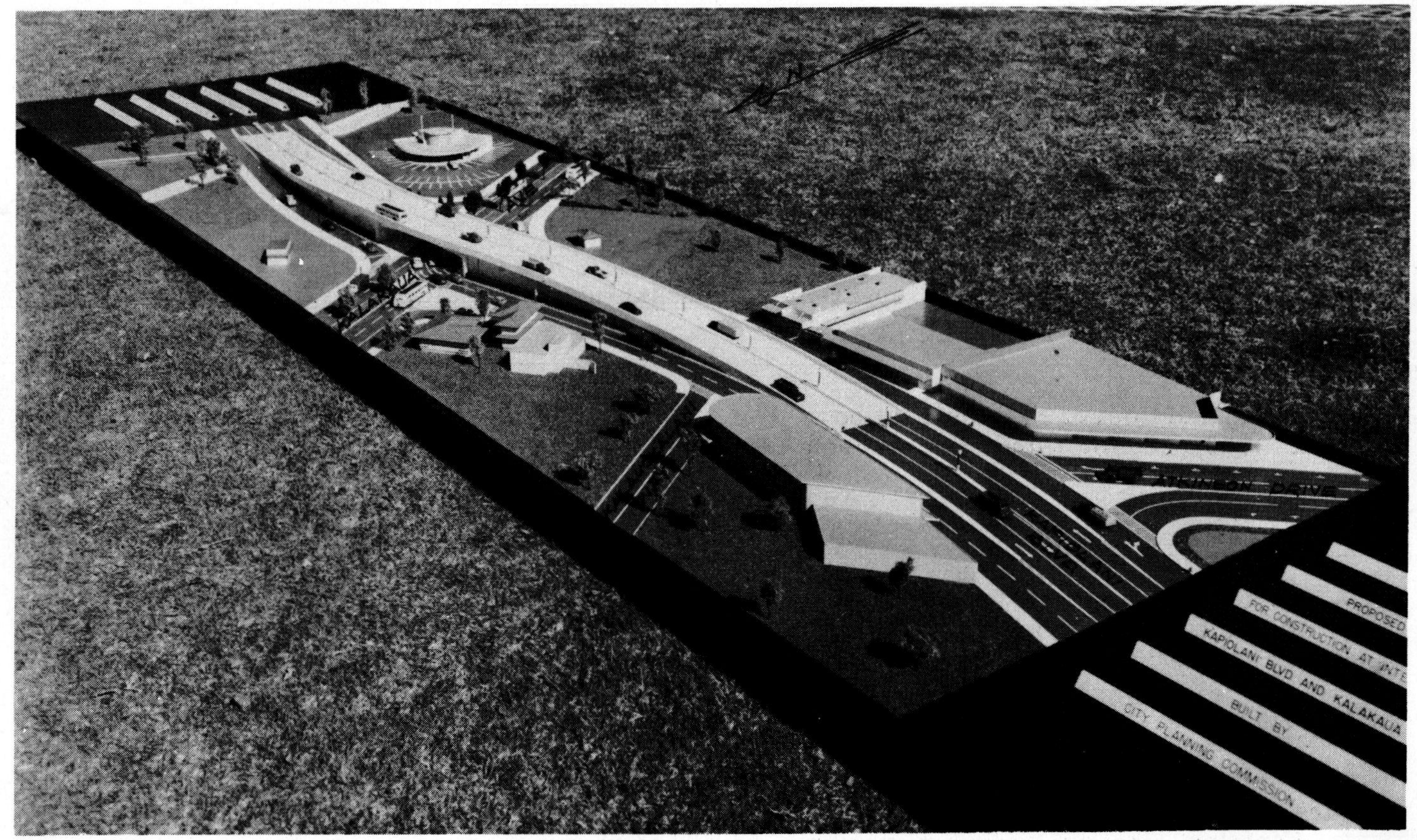
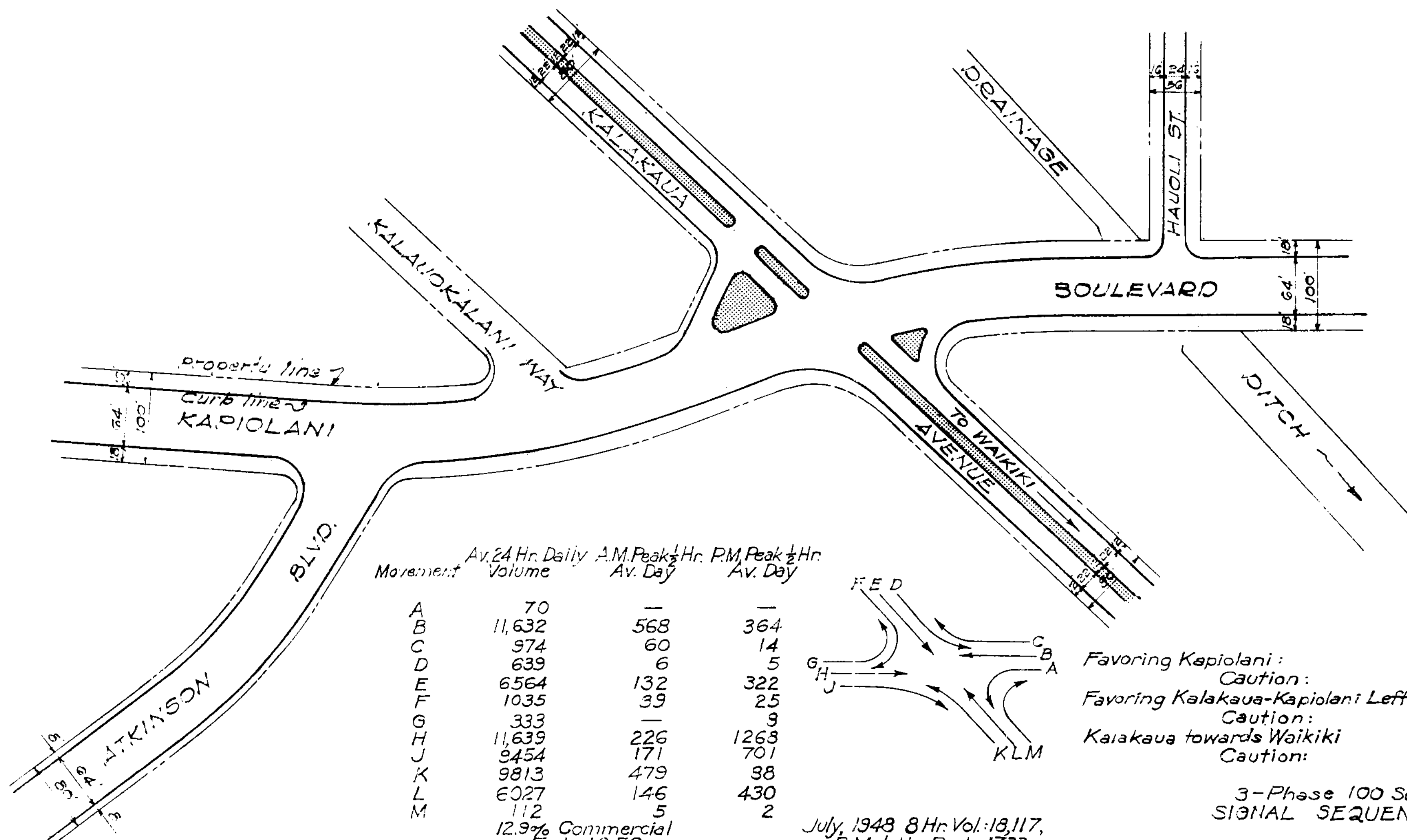


Figure 2. Scale model of proposed redesign of Kapiolani-Kalakaua intersection.

BEFORE

NO. 30 - HAWAII, HONOLULU: KAPIOLANI BLVD. - KALAKAUA AVENUE



Movement	Av. 24 Hr. Daily Volume	A.M. Peak ½ Hr. Av. Day	P.M. Peak ½ Hr. Av. Day
A	70	—	—
B	11,632	568	364
C	974	60	14
D	639	6	5
E	6564	132	322
F	1035	39	25
G	333	—	9
H	11,639	226	1268
J	9454	171	701
K	9813	479	38
L	6027	146	430
M	112	5	2

12.9% Commercial
Feb., 1950
TRAFFIC VOLUMES
Total 24 Hr. Vol.: 58,292

July, 1948 8 Hr. Vol.: 18,117,
P.M. ½ Hr. Peak: 1733
Total 24 Hr. Vol.: 46,000

Favoring Kapiolani:	35 sec. green
Caution:	3 sec. yellow
Favoring Kalakaua-Kapiolani Left Turn:	30 sec. green
Caution:	3 sec. yellow
Kalakaua towards Waikiki	26 sec. green
Caution:	3 sec. yellow

3-Phase 100 Sec.
SIGNAL SEQUENCE

0 50 100
SCALE

EXISTING STREET LAYOUT AT KAPIOLANI BOULEVARD AND KALAKAUA AVENUE INTERSECTION

NOTE:- We have no pedestrian count at this intersection.

Example 31

Location

ILLINOIS, District 1 near Lake Zurich
US 12 - Illinois 22 and 63

Submitted by

Harry H. Harrison, Traffic Engineer,
Illinois Division of Highways,
Springfield, Illinois

Type of Intersection

4-Way, Oblique

Date Constructed

June, 1948

Physical Data

5. Traffic Control Devices
   a. Signs: Type: "No special signs are used. Standard highway signs are maintained on all approaches to the intersection. See the Illinois Manual of Traffic Control Devices for details."
   b. Signals: The signals are full traffic actuated, and therefore do not have a fixed-time cycle.
   c. Markings: Type: no special markings are used
   d. Lighting: Type: none
   e. Other Control Devices: Guide Posts: none
6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: Drive-in establishments, mostly filling stations.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: None, except through buses on US 12.

Traffic Data

1. Volumes
   a. Average Daily: shown on plan.
   "The only reliable traffic counts were taken in 1946 and 1947. During 1949 and 1950, US 12 north of Lake Zurich has been under reconstruction, and any counts taken at the intersection would not represent normal conditions. Traffic today, if under normal conditions, would be somewhat heavier than in 1947. However, the turn- and through movements would be in about the same proportions."
   e. Pedestrian: negligible
2. Type
   b. Percent Commercial: "Relatively high on US 12, and relatively low on Illinois 22 and 63."
3. Speeds
   a. Approach Speed: 85 Percentile. "Approach speeds from both directions on US 12 are high. Those on Illinois 22 and 63 are much lower, especially from the east."
   c. Average Operating Speeds Through Intersection: "Operating speeds through the intersection are influenced by the traffic signals. No surveys have been taken to determine the average approach or operating speeds. US 12, as a four-lane divided pavement, is designed for high speed.
4. Delays at the intersection are due to traffic signal control, not channelization. Channelization helps reduce delay by allowing the traffic signals to be placed closer to the intersection.
5. Accidents
   a. Collision Diagram is not available for this intersection. The installation of traffic signals was the big factor in the reduction in the number of accidents, rather than the channelization. Because both were installed at the same time, it is difficult to determine how much channelization did to reduce accidents.
6. Pedestrian
   a. Volumes: negligible

Economic Data

1. Estimated Cost of New Installation
   a. $600 for cost of islands only

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "One of the principal advantages of this channelization with traffic signals is that it allows the signals to be placed closer to the center of the intersection. This enables vehicles to stop at the proper place by the signal instead of pulling ahead of it as is the case if the intersection has wide rounded corners."
   "In such a channelization, the lane for the right-turning vehicles is designed to be just wide enough to permit right turns to be made without difficulty, yet not too wide to encourage vehicles on the other road to make left turns into it. In spite of that, some vehicles do attempt such a left turn, and that situation may be potentially more dangerous with channelization than without."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "Because the channelization allows traffic signals to be placed closer to the intersection, congestion is reduced. The reason for this is that the distance on which vehicles must travel across the intersection is less, and more vehicles can cross on a green light."

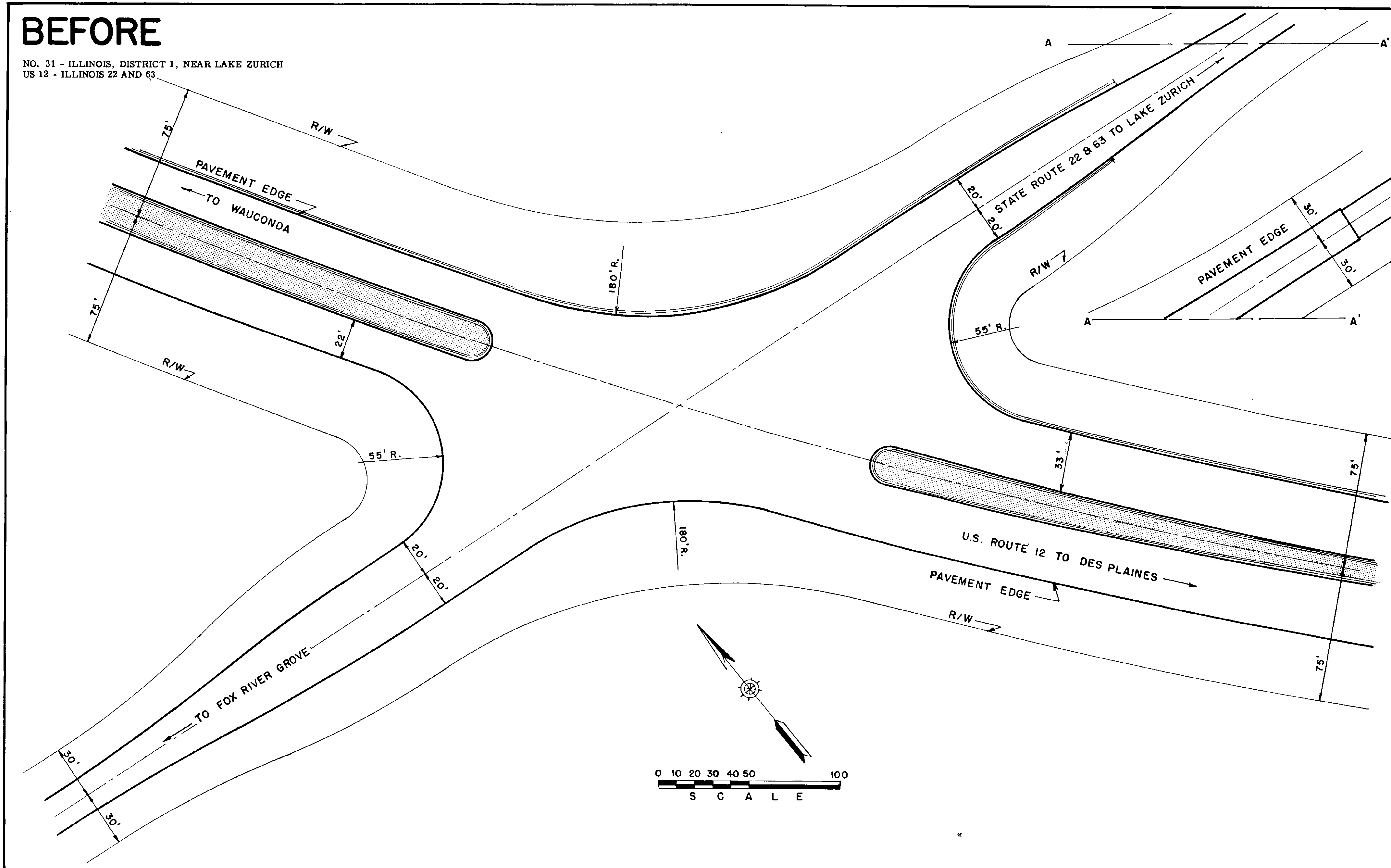
Comments by Committee Members

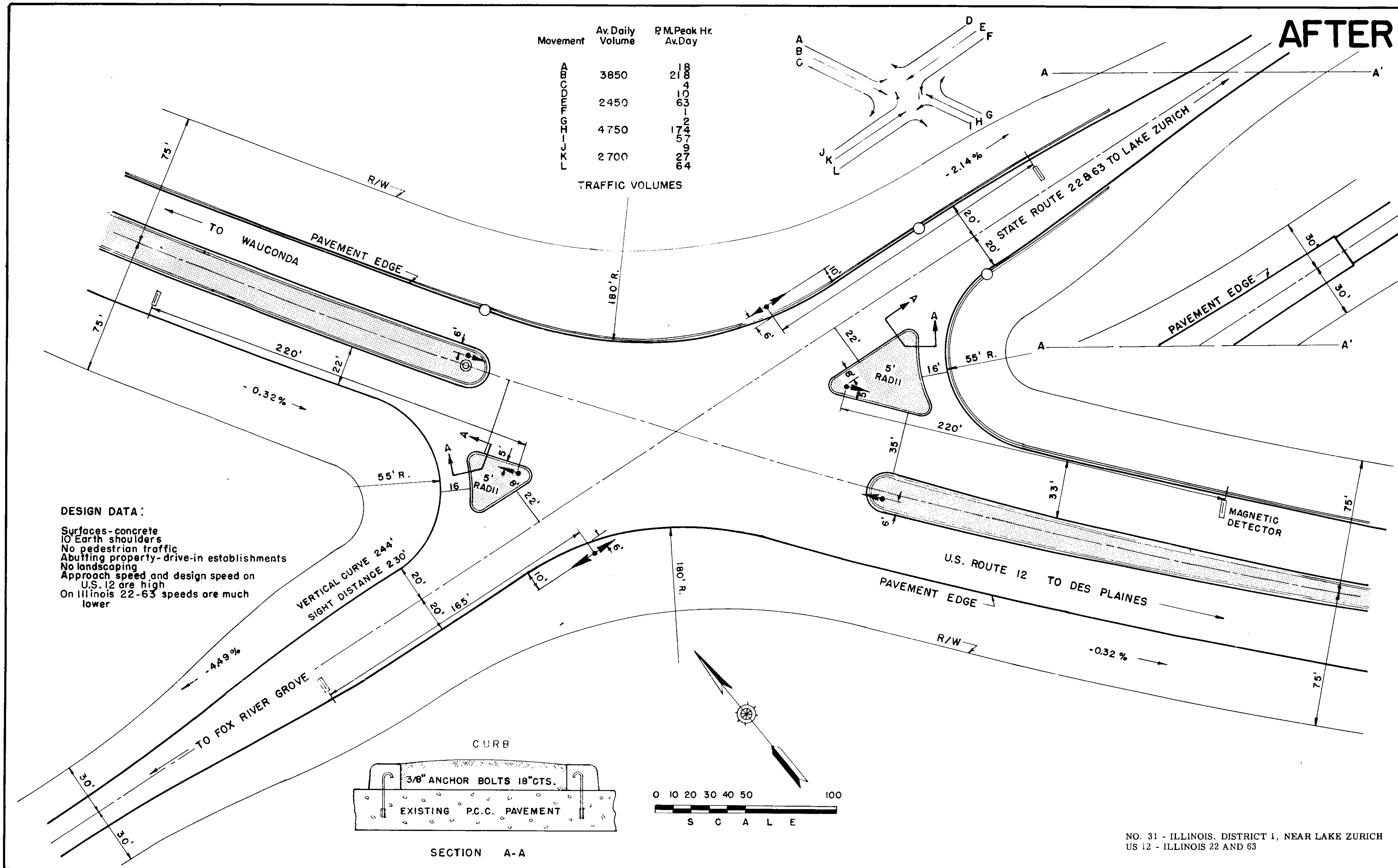
1. GUY KELCEY - While no treatment of an acute angle intersection is usually wholly satisfactory, the island installation shown is about as good as is possible under the circumstances. However, leeway is left for long radius, high speed, left turns at sum-of-the-speeds angles northbound on US 12 to westbound on State 22 and 63 and southbound on US 12 to eastbound on 22 and 63. If these turns are troublesome, a solution would be to extend the present islands on US 12 closer in to the intersection. The present gap between these islands is about 220 ft. This gap might be closed up to 100 ft. or even less to advantage. Or, not so good, narrow, low curb islands placed approximately on the centerline in both throats of State Route 22 and 63 would reduce this difficulty. Placement of these low and narrow curb islands should provide adequate turning radii for the other two left turns.

2. D. W. LOUTZENHEISER - This layout is hazardously wide open, with an opening about 225 ft. between the semicircular median ends. This permits flat-angle crossings between

BEFORE

NO. 31 - ILLINOIS, DISTRICT 1, NEAR LAKE ZURICH
US 12 - ILLINOIS 22 AND 63





NO. 31 - ILLINOIS, DISTRICT 1, NEAR LAKE ZURICH
US 12 - ILLINOIS 22 AND 63

the left-turn movements to leave the divided highway and the opposing through traffic. Median ends readily could be extended inward and by use of unsymmetrical bullet-nose design (patterned to permit left turns to enter the divided highway on a control edge radius of 50 to 60 ft.) the length of opening reduced to about half that shown. These ends would amply clear the cross road width. The outside of the triangle islands could have been made tangent, giving a better funnel effect.

This layout should handle much higher volumes than those indicated. For the volumes shown, the good traffic signal controls tend to cover up the wide open layout hazards.

The photos indicate driveways to corner businesses. While not shown on the plans, these offer additional interference and the intersection with them is not as clear-cut as the unbroken pavement edge lines suggest. Drive-way movements should be an essential part of any intersection plan.

Figure 1. Channelization of acute-angle intersection of high-speed state route, US 12, and secondary highway, Illinois 12 and 22, near Lake Zurich. Right-turn islands provide better placement of signals and remove right turns from intersection.

Figure 2. Close-up of south corner island, traffic signal, and curbs. Median on US 12 just beyond far vehicle.

Example 32

Location

MISSOURI, St. Louis County
Jennings Sta. Rd. - Kienlen Ave.
Natural Bridge Road

Submitted by

Robert W. Hodson, Division Engineer,
Missouri State Highway Department,
322 South Kirkwood Road,
Kirkwood 22, Missouri

Type of Intersection

4-Way, Oblique

Date Constructed

1947-1948

Physical Data

4. Cross Section not shown because not unusual.
5. Traffic Control Devices
   a. Signs: Type: standard; lettering of signs shown on plan, size: standard, some are mounted on traffic light pole, others mounted independently.
   b. Signals: Type: fully automatic with adjustable time intervals, location: shown on plan, timing: adjusted to traffic requirements.
   c. Markings: Type: none
   d. Lighting: Type: none, other than down lights on traffic signal poles
   e. Other Control Devices: Guide Posts: finger boards for destination directions.
6. Landscaping
   a. Grass plots in southeast quadrant.

Traffic Data

4. Delays: only when lights operate for non-existent cross traffic.
5. Accidents
   a. Collision Diagram: "Before": none reported for 12 months period. "After": none reported for 12 months period.

Economic Data

1. Estimated Cost of New Installation
   a. Construction: $42,000; Right-of-Way: $47,480

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
"The elimination of left turns in the main intersection and the construction of ramps in the southeast and northwest quadrants to facilitate turning movements, contribute to both safe and efficient operation."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
"The traffic signals contribute to safety by controlling flow of traffic, but if the signals were traffic actuated, delays during late evening and early morning periods would be eliminated."
3. Comments Regarding Over-all Operation of the Channelized Intersection:
"This improvement has aided in handling a greater volume of traffic, has eliminated many complaints and is considered safe and practical in overall operation."
Comment by Mr. D. W. Loutzenheiser of the Bureau of Public Roads in suggesting this intersection as an example: "A crossing under traffic signal control operated without left turns. Includes two at-grade inner loops, one of recent construction, the other via streets."

Comments by Committee Members

1. J. A. REDMAN - This interesting example of elimination of left turns by conversion to right turns at a grade intersection appears to work well from the designers description. However, the geometric design could be materially improved on the available area. By directing left turn traffic through the intersection twice (straight ahead and right turn) the widths at the main intersection may in some cases have to be increased to handle the increased volume on the second entrance to the main intersection. This method is particularly good in this case due to heavy pedestrian traffic which interferes with turning movements.

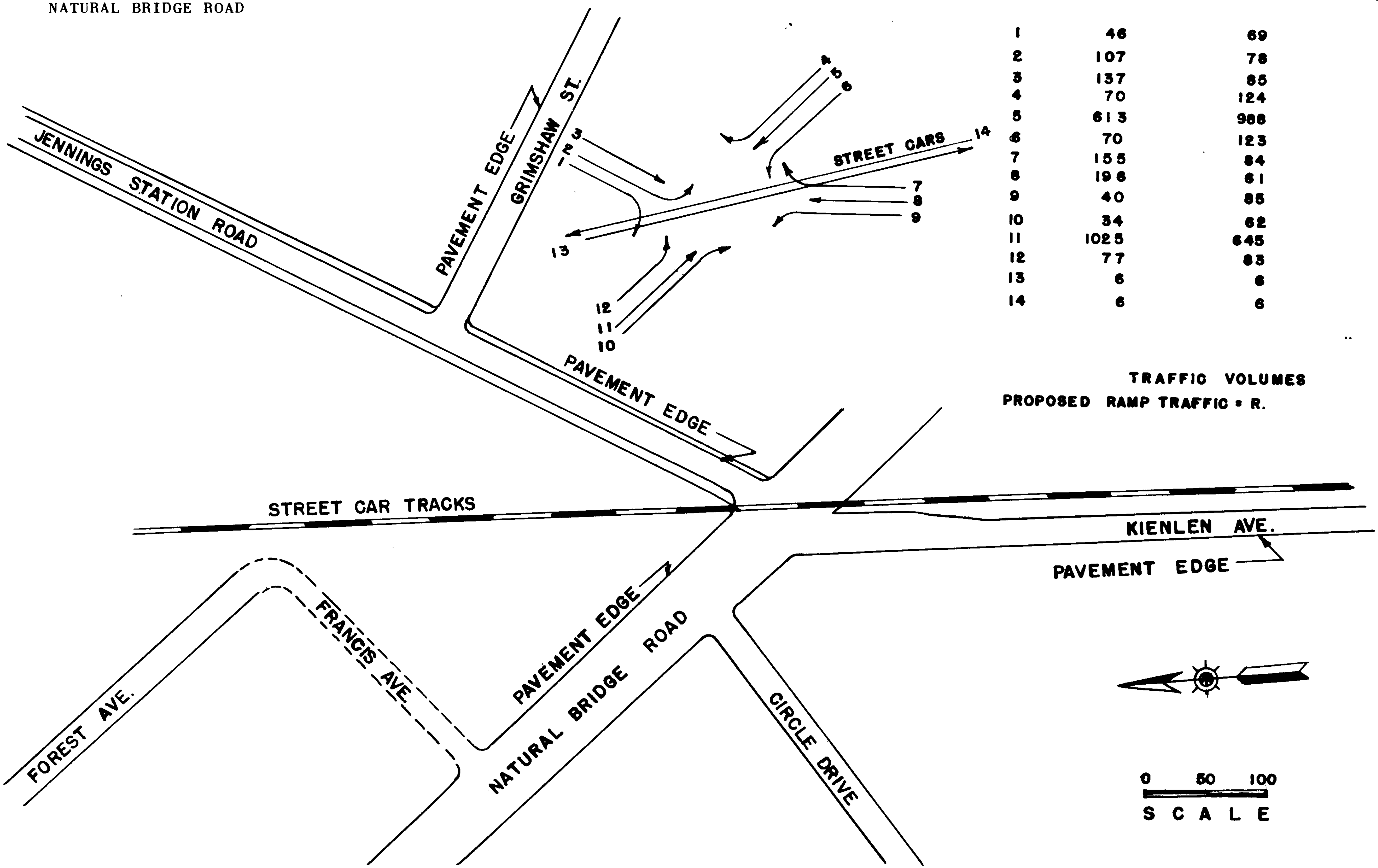
2. J. C. YOUNG - This method of eliminating left turns at a signalized intersection seems worth a try where the left turning volume is very small. If the left turning volume were as much as 20 percent of the through volume, a three-phase signal system without loops would be more economical of green time, since the loop method puts all left turns through the intersection twice.
Left turns NB to WB and SB to EB are still accomplished as left turns, albeit between intersections instead of at the intersection. This appears to be not as desirable as eliminating them would be, and also seems as though it would block a through lane just as much as if the turns took place at the intersection. It is noted that the turn from WB on Natural Bridge to SB on Kienlen must go an extreme distance out of the way.
The design could be improved by omitting the smallest of the three islands in the southeast quadrant. Except for holding the Directional sign, it is not understood what this island is for.

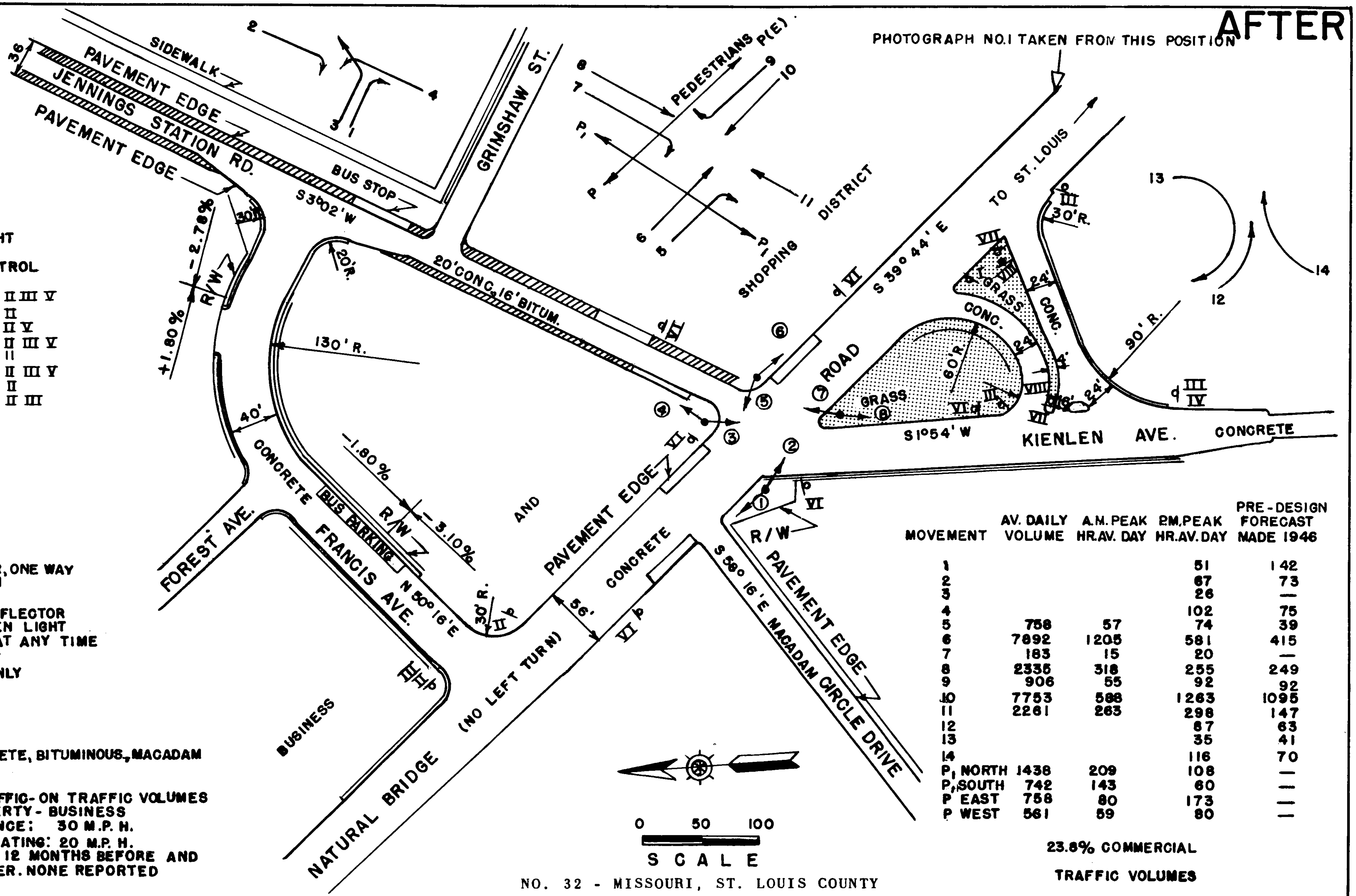
BEFORE

NO. 32 - MISSOURI, ST. LOUIS COUNTY
JENNINGS STATION ROAD-KIENLEN AVE. -
NATURAL BRIDGE ROAD

MOVEMENT	A.M. PEAK HR. AV. DAY	P.M. PEAK HR. AV. DAY	PRE-DESIGN FORECAST MADE IN 1946
1	46	69	73 R.
2	107	78	63 R.
3	137	85	249
4	70	124	92
5	613	988	1095
6	70	123	142 R.
7	155	84	70 R.
8	196	61	147
9	40	85	75 R.
10	34	62	39
11	1025	645	249
12	77	83	41 R.
13	6	6	—
14	6	6	—

TRAFFIC VOLUMES
PROPOSED RAMP TRAFFIC = R.





LIGHTS

R = RED
A = AMBER
G = GREEN
DL = DOWN LIGHT

TRAFFIC CONTROL

① R-A-G-DL, II III V
② R-A-G-DL, II
③ R-A-G-DL, II V
④ R-A-G-DL, II III V
⑤ R-A-G-DL, II
⑥ R-A-G-DL, II III V
⑦ R-A-G-DL, II
⑧ R-A-G-DL, II III

SIGNS

I DO NOT ENTER, ONE WAY
II NO LEFT TURN
III STOP SIGN
IV RED LENS REFLECTOR
V WALK ON GREEN LIGHT
VI NO PARKING AT ANY TIME
VII ONE WAY ONLY
VIII RIGHT TURN ONLY

DESIGN DATA:

SURFACES-CONCRETE, BITUMINOUS, MACADAM
8' SHOULDERS
ISLANDS-SOD
PEDESTRIAN TRAFFIC-ON TRAFFIC VOLUMES
ABUTTING PROPERTY-BUSINESS
SPEEDS: ORDINANCE: 30 M.P.H.
AV. OPERATING: 20 M.P.H.
ACCIDENTS: FOR 12 MONTHS BEFORE AND AFTER. NONE REPORTED

MOVEMENT	AV. DAILY VOLUME	A.M. PEAK HR. AV. DAY	P.M. PEAK HR. AV. DAY	PRE-DESIGN FORECAST MADE 1946
1			51	142
2			67	73
3			26	—
4			102	75
5	758	57	74	39
6	7892	1205	581	415
7	183	15	20	—
8	2335	318	255	249
9	906	55	92	92
10	7753	588	1263	1095
11	2261	263	298	147
12			87	63
13			35	41
14			116	70
P_1 NORTH	1438	209	108	—
P_1 SOUTH	742	143	60	—
P EAST	758	80	173	—
P WEST	561	59	80	—

23.8% COMMERCIAL

TRAFFIC VOLUMES

NOTE: % COMMERCIAL INCLUDES BUSSES

NO. 32 - MISSOURI, ST. LOUIS COUNTY
JENNINGS STATION ROAD-KIENLEN AVE. -
NATURAL BRIDGE ROAD

Figure 1. Channelization of intersection of Jennings Station Road, Kienlen Avenue, and Natural Bridge Road, St. Louis County, Missouri. This channelization is designed to eliminate left turns within the intersection.

Example 33

Location

MISSOURI, St. Louis
Natural Bridge - Goodfellow Boulevard

Submitted by

Robert W. Hodson, Division Engineer,
Missouri State Highway Department,
322 South Kirkwood Road,
Kirkwood 22, Missouri

Type of Intersection

4-Way, Oblique

Date Constructed

1943

Physical Data

3. Surface Type
   b. Islands: concrete surfaced
   c. Shoulders: sidewalks shown
4. Cross Section not shown because not unusual.
5. Traffic Control Devices
   a. Signs: Type: standard; see plan for lettering.
   b. Signals: Type: fully automatic with adjustable time intervals, timing: adjusted to traffic requirements.
   c. Markings: Type: none
   d. Lighting: Type: none, other than down lights on traffic signal poles.
   e. Other Control Devices: Guide Posts: none.
6. Landscaping
   a. None; islands surfaced with concrete.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: bus line operates on Natural Bridge Road.

Traffic Data

2. Type
   b. Percent Commercial: shown on "Before" plan.
4. Delays only when lights operate for non-existent cross traffic.

Economic Data

1. Estimated Cost of New Installation
   a. Not available for intersection because it was included with other improvements on Goodfellow Boulevard.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "The median strip at center and channelization islands for turning movements contribute to safe and efficient operation."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "The flow of traffic is controlled in a satisfactory manner; however, if the signals were traffic actuated, delays during the late evening and early morning periods would be eliminated."
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   'This improvement aids in handling a greater volume of traffic, eliminates complaints, and is considered safe and practical in over-all operation."

   Comment by Mr. D. W. Loutzenheiser of the Bureau of Public Roads in suggesting this intersection as an example: "A Channelized crossing under traffic signal control, with medians and some right turning lanes. Heavy volumes."

Comments by Committee Members

1. E. T. PERKINS - The westerly islands on the redesign appear to be located too far to the west. The easterly edge of the northwest island has been kept in line with the curb to the north which, for southbound vehicles in the outer lane of Goodfellow Boulevard, would appear to head them directly into the southwest island. Figure 1 indicates a revised location for the islands, as I believe they should be placed. The extension of these islands into Goodfellow Boulevard would have the effect of funneling southbound traffic into a reasonable number of lanes and prevent the wandering that must occur in the present wide street. Better protection for eastbound vehicles on Natural Bridge Road turning right into Goodfellow Boulevard would also result. If a future widening of Goodfellow Boulevard south of Natural Bridge Road is undertaken, the islands could be relocated to fit the new widths.

2. J. A. REDMAN - Existing street widths favor the lesser traffic movement (Goodfellow Boulevard). The intersection as designed would appear to be satisfactory. However, the island treatment could be revised to better protect turning movements. The northwesterly island, if extended toward the centerline of Goodfellow Boulevard, while it would have no effect on the right turn traffic, would tend to direct south bound Goodfellow Boulevard traffic (Movement No. 6) away from the island on the southerly side of Natural Bridge Road and would better serve pedestrian traffic on the northerly side of that road. There is more width on Goodfellow Boulevard than is required.

   The northeasterly island, if extended toward the centerline of Goodfellow Boulevard about ten feet would give protection to Movement No. 7 (See intersection sketch) and eliminate the need for signal No. 14.

   The width of Goodfellow Boulevard, southerly from the intersection, appears to narrow to a single lane on the east of centerline. If sufficient width were provided for Movement No. 3 to blend with Movement No. 6 then the southwesterly island could be extended toward the centerline of Goodfellow Boulevard, reducing the number of lanes south of the intersection. It would then appear possible to eliminate signal No. 3.

   Signal timing was not given, but presume it favored the east-west traffic.

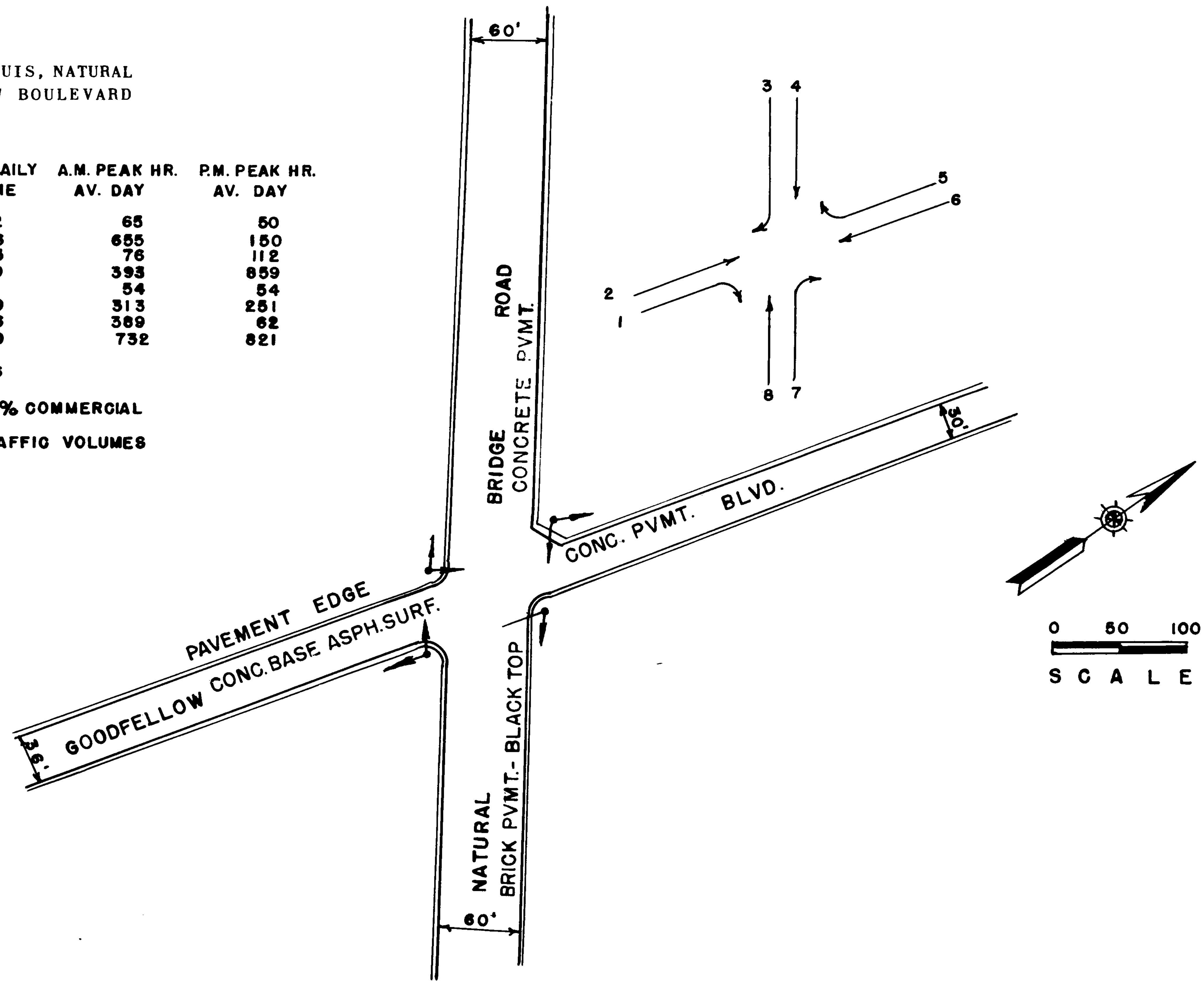
BEFORE

NO. 33 - MISSOURI, ST. LOUIS, NATURAL
BRIDGE ROAD-GOODFELLOW BOULEVARD

MOVEMENT	AV. 12 HR. DAILY VOLUME	A.M. PEAK HR. AV. DAY	P.M. PEAK HR. AV. DAY
1	632	65	50
2	2796	655	150
3	963	76	112
4	9289	393	859
5	691	54	54
6	3639	313	251
7	1736	389	62
8	7580	732	821
TOTAL	27,326		

15.2 % COMMERCIAL

TRAFFIC VOLUMES



NO. 33 - MISSOURI, ST. LOUIS
NATURAL BRIDGE ROAD - GOODFELLOW BOULEVARD

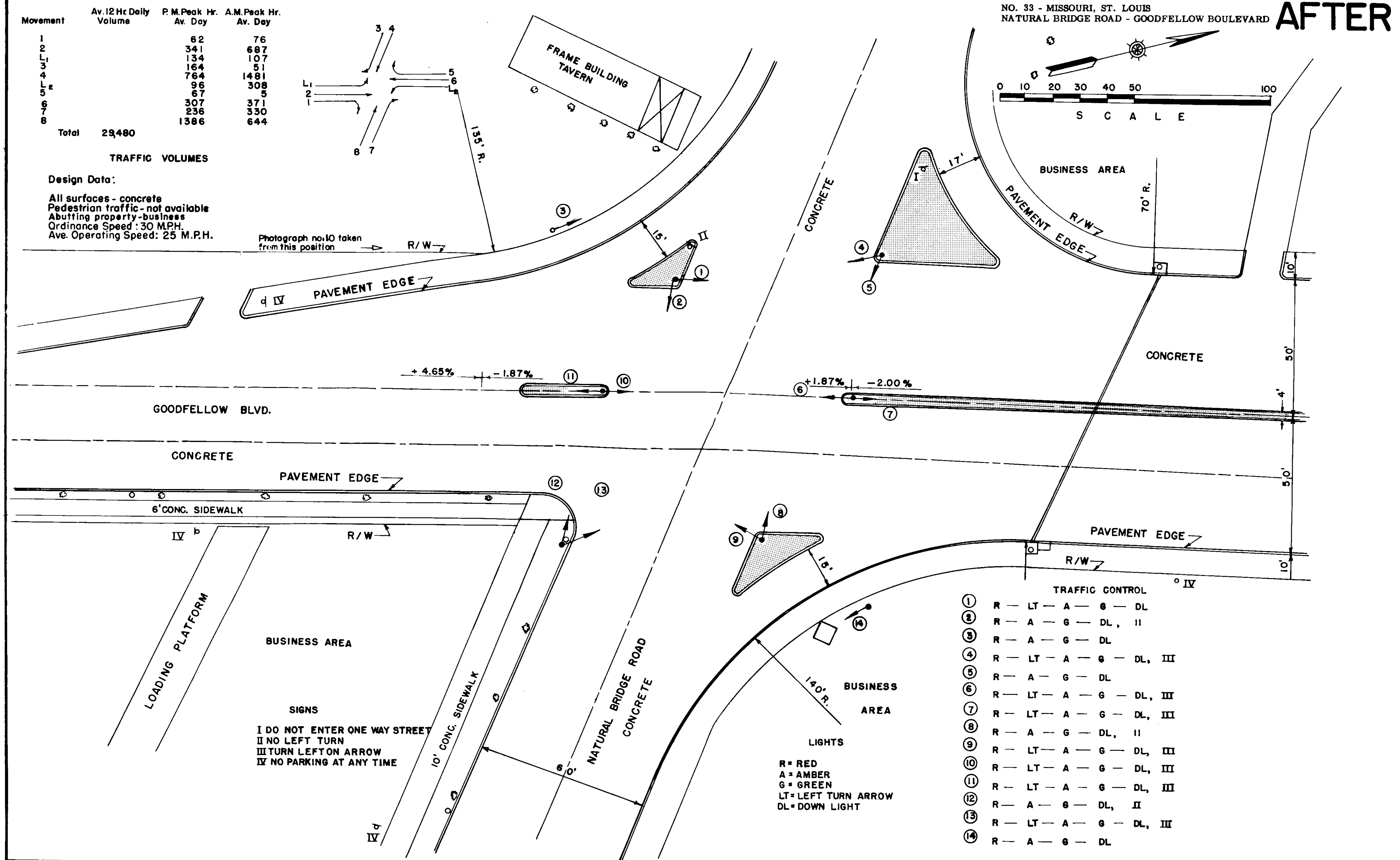
AFTER

Movement	Av. 12 Hr. Daily Volume	P. M. Peak Hr. Av. Day	A.M. Peak Hr. Av. Day
1		62	76
2		341	687
L_1		134	107
3		164	51
4		764	1481
L_2		96	308
5		67	5
6		307	371
7		236	330
8		1386	644
Total	29,480		

TRAFFIC VOLUMES

Design Data:

All surfaces - concrete
Pedestrian traffic - not available
Abutting property - business
Ordinance Speed: 30 M.P.H.
Ave. Operating Speed: 25 M.P.H.



SIGNS

I DO NOT ENTER ONE WAY STREET
II NO LEFT TURN
III TURN LEFT ON ARROW
IV NO PARKING AT ANY TIME

LIGHTS

R = RED
A = AMBER
G = GREEN
LT = LEFT TURN ARROW
DL = DOWN LIGHT

TRAFFIC CONTROL

1. R — LT — A — G — DL
2. R — A — G — DL, II
3. R — A — G — DL
4. R — LT — A — G — DL, III
5. R — A — G — DL
6. R — LT — A — G — DL, III
7. R — LT — A — G — DL, III
8. R — A — G — DL, II
9. R — LT — A — G — DL, III
10. R — LT — A — G — DL, III
11. R — LT — A — G — DL, III
12. R — A — G — DL, II
13. R — LT — A — G — DL, III
14. R — A — G — DL

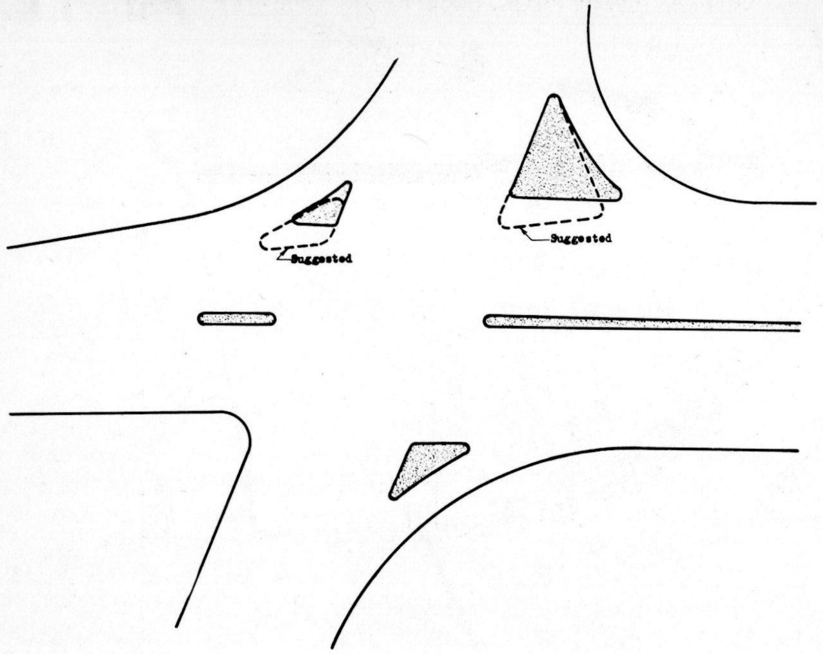


Figure 1.

Figure 2. Channelization of Goodfellow Boulevard and Natural Bridge Road, St. Louis.

Figure 3. Looking south of Goodfellow Boulevard. The small island at the left has been used for locating a traffic-control signal, street-lighting standard, and fire hydrant.

Example 34

Location

OREGON, McMinnville
US 99W - Oregon 18

Submitted by

R. H. Baldock, State Highway Engineer,
Oregon State Highway Department,
Salem, Oregon

Type of Intersection

4-Way, Oblique

Date Constructed

October, 1948

Physical Data

3. Surface Type
   c. Shoulders: not indicated except asphaltic concrete footpaths.
5. Traffic Control Devices
   b. Signals: Type: none after reconstruction.

Traffic Data

2. Type
   b. Percent Commercial: 22 percent
4. Delays not indicated except by Stop sign.

Economic Data

1. Estimated Cost of New Installation
   a. $65,000 including the cost of lighting installations.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "Although pedestrian traffic is not heavy at this point, a footpath was constructed to eliminate, insofar as possible, vehicular-pedestrian conflict. However, the main design feature contributing to safe operation was the elimination of a major portion of the area of conflict. The channelized right turn movement from OREGON 18 onto US 99W tends toward safer operation for that particular movement, even though it is a relatively light movement. The main feature resulting in safe operation was the placing of a stop sign on one leg of the US numbered highway (US 99W). This stopping of a heavy left turn movement, plus a general unfamiliarity with the new design of the intersection, caused some confusion. Also the merging lane for the right turn from the Corvallis leg of US 99W onto the McMinnville leg of US 99W has been found to be too short to allow good merging of traffic."

2. Design Features Which Relieve Congestion; Which Contribute to Congestion:

   "Although congestion was not so much the problem at this intersection, the reduction of conflict area, which tends to eliminate confusion, would be a factor in relieving any congestion."

3. Comments Regarding Over-all Operation of the Channelized Intersection:
   "Since the reconstruction of this intersection, the movement of traffic, especially on US 99W has been greatly facilitated. Prior to construction there was at this intersection, a set of semiactuated type signals with actuation required on the OREGON 18 leg. After channelization these signals were removed, with the result that traffic is now able to flow freely in all directions except that on the McMinnville leg, which, as stated above, is required to stop."

Comments by Committee Members

1. NORMAN KENNEDY - The operational characteristics of this intersection are not comparable before and after channelization since it was converted from a Y to a 4-way oblique by the relocation of Oregon Highway 18.

   The principal feature of this channelization is the provision of left-turn lanes, one for an almost negligible left-turn from new Oregon Highway 18 to the old highway; the space for such a lane is available, however, at practically no extra construction cost, and it does contribute to safe movement especially for northbound through traffic.

   It might be questioned if traffic movement M justifies the construction of a right-turn lane.

   Traffic movements O and B, both major, although volumes are not high, intersect at a hazardous oblique angle. Traffic movement O is, of course, required to stop which lessens the hazard of collision. To change the angle of intersection would require the extension of the 4-ft. median about 120 ft. southwest. This would eliminate the small island separating the left-turn lanes and require a cutting back of the island in the southwest quadrant of the intersection. The channelizing effect of the island between left-turn lanes would be lost, and a new, although probably minor, hazard would be introduced.

   Delineation of the left-turn lanes, either by the use of painted lines, mountable narrow curb, or traffic buttons would be desirable to encourage use of the lanes. It appears that the truck shown in the photograph, Figure 2, is turning left from a through lane.

2. EDWARD G. WETZEL - Analysis submitted originally with this example points out one deficiency - the short acceleration lane for right turns on US 99W to McMinnville. I would add that if this acceleration lane were lengthened with better turning radius it would be unnecessary then to require such movements to STOP.

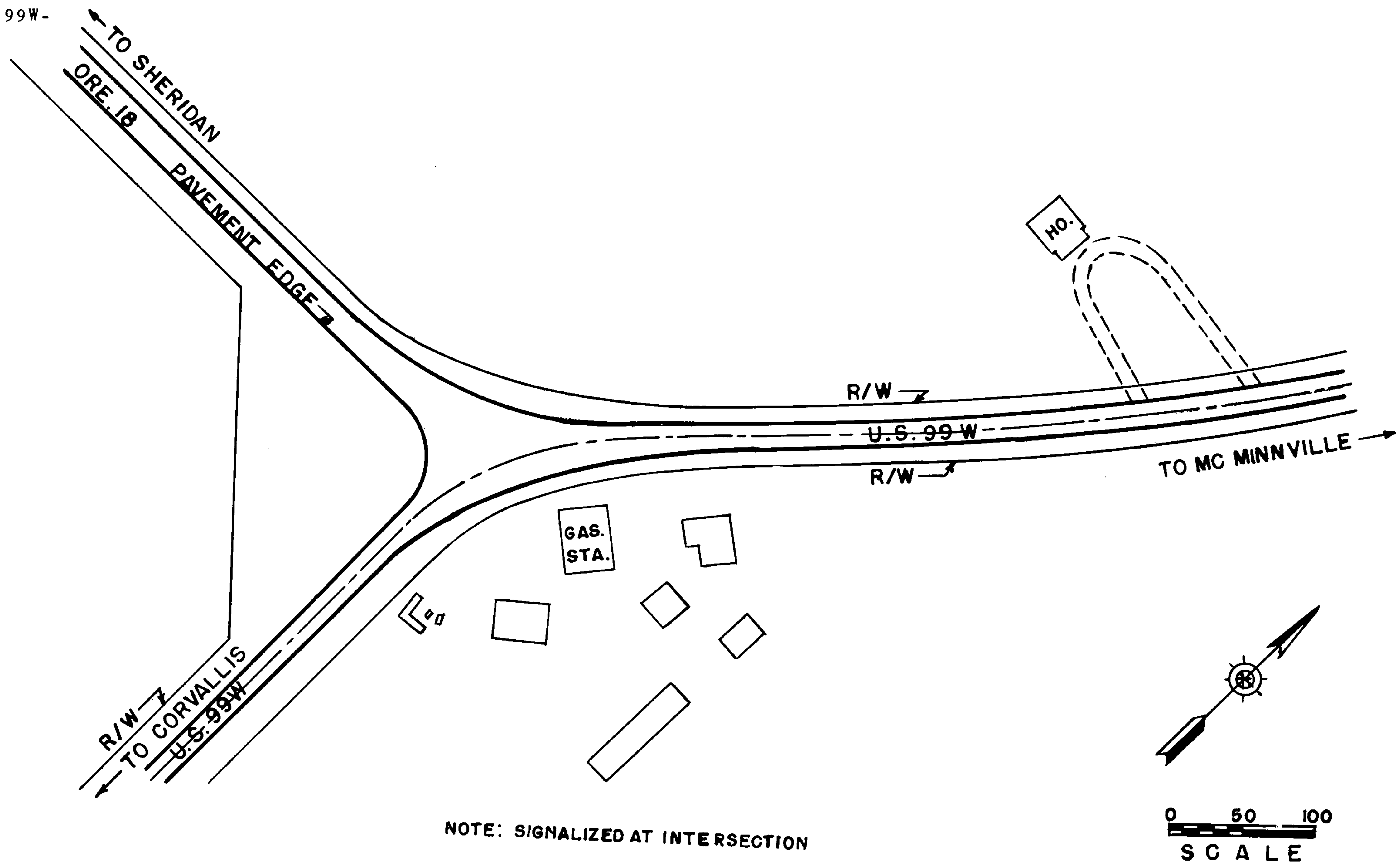
   In general this channelization scheme is satisfactory though I would question its justification. Neither the traffic and/or the accident record would seem to justify the cost of this installation.

Additional Comment by F. B. Crandall, Traffic Engineer, Oregon State Highway Commission

Reference the comment by Mr. Wetzel, please see the additional comments regarding volume warrants for channelization for Example 16.

BEFORE

NO. 34 - OREGON, McMINNVILLE US 99W-
OREGON 18

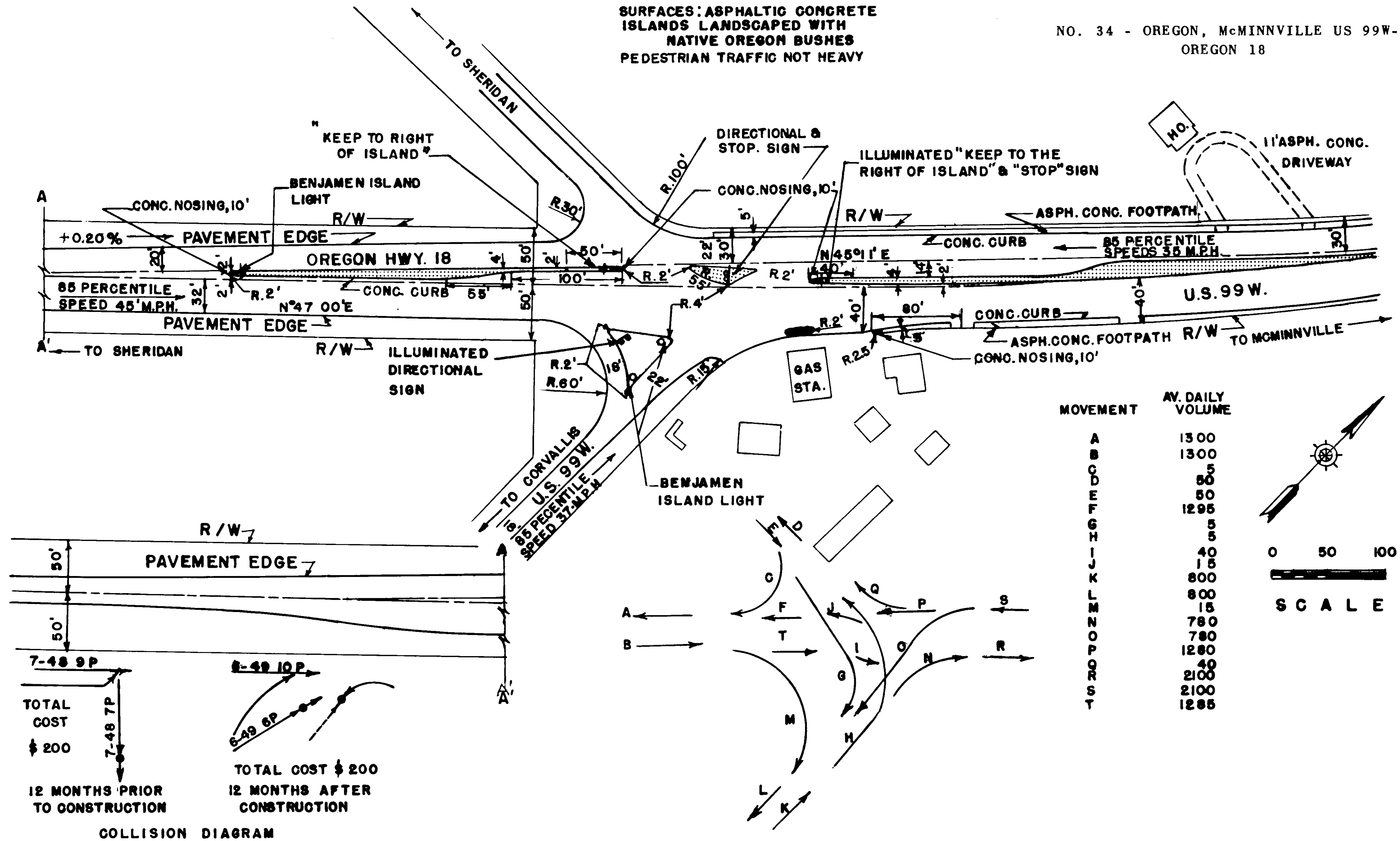


AFTER

NO. 34 - OREGON, McMINNVILLE US 99W-
OREGON 18

DESIGN DATA:

SURFACES: ASPHALTIC CONCRETE
ISLANDS LANDSCAPED WITH
NATIVE OREGON BUSHES
PEDESTRIAN TRAFFIC NOT HEAVY



MOVEMENT	AV. DAILY VOLUME
A	1300
B	1300
C	5
D	50
E	50
F	1295
G	5
H	5
I	40
J	15
K	800
L	800
M	15
N	780
O	780
P	1280
Q	40
R	2100
S	2100
T	1285

Figure 1. Channelization of four-way oblique rural intersection of US 99W and Oregon 18, near McMinnville.

Figure 2. Looking southwest from the McMinnville leg towards Willamina. Note the modern lighting used in connection with channelization of a rural intersection.

Example 35

Location

WASHINGTON, Seattle
Westlake Avenue, N. Dexter Avenue
Nickerson Street - 4th Avenue, N.

Submitted by

J. W. A. Bollong, Traffic Engineer,
400 County-City Building,
Seattle, Washington

Type of Intersection

4-Way, Oblique

Date Constructed

Traffic Signal Installed November 12, 1949

Physical Data

2. a. Grades: not of any consequence
3. Surface Type
3. a. Roadways: Westlake Avenue, blacktop; Dexter Avenue and Nickerson Street, concrete
   b. Islands: 4 in. crushed rock, 2 in. blacktop surface. The island is surrounded by white reflecting precast concrete curb of the New Jersey type.
4. Cross Section: Standard.
5. Traffic Control Devices
   b. Signals: timing: signal sequence shown.
   e. Other Control Devices: Traffic buttons shown on plan.
6. Landscaping:
   a. None
7. Abutting Property
   a. Character or Land Use: outlying commercial and residential
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: One bus route operates in both directions (north and south) between Westlake and 4th Avenue; another route in both directions between Dexter and Nickerson.
   b. Location of Passenger Stops and Zones: Bus zones for northbound Westlake - 4th Ave. route and for southbound Nickerson - Dexter route are located at curb lines slightly south of the center of the intersection; bus zones for southbound 4th Ave. - Westlake route and for northbound Dexter - Nickerson route are located immediately south of the curb return between Dexter Ave. and Westlake Ave.

Traffic Data

1. Volumes
   e. Pedestrian: 685 in 15 hr.
3. Speeds
   a. Speed limit: Westlake Avenue N., 35 mph.; others, 30 mph.
4. Delays: No delay studies were made, although operation of the bridge north of the intersection on occasions will delay enough traffic to block the intersection.
5. Accidents
   a. Collision Diagram: "Before": one year "Before" was given but only 4 months shown on plan so as to compare with "After".
   b. Personal Injury, Property Damage: Two injuries in one year "Before", with $1872 property damage.
6. Pedestrian
   a. Volumes: 685 in 15 hr.

Economic Data

1. Estimated Cost of New Installation
   a. $4,848.41 ($1,815.61 and $3,022.80)
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. $1872 for 12 months; $400 for last 4 months "Before", $255 for 4 months "After".

Operational Characteristics

1. Design Features Which Contribute to Safe Operation:
   a. Reduction of intersection area as a safety factor.
2. Design Features Which Relieve Congestion:
   a. The merging of traffic from two streets through a signalized intersection to reduce the delay occasioned by multi-phase operation of a signal.
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   a. In view of the fact that the intersection is an approach to a bridge and consequently an exceedingly high volume of traffic is funneled into it, the operation is quite satisfactory. The use of a three-dial control was necessary because of the extreme variation in traffic flow.

Comments by Committee Members

1. EUGENE MAIER - The channelization of this intersection is an example of good redesign of an existing all-paved intersection.

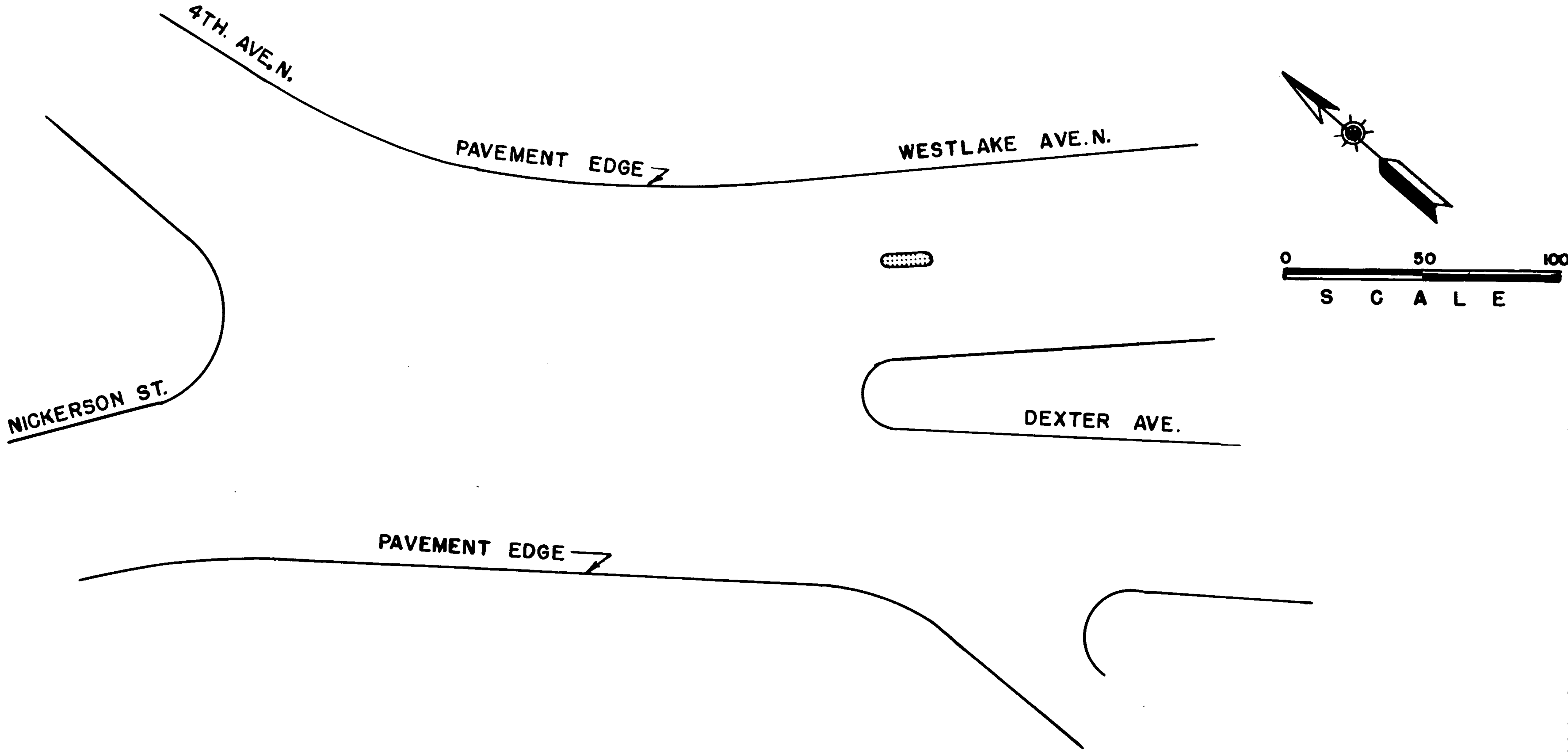
   The introduction of channelizing islands into this all-paved intersection may be considered as an essential element in the installation of traffic signal controls. Without the islands effective signal control would have been impossible. The islands have reduced the intersectional area and have provided limit lines as shown on the drawings. Right-turn lanes have been provided in two quadrants with continuous movement except for the time required for pedestrian crossing. The islands at these locations are well designed and ensure safe merging. The eastbound movement on Nickerson Street appears to be bent somewhat more than necessary. There may be a reason for this not apparent from the data furnished with the example.

2. E. T. PERKINS - The large paved area in the original intersection was conducive to wandering and must have led to considerable conflict between the various turning movements.

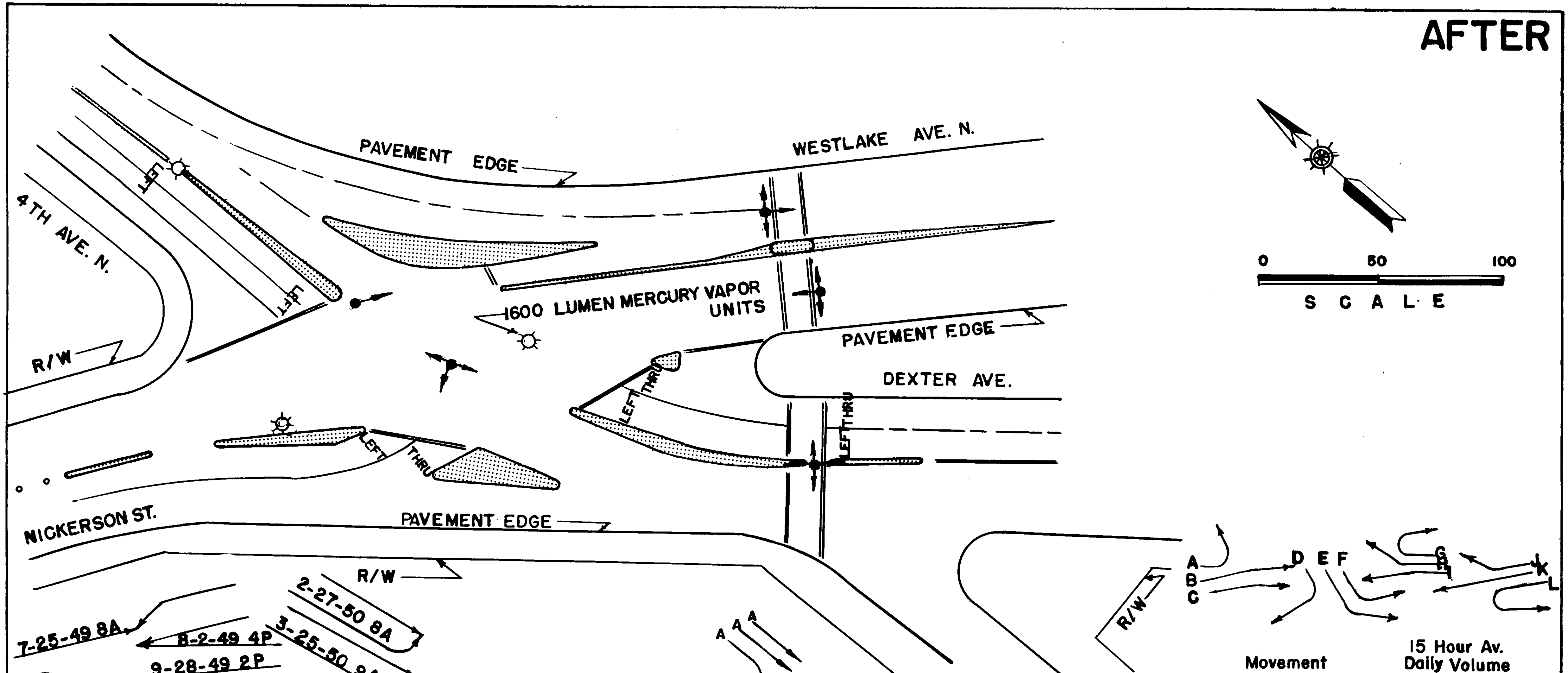
   The channelizing islands appear to be well located and I have no critical comment. If adjustments are required in island locations or channel widths, such determination could only be made after a detailed study of actual operation. By and large, I believe the design is satisfactory. The traffic signal sequence, with proper field timing, should result in maximum movement through the intersection.

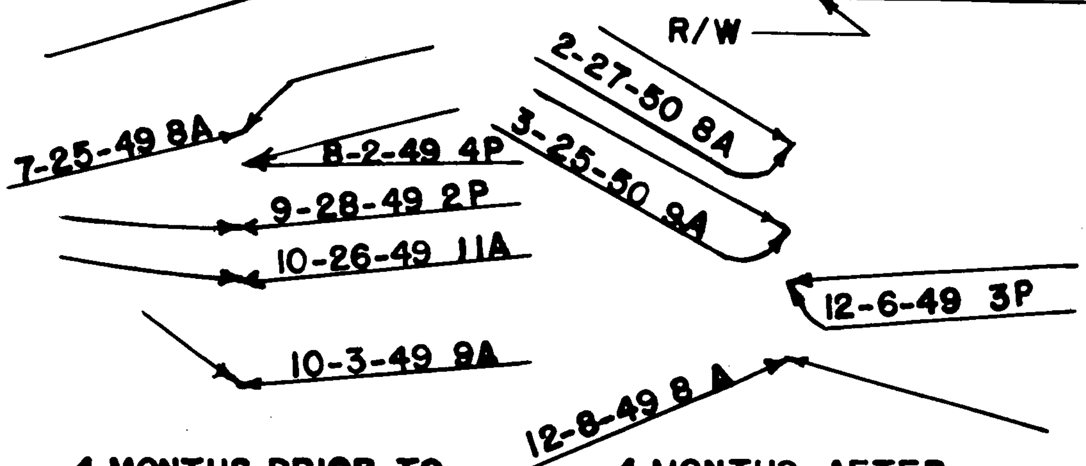
BEFORE

NO. 35 - WASHINGTON, SEATTLE-WESTLAKE AVENUE, N. - DEXTER AVENUE-NICKERSON STREET-4th AVENUE, N.



AFTER





4 MONTHS PRIOR TO CONSTRUCTION

Total Damage

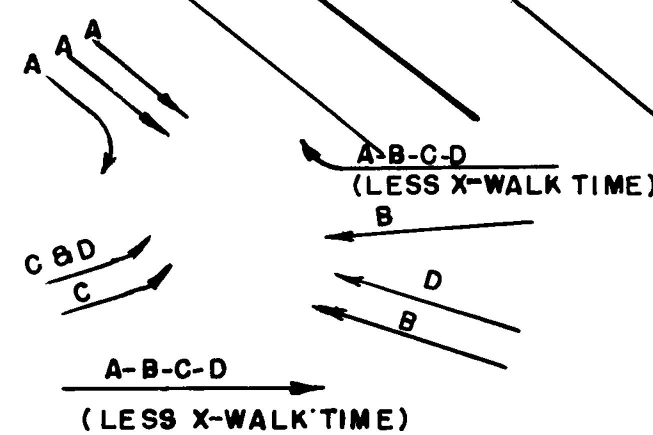
$400

4 MONTHS AFTER CONSTRUCTION

Total Damage

$255

COLLISION DIAGRAM



TRAFFIC SIGNAL SEQUENCE

NO. 35 - WASHINGTON, SEATTLE-WESTLAKE AVENUE, N. - DEXTER AVENUE-NICKERSON STREET-4th AVENUE, N.

Movement	15 Hour Av. Daily Volume
A	3400
B	1700
C	800
D	328
E	2100
F	6200
G	194
H	1600
I	300
J	7000
K	1089
L	300

TRAFFIC VOLUMES

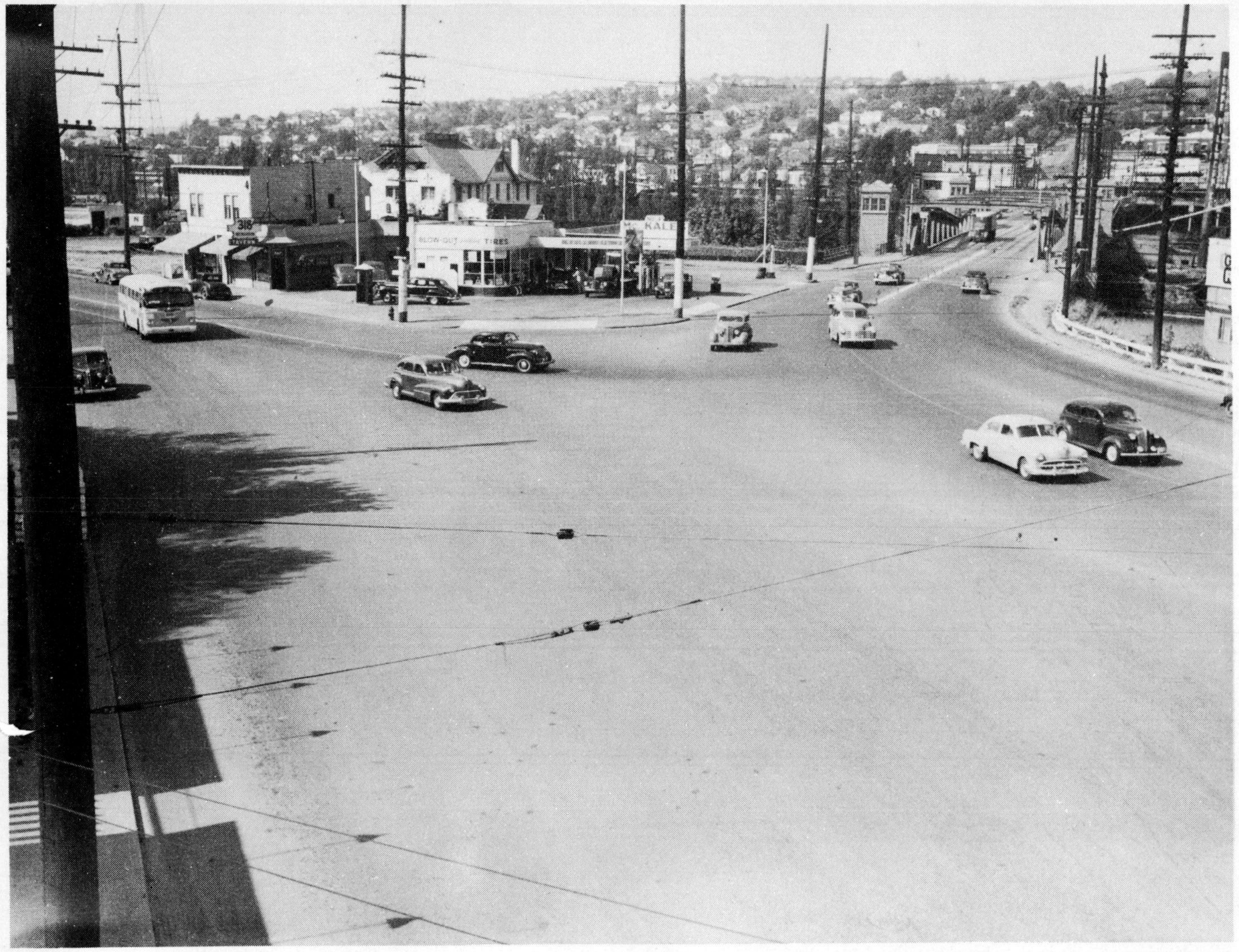


Figure 1. Intersection of 4th Avenue, N., and Nickerson Street, looking north from Dexter Avenue, Seattle, before channelization.

Figure 2. Intersection looking west after completion of channelizing islands and signal controls.

Example 36

Location

KENTUCKY, Frankfort
Main Street - High Street - Capitol Avenue

Submitted by

Kentucky Department of Highways,
Frankfort, Kentucky

Type of Intersection

4-Way, Offset

Date Constructed

September 15, 1949

Physical Data

1. d. "After": photograph shown. "The white band which appears to be a stop line on the Capitol Avenue approach is an expansion joint which was reflecting a glint of sunlight when the picture was made. Stop lines for this approach can be seen in front of a bus approximately 40 ft. north of this expansion joint."
3. Surface Type
   a. Roadways: concrete surface throughout the intersection; Main Street and High Street approaches are bituminous; Capitol Avenue approach is Portland cement concrete.
   c. Shoulders: sidewalks.
4. Cross Section has 3 to 1 side slopes and 12 to 1 end slopes.
5. Traffic Control Devices
   c. Markings: Type: crosswalk and Stop lines
6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: primarily residences with some business establishments.
   b. Location and Importance of Entrances: there is no rear access to establishments located north of the intersection.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: no bus stops within intersection. City bus routes follow Main Street and Capitol Avenue. Westbound inter-city buses entering from the east leave via High Street. Eastbound inter-city buses enter from the West Main Street approach and leave via East Main Street and Capitol Avenue.
9. Right-of-Way Limits
   a. Curb lines establish right-of-way limits.

Traffic Data

4. Delays not available; do not have equipment necessary for obtaining this information.
6. Pedestrian
   a. Volumes: 12-hr. daily volume of 367 at Main and High Streets

Economic Data

1. Estimated Cost of New Installation

   a. $300

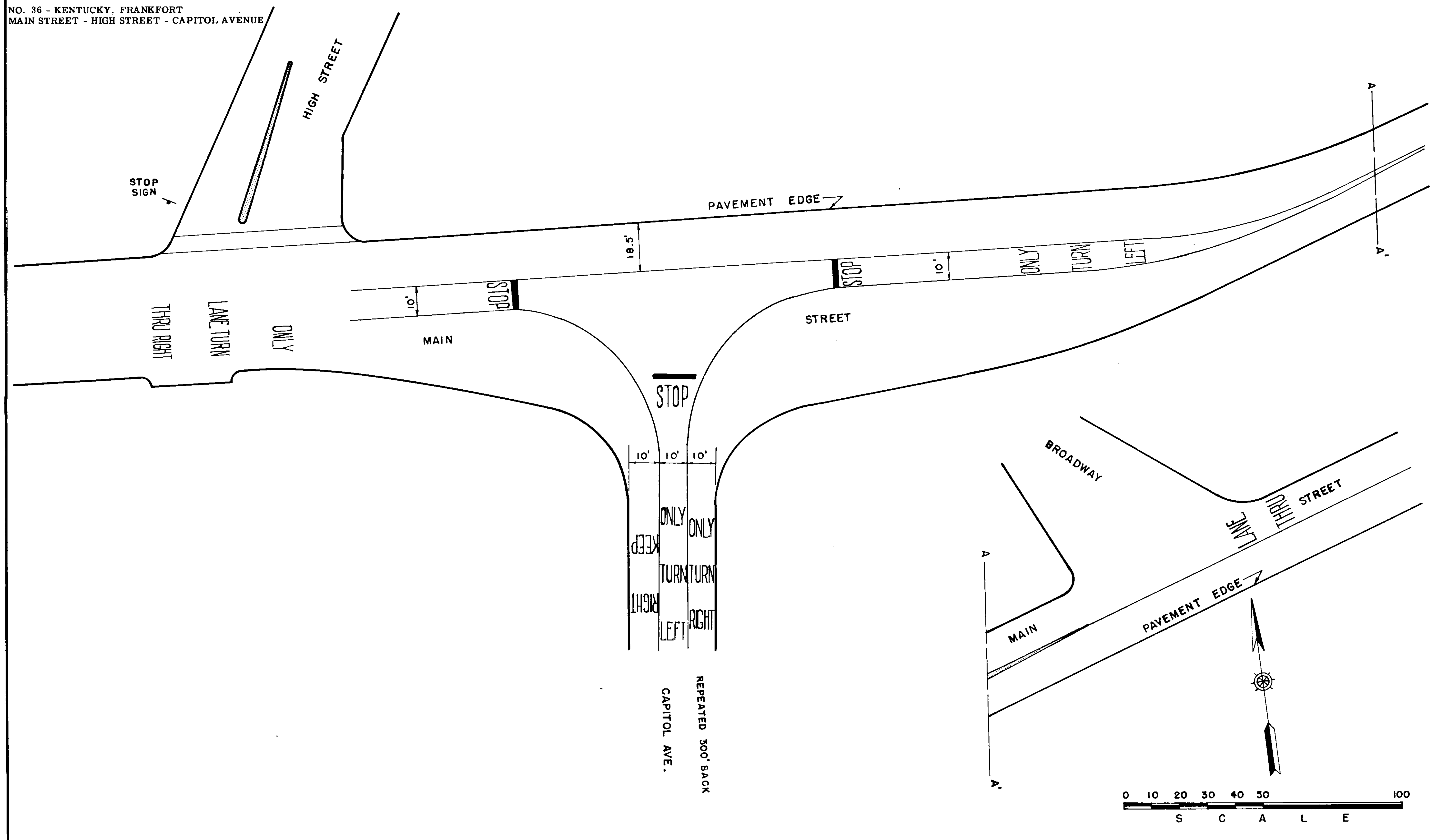
Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "The principal purpose of this protection was to eliminate the degree of confusion brought about by the promiscuous use by motorists of the large unprotected area in the intersection. All accidents were of a minor nature.
   Probably the feature which contributes the most to safe operation is a separation of opposing "through" traffic lanes on Main Street. Previous to the island construction, westbound "through" traffic moved freely while left turning westbound traffic was required to stop. Eastbound "through" traffic also was required to stop directly in front of the left turning traffic mentioned above. Another feature which has undoubtedly relieved the probability of accidents, was the continuance of the eastern-most island around the curve on the East Main Street approach in order that inbound traffic could be brought under control before entering the curve."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "Before channelization, trucks moving from Lexington to Louisville experienced a great deal of difficulty when attempting to recover from a left turn in the short distance which was available for this maneuver. The lanes on Capitol Avenue are of a 10 ft. width. This added to the difficulty. When potential left turning vehicles were occupying the middle lane on Capitol Avenue, it was necessary for a truck driver to almost fully recover from a turning maneuver before entering the narrow lane. Truck drivers unfamiliar with this intersection generally failed to do so and in each case it was usually necessary for both drivers to jockey through a number of maneuvers in order to provide the necessary clearance. This difficulty was eliminated in the design by providing a 35 ft. radius for the Main Street left turning lane and making this tangent to the extended left side of the southbound lane on the bridge. Since all left turning traffic was required to stop, it was felt that the minimum recommended by AASHO for designed vehicles would suffice. This assumption has proved to have been correct, as from observation it has been noted that only on rare occasions do the trailing wheels of a vehicle touch any part of the median island. Admittedly, this left turn remains a difficult maneuver; however, interference with other traffic has been eliminated.
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   Present operation of the intersection calls for police control during the afternoon peak period. This is necessary to enable traffic to enter the intersection from the Capitol Avenue and Main Street approaches. Through the use of the short time condition it has been found that the maximum of movement during times of police control is 1700 vehicles per hour. The intersection could operated much more efficiently were it not for the extreme grade immediately to the east. The number of commercial vehicles drastically affects operation conditions as this grade is approximately one mi. in length and no passing opportunities are afforded for approximately 60 percent of this length. Several times during the afternoon period it is necessary for the officers to allow traffic on the grade to clear before more vehicles are allowed to leave the intersection on this approach. Although facilities are not available for determining the delay incurred in passing through the intersection, through the use of short time counts and the observation of conditions, it has become apparent that the intersection will handle traffic at a rate of 1500 vehicles per hour before appreciable congestion is apparent.

Comments by Committee Members

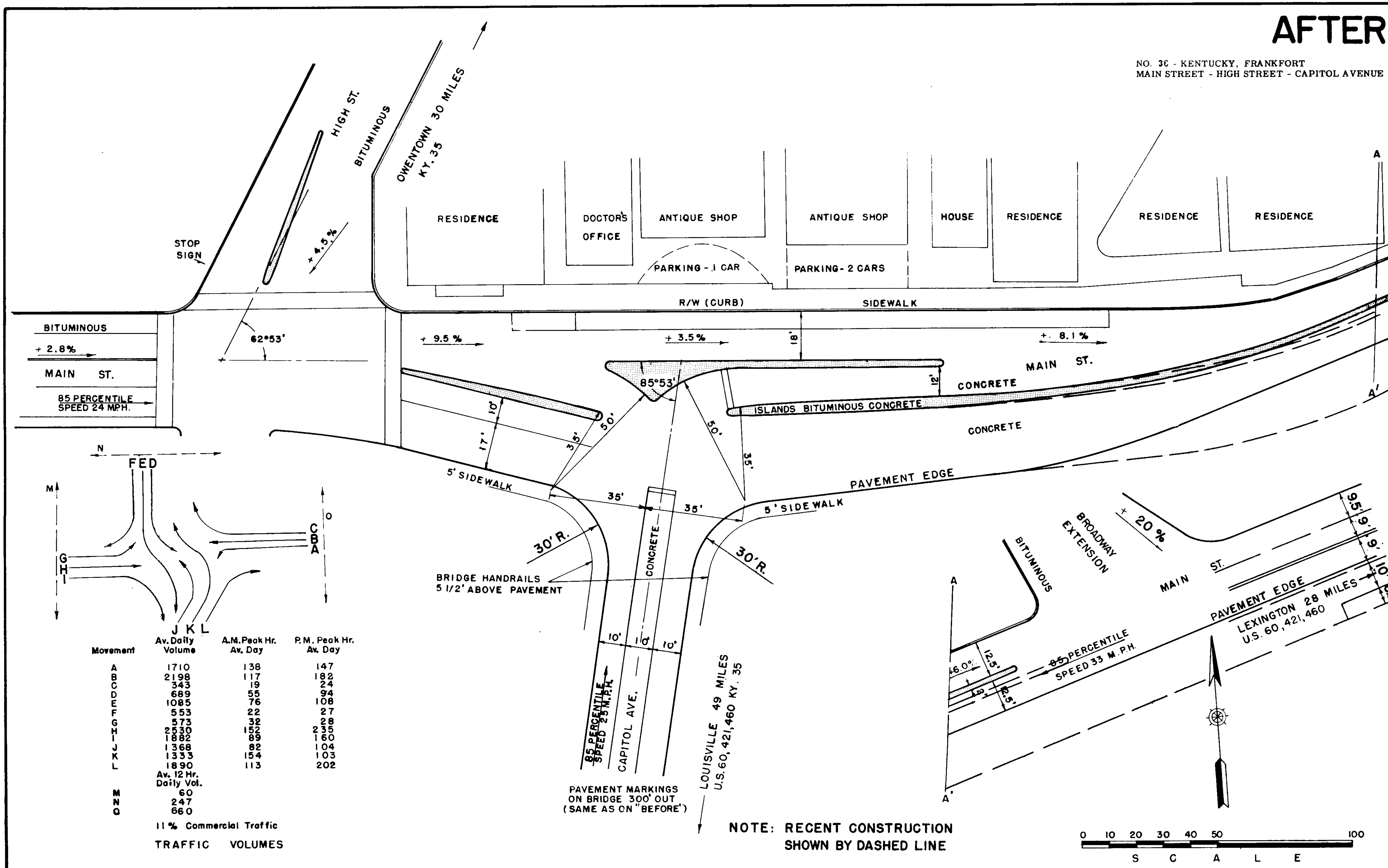
BEFORE

NO. 36 - KENTUCKY, FRANKFORT
MAIN STREET - HIGH STREET - CAPITOL AVENUE



AFTER

NO. 36 - KENTUCKY, FRANKFORT
MAIN STREET - HIGH STREET - CAPITOL AVENUE



Movement	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	1710	138	147
B	2198	117	182
C	343	19	24
D	689	55	94
E	1085	76	108
F	553	22	27
G	573	32	28
H	2530	152	235
I	1882	89	160
J	1368	82	104
K	1333	154	103
L	1890	113	202
	Av. 12 Hr. Daily Vol.		
M	60		
N	247		
O	660		

11 % Commercial Traffic

TRAFFIC VOLUMES

1. FRED W. HURD - Figure 1 shows an "ideal" channelization layout for the intersection of Capitol and Main Streets. This would require widening of the bridge and therefore may not be practicable. Prohibition of right turns into High Street or one-way movement on High Street would be desirable if permissible.

2. GUY KELCEY - Channelization layout appears excellent particularly in the light of grade conditions indicated. Wheel track marks shown by photographs show well organized pattern of traffic movement. The arrangement of islands to separate and channelize left turn movements is well thought out and makes excellent use of the pavement area available.

Additional Comments by W. P. Ringo, Director, Division of Traffic

The intersection continues to operate very favorably without signals or officer control with the exception of the afternoon peak hour. We are finding that police officer control is becoming progressively less desirable as a method of reducing the congestion during that period. The present peak hour operation is handled with four (4) distinct movements as it is apparently necessary to allow separate movement for each direction of traffic on Main Street due to the heavy left turning movement from Main to the Capitol Avenue bridge. Whether this necessity for four phase operation is due to a heavy volume or to the accumulation of traffic resulting from a policeman's tendency toward longer cycles has not been determined. However, just recently a feeling is developing that signalization would be more desirable for this period of movement. Signalization, under the present conditions, would require at least three phases - possibly four; however, as a measure to alleviate conditions at the intersection and at other locations in the City, we have attempted for some time to have High Street paired with the adjacent street to the west as a one way couplet with High Street carrying northbound traffic. It would then be possible to signalize the intersection using a minimum of phases. It is possible that two phase operation would be sufficient as eastbound traffic on Main Street will be required to stop west of the High Street approach which will in effect provide a "leading green" for the left turn from Main Street to the Capitol Avenue bridge. A detailed analysis of signalized operation has been deferred pending one way consideration by the City.

Main Street east of the High-Capitol intersection was widened during the past summer; thus ending a problem of inadequate exit capacity. The new construction had been designed and constructed for two lane movement upgrade and one down, with one parking lane. When this construction was released to the Division of Traffic for lane markings, consideration had already been given to four lane operation and the street was laned for such movement. Admittedly, traffic lanes are narrow; however, the relatively great improvement over two lane operation has de-emphasized the narrow lanes and favorable comments have been received from the general public. At this time, it is not possible to prohibit parking on the grade.

No detailed analysis of traffic movement in the intersection has been made since the construction improvement; however, after checking with the police officers, we have learned that at no time has intersectional movement been affected adversely by the exit to the east.

This Division is contemplating the construction of an island to shadow right turning traffic from the Capitol Avenue bridge as was suggested by Mr. Hurd. We feel, however, that the short curb radius at the southwest curb, combined with difficulties arising to traffic entering the narrow Capitol Avenue lanes, would prohibit the construction of the small island designated at Point A on Mr. Hurd's Figure 1.

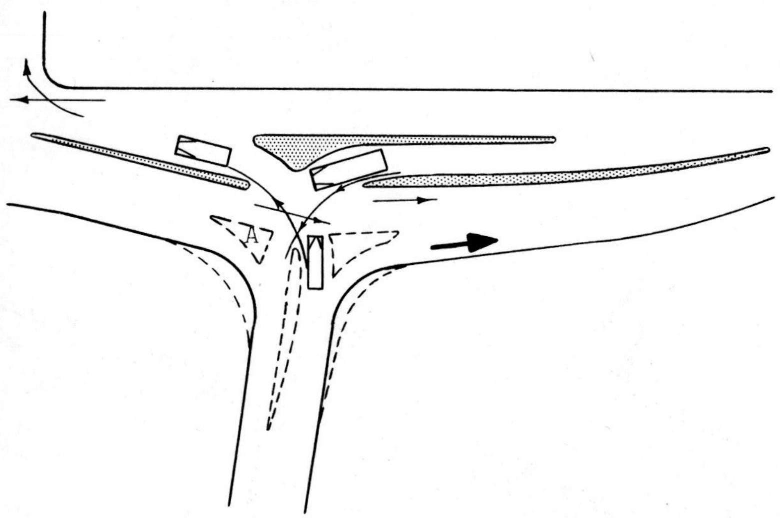


Figure 1.

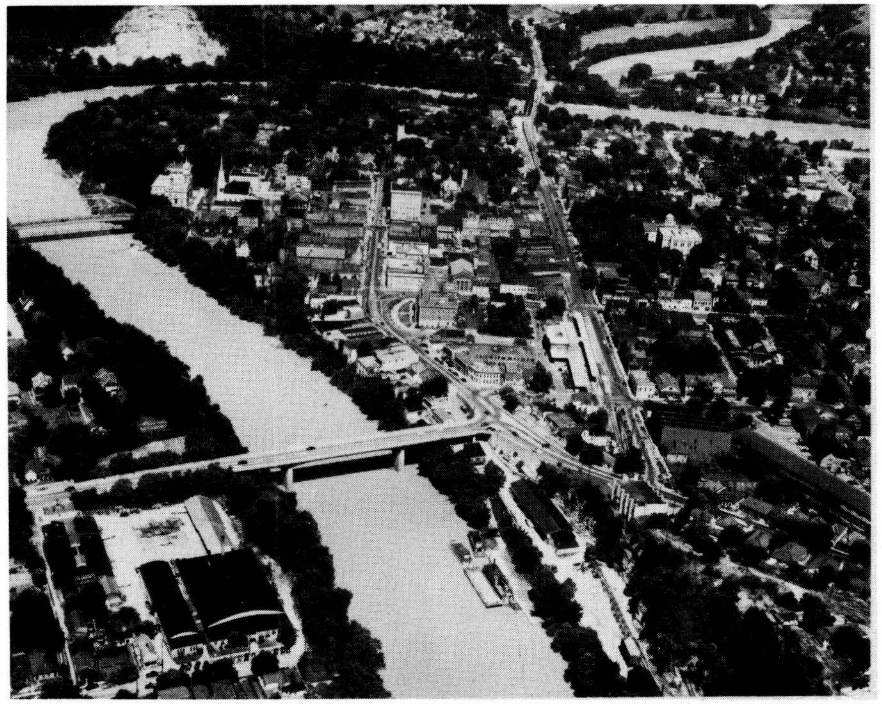


Figure 2. Channelization of 4-way offset intersection of Main Street, High Street, and Capitol Avenue in Frankfort, Kentucky. An example of good results at a location where grades and physical conditions have limited the design.

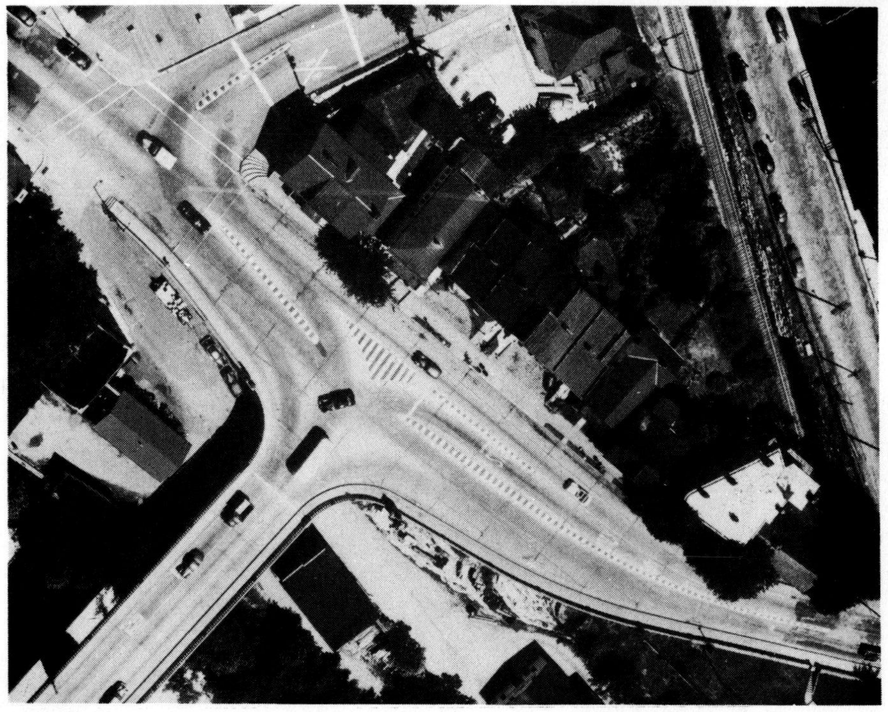


Figure 3. Details of channelization design. Note that some pavement markings used at the intersection before channelization still remain.

Example 37

Location

VIRGINIA, Henrico County (near Richmond)
US 1 - Virginia 161

Submitted by

Virginia Department of Highways,
Richmond, Virginia
Division of Traffic and Planning
Through W. F. Smith, Urban Engineer

Type of Intersection

4-Way, Offset

Date Constructed

November, 1947 (Approximately)

Physical Data

4. Cross section not unusual; the left turning lane separation is the raised type.
5. Traffic Control Devices
   b. Signals: Type: none
   e. Other Control Devices: Guide Posts: special overhead neon flashing amber sign.
6. Landscaping
   a. The raised median and channelizing islands are topsoiled and seeded.
7. Abutting Property
   a. Character or Land Use: golf course on northwest, filling stations on northeast and southeast, and dwelling on southwest.

Traffic Data

2. Type
   b. Percent Commercial: on Route 1: negligible; hence no facilities are provided. 23 percent of total, of which about 48 percent of traffic is trailer trucks and buses. On Route 161, 19 percent of the traffic is commercial and about 1.75 percent is trailer trucks and buses.
3. Speeds
   a. Approach Speed: 85 Percentile: no speed study has been made, but the 85 percentile speed is estimated to range from 40 to 45 mph.
6. Pedestrian
   a. Volumes: negligible
   b. Location of Crossings: none provided

Economic Data

1. Estimated Cost of New Installation
   a. $80,500, including considerable pavement widening along Route 1 as well as new bridge on Route 161.
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. $14,285
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $4600

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "The paramount feature is, of course, the left turn storage lane, provided to accommodate a heavy, and formerly a hazardous, left turn. During and immediately after construction, there appeared some misunderstanding as to its intended use; however, that quickly disappeared, and we feel that it is now eminently satisfactory."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "The only inconvenience is to "through" traffic on Hilliard Avenue, but that movement is negligible."

Comments by Committee Members

1. GUY KELCEY - The treatment of this problem is excellent. It might have been advantageous however if the islands at the opening opposite Hilliard Avenue could have been made wide enough fully to shield a car outbound from Hilliard and caught in midstream, and if a left turn storage lane could have been provided for traffic southbound on US 1 turning into Hilliard.
2. NORMAN KENNEDY - In general this design seems to comply with the fundamental principles of channelization. Its principal feature is the provision of a protected left-turn for traffic from the south on US 1 turning west to Route 161.

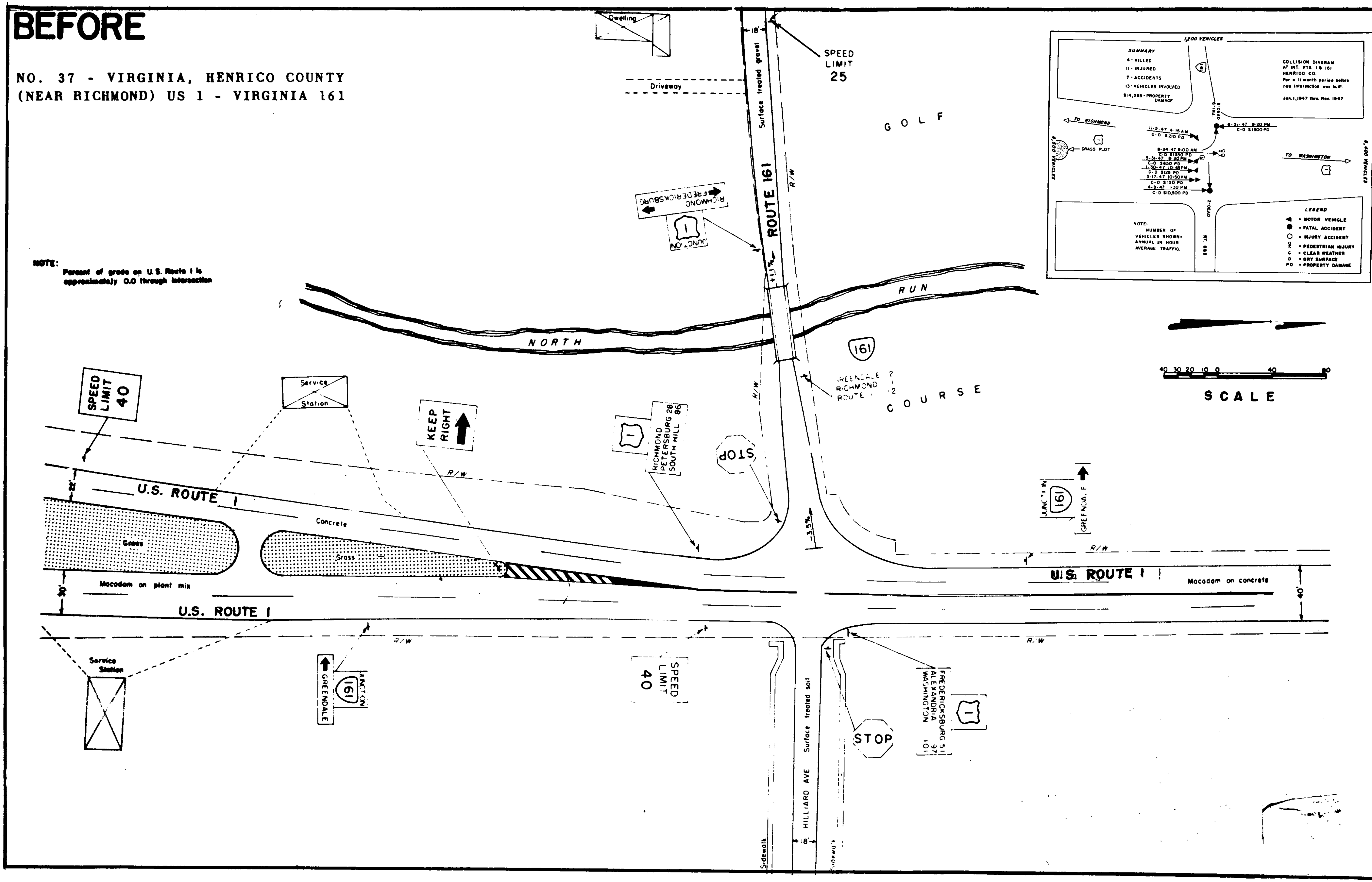
   The 6 in. concrete median separating the left-turn lane from northbound through traffic might be shortened to permit a larger opening into the left-turn lane. The "after" accident record seems to indicate that conflict might occur between through vehicles and those which have missed the entry into the left-turn lane and are turning left from a through lane.

   Although traffic movement G is almost negligible, a short left-turn refuge might well have been left in the median island north of the intersection on US 1.

   Presumably, right-of-way and/or structural considerations in the construction of the new bridge on Route 161 offset the desirability of leaving the intersection as a simple 4-way as it originally was.

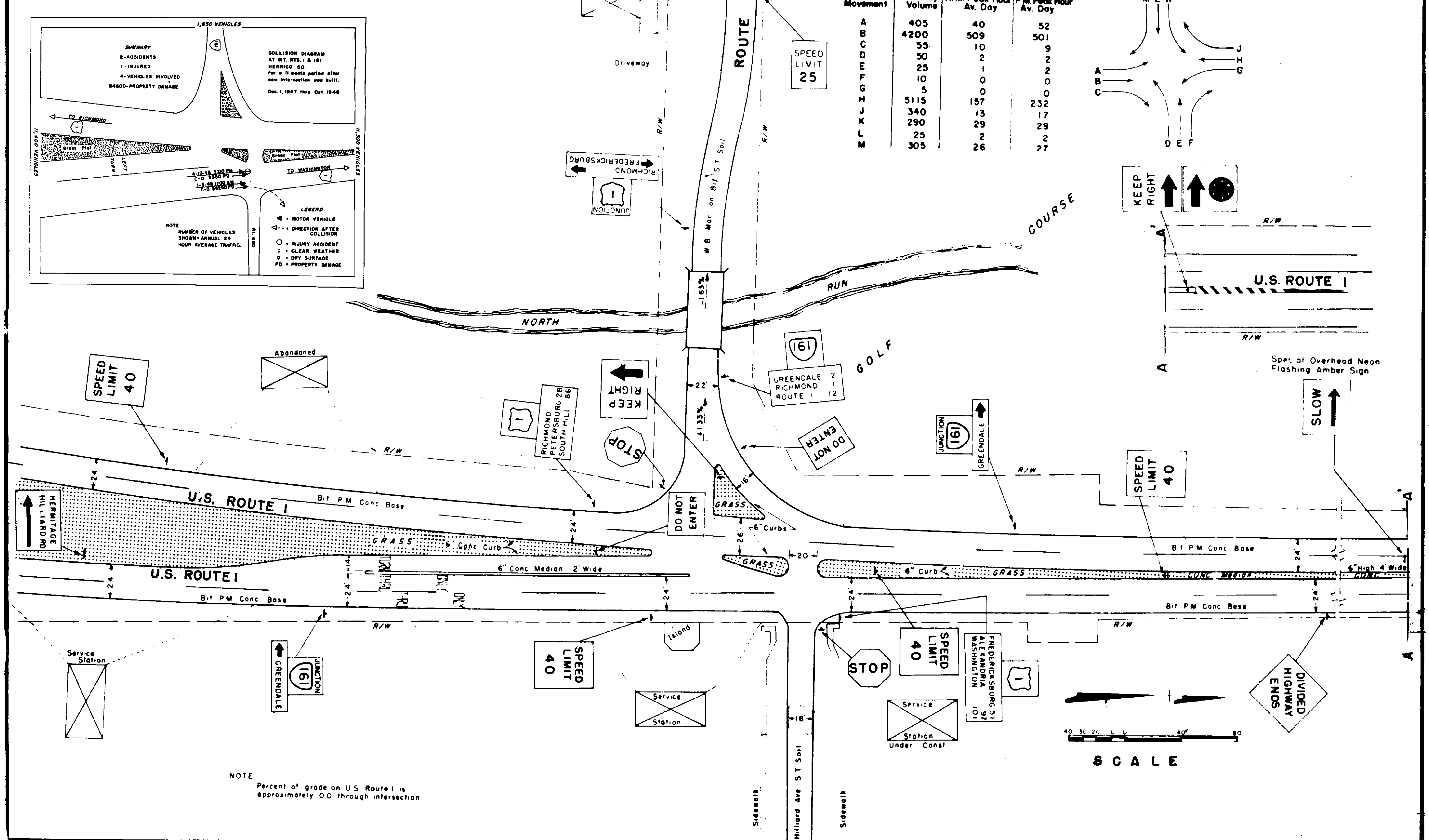
BEFORE

NO. 37 - VIRGINIA, HENRICO COUNTY
(NEAR RICHMOND) US 1 - VIRGINIA 161



NO. 37 - VIRGINIA, HENRICO COUNTY (NEAR RICHMOND) US 1 - VIRGINIA 161

AFTER



TRAFFIC VOLUMES

Movement	Av. Daily Volume	A.M. Peak Hour Av. Day	P.M. Peak Hour Av. Day
A	405	40	52
B	4200	509	501
C	55	10	9
D	50	2	2
E	25	1	2
F	10	0	0
G	5	0	0
H	5115	157	232
J	340	13	17
K	290	29	29
L	25	2	2
M	305	26	27

Figure 1. Four-way offset intersection of US 1 and Virginia 161 near Richmond. The wheel-track pattern shows excellent organization of traffic movements at intersection of a high-speed, heavy-volume artery with a secondary road.

Example 38

Location

DELAWARE; Wilmington
Delaware Avenue - Van Buren Street
Pennsylvania Avenue

Submitted by

William J. Miller, Jr.,
Traffic and Planning Engineer,
State Highway Department, 152 S. State St.,
Dover, Delaware

Type of Intersection

Multiway

Date Constructed

1941

Physical Data

3. Surface Type
   c. Shoulders: concrete or brick sidewalks.
5. Traffic Control Devices
   b. Signals: Type: the signal located at this intersection is controlled by the City of Wilmington. It is part of a connected synchronized system.
   c. Markings: Color: White
   e. Other Control Devices: Guide Posts; attention is called to the depressed walkway which passes through the island on Pennsylvania Avenue. This facilitates baby carriage movements particularly.
6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: apartments and residences.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: trackless trolleys use the eastern leg of Pennsylvania and Delaware Avenue. Buses use both legs of Pennsylvania Avenue.
9. Right-of-Way Limits
   a. Building lines shown on plan.

Traffic Data

4. Delays: none.

Economic Data

1. Estimated Cost of New Installation
   a. $1,000.
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $45.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   "The most serious problem which presented itself at this intersection, was protecting eastbound Pennsylvania Avenue traffic from westbound Pennsylvania Avenue traffic. The traffic leaving Delaware Avenue and entering Pennsylvania Avenue going west often cut the corner and endangered the eastbound movement. In addition, pedestrians were assisted with the large refuge island."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "The heavy traffic volumes during peak hours sometimes backed traffic up on the artery as well as on the side streets."
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   "The intersection has been working very well."

Comments by Committee Members

1. NORMAN KENNEDY - This channelization serves principally to reduce the area of conflict and to channelize northbound traffic from Delaware Avenue into Pennsylvania Avenue. A narrow mountable median curb on Delaware Avenue in the place of the painted line might be more effective for this latter function.
   The large median island on Pennsylvania Avenue contributes to pedestrian safety.

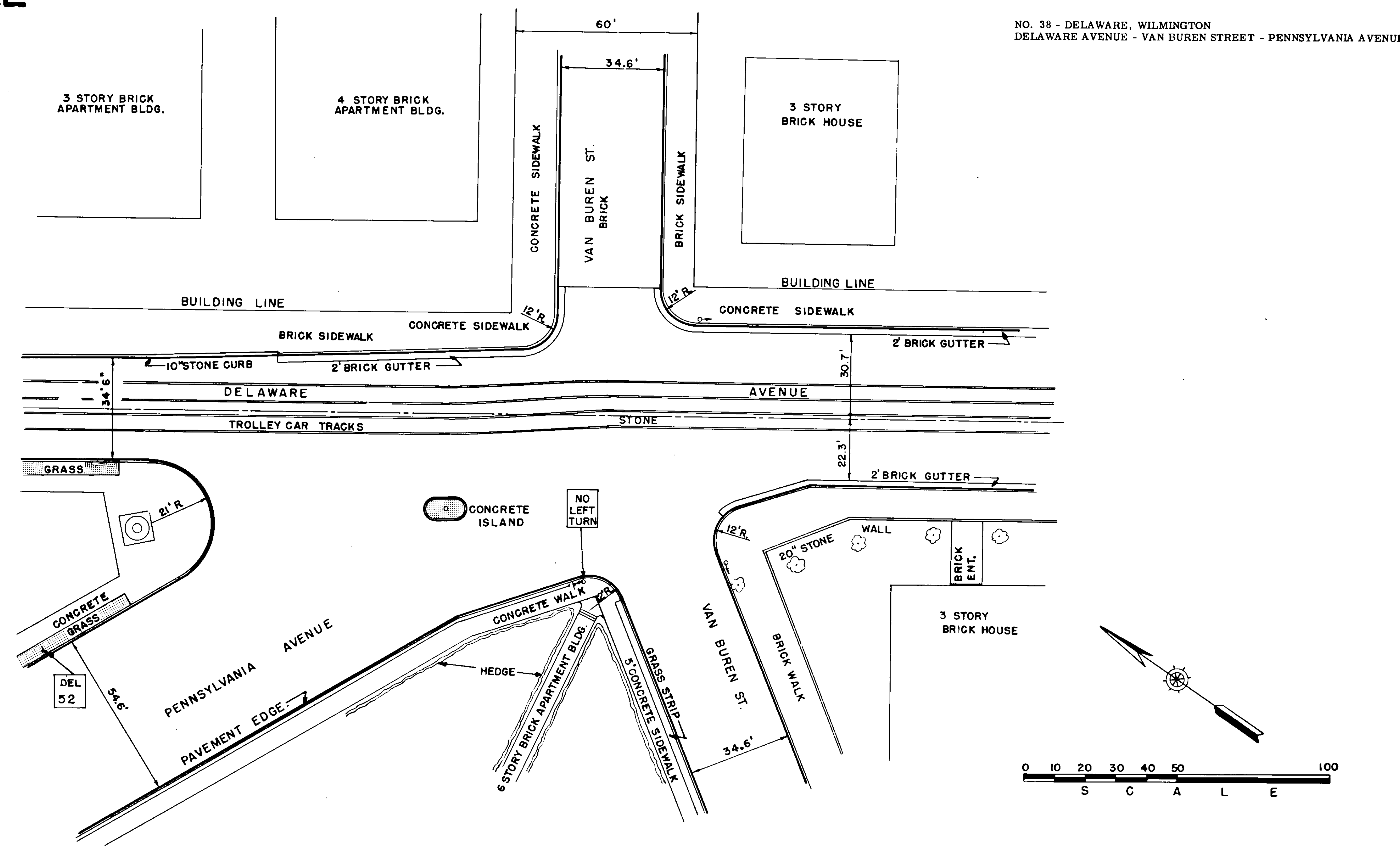
2. E. T. PERKINS - The present island in Pennsylvania Avenue seems properly located and proportioned to control movements as indicated. I believe that a reference island should be located in Delaware Avenue just south of Van Buren Street to limit the point from which vehicles turn left westbound into Pennsylvania Avenue. Without this reference turning point, there might be a tendency for vehicles to cut across the path of vehicles southbound on Delaware Avenue and passing through the intersection.

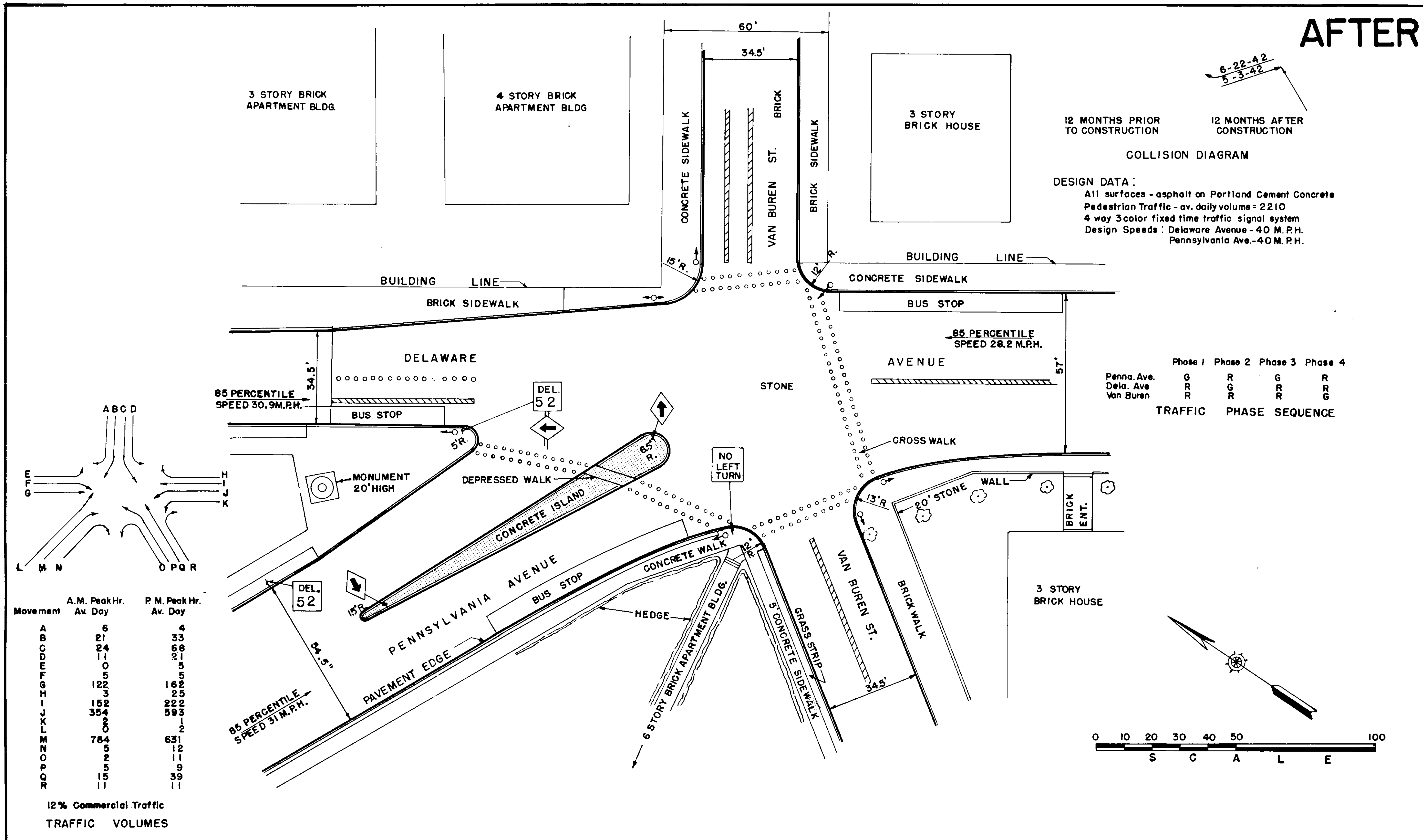
Figure 1. Intersection of Delaware Avenue, Van Buren Street, and Pennsylvania Avenue in Wilmington, Delaware.

Figure 2. Intersection after channelization. Note that the pedestrian crosswalk has been cut through the median on Pennsylvania Avenue.

BEFORE

NO. 38 - DELAWARE, WILMINGTON
DELAWARE AVENUE - VAN BUREN STREET - PENNSYLVANIA AVENUE





Movement	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	6	4
B	21	33
C	24	68
D	11	21
E	0	5
F	5	5
G	122	162
H	3	25
I	152	222
J	354	593
K	2	1
L	0	2
M	784	631
N	5	12
O	2	11
P	5	9
Q	15	39
R	11	11

12% Commercial Traffic

TRAFFIC VOLUMES

NO. 38 - DELAWARE, WILMINGTON
DELAWARE AVENUE - VAN BUREN STREET - PENNSYLVANIA AVENUE

Example 39

Location

DISTRICT OF COLUMBIA: Washington.
New York Avenue - 13th Street - H Street.
N. W.

Submitted by

D. S. Brinkley. Planning Engineer.
Department of Highways. 14th and Penn.
Aves. . N. W.
Washington 4. D. C.

Type of Intersection

Multiway

Date Constructed

December 12. 1949

Physical Data

3. Surface Type
   c. Shoulders: sidewalks
7. Abutting Property
   a. Character or Land Use: business district.

Traffic Data

4. Delays not indicated except in a general way in comments (see subsequent discussion)

Economic Data

1. Estimated Cost of New Installation
   a. Signs and traffic control devices. $3,500; channelization. $10,600. (Note: Low figure explained by fact that no new base was constructed)

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   See following comments
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   "This irregular intersection is located in the congested downtown area of Washington, and is composed of 13th Street. an important north-south arterial, and New York Avenue which is an equally important feeder street running diagonally through a portion of the business district. H Street at this point is offset and, before re-design, was limited between 13th and 14th Streets to one-way traffic westbound.
   Increasingly heavy traffic, averaging some 52,000 cars on a 24-hr. weekday, made the organization of often conflicting flows of vehicles using the intersection a necessity in order to promote more orderly and safer patterns by engineering means.
   Studies were conducted to determine the characteristics of the principal vehicular movements. Left-turning movements were found to generate confusion and hazard, and to cause a reduction in the capacity of the streets involved by blocking two lanes of traffic for as long as two green light periods. The delays were often cumulative and affected other streets in the vicinity. H Street was practically inaccessible to westbound vehicles which had to cross New York Avenue at a point further west where a large off-street parking facility added to the confusion."
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   "As a result of these studies, the standard channelization, which consists primarily of diverting a certain proportion of the traffic away from the "trouble spot" by means of special roadways. connecting the two streets where the major conflicts are generated at points removed from the intersection proper, was applied in this case. Moreover, the reopening of H Street to two-way traffic reduced unnecessary pressures on neighboring intersections, particularly that of New York Avenue with 14th Street, and provided another much needed route eastward for that traffic which had been forced to use parallel streets. A system of traffic lights regulates movements in the redesigned intersection."

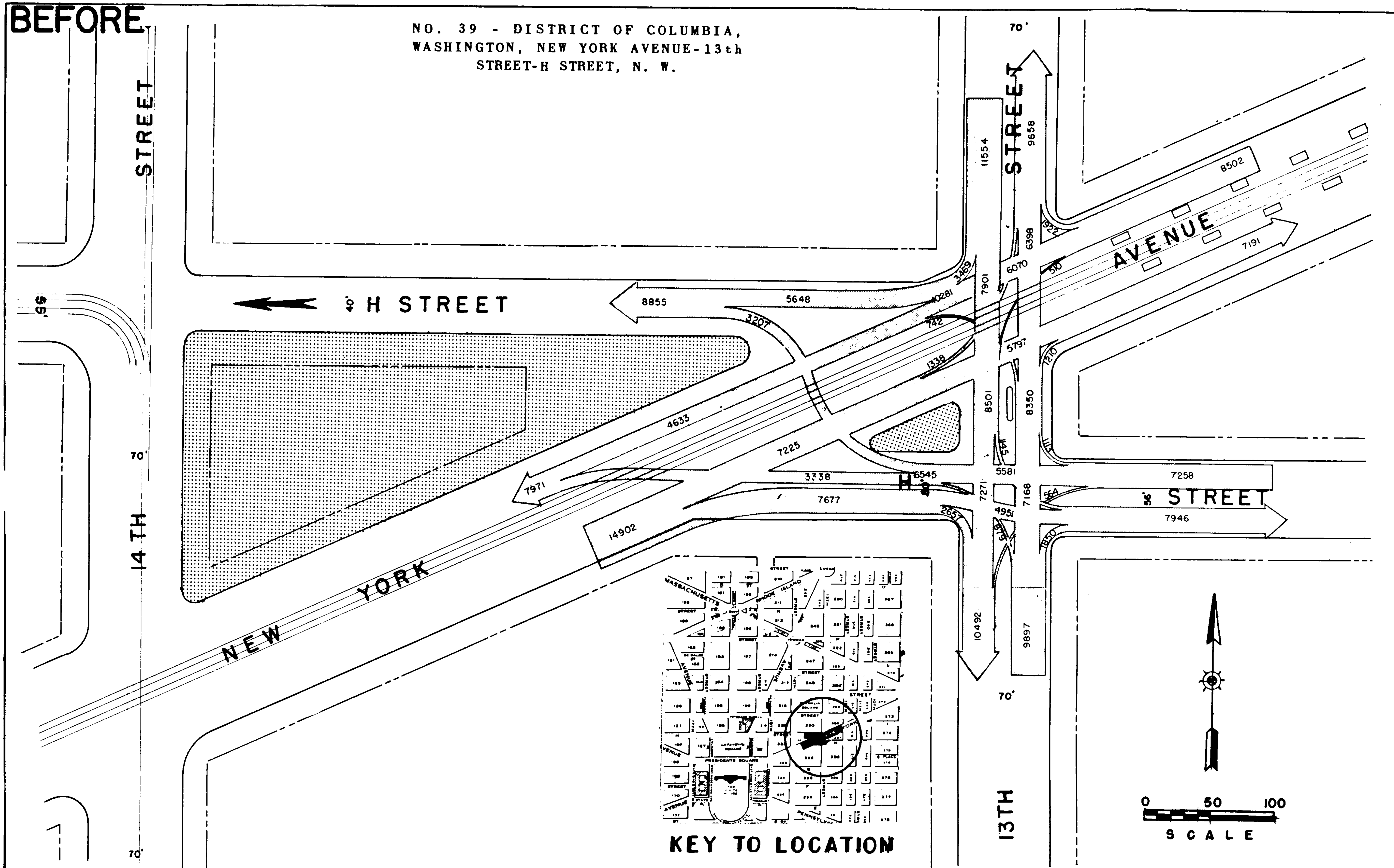
Comments by Committee Members

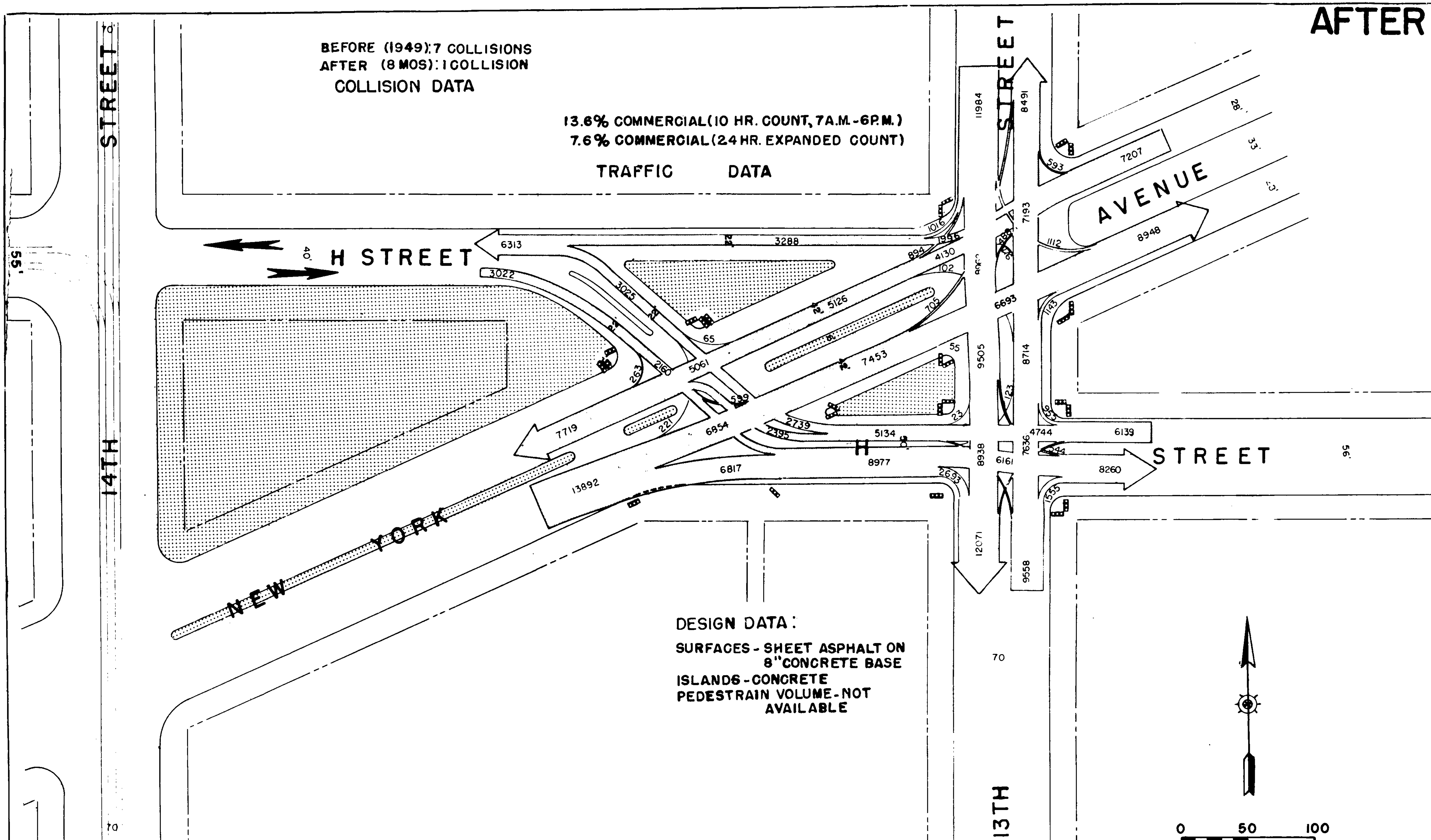
1. NORMAN KENNEDY - The principal feature of this project appears to be the re-opening of H Street to two-way traffic through relatively major reconstruction and the installation of traffic signals to assign right-of-way. Channelization as such seems to be incidental.

2. J. C. YOUNG - The physical features of the channelization appear good; the traffic pattern has not changed appreciably except that about 2,000 VPD formerly turning west into H Street from southbound on 13th now cannot do so because H Street does not have the capacity as a two-way street. It looks as though perhaps the signals at H Street and New York Avenue have done as much to improve the accident record as the other changes.
   I am interested to note in these photographs, as in others of Eastern cities, that lane striping is not used except at signals. The vehicles in the pictures seem to be following each other pretty well but it is natural to wonder whether they still remain in single file as the volumes increase. There is enough room on New York Avenue in this picture for at least three cars abreast in each direction, and it is likely that the volumes attained without striping will not equal what could be done with striping. It is presumed that the cars shown parked at the curb on the south side of H Street at the corner of New York Avenue are prohibited from parking during the rush hours.

BEFORE

NO. 39 - DISTRICT OF COLUMBIA, WASHINGTON, NEW YORK AVENUE-13th STREET-H STREET, N. W.





NO. 39 - DISTRICT OF COLUMBIA, WASHINGTON, NEW YORK AVENUE-13th STREET-H STREET, N. W.

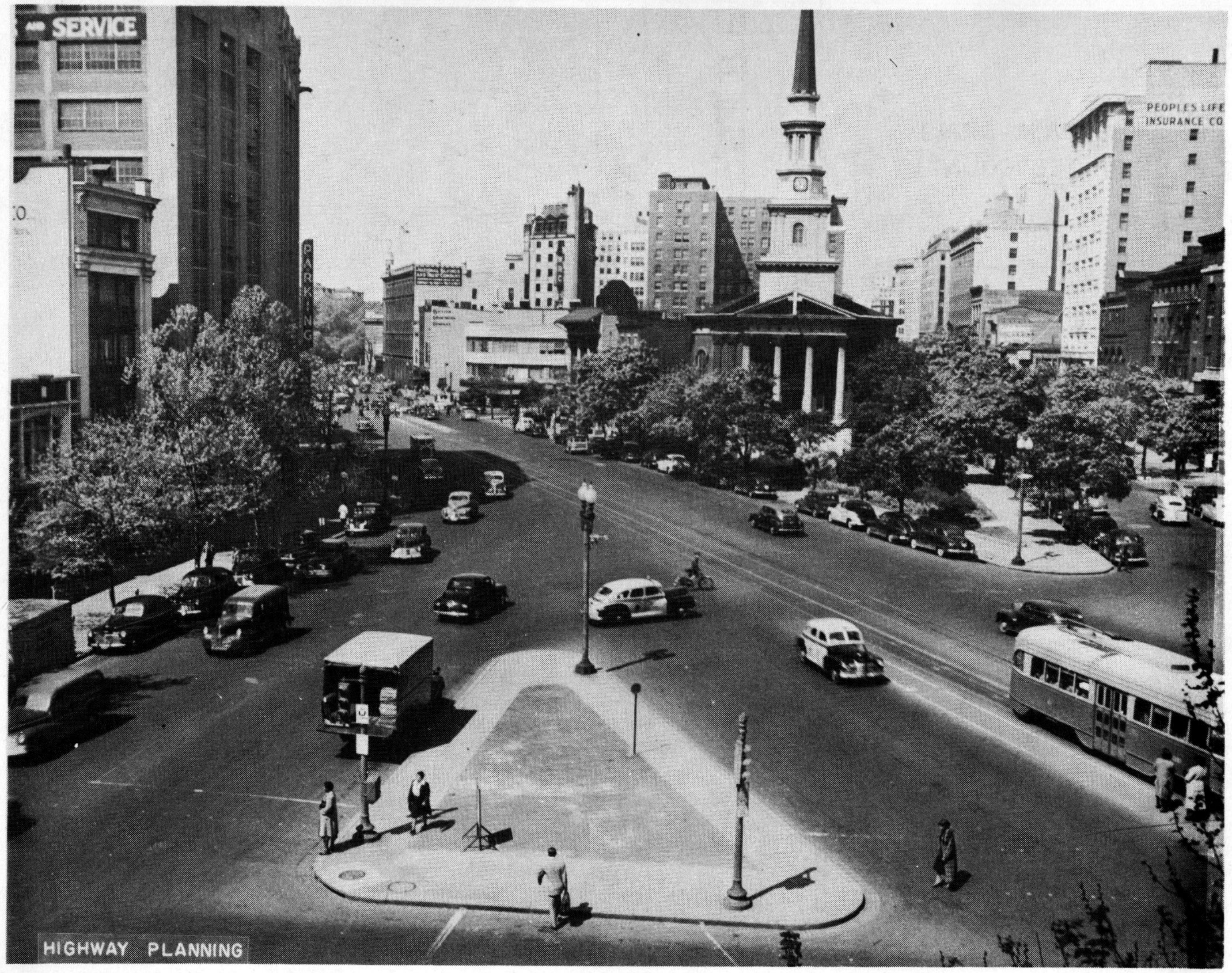


Figure 1. Multiway intersection of New York Avenue, 13th Street, and H Street NW., Washington, D. C. before channelization.

Figure 2. Completed channelization of intersection. Note the good contrast achieved between the concrete islands and the asphalt street surface.

Example 40

Location

HAWAII, Honolulu
School-Emma-Lusitana-
Iolani-Magellan Streets

Submitted by

George Houghtailing, Planning Engineer,
City of Honolulu, Territory of Hawaii

Type of Intersection

Multiway

Date Constructed

Proposed, not yet built

Physical Data

2. a. Grades: shown partially.
7. Abutting Property
   a. Character or Land Use: apparently residential, from photograph

Traffic Data

1. Volumes
   e. Pedestrian: no pedestrian count.
2. Type
   b. Percent Commerical: 16 percent.
5. Accidents: See general comments under Operational Characteristics

Economic Data

1. Estimated Cost of New Installation
   a. $725,000, including acquisition of land, property damages, relocation of utilities, construction and engineering.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. See General Comments
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. See General Comments
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   This intersection is one of the most congested from the standpoint of multiple traffic movements. Traffic converges here from six different directions. The existing small area of this intersection is traversed by twenty separate traffic paths. The cross pattern of these paths involves 49 conflict points or possible accident hazards.
   Analysis of the traffic tabulations shows an occurrence of heavy traffic interchange between School Street and Lusitana during peak morning and afternoon hours.
   There are also indications of curtailed interchange activity between School Street and Iolani-Magellan Streets, and along Lusitana Street. It is suspected that much traffic that would normally travel through this intersection is avoiding it because of bottleneck conditions at peak hours.

Traffic Data

Present day traffic counts show a volume of 28,469 cars per 24-hr. day entering this intersection. There are six main streams of traffic passing through the intersection. These are as follows:

	24-hr. Vol. (cars)	Percent
1. School Street Right Turn to Lusitana	5120	18.0
2. Lusitana Street Left Turn to School	4100	14.4
3. Lusitana Street Straight Mauka	3100	10.9
4. Lusitana Street Straight Makai	2730	9.6
5. Iolani Street to School	3220	11.3
6. School Street to Iolani	3160	11.1
	21430	75.3

Thus the six lines of traffic listed above constitute 75.3 percent of the total traffic entering the intersection.

There is also a secondary flow along Emma-Lusitana Streets, which is as follows:

1. Emma Street to Lusitana Mauka	1060 cars	3.7 percent
2. Lusitana Street Right Turn to Emma	1270 cars	4.5 percent

The remaining directions of flow are minor, ranging between 19 to 776 cars per day.

Accident Data

From 1946 to the present date, there have been 45 accidents at this intersection involving 16 injured persons.

After due consideration of the various types of channelization, both at grade and vertical separation, it was concluded that the underpass type of construction, as noted on the model favoring the 43 percent traffic entering the intersection, would provide a workable solution. There are some questions in the mind of those who have reviewed the model, that due consideration was not given to the possible signalization of this intersection. That phase of the solution was gone into, and it was concluded that a three phase traffic signal without extensive channelization is unsuitable and unworkable in view of the six main conflicting streams of traffic. If anything, it would require a four phase signal control at this intersection. Imagine what would happen if a four phase traffic signal was installed at this multiple intersection - traffic movement would be paralyzed and traffic waiting to pass through the intersection on the green phase would back up worse than under present day conditions.

Even with the completion of the Mauka arterial it is estimated that due to an increase in the motor vehicle registration and motor vehicle travel, traffic in 1970 will be one-third greater than 1947 traffic volumes which indicates that there will be enough traffic in 1970 at this intersection to justify redesign and reconstruction at this time.

With the construction of this proposed project, School Street can continue to serve more adequately as a Mauka route by installation of synchronized signal lighting at Liliha, Nuuanu, and Fort Streets. Emma Street will come into its own as a major Mauka-Makai thoroughfare. Lusitana Street will serve as a circumferential street for interchange of traffic between government civic center and Halekauwila-Kakaako District and the Nuuanu Valley, Pauoa

Valley and Makiki-Punchbowl area.

The Construction of the Model

Realizing the fact that it would be rather difficult to convince the public of the need for a project of this nature by mere blueprint drawings, the Board of Supervisors requested the Commission to construct a scale model of the proposed redesign. The construction of this model was a rather complicated process inasmuch as it was necessary to show the contours as well as the existing features of the surrounding area.

Actual field surveys were made to determine the contours and the elevation of the existing streets. The locations of the houses and other features were determined from an aerial photograph, which was enlarged to the same scale as the model which is 1/16 in. to a foot.

The base for the model consists of 3/4 in. thick plywood panel reinforced with 2 by 4 members to give it the necessary rigidity. A print of the plan, showing the proposed redesign of the intersection together with the contours and lot lines, was then pasted onto the base.

The streets were cut to shape on lightweight cardboard and glued to a balsa framework cut to the necessary elevation and width as indicated on the print.

The contours of scenery material were then made by applying plaster to burlap on a backing of hardware cloth and fastened to dowels which were cut to the desired contour elevations and nailed to the base.

Tex-kote or flocking material was used for grass material.

The construction of this model required 1087 man hours of labor and the expediture of $675 for materials and aerial photographs. At $2.00 per man hour, the cost for labor amounted to $2174. Including material, the cost to construct the model of the proposed redesign of this intersection totaled $2849.

Comments by Committee Members

1. NORMAN KENNEDY - The statement submitted with the example by the designer of this proposed bridged rotary contains convincing arguments for the reconstruction, based partly upon traffic considerations away from this intersection. The present traffic volumes do not appear to warrant reconstruction involving expenditure of nearly three-quarters of a million dollars, but it is expected that traffic will be diverted from other streets and intersections upon the completion of this project.

   The bridged rotary appears to be well designed, although there might be some question of widths in the depressed sections. The photograph does not reveal whether or not widths are sufficient to allow by-passing disabled vehicles in these sections.

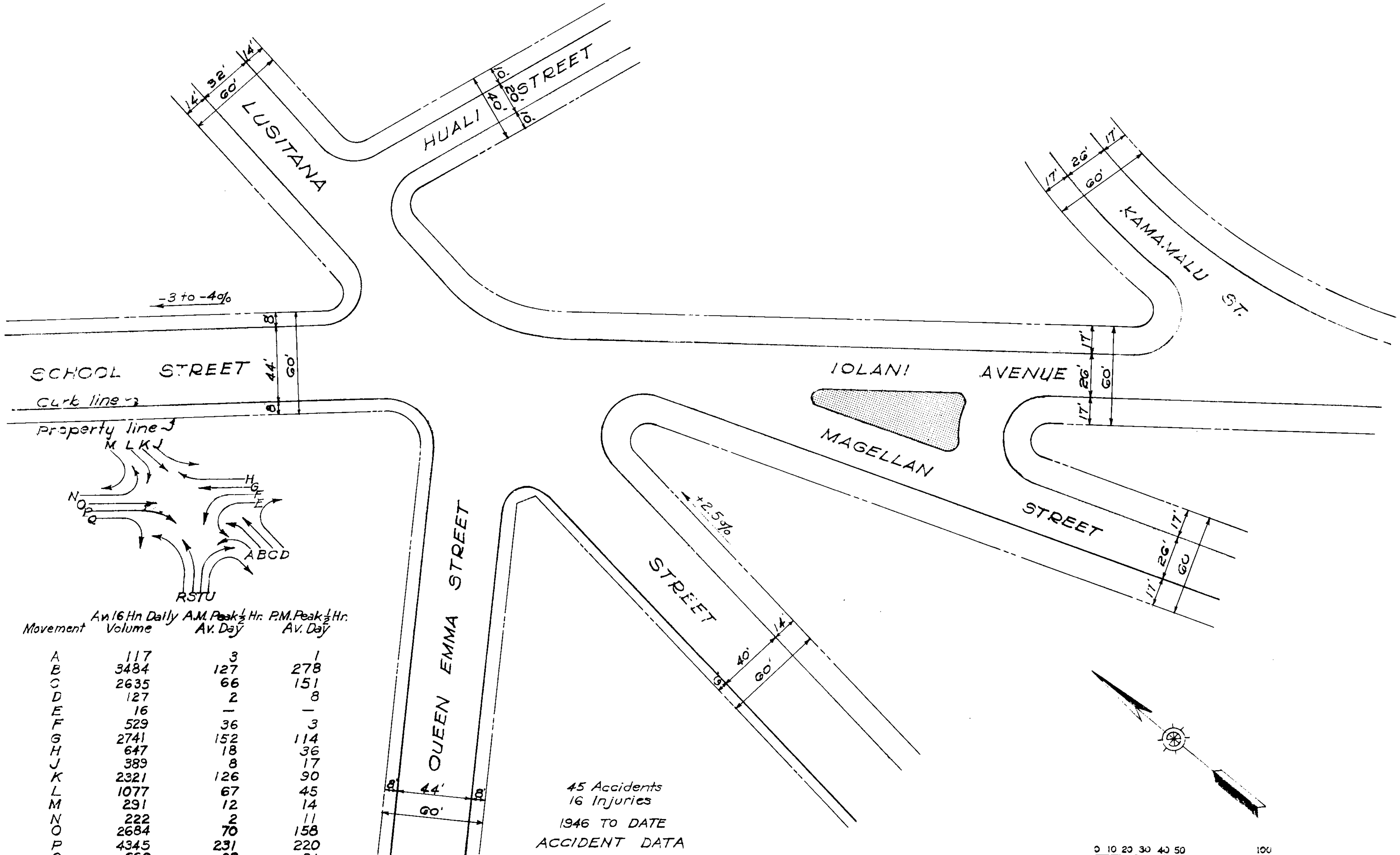
2. H. G. VAN RIPER - Proposed plan very much overdesigned. The volume of traffic is not considered sufficient to justify such an elaborate layout. Furthermore, after the improvement is built traffic signals are still required to regulate many of the traffic movements. It is likely that the problem can be solved about as satisfactorily at much less expense in both construction and property damage.

Figure 1. Aerial view of present intersection of School, Emma, Lusitana, Iolani, and Magellan Streets in Honolulu.

Figure 2. An excellent example of the use of a scale model to present a proposed intersection design. Note the fine detail and the clear presentation of a complicated reconstruction project. The cost of the model was $2,849.

BEFORE

NO. 40 - HAWAII, HONOLULU
SCHOOL - EMMA - LUSITANA - IOLANI - MAGELLAN



Movement	Av. 16 Hr. Daily Volume	A.M. Peak ½ Hr. Av. Day	P.M. Peak ½ Hr. Av. Day
A	117	3	1
B	3484	127	278
C	2635	66	151
D	127	2	8
E	16	—	—
F	529	36	3
G	2741	152	114
H	647	18	36
J	389	8	17
K	2321	126	90
L	1077	67	45
M	291	12	14
N	222	2	11
O	2684	70	158
P	4345	231	220
Q	660	28	21
R	367	5	24
S	899	12	65
T	443	2	22
U	193	4	9

TRAFFIC VOLUMES (Aug., 1948)
Total 24 Hr. Vol. 28,469 (Est., 1950)

EXISTING STREET LAYOUT AT FIVE POINT INTERSECTION

NOTE:- We have no pedestrian count at this Intersection

Example 41

Location

ILLINOIS, Chicago
57th Street - South Shore Drive -
North Circuit Drive

Submitted by

Victor G. Hofer, Traffic Engineer,
Chicago Park District,
425 East 14th Boulevard
Chicago 5, Illinois

Type of Intersection

Multiway

Date Constructed

1936 (?)

Physical Data

7. Abutting Property
   a. Character or Land Use: park and beach.

Traffic Data

3. Speeds
   a. Approach Speed: 85 Percentile: Speeds of 25 mph. on North Circuit Drive and 35 mph. on southern leg of South Shore Drive are shown; what speed is designated is not clear, but probably approach speed.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "During a 12-hr. period ("Before" revision of the intersection) approximately 25,000 cars utilized Shore Drive (shown on diagram as South Shore Drive), traveling north and south, at the extreme northeast corner of Jackson Park, with heavy turning movements at the North Circuit Drive and 57th Street intersections. Collissions were numerous - eight involving personal injury and 23 property damage. Traffic movement was not clearly defined by the two safety islands and two stop signs.

   Revision of the North Circuit Drive and 57th Street intersections at Shore Drive involved construction of a wide parkway to more clearly define the north-south drives and the installation of safety islands and stop signs, as the diagram shows. Despite summer weather and consequent heavier traffic, the changes resulted in reducing the number of personal injuries from eight to nothing and the property damage cases from 23 to 4.

   Shown is a 'bird's-eye view', looking south of the Shore Drive-Fifty-Seventh Street intersection before revision. Shore Drive curves left, North Circuit is straight ahead in the center of the picture. Fifty-Sixth Street is in the immediate foreground and curving right at the wrecked pavillion is North Circuit Drive. Fifty-Seventh Street is immediately beyond, on the right. The wide-open plaza, devoid of traffic lanes, shows itself as a traffic danger spot."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Traffic movement was measurably accelerated at the Fifty-Seventh Street intersection of Shore Drive after the installation of the center parkway shown slightly to the right of the center of the ("After") picture and the application of well defined lane marking. Removal of the old pavillion (from the area shown in the foreground) provided a clear view for southbound motorists. Shore Drive curves left along the shore of the lake, while North Circuit Drive is at the right."

Comments by Committee Members

1. GUY KELCEY - I can't find anything wrong with the treatment shown. It is a professional job. The "Before" and "After" accident accident diagrams and acceleration of traffic movements are proof that the channelization is well thought out and applied.

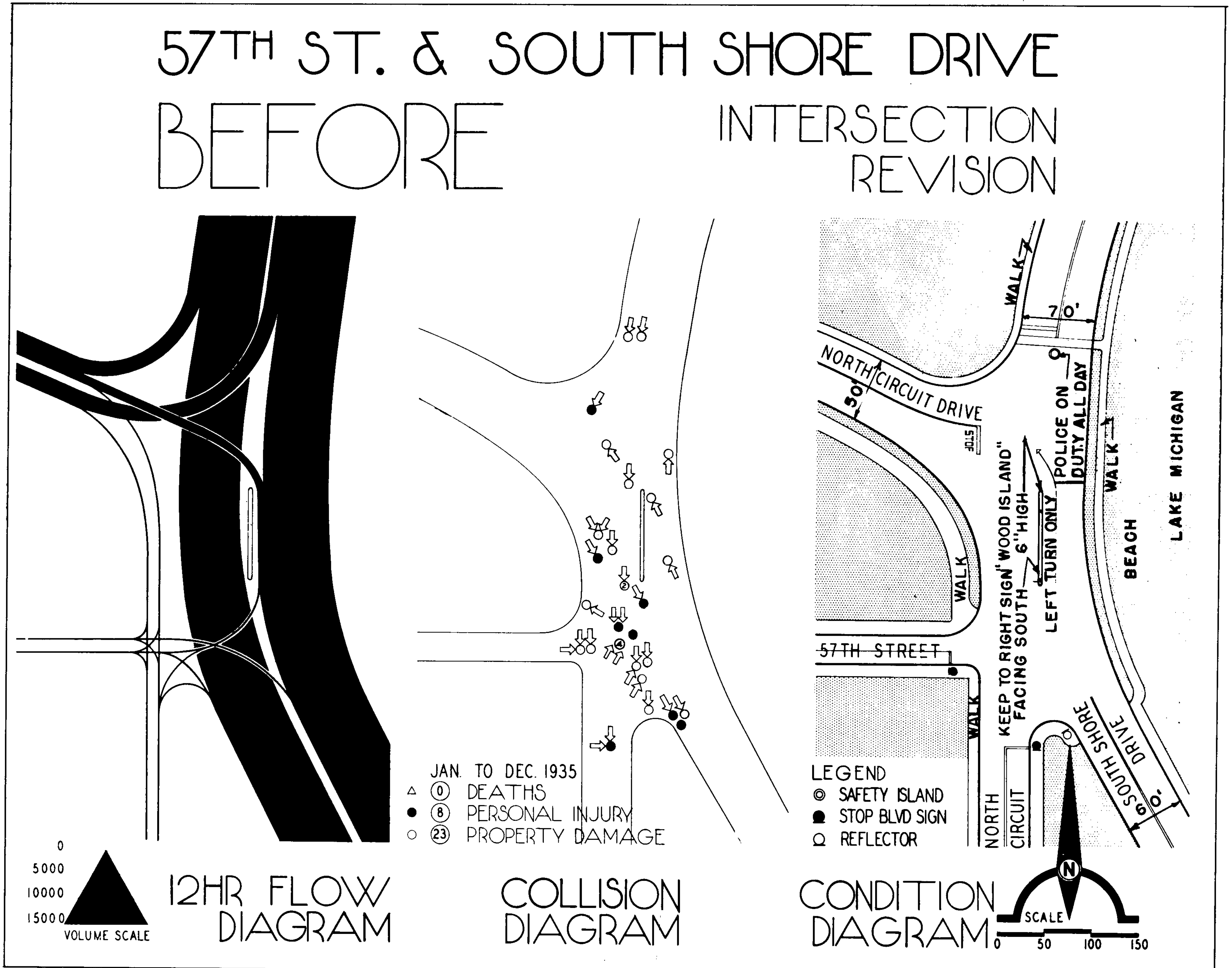
2. JAMES L. SHOTWELL - This is a good example of what can be done toward custom designing complicated intersections at grade. The reduction in the number of accidents alone after the improvement will go a long way in justifying the cost of the new work.

   The use of precast median blocks spaced about 15-18 ft. apart between the median lane and through traffic lane might be helpful. The use of mountable curbs around the two triangular islands would provide more definite traffic control.

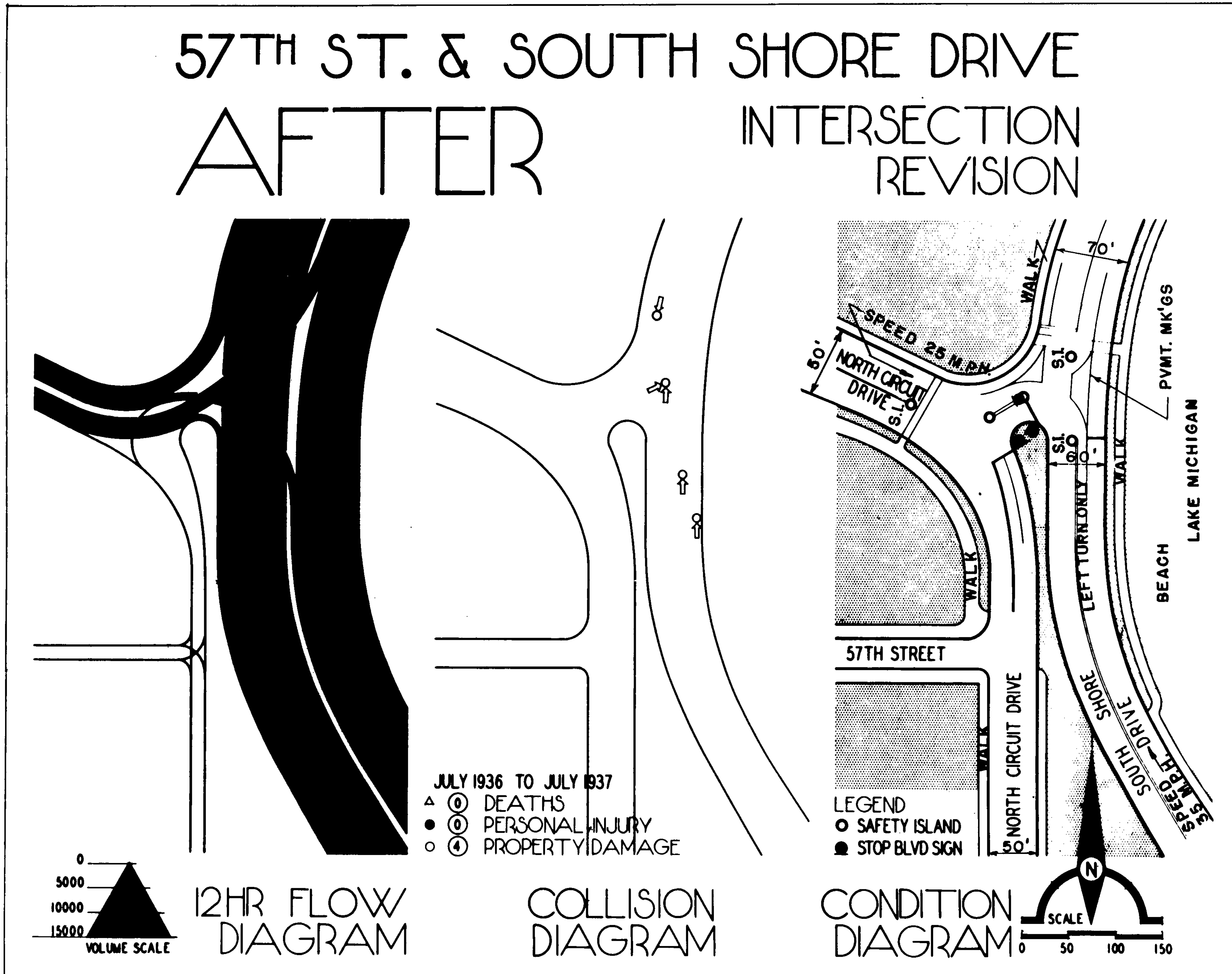
   Signing of this intersection would be quite important but it is not indicated on the plans or photographs. Paving markings for the through traffic lanes would be beneficial.

Figure 1. Birdseye view, looking south of the Shore Drive and 57th Street intersection before revision. Shore Drive curves left, North Circuit Drive is straight ahead in the center of the picture. Fifty-Sixth Street is in the immediate foreground, and curving right at the wrecked pavilion is North Circuit Drive. Fifty-Seventh Street is immediately beyond, on the right. The wide-open plaza, devoid of traffic lanes, shows itself as a traffic danger spot.

Figure 2. Traffic movement was measurably accelerated at the 57th Street intersection of Shore Drive after the installation of the center parkway (shown slightly to the right of center in the picture) and the application of well-defined lane marking. Removal of the old pavilion (from area in foreground) provided a clear view for southbound motorists. Shore Drive curves left along the shore of the lake, while North Circuit Drive is at the right.



NO. 41 - ILLINOIS, CHICAGO: 57th
STREET-SOUTH SHORE DRIVE-NORTH CIRCUIT DRIVE



NO. 41 - ILLINOIS, CHICAGO: 57th STREET-SOUTH SHORE DRIVE-NORTH CIRCUIT DRIVE

Example 42

Location

ILLINOIS, Chicago
51st Street - South Parkway

Submitted by

Victor G. Hofer, Traffic Engineer,
Chicago Park District, 425 E. 14th Blvd.,
Chicago 5, Illinois

Type of Intersection

Multiway

Date Constructed

October, 1936

Physical Data

6. Landscaping
   a. Planting spaces shown on "Before" plan.
7. Abutting Property
   a. Character or Land Use: park and apartment residences.
9. Right-of-Way Limits
   a. Not indicated except that sidewalks are shown on plan.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "South Parkway and Fifty-First Street was a hazardous intersection, laid out years ago, when speed was not important. Washington monument, in the middle of the boulevard, caused bad turns and crossing of traffic, as shown in the flow diagram. Work on the redesigned intersection began in January, 1936, and was completed in October and provided a simplified intersection. The heaviest traffic was on South Parkway, south of Fifty-First Street. The "Before" photograph, taken January 1, 1936, shows the dangerous reverse curb, on South Parkway at the Fifty-First Street intersection, with Northwest Drive entering Washington Park on the extreme left. Work on the new alignment was immediately begun. The photograph does not show the position of Washington monument, which was directly in the traffic lane. This is shown in the "Before" and "After" diagrams, as well as the intricate roadway design that served traffic in horse and buggy days."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Compare the "After" picture, taken October 14, 1936, with the "Before" photograph of January 1, 1936. This is a view taken from a point a little north of Fifty-First Street and shows the reconstructed intersection, with South Parkway on the right and Northwest Drive, entering Washington Park on the left. Traffic heading toward these two drives is separated by a safety island and light posts. Since this improvement was completed traffic has moved without congestion."

Comments by Committee Members

1. D. W. LOUTZENHEISER - This "After" demonstration is considerably "before" most of the other examples herein. While the general layout and marking are well done, the dimensions, traffic signals, signs, and lighting obviously are standards of 15 years ago. It is unfortunate that the contributor did not add a brief statement or current photo to indicate the present conditions and interim experience. No doubt most of the obsolete features in the 1936 photo have been altered.

   In an area with parkway grass spaces on each side, current layout practice would include a curbed median on both of the wide streets and possibly on the far side South Parkway. Also, the approach end treatment of the near right island ("After" photo) would be modified to direct drivers away from the "meat-block" light base and physically prevent their vehicles from hitting it. Extra lanes for bus stops also are suggested.

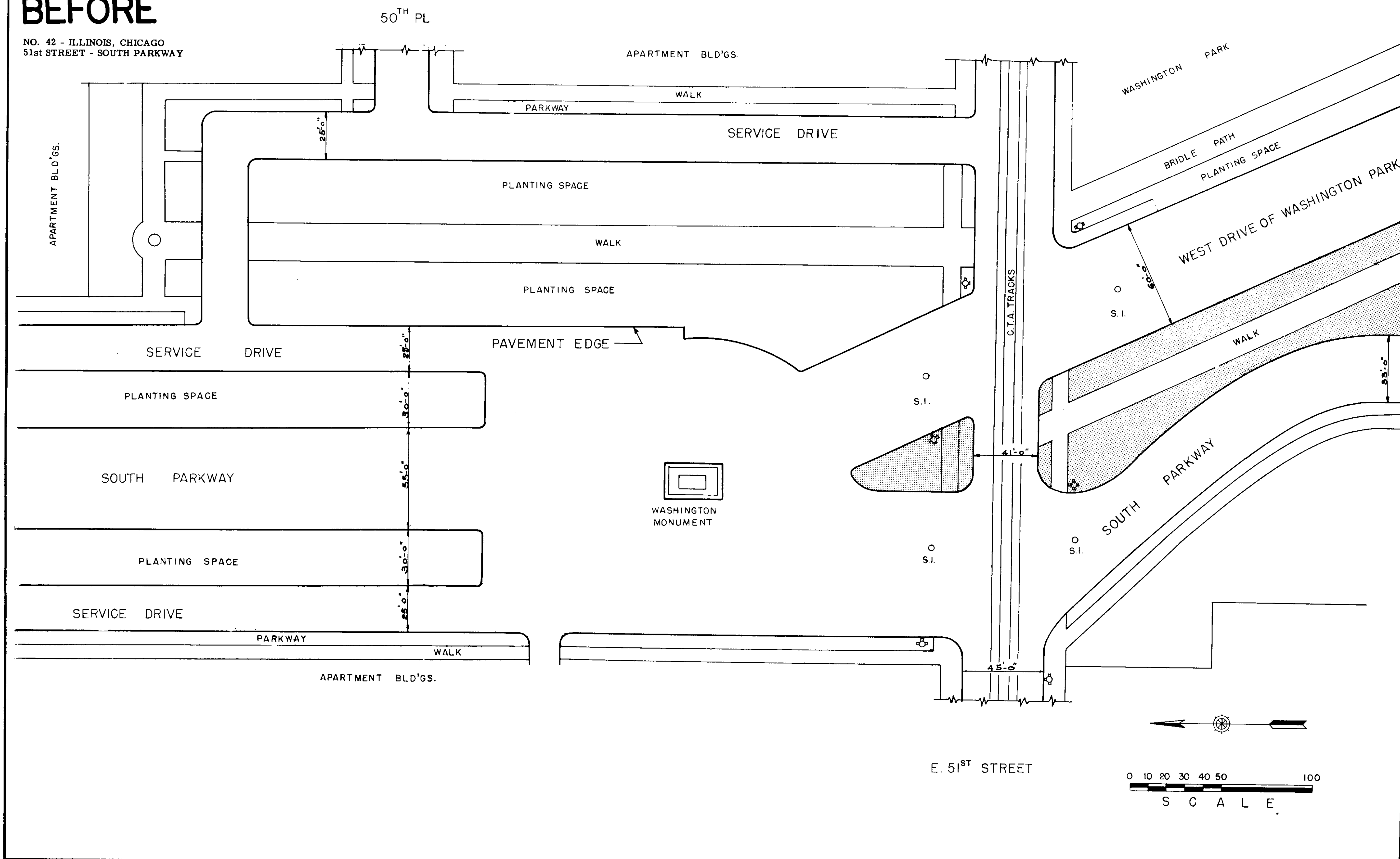
2. J. A. REDMAN - This is one of those rare situations where a great improvement can be accomplished with a small expenditure. The intersection can function only with signal control. If constructed today the lane widths would likely be more generous. Also, the curb radii at the intersection should be lengthened to facilitate turning movements. The increased safety record probably results from simplification of movements directionally. As a whole this is a good example of improved traffic operation with a minimum expenditure.

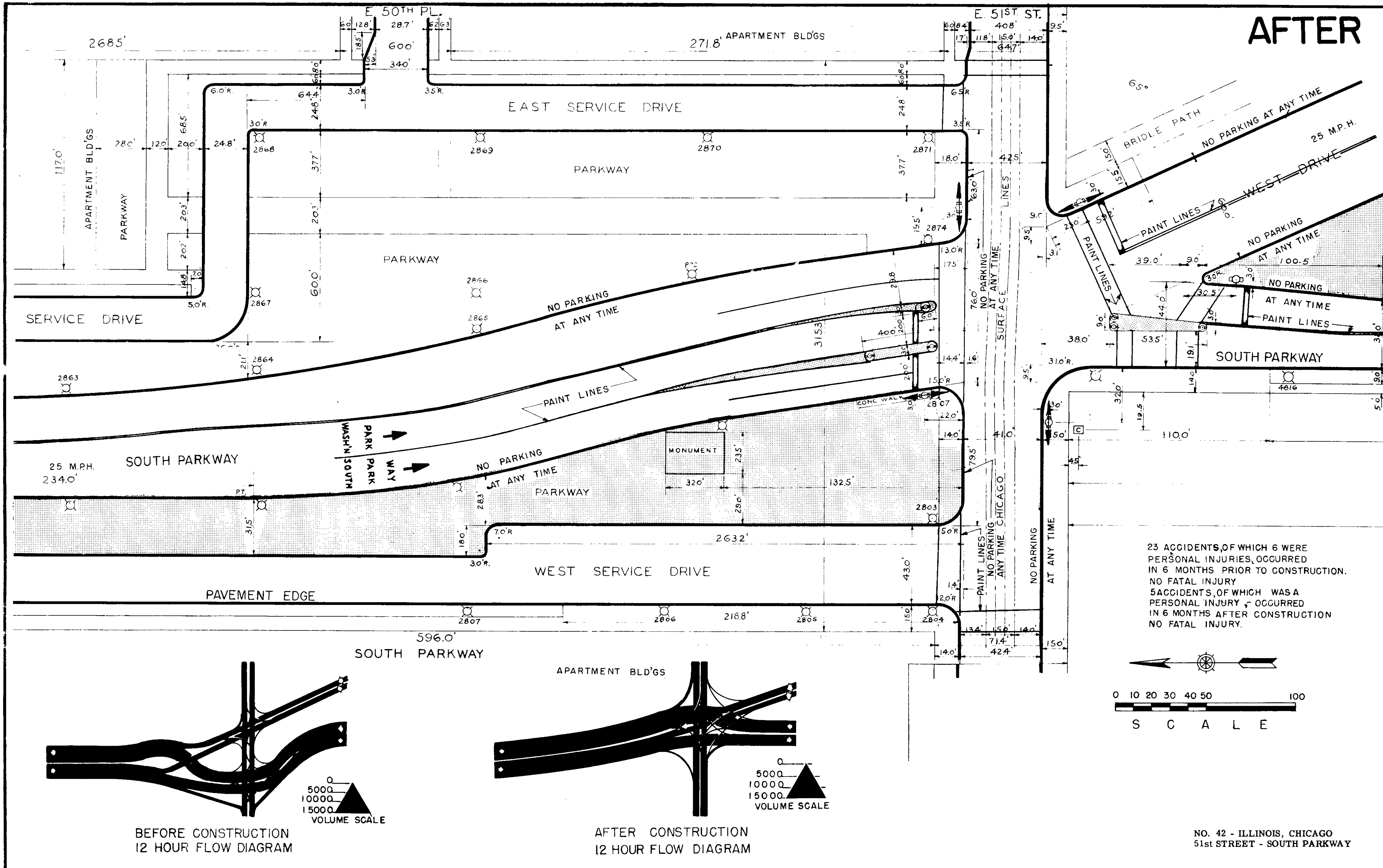
Figure 1. Intersection of 51st Street and South Parkway, Chicago, in January 1936 before channelization, showing dangerous reverse curb on South Parkway, with Washington Park at extreme left. Note the several ancient features.

Figure 2. October 1936, after reconstruction, looking across 51st Street down South Parkway at right. Safety islands and lightposts are part of improvement.

BEFORE

NO. 42 - ILLINOIS, CHICAGO
51st STREET - SOUTH PARKWAY





NO. 42 - ILLINOIS, CHICAGO
51st STREET - SOUTH PARKWAY

Example 43

Location

PENNSYLVANIA, Philadelphia
Church Lane-Cobb's Creek Parkway
- 70th Street

Submitted by

Robert Mitchell, Traffic Engineer,
Department of Public Safety,
Philadelphia, Pennsylvania

Type of Intersection

Multiway

Date Constructed

January 12, 1950

Physical Data

2. b. Sight distance at vertical curves: visibility good.
3. Surface Type
   c. Shoulders: curbed
4. Cross Section
   a. Not unusual, so not shown on plan.
5. Traffic Control Devices
   b. Signals: Type: none.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: bus service via Chester Avenue and Church Lane.

Traffic Data

1. Volumes:
   a. Average Daily: not available; within Park jurisdiction
   e. Pedestrian: very light; no paint markings required.
2. Type
   b. Percent Commercial: 10 percent commercial on Church Lane; none on other streets except bus line.
3. Speeds
   b. Average Operating Speeds Through Intersection: 20 mph. posted by Park Commission.

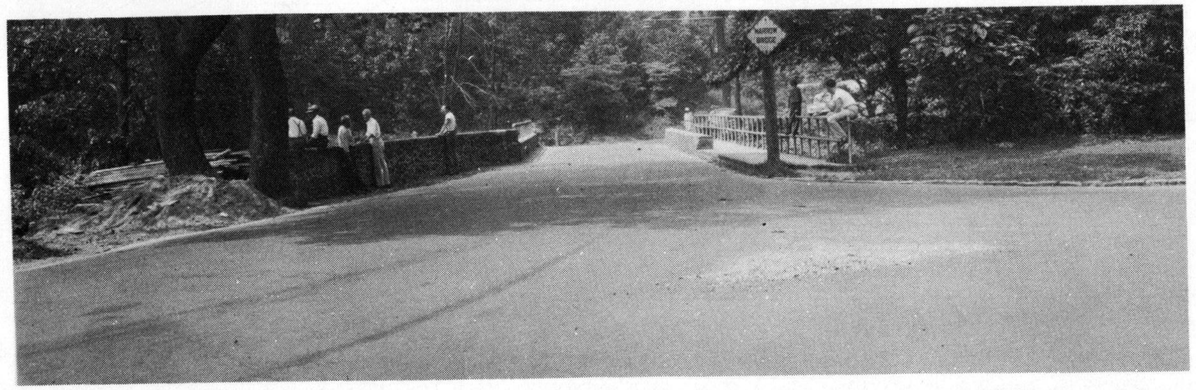


Figure 1. Intersection of Church Lane, Cobb's Creek Parkway, and 70th Street in Philadelphia before reconstruction and channelization.

6. Pedestrian
   a. Volumes: very light; no paint markings required.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "Safe"
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Relieve congestion".
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Eliminated separate crossings and gave an easier flow to traffic travel without signalization."

Comments by Committee Members

1. FRED W. HURD - When I first looked at this installation, my instinctive feeling was that it was not properly designed. I suppose this first reaction was caused by the lack of channelization for east bound and south bound traffic. You will notice that north bound traffic on Cobbs Parkway has the choice of several paths and that it enters the intersection in head-on conflict with south bound traffic on Church Lane. After more study, however, it became apparent that the channelization installed was about the best that could be designed for an intersection of this sort. To me, therefore, this is an example of the kind of intersection to be avoided in highway location and design. It also shows that channelization although installed in violation of some of the fundamental principles will improve the operations of such intersections when they cannot be avoided in the planning stage.

2. J. C. YOUNG - The "Before" and "After" comparison here seems to be considerably affected by the construction of a new bridge on completely new alignment. Channelization appears to fit the existing conditions satisfactorily and to promote orderly traffic flow. Several sharp turns are involved which may be objectionable, particularly for large commercial units. Speeds are low and existing control appears satisfactory. It is noted that stop control is achieved by pavement markings only. Lane stripes would be a desirable addition.

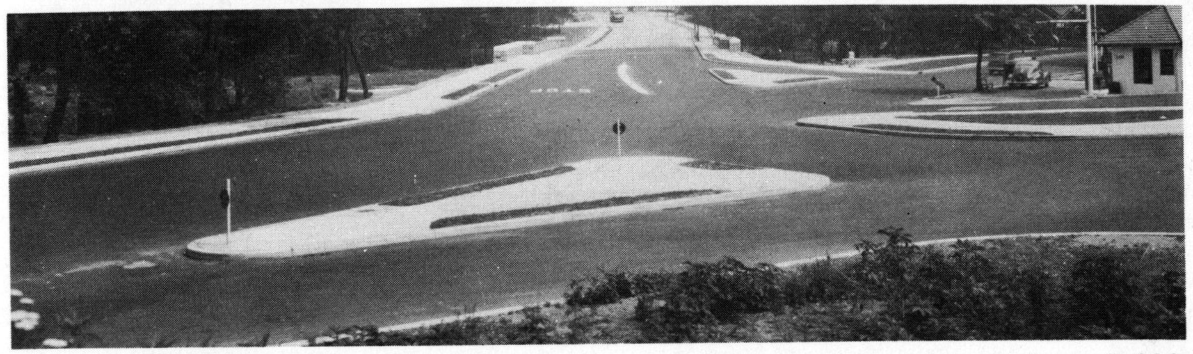
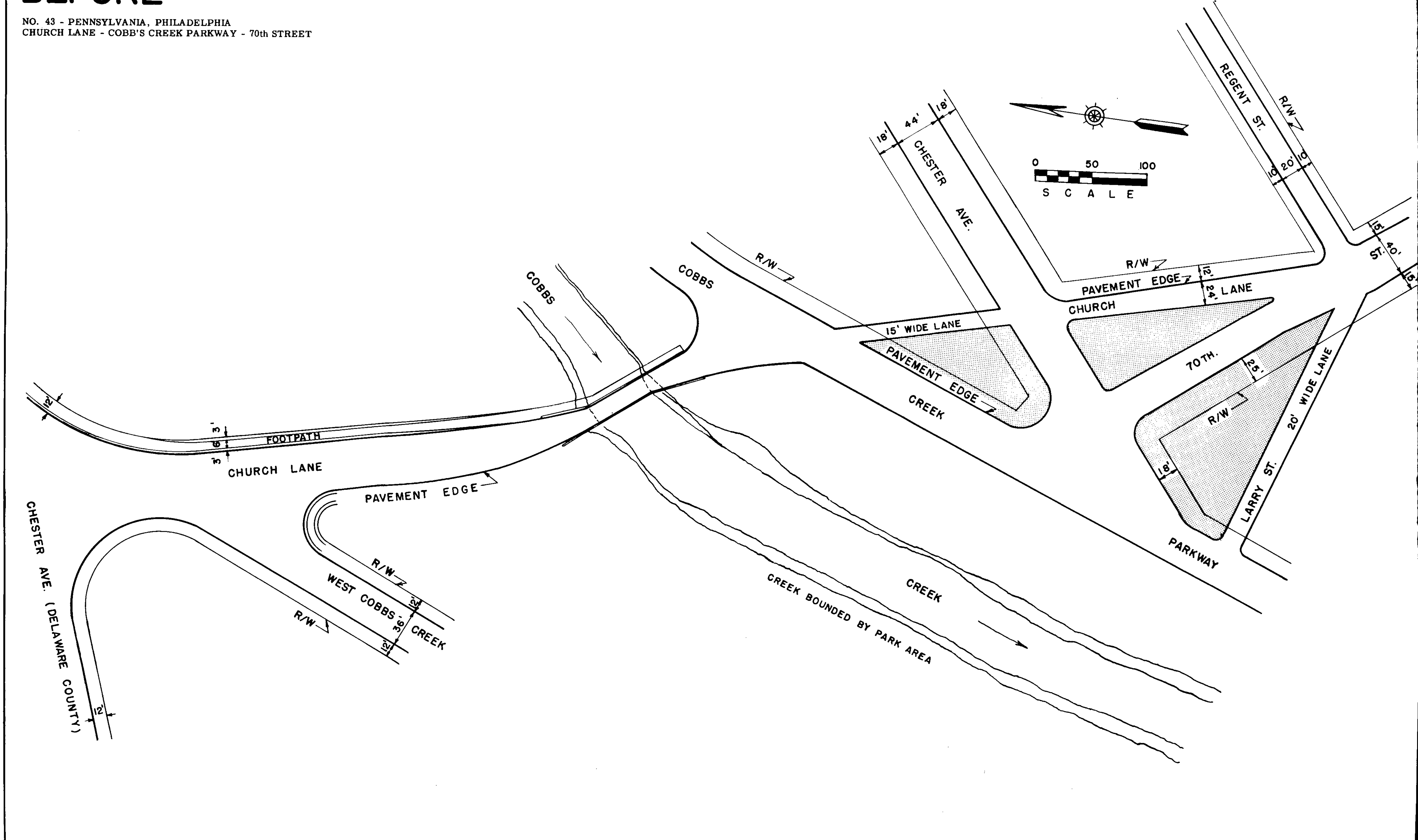


Figure 2. Reconstructed-and-channelized intersection, looking northwest from Cobb's Creek Boulevard. Note the small grass plots on the islands which require considerable maintenance.

BEFORE

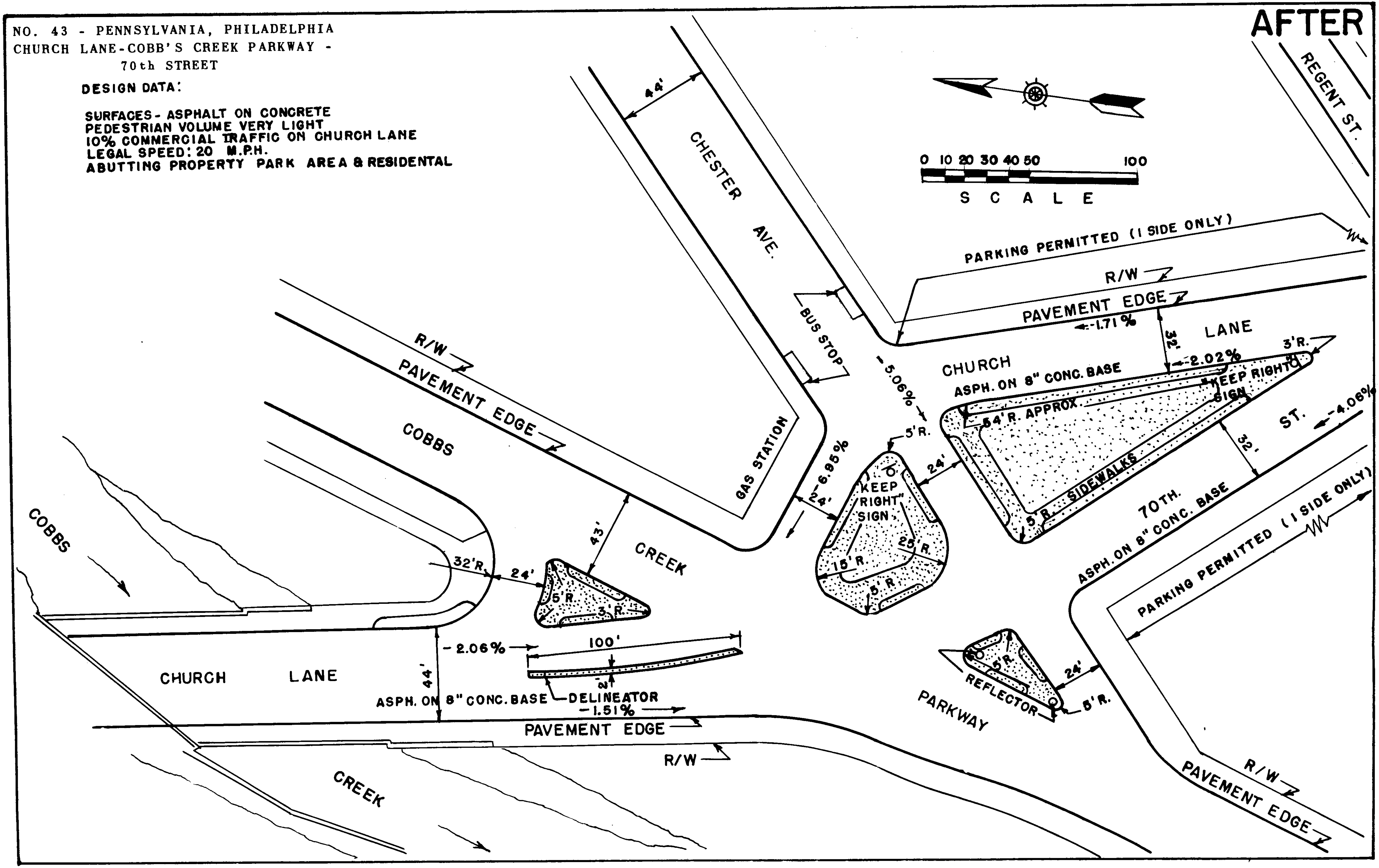
NO. 43 - PENNSYLVANIA, PHILADELPHIA
CHURCH LANE - COBB'S CREEK PARKWAY - 70th STREET



NO. 43 - PENNSYLVANIA, PHILADELPHIA
CHURCH LANE-COBB'S CREEK PARKWAY -
70th STREET

DESIGN DATA:

SURFACES- ASPHALT ON CONCRETE
PEDESTRIAN VOLUME VERY LIGHT
10% COMMERCIAL TRAFFIC ON CHURCH LANE
LEGAL SPEED: 20 M.P.H.
ABUTTING PROPERTY PARK AREA & RESIDENTAL



Example 44

Location

PENNSYLVANIA, Philadelphia
10th Street - 11th Street - Wagner Avenue - Somerville Avenue

Submitted by

Robert Mitchell, Traffic Engineer,
Department of Public Safety
Philadelphia, Pennsylvania

Type of Intersection

Multiway (Modified Circle)

Date Constructed

Proposed - 1950

Physical Data

1. d. "After": photograph not shown; new installation not yet made.
   b. "After": plan shown (proposed).
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: bus route along 11th Street and onto Wagner Avenue.

Traffic Data

3. Speeds
   b. Average Operationg Speeds Through Intersection: not given, but legal speed is stated as 20 mph.
5. Accidents
   a. Collision Diagram: "Before" and "After": none given, but statement is made that the record indicates: 10 accidents in 10 years - no deaths included.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. See general comment following.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. See general comment following.

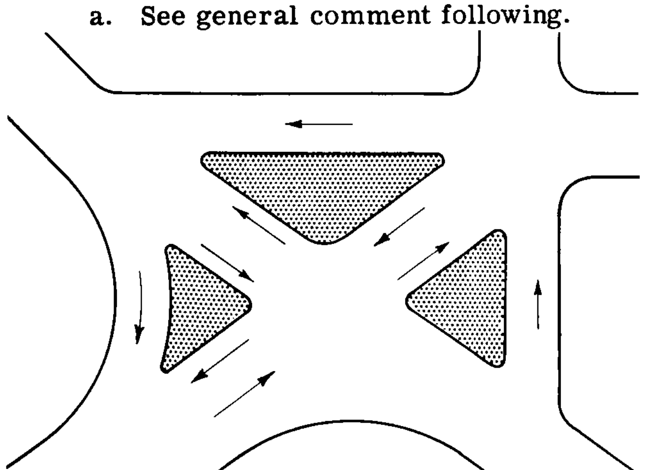


Figure 1.

Figure 2. Existing intersection of 10th, 11th, Somerville, and Wagner Streets in Philadelphia, looking south from 11th Street.

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "The new installation was designed to control the intersection without signal, eliminating the possibility of any through street speeding, at the same time giving each street equal opportunities for pedestrian and vehicular crossing."

Comments by Committee Members

1. NORMAN KENNEDY - It is stated in the comments of the submitter of this example that the design is intended to control the intersection without signalization, eliminate the possibility of any through street speeding, and give each street equal opportunities for pedestrian and vehicular crossing.

   It is probable that the design will accomplish these purposes, but it will be surprising if the accident experience is not greater with the rotary than with the old channelization. Turning radii and weaving distances are very short, and it can be expected that confusion will exist where the various traffic streams merge and cross because there is insufficient distance in which to safely accomplish the maneuver.

   The major movements are penalized, particularly movement F, but this seems to be in accordance with the thought that speed can be controlled by excessive bending of the traffic stream.

   It is suggested that the intersection might have been converted to a simple four-way in a manner indicated in Figure 1. There is not sufficient traffic through the intersection to warrant a traffic signal, but minor street movements could be controlled with stop signs. The new islands would facilitate safe crossing of the streets for pedestrians.

2. JAMES L. SHOTWELL - The existing intersection no doubt confuses the unfamiliar driver because of the lack of signs and markings. It appears that much could be done by a channelized design other than a rotary.

   The proposed rotary design should help some of the minor traffic movements but may penalize some of the major traffic depending on its path of travel. The oblong rotary is appropriate for this intersection. The pavement adjacent to the islands should be wider on the entrance than on the exit ends. The use of tangents instead of curves for the sides of the islands would accomplish this.

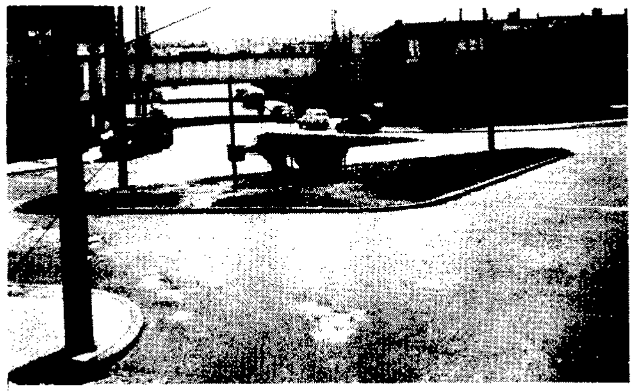
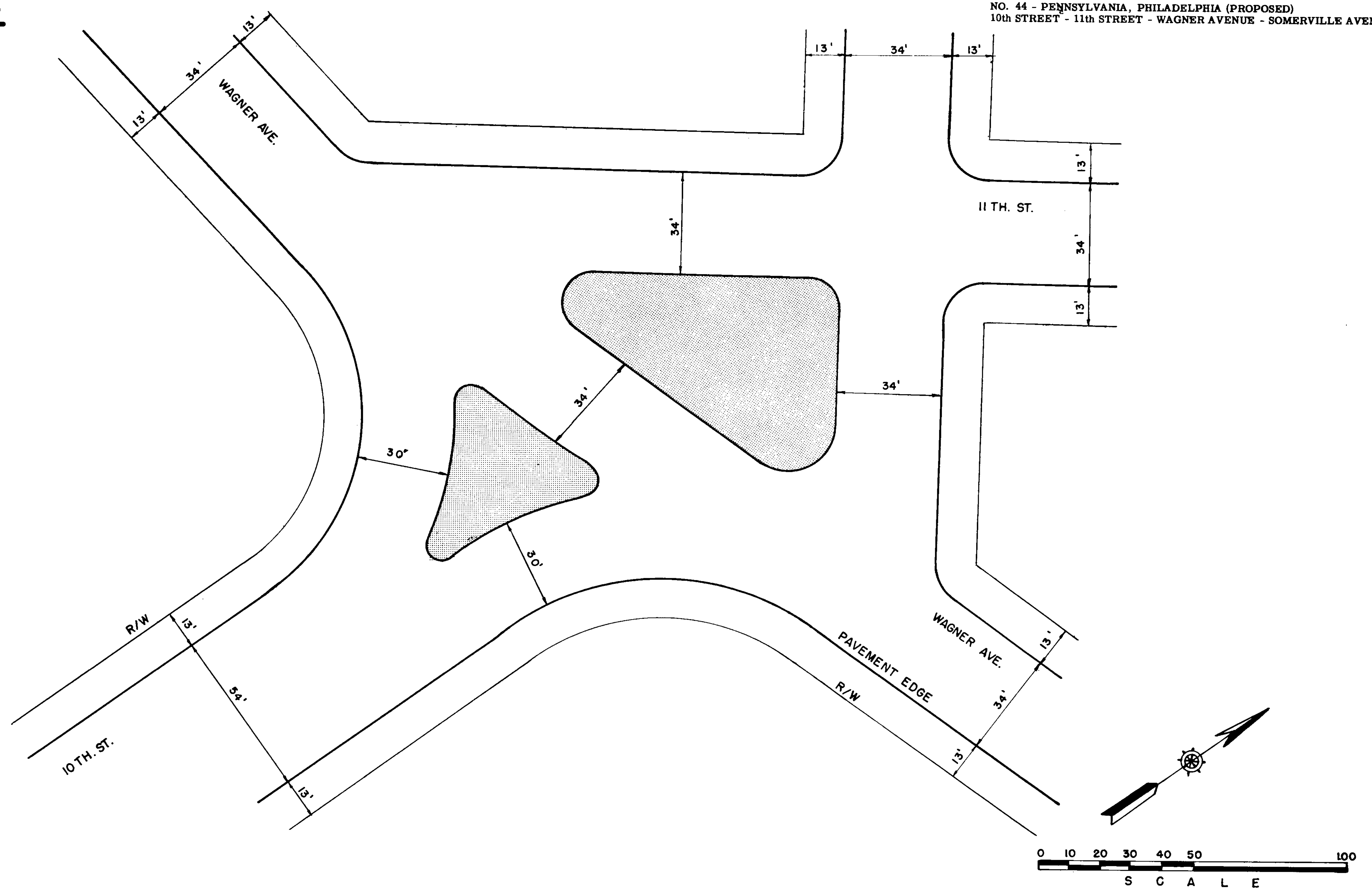


Figure 3. Existing intersection looking southwest from 11th and Somerville Avenue.

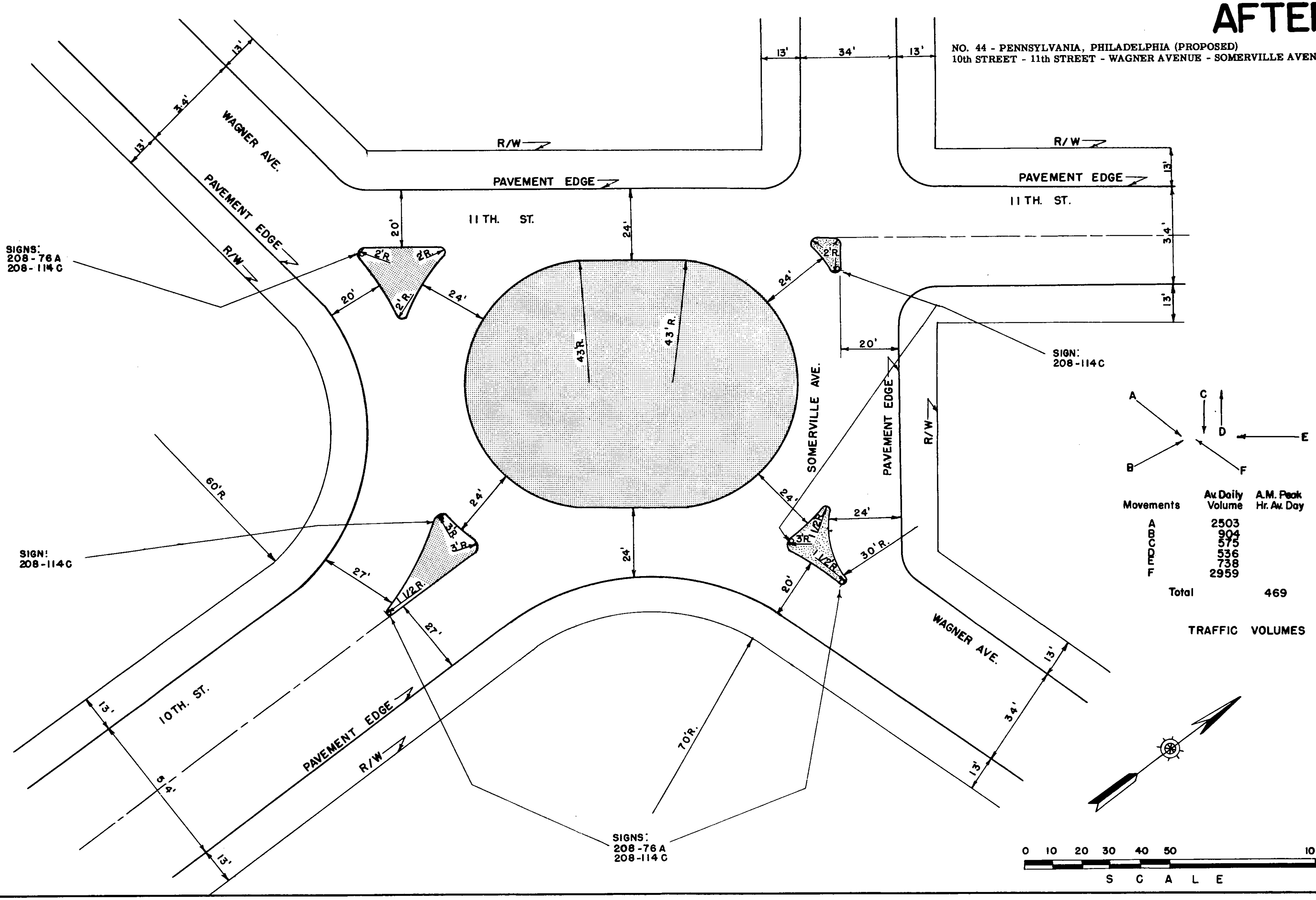
BEFORE

NO. 44 - PENNSYLVANIA, PHILADELPHIA (PROPOSED)
10th STREET - 11th STREET - WAGNER AVENUE - SOMERVILLE AVENUE



AFTER

NO. 44 - PENNSYLVANIA, PHILADELPHIA (PROPOSED)
10th STREET - 11th STREET - WAGNER AVENUE - SOMERVILLE AVENUE



Movements	Av. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	2503		
B	904		
C	575		
D	536		
E	738		
F	2959		
Total		469	619

TRAFFIC VOLUMES

Example 45

Location

PENNSYLVANIA, Philadelphia
Roosevelt Boulevard - Whitaker Avenue - Adams Avenue

Submitted by

Robert Mitchell, Traffic Engineer,
Department of Public Safety,
Philadelphia, Pennsylvania

Type of Intersection

Multiway

Date Constructed

December 14, 1948

Physical Data

5. Traffic Control Devices
   b. Signals: Type: none.

Traffic Data

5. Accidents
   a. Collision Diagram: "Before": no collision diagram available, but collision data is shown on plan.

Comments by Committee Members

1. NORMAN KENNEDY - The information supplied for this example does not indicate clearly what the "Before" and "After" traffic movements are. It appears, however, that head-on points of conflict were eliminated by constructing a rotary which results in one-way movements within the intersection on Roosevelt Boulevard, Adams Avenue or Whitaker Avenue.

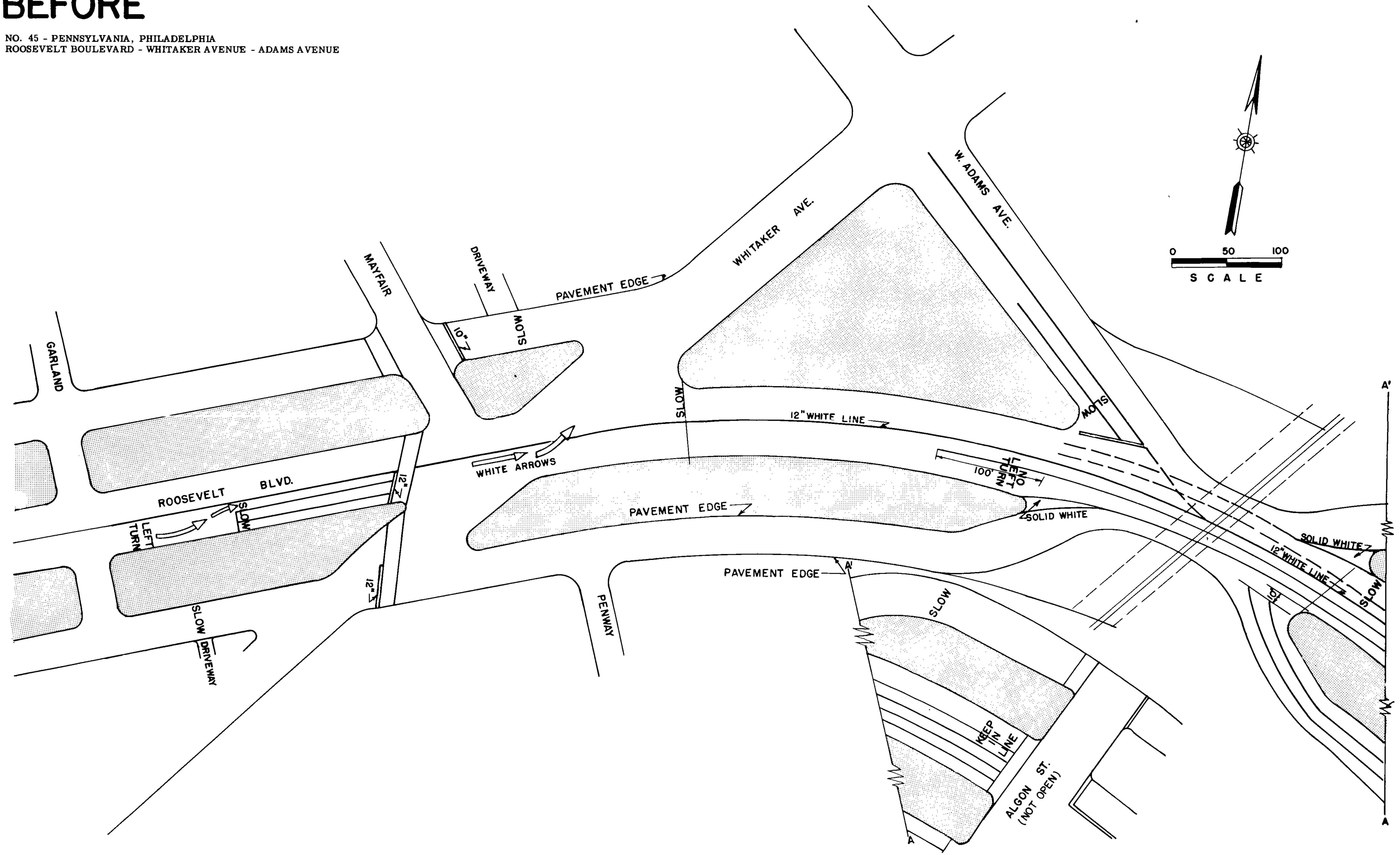
2. J. C. YOUNG - The next paragraph will be comments based on the information as it appears to us:
   On the surface, this modified traffic circle appears to have been very helpful judging by the before-and-after accident record. The design seems fairly simple and clean.
   However, the unbalance in traffic flow between movements A (3155) and B (366) indicates that the left turn Roosevelt to Whitaker has been made so difficult by this channelization (due probably to the short weaving distance on Adams) that this left turn movement has been transferred to some other location. It would be interseting to see the "Before" and "After" accident record at the other location. Apparently this example is an illustration of a general principle regarding channelization, which is to be wary about transferring the problem to another site, which does not necessarily cure the problem.

Figure 1. Intersection of Roosevelt Boulevard, Whitaker Avenue, and Adams Avenue, Philadelphia, before redesign and channelization.

Figure 2. Looking west from intersection of Roosevelt Boulevard and Adams Avenue after channelization.

BEFORE

NO. 45 - PENNSYLVANIA, PHILADELPHIA
ROOSEVELT BOULEVARD - WHITAKER AVENUE - ADAMS AVENUE



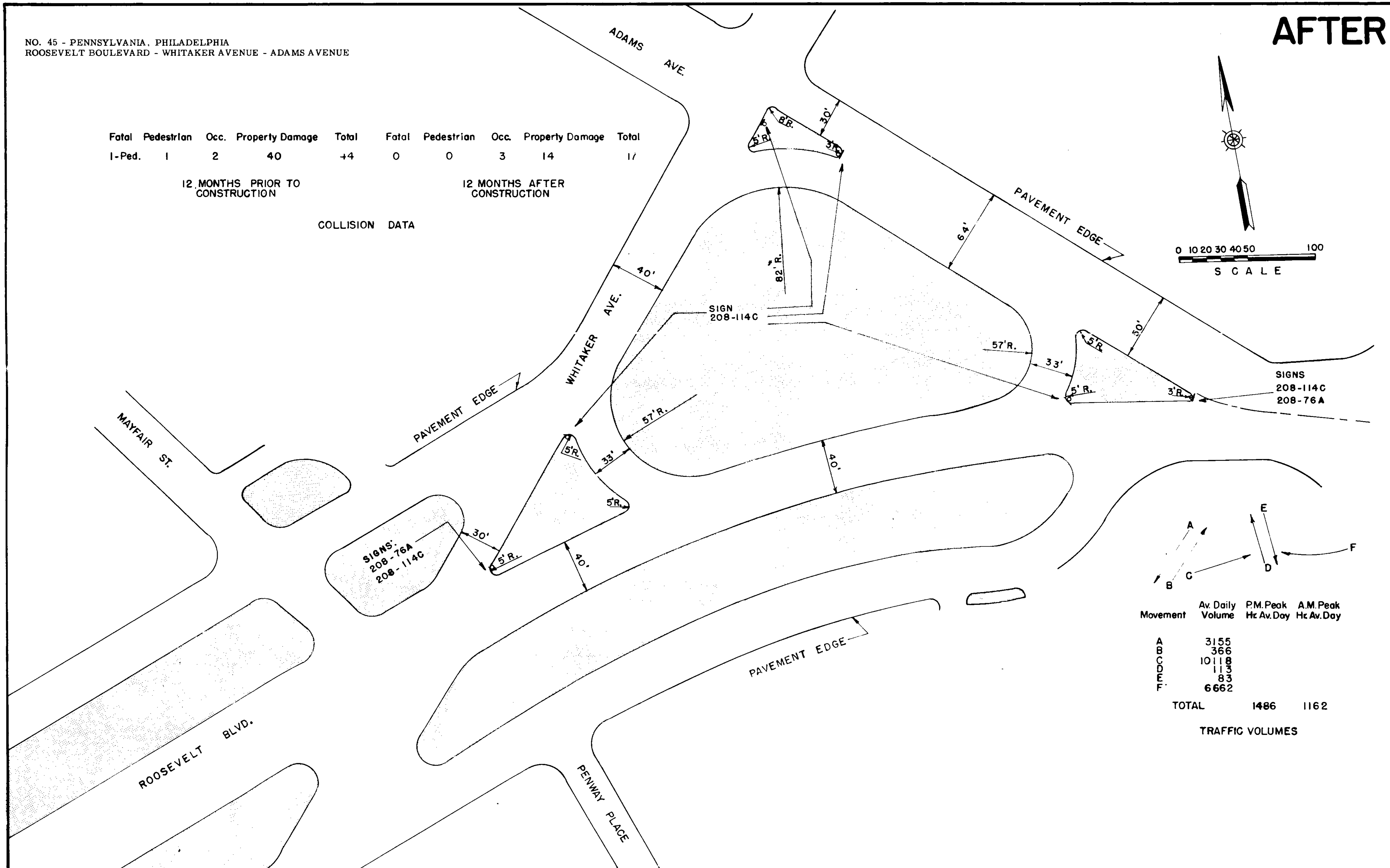
NO. 45 - PENNSYLVANIA, PHILADELPHIA
ROOSEVELT BOULEVARD - WHITAKER AVENUE - ADAMS AVENUE

AFTER

Fatal	Pedestrian	Occ.	Property Damage	Total	Fatal	Pedestrian	Occ.	Property Damage	Total
1-Ped.	1	2	40	44	0	0	3	14	17

12 MONTHS PRIOR TO CONSTRUCTION — 12 MONTHS AFTER CONSTRUCTION

COLLISION DATA



Movement	Av. Daily Volume	P.M. Peak Hr. Av. Day	A.M. Peak Hr. Av. Day
A	3155		
B	366		
C	10118		
D	113		
E	83		
F	6662		
TOTAL		1486	1162

TRAFFIC VOLUMES

Example 46

Location

TEXAS, near Austin
(Travis County), US 290 -
Texas 29, 7th St., near Montopollis Bridge

Submitted by

J. C. Dingwall, Engineer of Road Design.
Texas Highway Department,
Austin, Texas

Type of Intersection

Multiway

Date Constructed

1948

Physical Data

1. a. "Before" plan: No prior comparable intersection at this location.
2. a. Grades: shown on plan
3. Surface Type
   a. Roadways: hot mix asphaltic concrete on concrete base.
4. Cross Section
   a. Not unusual
5. Traffic Control Devices
   b. Signals: Type: none
   d. Lighting: Type: none
   e. Other Control Devices: Guide Posts: none
6. Landscaping
   a. None except grass areas and roadside development.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none
   b. Location of Passenger Stops and Zones: none

Traffic Data

3. Speeds
   b. Average Operating Speeds Through Intersection: Speed Limit signs: 45 mph.
5. Accidents
   a. Collision Diagram: "Before": none. "After": shown on plan. Length of Period. 1 year.
   b. Fatal, 0, Personal Injury, 2, Property Damage, 8.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. See general comment following.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. See general comment following.
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Although such marginal establishments as warehouses, tourist courts, and a drive-in theater have developed on the approaches in all directions, the intersection itself is still open and fairly free from such congestion. This installation is functioning satisfactorily, although there is some evidence of need for improvement in directional signs to eliminate slight confusion of traffic bound for mid-Austin from across the bridge."

Comments by Committee Members

1. H. G. VAN RIPER - This layout represents an effective treatment of actue angle intersections. The collision diagram indicates the need for "Slow" pavement marking on lane "C" south of lane "D".

2. EDWARD G. WETZEL - The channelization at this intersection appears to be over designed or more specifically the layout does not seem to adequately satisfy the conditions. I would guess the channelizing islands were designed to fit the apparent wide intersection area, instead of redesigning the intersection first as part of the complete channelization design.

   The heaviest volume of traffic is between Airport Boulevard (south) and 1st Street and 7th Street. While the traffic flow in the southbound direction is relatively free, the traffic in the opposite direction is confronted with a cross movement of southbound Airport Boulevard traffic at approximately the center of the channelization and intersection. The approach speeds being what they are and with only a STOP sign to control this cross traffic, it is not surprising to note that the majority of the accidents have occurred here.

   It is also observed that the "breaks" in the islands to allow for turning back probably do not accommodate more than 2 or 3 passenger cars safely. Any more than the number that can safely be "shadowed" will extend into the intersection or merge with fast moving and heavy traffic stream.

   Among several modifications that could be made to improve the operation at this intersection, particularly since it is located in a fairly open area, I would offer the following:

   a. Turn 1st Street north to intersect 7th Street more nearly at right angle to form a "T" at a point west of present intersection. Make the coincidental portion of 1st Street and 7th Street intersect Airport Boulevard at near right angle or a "T". Allow for larger size "tear drop" islands such as the one separating traffic movements "L" and "E" at the center of the "T's". The channelized roadways should be wide enough to handle the peak volumes and with additional speed change lanes where necessary. Intersecting traffic should cross at near a right angle where possible.

   b. Another suggestion with the present layout: enlarge the "tear drop" island separating movements "L" and "E" to provide adequate storage or reservoir for the traffic required to stop; redesign the "breaks" or "cross overs" in the approach islands to limit the turning to only the major movements, such as from "E" to "B" not "A" to "M".

Additional Comments by J. C. Dingwall

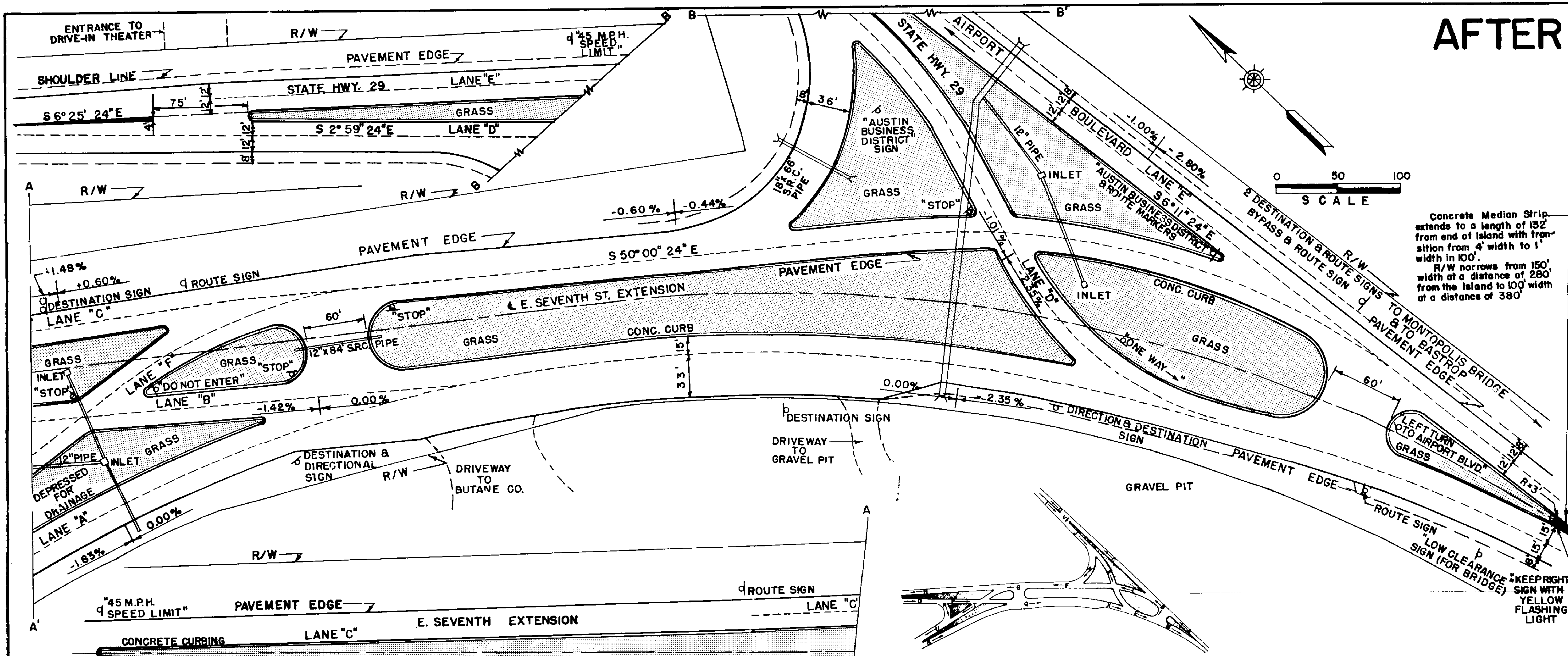
We are of the opinion that the greatest deficiency this intersection channelization possesses is the fact that the island between lane "D" and lane "E" is only something over 200 ft. wide. This means that a motorist who may stop on lane "D" is required too frequently to make a split-second decision as to whether or not potentially conflicting traffic on lane "E" is destined toward the north or toward the west. We believe the collision diagram bears out this theory.

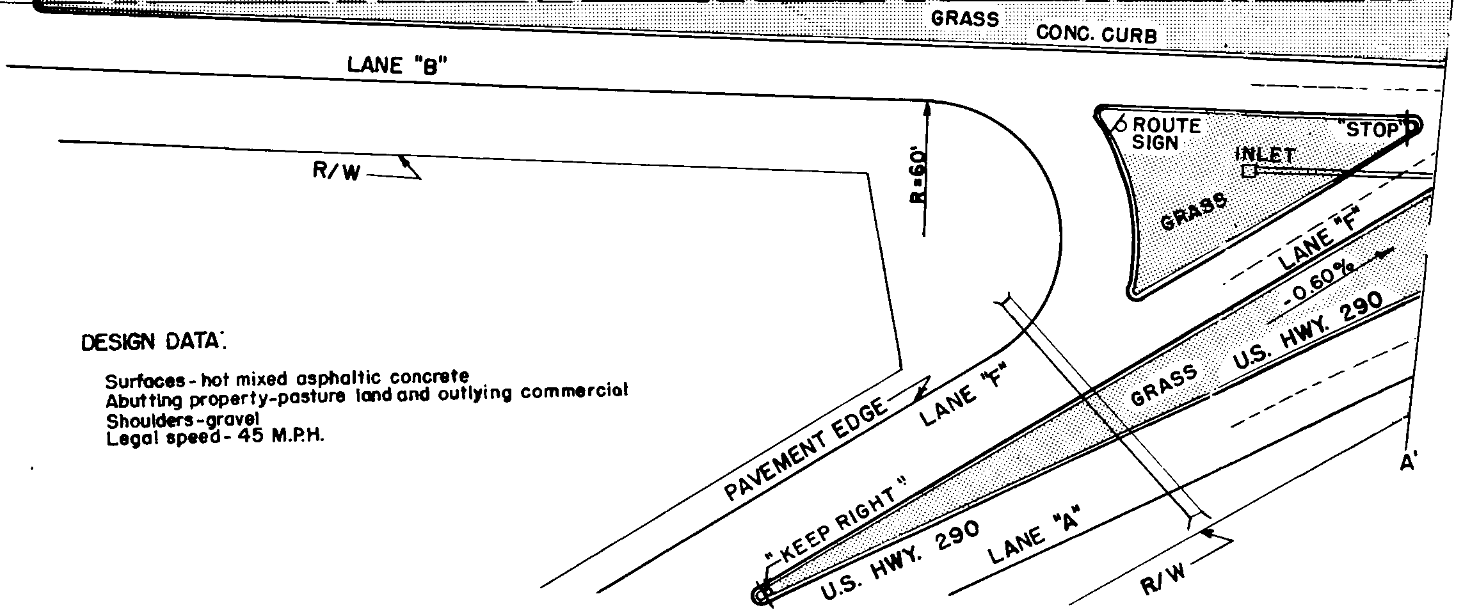
In our opinion the intersection could have been improved considerably had lane "D" been located, say, 200 ft. west of its present location. This would have increased the time a motorist would have to determine whether his crossing would be opposed or not. This time should be a minimum of six seconds and at 45 mph. the lanes should be located better than 300 ft. apart. In this connection it may be noted that at the intersection of lane "B" and lane "F" only one accident occurred in the same period. The design requires a slower crossing here. Therefore, the decision time required can be shorter.

In reply to some of Mr. Wetzel's objections, while it would have been desirable to increase the width of the islands between the movements "L" and "E" this could have been done only with additional right-of-way. Mr. Wetzel's comment that the island at the south could well have been constructed as to prohibit the "A" to "M" movement is a good one but unfortunately roadside access required consideration. Actually these movements are small in number and, as the collision diagram shows, no accidents from this source have resulted.

Figure 1. Channelized intersection of US 290, Texas 29, and 7th Street, near Austin.

AFTER



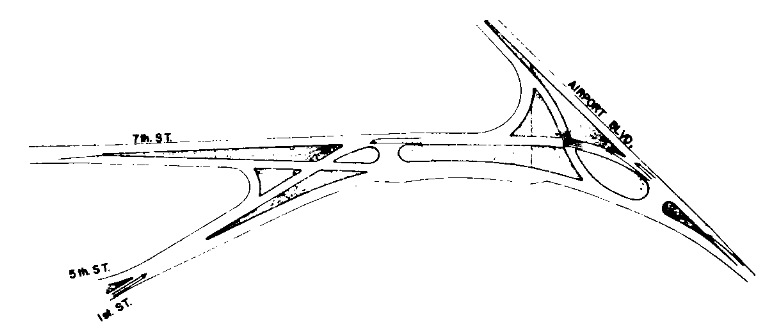


DESIGN DATA:

Surfaces - hot mixed asphaltic concrete
Abutting property - pasture land and outlying commercial
Shoulders - gravel
Legal speed - 45 M.P.H.

Movement	Av. Daily Volume	Peak Hr.
A	5639	564
B	6257	612
C	2342	302
D	2256	254
E	6502	509
F	4052	410
G	4609	405
H	2443	279
I	1952	195
J	2515	256
K	1759	195
L	3891	363
M	5996	482
N	761	102
O	2329	198
P	2045	181
Q	4762	387
R	308	29
S	2680	213
T	1744	159
U	2052	183
V	344	112
W	506	100
X	4741	378

TRAFFIC VOLUMES



FOR YEAR 1949
AFTER CONSTRUCTION

COLLISION DIAGRAM

NO. 46 - TEXAS, NEAR AUSTIN (TRAVIS COUNTY)
US 290 - TEXAS 29 - 7th STREET, NEAR MONTOPOLIS BRIDGE

Example 47

Location

VIRGINIA, Falls Church
Fort Buffalo Intersection -
US 50-Virginia 338-Virginia 613-
Wilson Blvd. -Virginia 7

Submitted by

Virginia Department of Highways,
Richmond, Virginia,
Division of Traffic and Planning,
Through W. F. Smith, Urban Engineer

Type of Intersection

Multiway

Date Constructed

1948

Physical Data

3. Surface Type
   b. Islands: Grass plots, with sloping precast concrete curbs.
   c. Shoulders: about 6 to 8 ft. wide.
4. Cross Section not unusual; used local material base with an initial bituminous surface treatment and a later plant mix top.
5. Traffic Control Devices
   a. Signs: Type: shown on plan, standard and reflectorized.
   e. Other Control Devices: Guide Posts: All corners of triangular islands and grass plots, within intersections, have 8 by 8 in. delineator posts with reflectors attached.
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none
   b. Location of Passenger Stops and Zones: none

Traffic Data

1. Volumes
   e. Pedestrian: negligible
2. Type
   b. Percent Commercial: "averages about 10.6 percent of which about 90 percent is light and medium trucks. In other words, only about 1 percent of the total traffic is trailer trucks or busses, attributable to an 8-ton gross load limitation on Route 50."
3. Speeds
   a. Approach Speed: 85 Percentile: Estimated at about the legal speed limits, 50-55 mph.
   c. Average Operating Speeds Through Intersection: "We do not know the average operating speeds through the intersection but would estimate them to approach the legal limit along Routes 50 and 338, which the design favors, and possibly 20-25 mph. along the other routes."
5. Accidents
   a. Collision Daigram: "Before" and "After" collision diagrams are shown in separate plans from the condition plans.
6. Pedestrian
   a. Volumes: negligible

Economic Data

1. Estimated Cost of New Installation
   a. $71,000, including a raise in grade for approximately 1000 ft. on both lanes of Route 50 to the west. Construction by state forces.
2. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "Before"
   a. $3005
3. Estimate of Monetary Value of Traffic Accidents for 12-Month Period "After"
   a. $2100

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "We feel that separating the points of conflict and providing some refuge area for left turning traffic, have contributed to the safety of the intersection. On the other hand, we feel that the summit vertical curve, existing prior to channelization, detracts from the safety afforded."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "We believe congestion has been relieved by providing more definite paths for the numerous maneuvers which are at the same time spread over a larger area."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Overall operation, we believe, is about as good as could be attained with the above mentioned expenditure, except that considerable 'through' traffic on Route 7 is forced into an undesirably circuitous path by the elongated island on Route 50. Considerable congestion occurs on Sunday afternoons due to large numbers of pleasure drivers, and we recognize the eventual solution is a separation of grades, depressing Route 50 and carrying Route 7 over."

      "The precast sloping concrete curb around the islands was not installed until the layout had been in operation for six months, during which time the islands were outlined with sandbags. This was to permit minor adjustment of vehicle paths if proved desirable in actual operation. None of any magnitude was made."

Comments by Committee Members

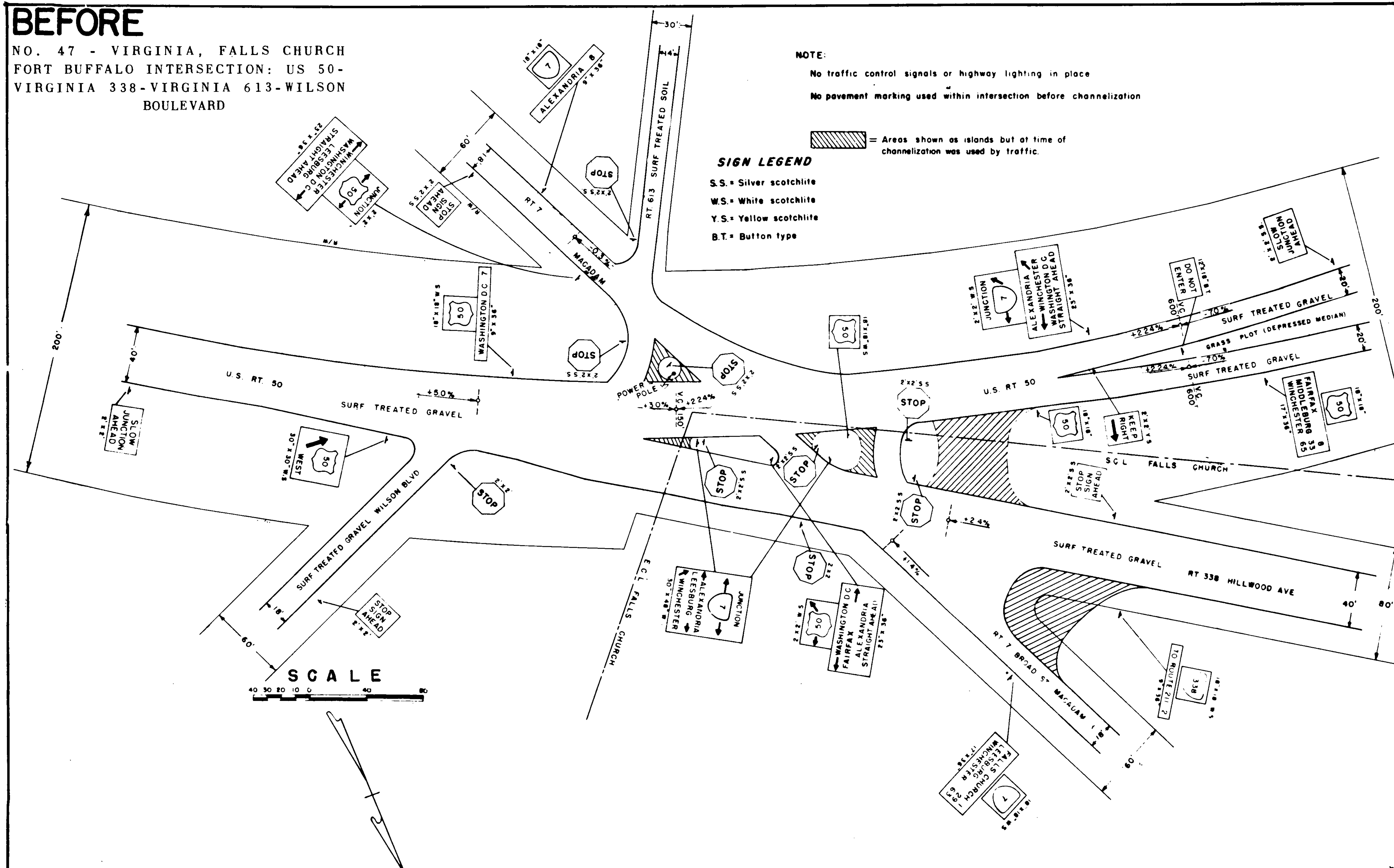
1. JAMES L. SHOTWELL - From a channelization viewpoint this intersection has been well handled, but from a broad planning viewpoint it is a good example of what not to do. This intersection originally consisted of Routes 7 and 613 and Wilson Boulevard. Later Route 50 was constructed east of the intersection and continued west of the intersection on what is now Route 338, which intersected US 211 about one mi. west. Routes 211 and 338 soon became congested and Route 50 west of the intersection was then constructed on its present location. The error has been concentrating too many roads at one intersection.

   Except for the traffic on Route 50 and perhaps 338, this intersection completely breaks down under week-end traffic. As pointed out in the State's submission, an underpass will be required and it will be a costly one.

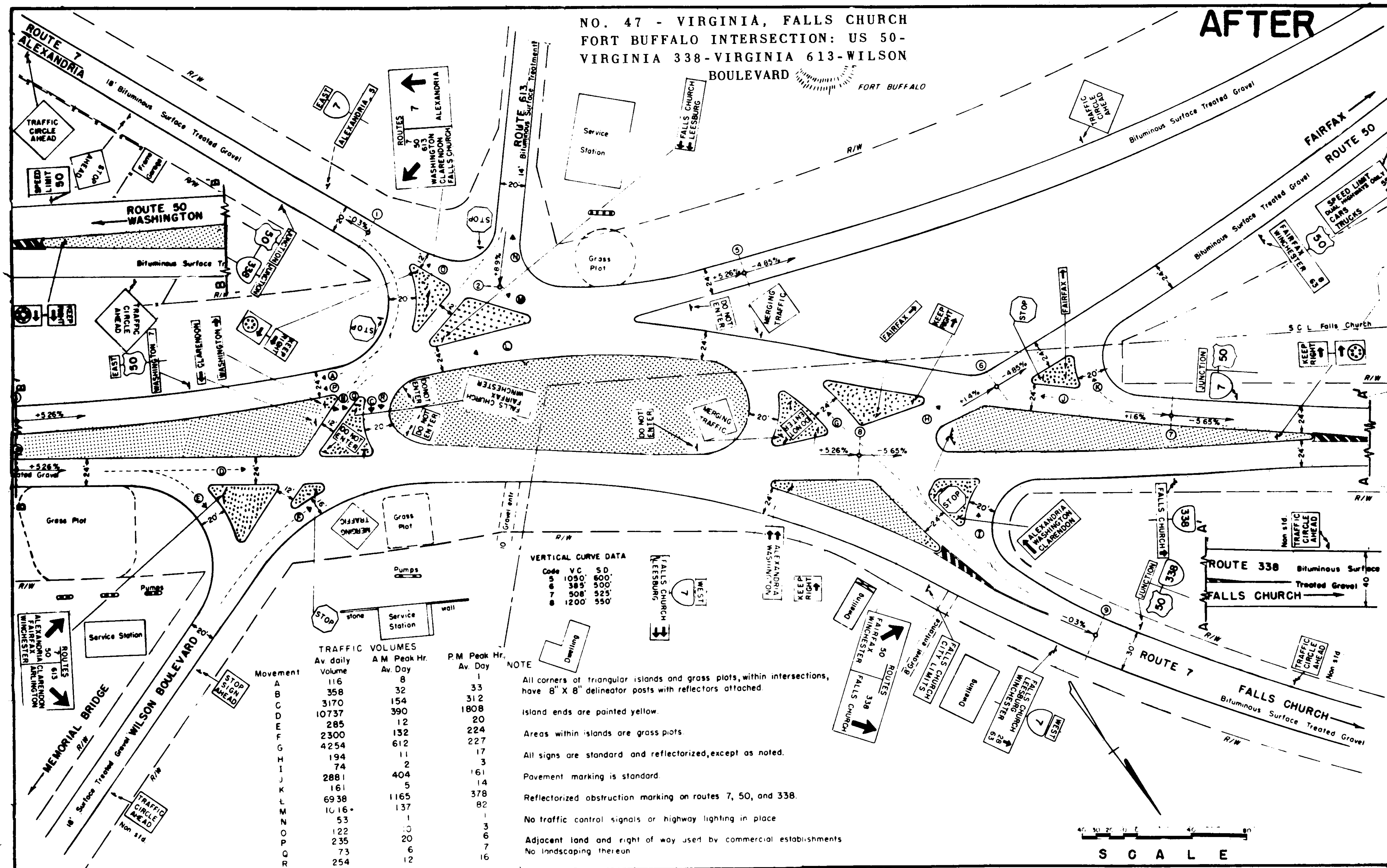
   For an at-grade intersection with seven approach roads and the high volume of traffic that exists here, the State had done a commendable job. The manner in which they tested their design by the use of sandbags to delineate the island and adjusted them where possible to fit the traffic has considerable merit. After they were satisfied with their design the sandbags were replaced by a concrete curb which was precast and placed in short sections.

BEFORE

NO. 47 - VIRGINIA, FALLS CHURCH
FORT BUFFALO INTERSECTION: US 50-
VIRGINIA 338-VIRGINIA 613-WILSON
BOULEVARD



NO. 47 - VIRGINIA, FALLS CHURCH
FORT BUFFALO INTERSECTION: US 50-VIRGINIA 338-VIRGINIA 613-WILSON BOULEVARD



VERTICAL CURVE DATA

Code	V C	S D
5	1050'	600'
6	385'	500'
7	508'	525'
8	1200'	550'

TRAFFIC VOLUMES

Movement	Av. daily Volume	A M Peak Hr. Av. Day	P.M Peak Hr. Av. Day
A	116	8	1
B	358	32	33
C	3170	154	312
D	10737	390	1808
E	285	12	20
F	2300	132	224
G	4254	612	227
H	194	11	17
I	74	2	3
J	2881	404	161
K	161	5	14
L	6938	1165	378
M	1016 •	137	82
N	53	1	1
O	122	10	3
P	235	20	6
Q	73	6	7
R	254	12	16

NOTE

All corners of triangular islands and grass plots, within intersections, have 8" X 8" delineator posts with reflectors attached.

Island ends are painted yellow.

Areas within islands are grass plots.

All signs are standard and reflectorized, except as noted.

Pavement marking is standard.

Reflectorized obstruction marking on routes 7, 50, and 338.

No traffic control signals or highway lighting in place

Adjacent land and right of way used by commercial establishments
No landscaping thereon

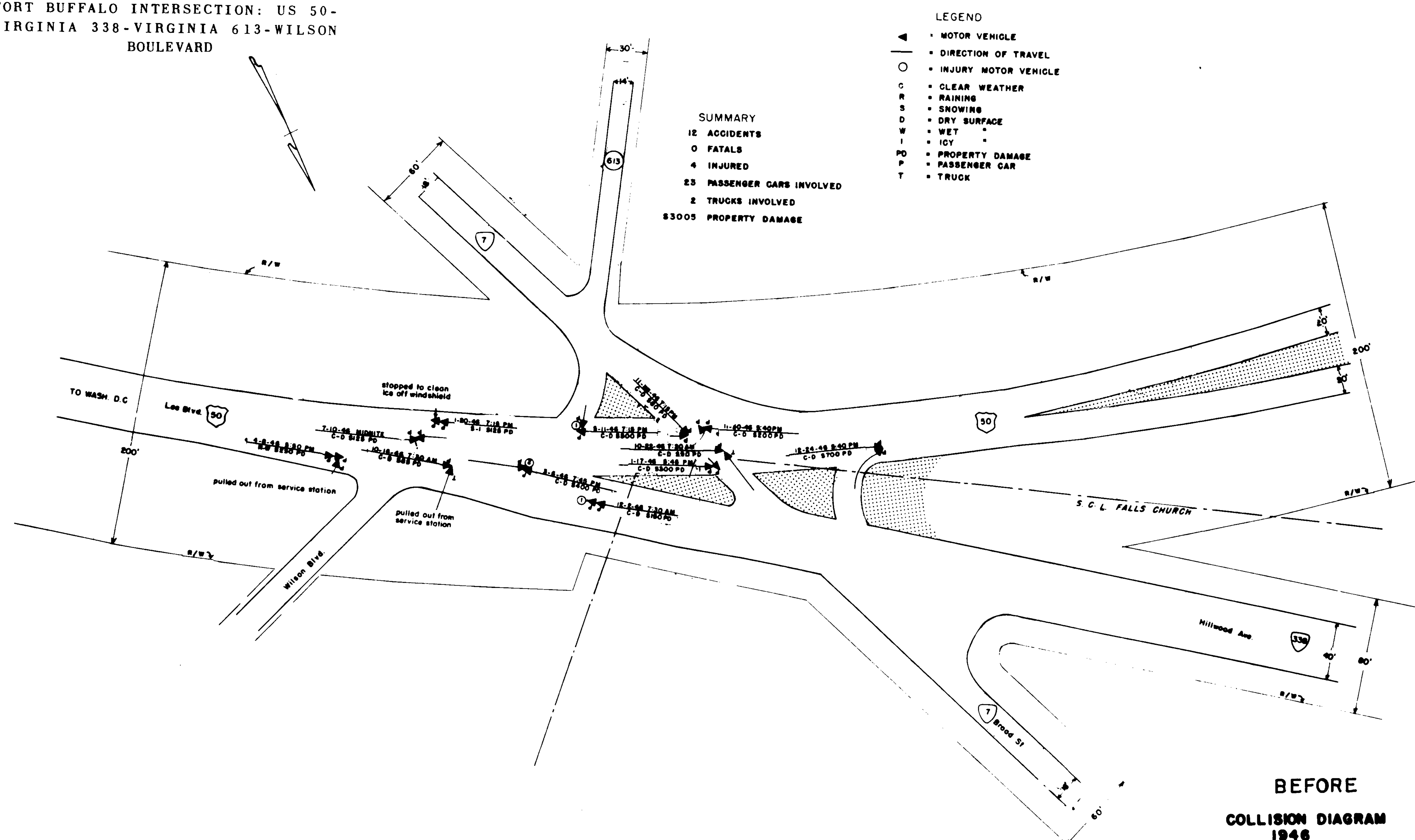
The use of traffic signals (I would hate to have to design it) should help the minor flows of traffic during the peak hours.

2. J. C. YOUNG - My first reaction is that it would have improved matters considerably here if the west leg of Route 50, which does not show in the "Before" photograph, could have been joined to Route 338 at some other location. The second reaction is to wonder whether the weaving movement of the 2,300 ADT (movement F) northbound on Wilson with the 10,737 westbound from Route 50, is accomplished as easily as a straight across movement would be. The collision diagram does not show these people getting into any trouble, and this surprises me, if the 2,300 is correct. It is especially surprising when I realize that a third conflict of 3,170 per day (C and R) weaves with both of these streams. Apparently, most of these 2,300 go all around the oval, which would be a long way for one of the major maneuvers. The volumes are extremely hard to discern. Apparently the 4-lane divided section of Route 50 carries about 700 vpd (355 westbound) on the west leg (Fairfax). However, it does look as though Route 50 east of the intersection carries about 20,000 and if so, the proof of the pudding is in the performance of this intersection, which is remarkable. If we could have a complete single-line traffic diagram of this intersection, and positive assurance that it is working without undue congestion, we might revise our opinion of rotary intersections with their short weaving sections, upon which we have heretofore looked askance. We should almost certainly have used signals at an intersection carrying these volumes, but if the circle will eliminate their necessity, and, at the same time not cause undue friction or accidents, it would seem to be a better solution.

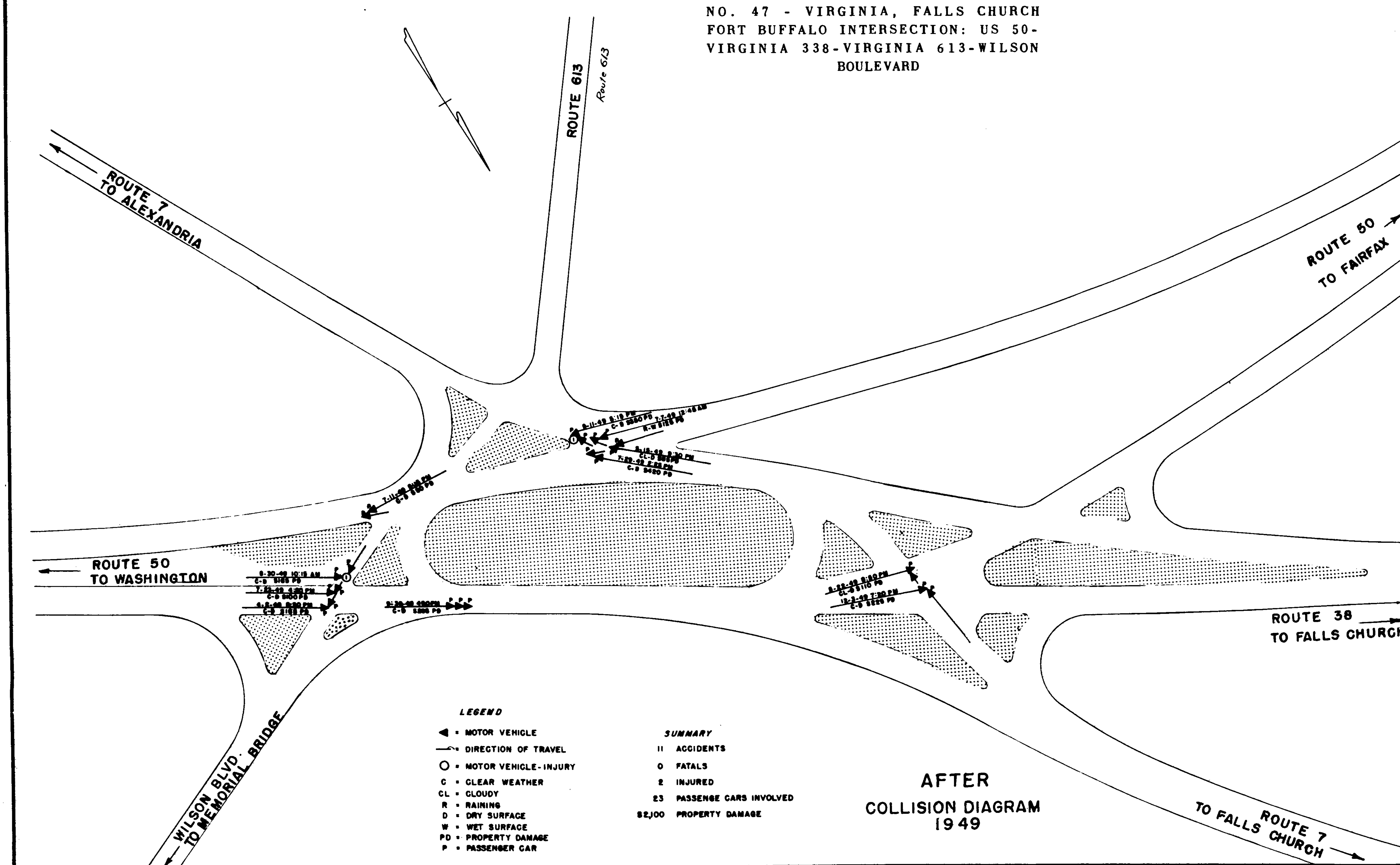
Figure 1. Fort Buffalo Intersection of US 50, Virginia 338, Virginia 613, Virginia 7, and Wilson Boulevard, near Falls Church, before channelization.

Figure 2. Channelization of a multiway intersection with seven approach roads and complex turning movements.

NO. 47 - VIRGINIA, FALLS CHURCH FORT BUFFALO INTERSECTION: US 50-VIRGINIA 338-VIRGINIA 613-WILSON BOULEVARD



NO. 47 - VIRGINIA, FALLS CHURCH
FORT BUFFALO INTERSECTION: US 50-VIRGINIA 338-VIRGINIA 613-WILSON BOULEVARD



AFTER
COLLISION DIAGRAM
1949

Example 48

Location

WASHINGTON, Seattle
Green Lake Way - North 50th Street

Submitted by

J. W. A. Bollong, Traffic Engineer,
400 County-City Building,
Seattle, Washington

Type of Intersection

Multiway

Date Constructed

Signal installed April 27, 1949

Physical Data

2. b. No vertical curves of any consequence.
3. Surface Type
   a. Roadways: Green Lake Way and Stone Way - blacktop, N. 50th Street - concrete
   b. Islands: 4 in. crushed rock, 2 in. blacktop. The island is surrounded by white reflecting precast concrete curb of the New Jersey type.
4. Cross Section
   a. Standard
5. Traffic Control Devices
   b. Signals: Type: 3-section 5-way suspended signal. Timing: Signal sequence and lens sequence drawings are available but not included in this publication.
   d. Lighting: Type: none shown except illuminated nosing terminal.
6. Landscaping
   a. None
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: Straight through both directions on Stone Way.

Traffic Data

1. Volume
   e. Pedestrian: 251 in 15 hr.
3. Speeds
   a. Arterial speed limit, 30 mph.
6. Pedestrian
   a. Volumes: 251 in 15 hr.

Economic Data

1. Estimated Cost of New Installation:
   a. $5,526.04

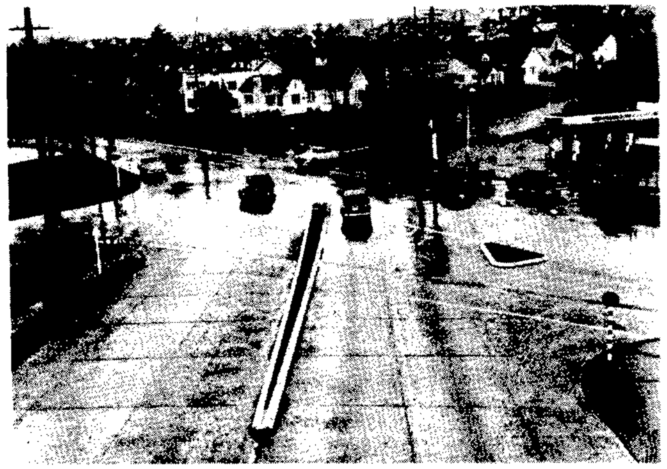


Figure 1. Channelization of multiway intersection of Green Lake Way and 50th Street Seattle. Note the pavement level beacon at the approach end of the median in the foreground.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation:
   a. Principal safety feature is reduction of size of intersection by channelization.
2. Design Features Which Relieve Congestion:
   a. Congestion reduced by signalization.
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. Over-all operation quite satisfactory.

Comments by Committee Members

1. JAMES L. SHOTWELL - It has been surprising to note that the improvement of this intersection and the others that I have reviewed have not resulted in an appreciable reduction in accidents. It may be that the intersections are carrying much larger volumes of traffic after the improvements which might account for the continued number of accidents.

   In my opinion the design of this intersection has been well handled. The designer has used long narrow islands, triangular islands and precast buttons appropriately.

   As a general comment, I would suggest that when designing a channelized intersection where the existing concrete pavement with numerous transverse and longitudinal joints is to remain that consideration be given to the use of a bituminous retread through the intersection area. This would permit clearer pavement markings for the direction of traffic.

2. H. G. VAN RIPER - Channelization treatment fot the above described intersection is considered very good - simple but effective. There are a few minor turning movements - A, K, L - not provided for.

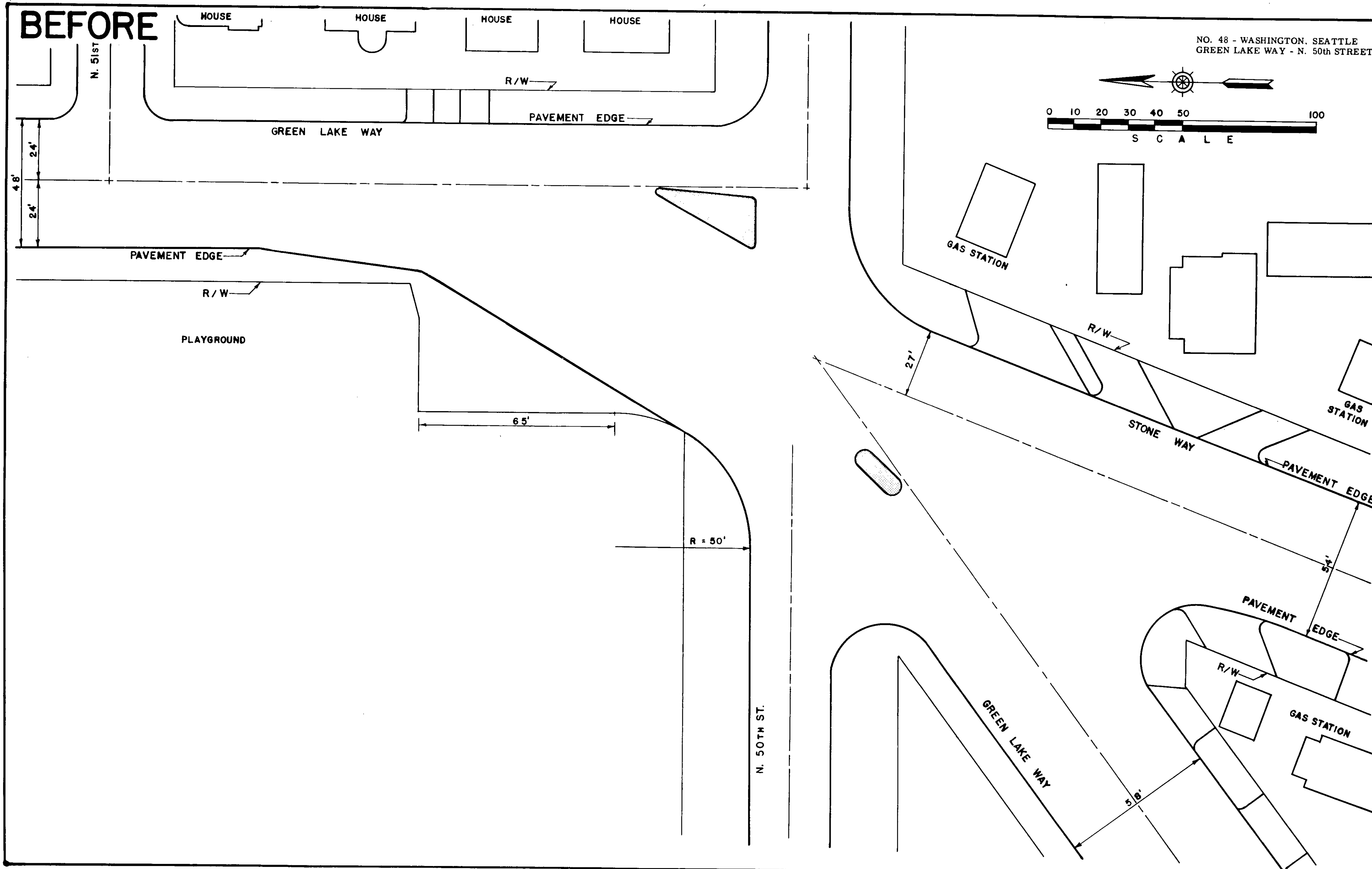
   Suggest that the nose of the islands be offset slightly from the center line of the pavement to clear approaching traffic. This is especially true for the nose of the island on Green Lake Way near 51st Street, where the offsetting appears to be on the wrong side of the pavement center line.

   It also appears that better provision might be made for pedestrian traffic, notwithstanding the fact that it is relatively light.

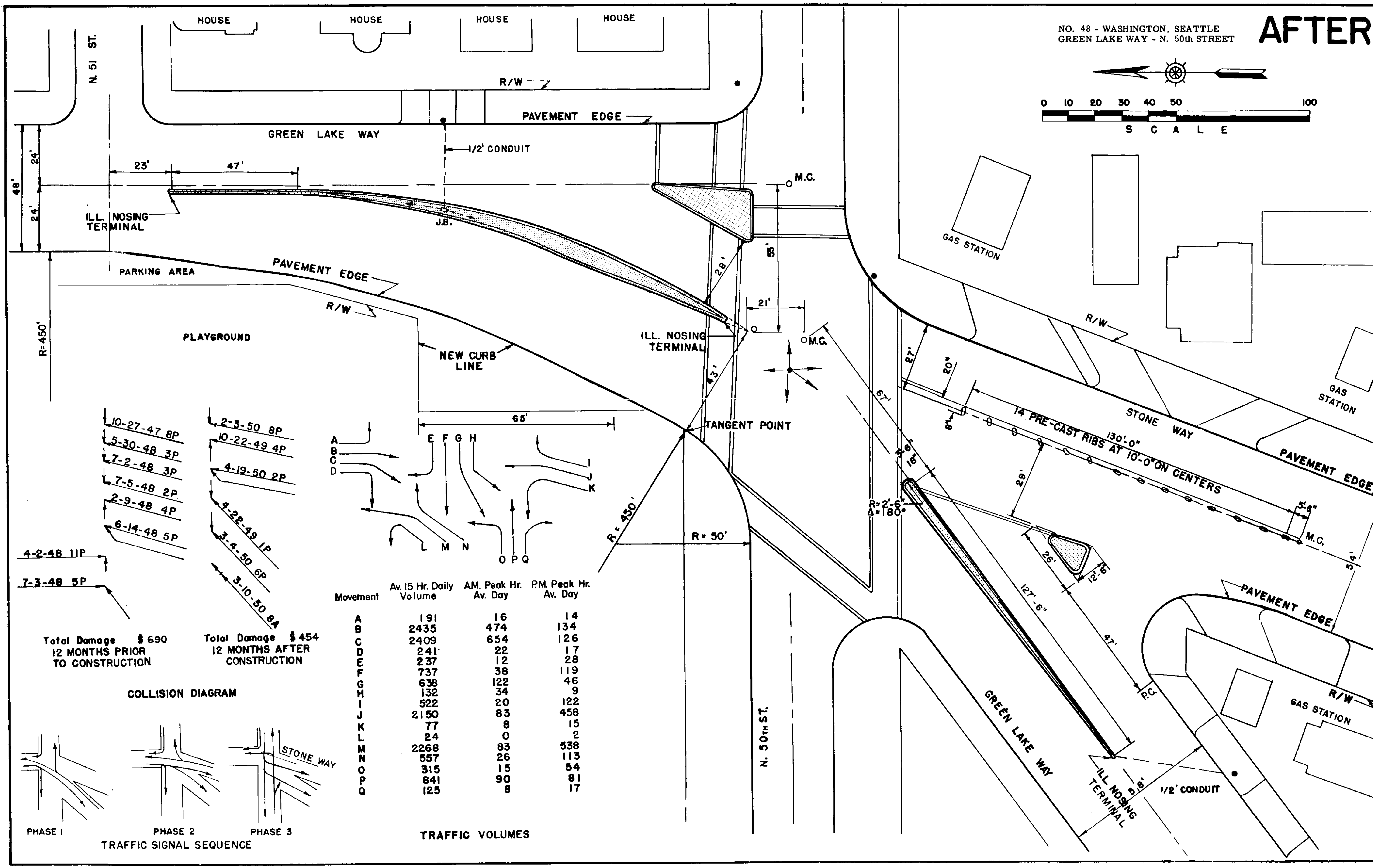
Additional Comment by J. W. A. Bollong

Reference the comment by James L. Shotwell in regard to the use of bituminous retread, the entire area occupied by the islands was resurfaced by bituminous retread in order first, to give good drainage, and second, for clear marking of paint line and lane approach.

Reference the comment by H. G. Van Riper, parking is permitted on the east side of Green Lane Way north of North 51st Street with parking prohibited on the west side in the same area. This results, then, in an offset center line and gives proper approach to the throat.



BEFORE
NO. 48 - WASHINGTON, SEATTLE
GREEN LAKE WAY - N. 50th STREET
0 10 20 30 40 50 100
SCALE
HOUSE
HOUSE
HOUSE
HOUSE
N. 51ST
R/W
PAVEMENT EDGE
GREEN LAKE WAY
48'
24'
24'
PAVEMENT EDGE
R/W
PLAYGROUND
65'
R = 50'
N. 50TH ST.
GAS STATION
R/W
27'
STONE WAY
PAVEMENT EDGE
GAS STATION
54'
PAVEMENT EDGE
R/W
GAS STATION
GREEN LAKE WAY
58'



Movement	Av. 15 Hr. Daily Volume	A.M. Peak Hr. Av. Day	P.M. Peak Hr. Av. Day
A	191	16	14
B	2435	474	134
C	2409	654	126
D	241	22	17
E	237	12	28
F	737	38	119
G	638	122	46
H	132	34	9
I	522	20	122
J	2150	83	458
K	77	8	15
L	24	0	2
M	2268	83	538
N	557	26	113
O	315	15	54
P	841	90	81
Q	125	8	17

TRAFFIC VOLUMES

Example 49

Location

WASHINGTON, Seattle
16th Avenue, S.W. - W. Roxbury Street
Delridge Way

Submitted by

J. W. A. Bollong, Traffic Engineer,
400 County-City Building,
Seattle, Washington

Type of Intersection

Multiway

Date Constructed

Signal installed July 30, 1948

Physical Data

2. b. No vertical curves involved
3. Surface Type
   a. Roadways: concrete
   b. Islands: 4 in. crushed rock, 2 in. blacktop surface. The islands are surrounded by white reflecting precast concrete curb of the New Jersey type.
   c. Shoulders: curbs and sidewalks at edge of roadway.
4. Cross Section
   a. Standard
5. Traffic Control Devices
   b. Timing: Signal Sequence shown.
   d. Lighting: Type: mercury vapor lighting; no illuminated signs.
6. Landscaping
   a. None
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: Bus Route approaches the intersection from the west on W. Roxbury Street turning left through the intersection and dividing into two routes, one going northwest on Delridge Way and one going north on 16th Avenue, S. W.
   b. Location of Passenger Stops and Zones: On Delridge Way: on right-hand side proceeding northwest, just back of crosswalk. On 16th Avenue, S. W.: on right-hand side proceeding north, opposite the southern end of large traffic island.

Traffic Data

3. Speeds

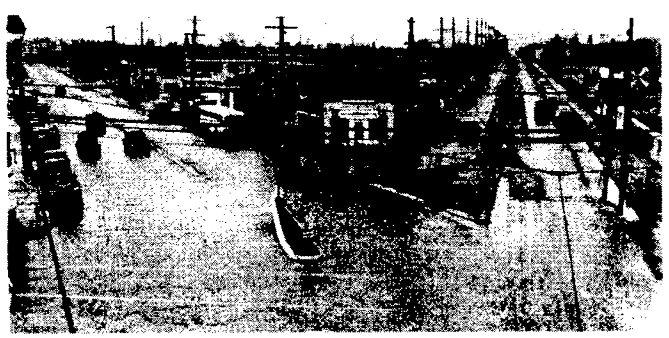


Figure 1. Channelization of a complex intersection in an urban area. Sixteenth Avenue SW, West Roxbury Street and Delridge Way, Seattle, looking north.

   a. Arterial speed limit 30 mph.

Economic Data

1. Estimated Cost of New Installation: $3,332.66

Operational Characteristics

1. Design Features Which Contribute to Safe Operation:
   a. Principal safety feature is reduction of size of intersection area and establishment of crosswalks.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. Congestion reduced by signalization.
   b. See comment on 3a following.
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. Overall operation satisfactory although some congestion is caused by persons making improper left turns into or out of parking lots.

Comments by Committee Members

1. EUGENE MAIER - The channelization of this multiway intersection is a satisfactory treatment of a complex urban traffic problem. A complete analysis of the design is not possible since the traffic flow southbound on 16th Avenue S. W. was not furnished. Assuming southbound traffic to equal the northbound flow, the severe bending of the southbound flow should not prove unsatisfactory. However with larger southbound flows, congestion would develop unless the left turn into Delridge Way were permitted in two lanes.

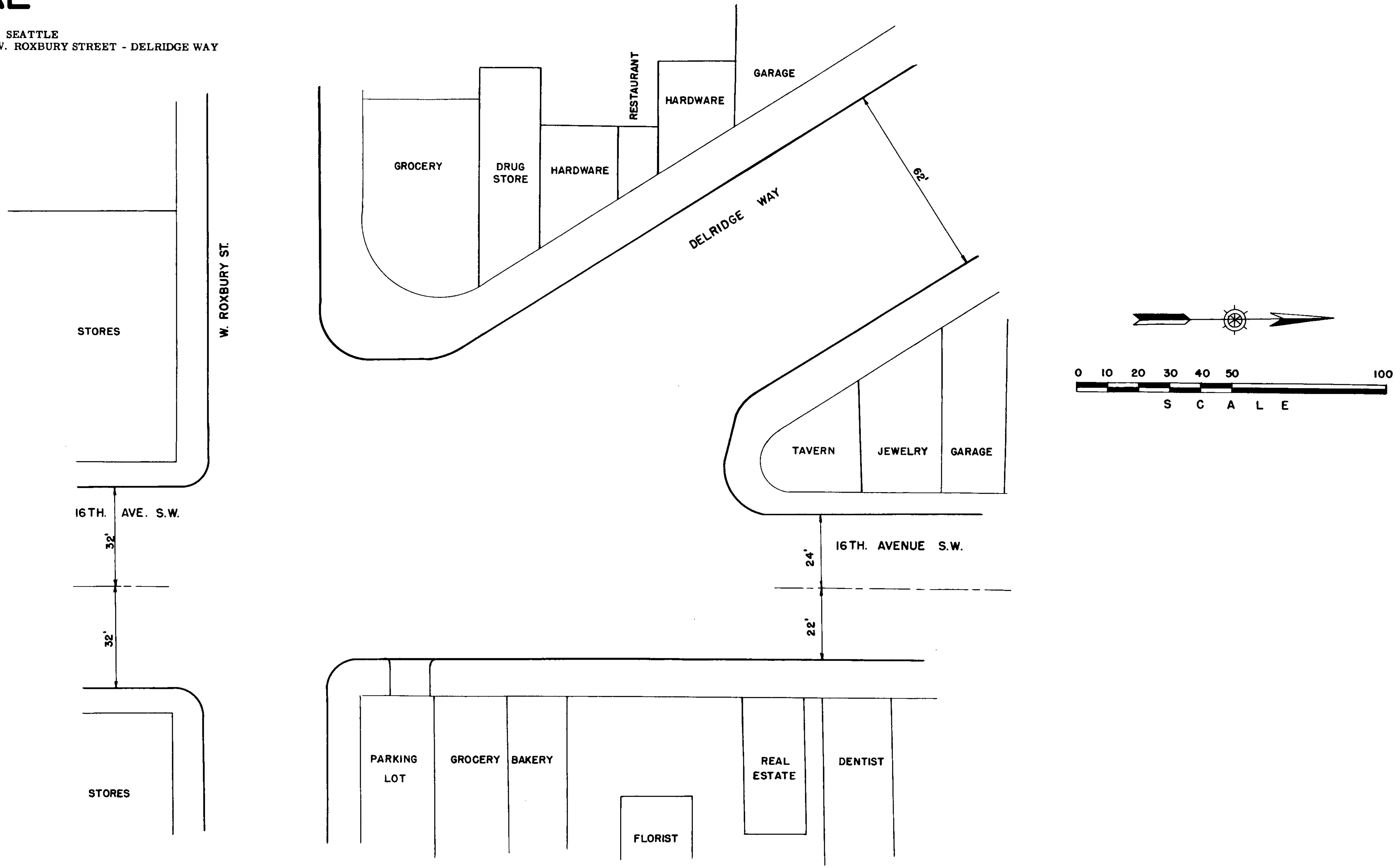
2. EDWARD G. WETZEL - This channelization scheme appears to fit well the physical layout of the intersection and the adjacent land use. The traffic flow on the northerly leg of 16th Avenue S. W. appears to have been omitted from the "After" sketch. Assuming the southbound flow is approximately equal to that which goes north, it would appear that another signal sequence is required.

   The difficulty of entering and leaving the parking lot will probably continue to be a traffic hazard; however, if the access to this lot were on W. Roxbury Street it would surely aid the situation.

   I believe this channelization is as good as any that might be developed for such an intersection.

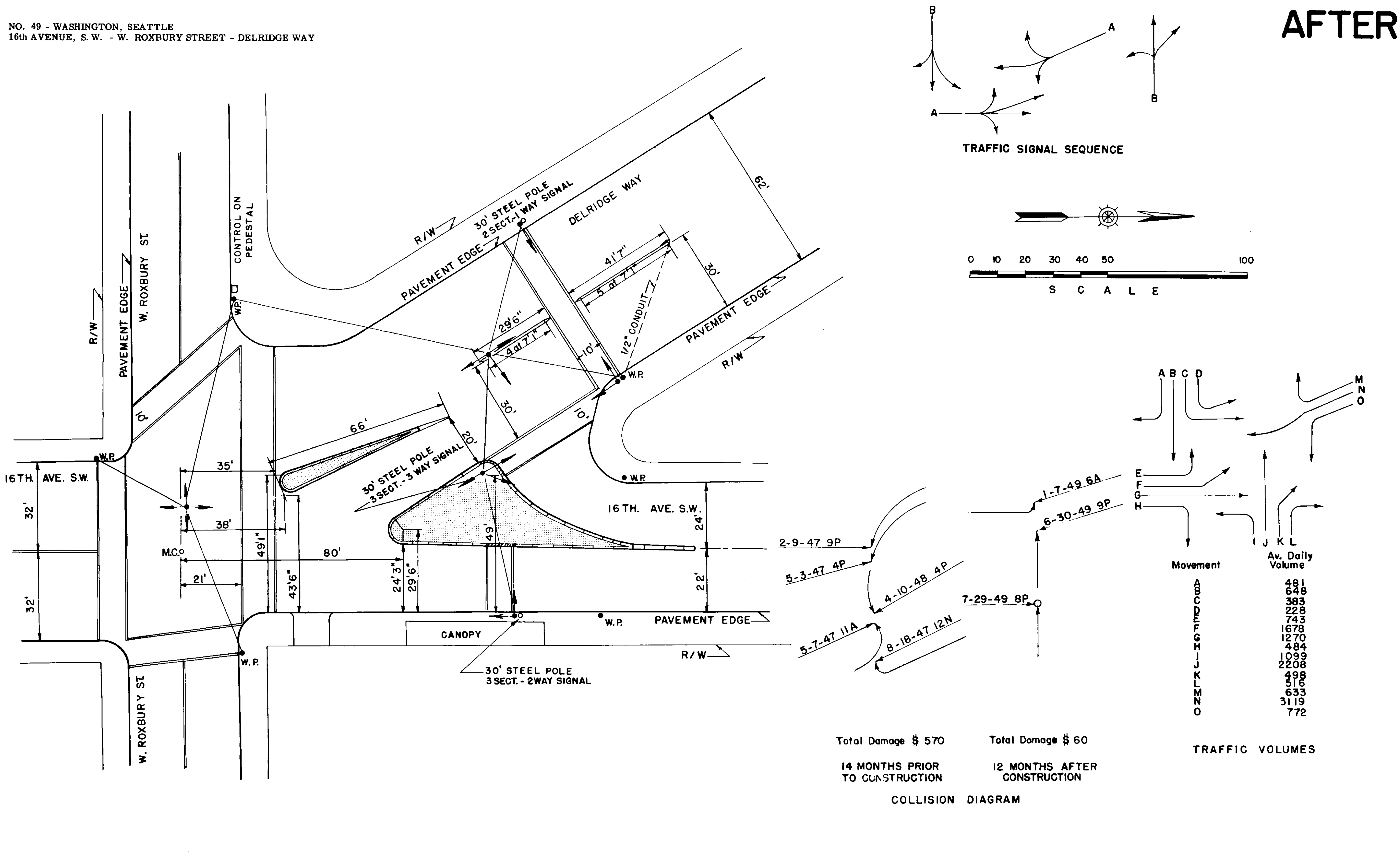
BEFORE

NO. 49 - WASHINGTON, SEATTLE
16th AVENUE, S. W. - W. ROXBURY STREET - DELRIDGE WAY



NO. 49 - WASHINGTON, SEATTLE
16th AVENUE, S. W. - W. ROXBURY STREET - DELRIDGE WAY

AFTER



Example 50

Location

WASHINGTON, 3 miles North of Seattle
US 99-N. 145th Street - SSH 1-J

Submitted by

H. C. Higgins, Traffic Engineer,
Washington Department of Highways,
Olympia, Washington

Type of Intersection

Multiway

Date Constructed

Opened to traffic October, 1949

Physical Data

5. Traffic Control Devices
   a. Signs: Type: shown on plan, Scotchlite reflectorized.
   b. Three phase traffic-actuated signal and semi-actuated signal.
   c. Markings: Traffic lane stripes are 4 in. wide, stop lines 18 in. wide. Color: Traffic lane stripes, stop lines, and messages on pavement are of yellow reflectorized paint; pedestrian crossings are of white paint.

Traffic Data

5. Accidents
   a. Collision Diagram for 12-month period "After" construction is shown in Figure 2.
   b. Fatal: 0, Personal Injury: 6 "Before", Property Damage: 16 "Before"

Economic Data

1. Estimated Cost of New Installation
   a. $15,000.

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "These channelization projects have eliminated congestion, as well as a great many types of accidents, and have clearly defined the paths for vehicular movements, as well as providing additional protection for pedestrians."

Comments by Committee Members

1. D. W. LOUTZENHEISER - This improvement of US 99 from a 38 ft. pavement to a divided highway, together with the channelization and signal control in conjunction with the cross and diagonal street is an excellent example of a broad scale solution. The increased capacity through extra width and the removal of a major conflicting movement from the central area has "solved" this intersection for the time being.

   By separation of traffic on the diagonal road the intersection control area was brought under simple, logical control. Traffic from right to lower left in the plan uses the median lane, goes through the crossroad intersection then turns into the diagonal one-way road. The reverse, from lower left to right, swings right on the parallel street, turns left into the cross street, then can use the "free right turn" to enter the through highway. This is the basic pattern of fifth road channelization, necessarily involving traffic signal controls to effect.

   The marking and delineation are good, the signal set-up is adequate, and the indicated overhead signs add much for lack of confusion in the area. The median lane cross section is on minimum scale but appears to work well. The lack of "control" at the outer edges of the shoulders is a striking contrast to the remainder of the improvement. The interference of vehicles entering and leaving the roadside areas at any point along US 99 can be expected to boost the accident record as traffic and development expand.

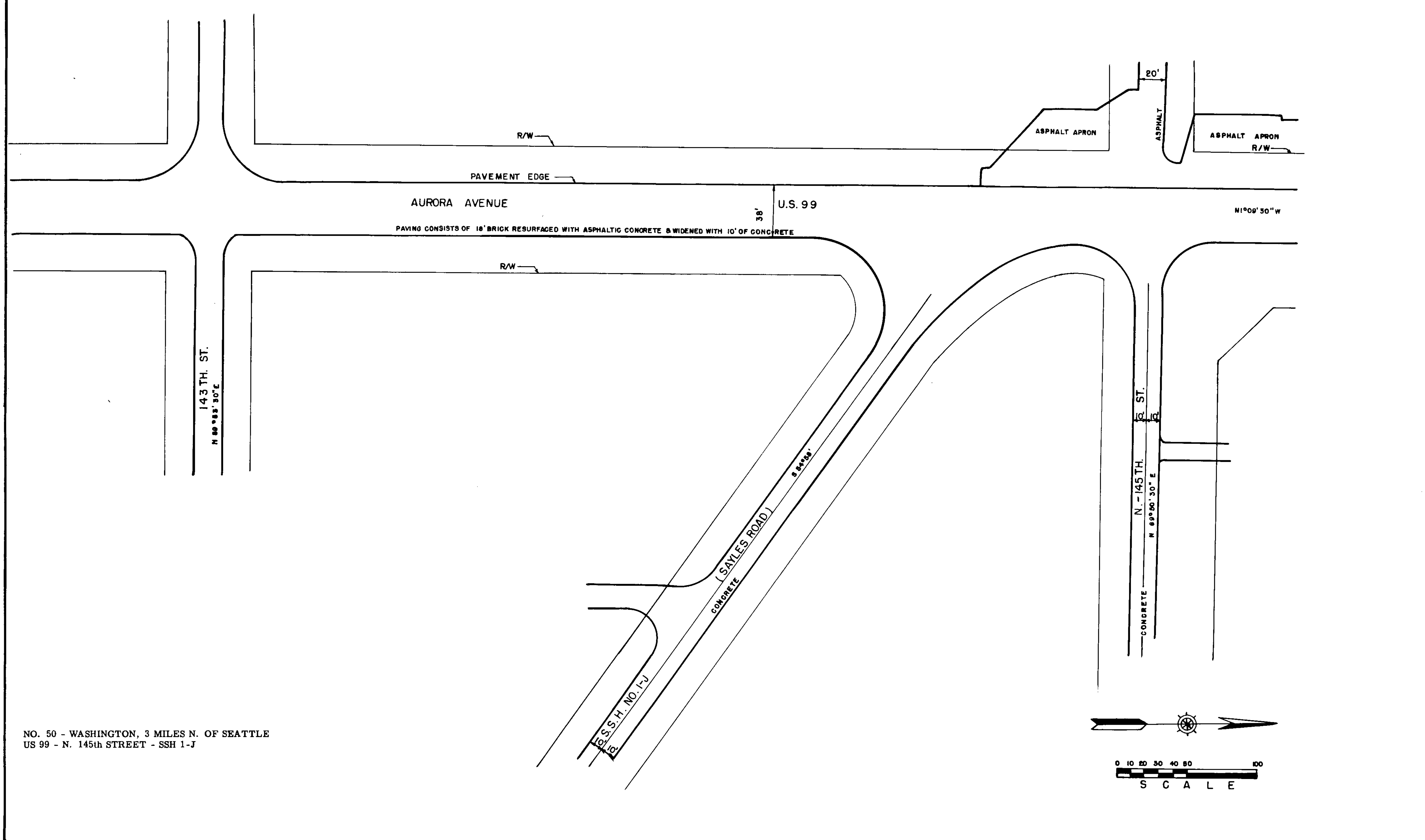
2. H. G. VAN RIPER - This is considered a good example of effective channelization treatment in correcting a dangerous condition at an intersection at a reasonable cost.

   All turning movements have been satisfactorily provided for, especially westbound traffic from SSH 1-J.

Additional Comments by Rex G. Still, Traffic Engineer, Washington Department of Highways

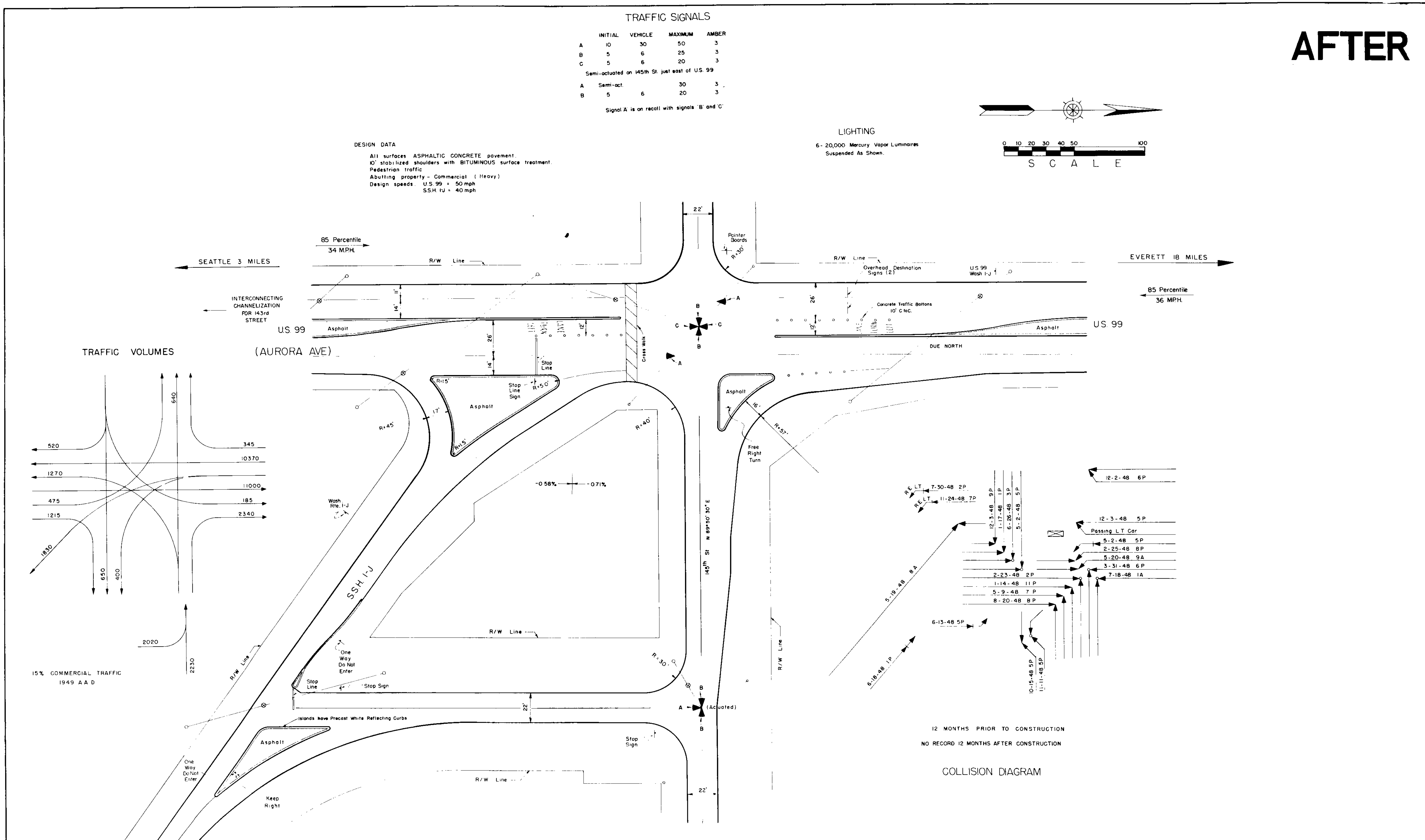
We fully concur with the comments made regarding the access control at this location. However, as, at the time of the reconstruction of this intersection, we had no limited access law, we were unable to control the access to the adjacent property on US 99. We attach a traffic accident summary covering the period of twelve months after this installation (Fig. 2).

BEFORE



NO. 50 - WASHINGTON, 3 MILES N. OF SEATTLE
US 99 - N. 145th STREET - SSH 1-J

AFTER



NO. 50 - WASHINGTON, 3 MI. E. OF SEATTLE: US 99 - N.145th STREET - SSH 1-D

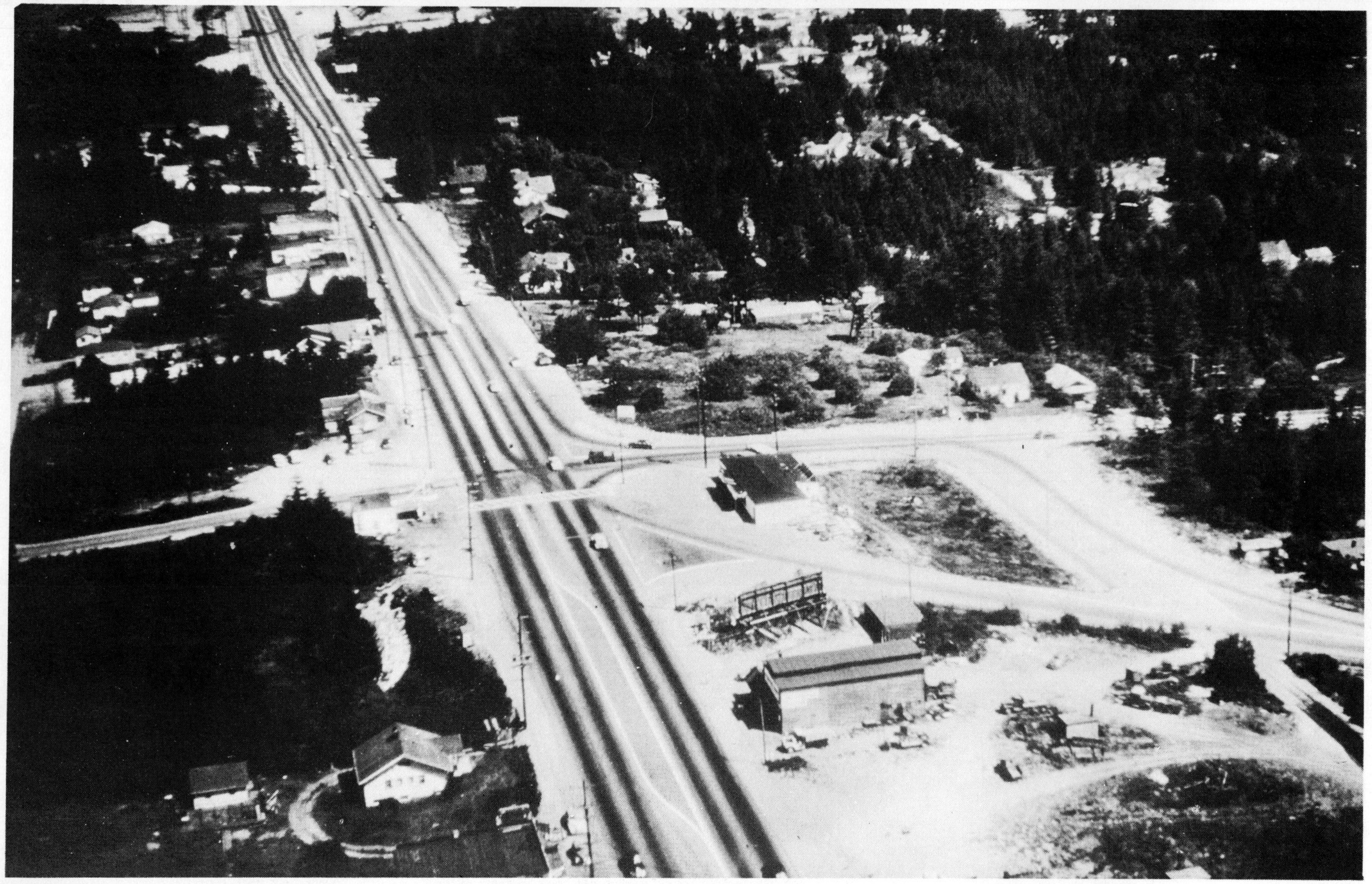


Figure 1. Effective channelization treatment to correct a dangerous intersection: US 99, North 145th Street, and SSH 1-J, near Seattle.

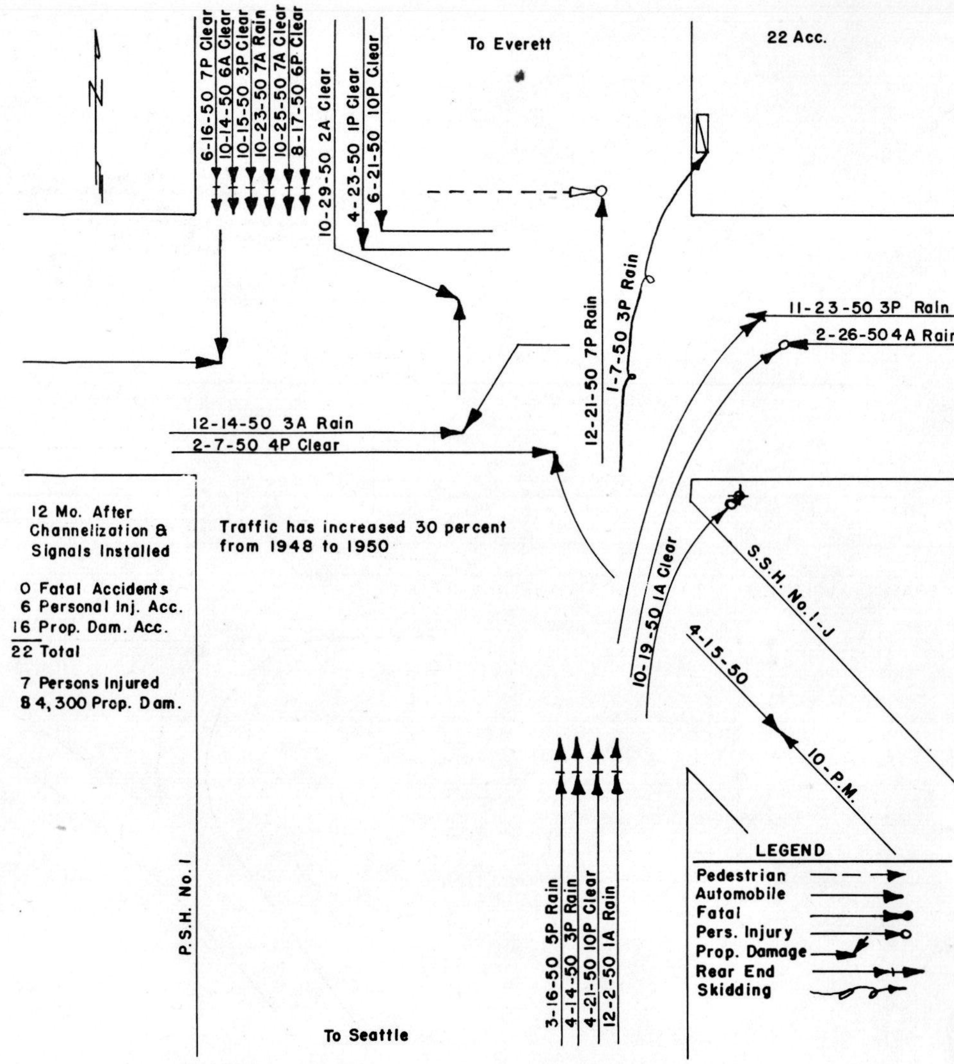


Figure 2. Collision diagram; from January 1, 1950, to December 31, 1950.

Example 51

Location

WASHINGTON, 9 miles north of Seattle
US 99 - Linwood
(Alderwood Manor and Edmonds Road)

Submitted by

H. C. Higgins, Traffic Engineer,
Washington Department of Highways,
Olympia, Washington

Type of Intersection

4-Way, Oblique

Date Constructed

Opened to traffic October, 1949

Physical Data

1. a. "Before" Plan: The overall pavement width on US 99 is 44 ft. and not 40 ft. as shown on the "Before" plan.
2. a. Grades: level.
3. Surface Type
   b. Islands: asphalt
5. Traffic Control Devices
   a. Signs: Type: Scotchlite reflectorized, in accordance with Manual on Traffic Control Devices.
   b. Three-phase traffic-actuated signal.
   c. Markings: Traffic Lane Stripes: 4 in. wide, of yellow reflectorized paint, Stop Lines: 18 in. wide, of yellow reflectorized paint, Messages on Pavement of yellow reflectorized paint, Pedestrian Crossings, white paint. Location: shown on plan, Color: Yellow and white, as indicated.
   e. Other Control Devices: Guide Posts: None, Reflectorized Delineators: none.

Traffic Data

3. Speeds
   c. Average Operating Speeds through intersection: speed limit signs: 35 mph. at intersection on US 99; Stop signs on county road.
5. Accidents
   a. Collision Diagram for 12-month period "After" construction is shown in Figure 2.
   b. Personal Injury: 5 shown, Property Damage: not given, Period: 12 months "Before" only.

Economic Data

1. Estimated Cost of New Installation
   a. $12,500.

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "These channelization projects have eliminated congestion as well as a great many types of accidents, and have clearly defined the paths for vehicular movement, as well as providing additional protection for pedestrians."

Comments by Committee Members

1. D. W. LOUTZENHEISER - First glance at this suggests an over-channelized plan. But as evident in the photo (and more so in driving through) this is a non-confusing and efficient layout. While of minimum width, the median lanes are effective, with a narrow curb separator at their left and row of traffic buttons at right. On approach side an extra 11-ft. lane width was provided for right turns. In total, the approach width was doubled, as was the approximate capacity. Specifically shaped curbed islands delimit the unused areas and guide the turning movements. The major pedestrian crosswalk is well marked.

   The major 4-way traffic-signal head suspended at the intersection center is supplemented by one-way heads for approach traffic only. Additional signals located on the islands would appear to be helpful.

   Internally, this layout is well done. Externally it is wide open. Some system of outer curbs to specifically locate and control all driveway connections would do much to reduce interference and the roadside hazards of indiscriminate access.

   Less abrupt reverse curves on the entry to median lanes would eliminate paved areas not now used.

2. JAMES L. SHOTWELL - This is an excellent example of a 4-road channelized intersection. Some confusion may exist for the eastbound traffic that wishes to turn north. Some additional signing may be necessary to guide this movement into the proper slot on US 99.

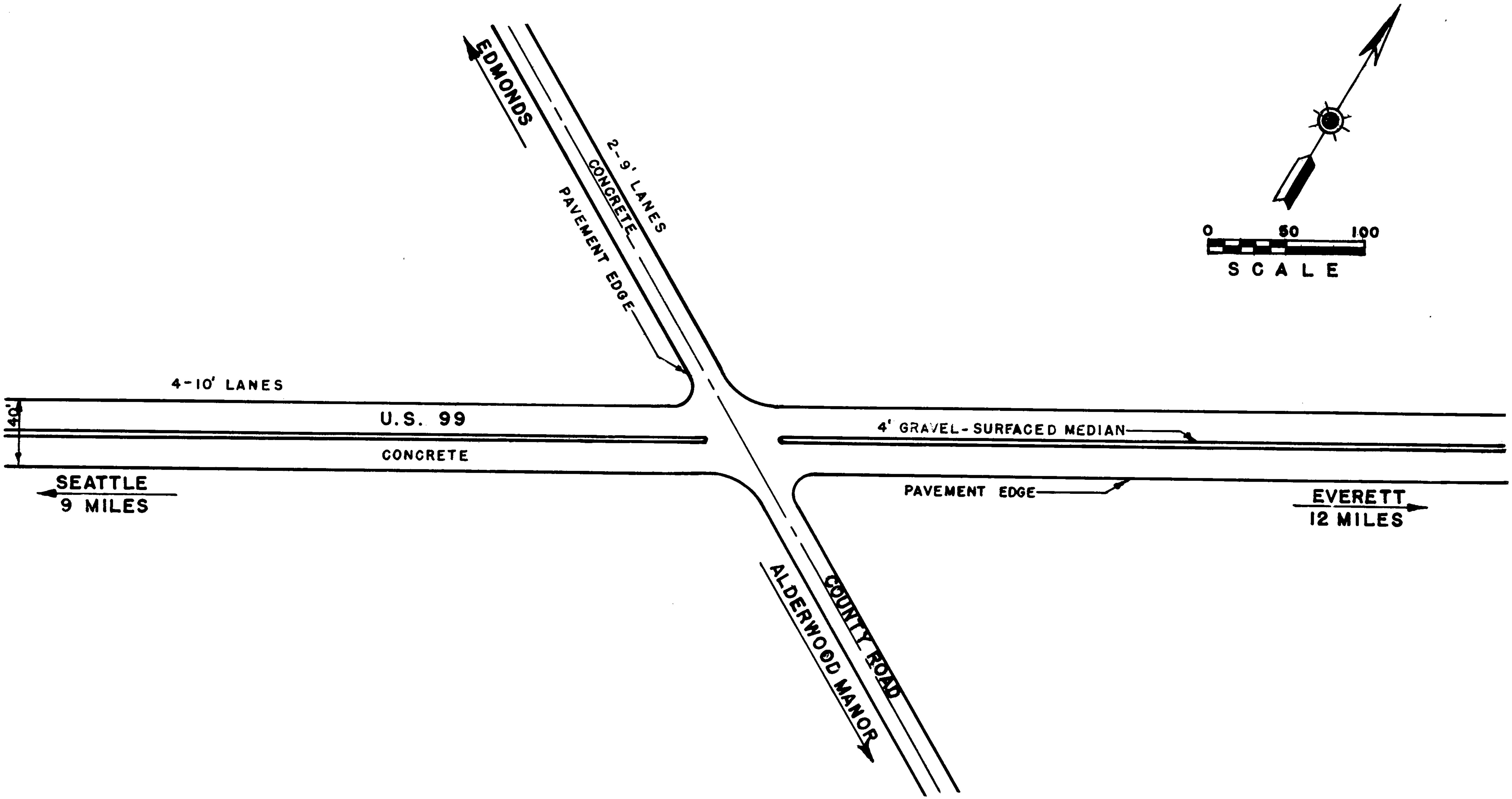
   The photograph indicates the great need of limiting entrances and exits to the main roadways. Continuous connections as shown here are very dangerous and I would suggest the use of some type of a curb to restrict the places of entrance and exit.

Additional Comments by Rex G. Still, Traffic Engineer, Washington Department of Highways

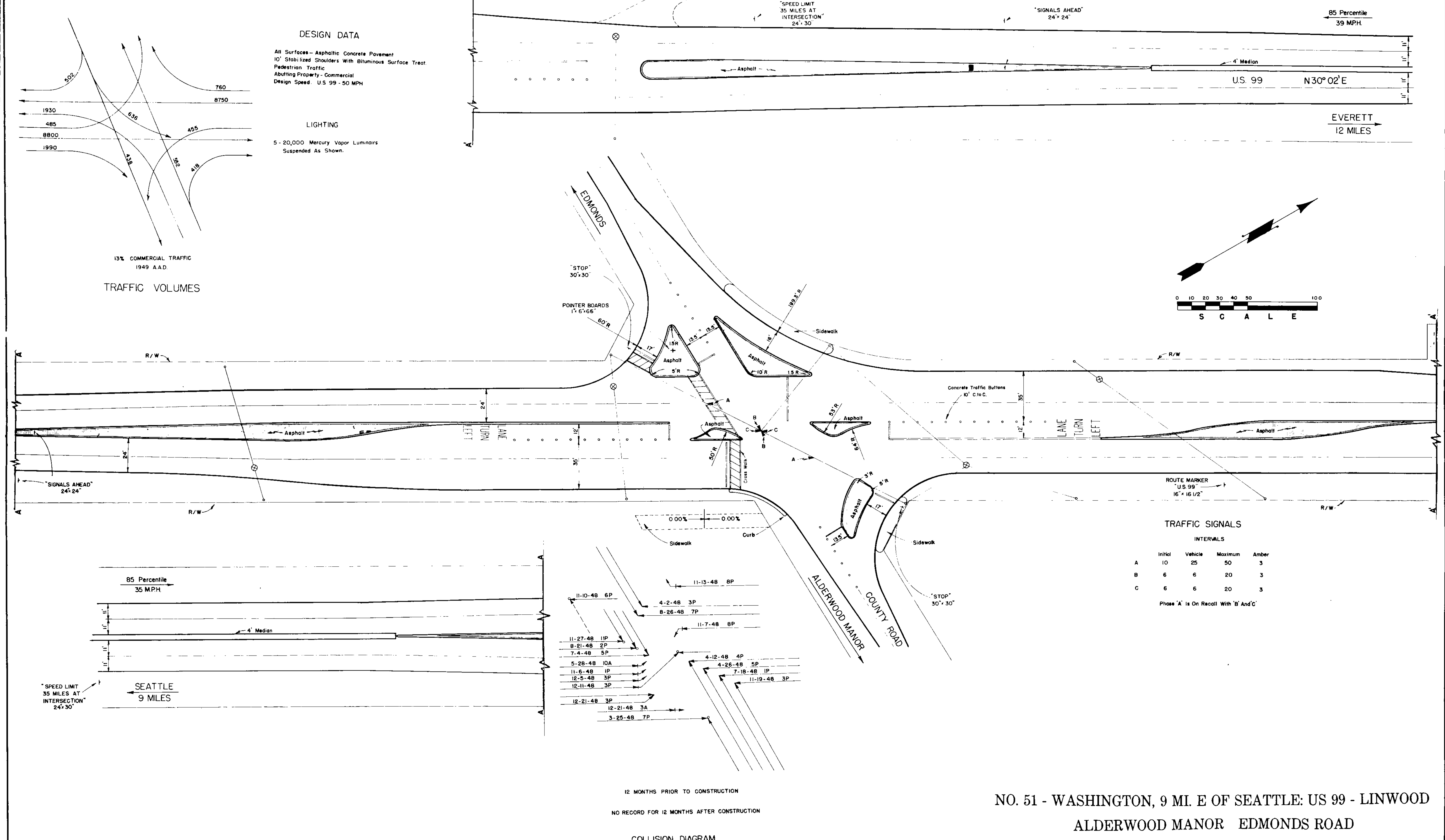
The four-way signal head suspended at the center of the intersection controls the left-turn lanes on the arterial highway and the cross traffic from the minor road. The one-way signal head suspended over the center of the two approach lanes of the arterial highway on the off-street side controls the two major flows of traffic. The red lenses in the left-turn lane signal faces are shielded by straight-ray directors so that they are not visible to the through traffic on US 99. Signals suspended over the lanes have proven more effective in this area than corner signals or signals installed in island areas, which quite frequently are collided into by vehicles. We concur with the comments made regarding access control at this location. However, as, at the time of the reconstruction of this intersection, we had no limited access law, we were unable to control the access to the adjacent property on US 99. We attach the accident summary at this intersection covering the period of 12 months after this installation was made (Fig. 2).

BEFORE

NO. 51 - WASHINGTON, 9 MI. E. OF SEATTLE: US 99 - LINWOOD (ALDERWOOD MANOR - EDMONDS)



AFTER



NO. 51 - WASHINGTON, 9 MI. E OF SEATTLE: US 99 - LINWOOD
ALDERWOOD MANOR EDMONDS ROAD

Figure 1. Aerial view of US 99 after 4-lane divided highway with 4-ft. median was widened, median expanded to include left-turn lanes, and channelizing islands added.

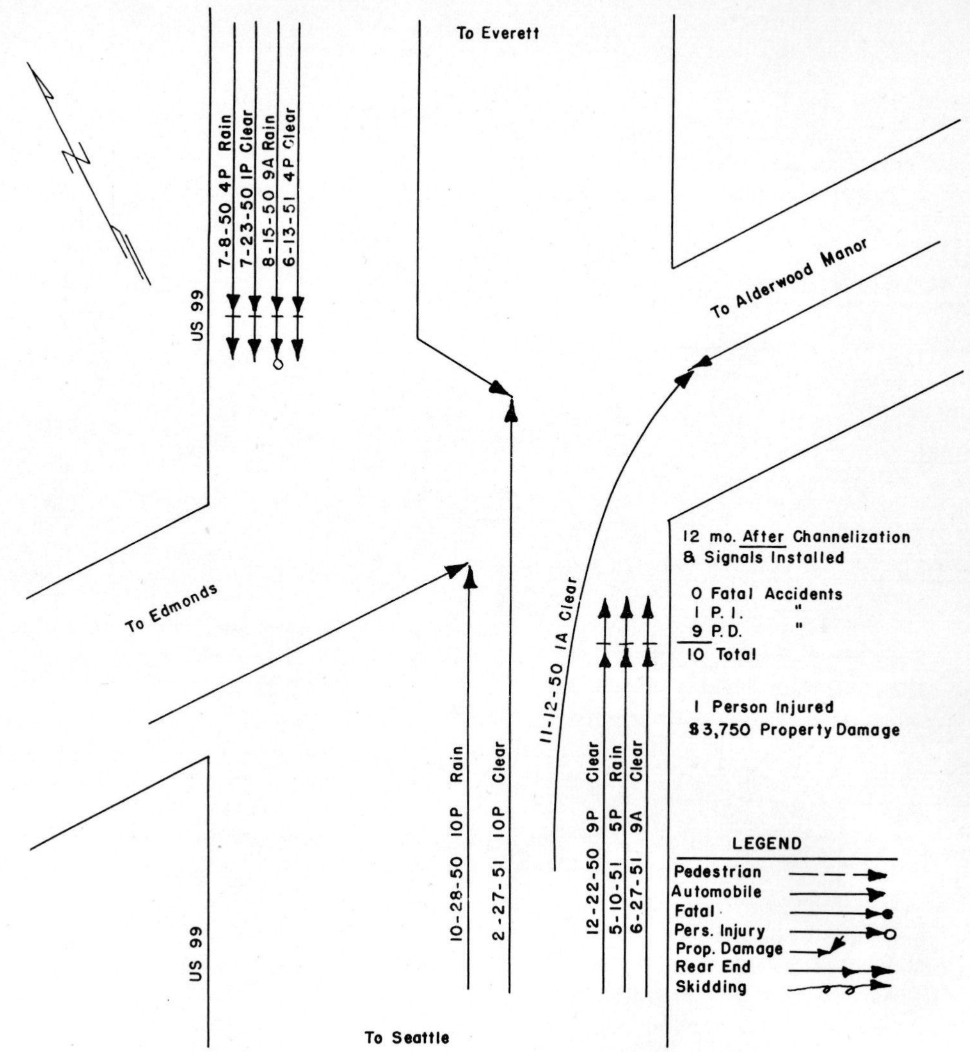


Figure 2. Collision diagram; from July 1, 1950, to June 30, 1951.

Example 52

Location

TEXAS, 7 miles NE of Fort Worth
(near Birdville) Texas 121 - Texas 183

Submitted by

W. W. Finley, District Engineer,
Texas Highway Department,
Fort Worth, Texas

Type of Intersection

3-Way, Y, with grade separation

Date Constructed

Completed March 31, 1950

Traffic Data

1. Volumes
   a. Average Daily: shown on plan at three points; data is for "Before" situation in 1949.

Comments by Committee Members

1. D. W. LOUTZENHEISER - This interchange has the same general layout as the channelizing intersection of Example 15, with a grade separation of one-way pavements at the central point of crossing. The "After" is on interchange scope of layout and is not directly comparable to an at-grade or channelized plan.

   Provision of grade separation is inconsistent with the frequent openings evident in the introduced median. If the condition requiring these openings prevails, then likely speeds, land values, etc., do not justify the structure and extensive layout. A more confined at-grade channelized plan would appear sufficient. Or, if the speeds and volumes warrant the grade separation plan, then median openings should not be permitted and a plan with control of access would be in order.

   The separate right turn lane E to NE is unduly abrupt at the far end. This lane duplicates the Grapevine Cutoff, and might have been omitted. Note the channelized T at the south end of Grapevine Cutoff, with median lanes on each side of stem road. At north end, a simple median opening is used with outer speed-changed lanes.

2. J. C. YOUNG- This is something more than "channelization". This is a good clean interchange and the only movement which is not separated is left turns southwest bound to eastbound, although the return movement has been provided for.

   This is a case of providing an "at grade expressway" with a freeway interchange at an important junction. With the separation structures so near to the numerous entrances and median openings indicated, it seems unfortunate that frontage roads and elimination of all median openings were not accomplished at the same time. Our experience with divided highways having median openings for grade crossings and left turns indicates that they should be eliminated whenever possible. Even if frontage roads are not constructed there seem to be a great many extra median openings. It is impossible to analyze the operation of this intersection from the volumes shown, but my interpretation of these volumes is that the main structure has the purpose of separating only 1,100 ADT from the principal westbound lanes. This is commendable but the design seems out of balance with all the other intersections at grade.

Additional Comments by W. W. Finley

We agree with Mr. D. W. Loutzenheiser and Mr. J. C. Young that the openings in the medians on S. Hwys. 121 and 183 are undesirable and that the use of frontage streets or roads in conjunction with controlled access would have been preferable. However, it was not feasible for us to obtain additional right-of-way for frontage streets for the project which was completed before the passage of our recent Access Law. And, as in many other projects of this type, we were confronted with the necessity of providing the maximum possible traffic facility with limited available funds.

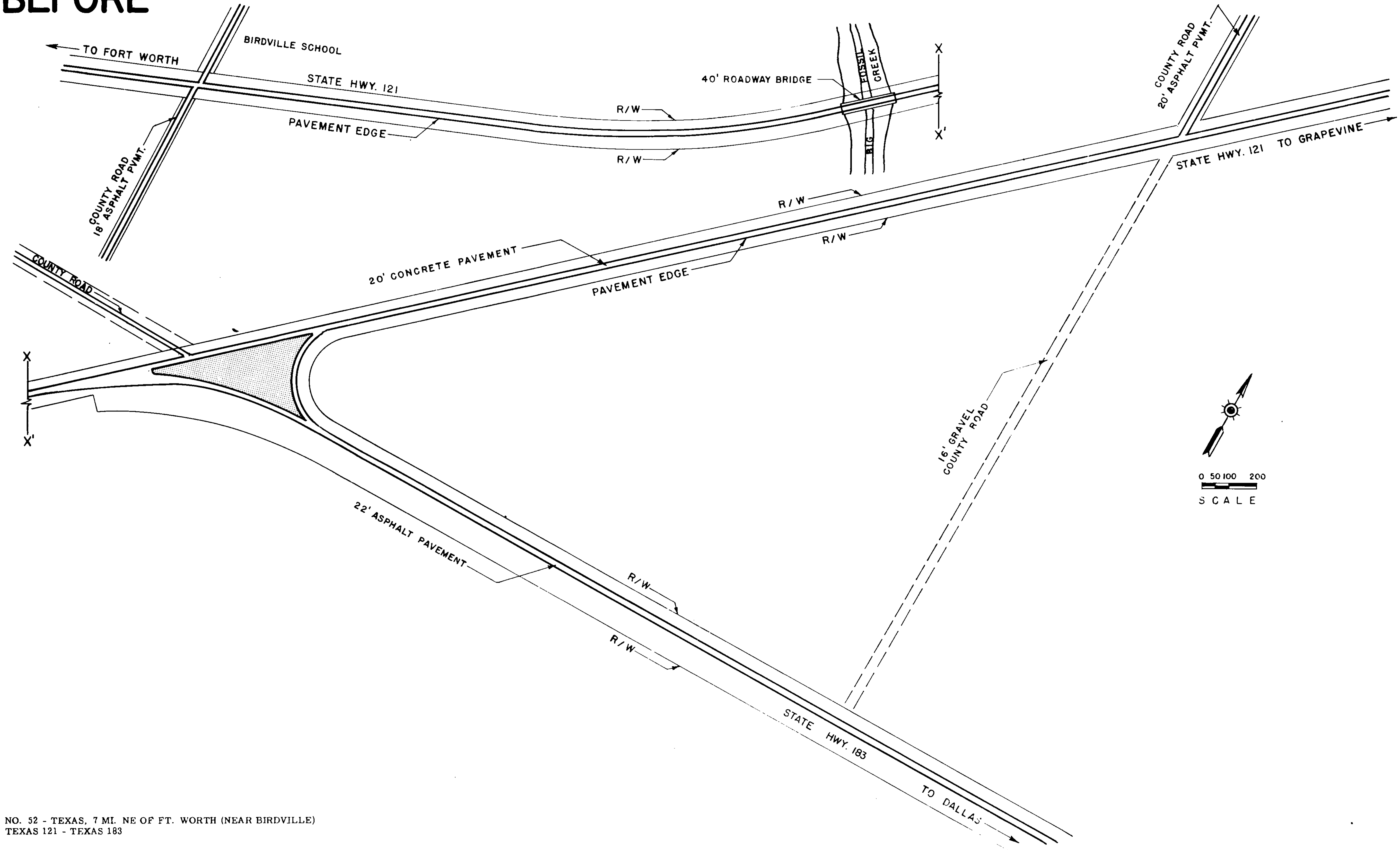
Any effort to use an intersection at grade, as mentioned by Mr. Loutzenheiser, instead of the grade separation that was constructed would have been impracticable both from the standpoint of safety and construction. The project was designed so as to take every advantage of terrain conditions which are not altogether evident in the photos accompanying the data submitted for the project. Had an intersection at grade been used, we would have been forced to construct the intersection with limited horizontal and vertical sight distances. Otherwise, any effort to use an intersection at grade with adequate sight distances would have required a complete revision of the existing landscape and necessitated an expensive handling of the drainage crossing the two highways to the north and east of the overpass. Also it would have been necessary for us to have installed signal lights. Consequently, the cost of constructing a comparably safe intersection at grade would have been equal to that of the present separation.

We believe that the use of a grade separation has already been justified, for during the planning stage the designer evaluated the incipient development possibilities of the areas along the highways east and northeast of the intersection, and had in mind a much greater future traffic volume than would be using this facility at first. Traffic on both highways is now greatly increasing. State Highway 121 increased from an average daily count of 2260 in 1949 to 5130 in 1951 and State Highway 183 increased from 6470 in 1949 to 10120 in 1951. Moreover, the entire region extending for several miles to the northeast and east away from the intersection is being placed under residential development. An aircraft plant and a large airport, located about 5 and 11 miles respectively east of the intersection, are nearing completion on S. Hwy. 183.

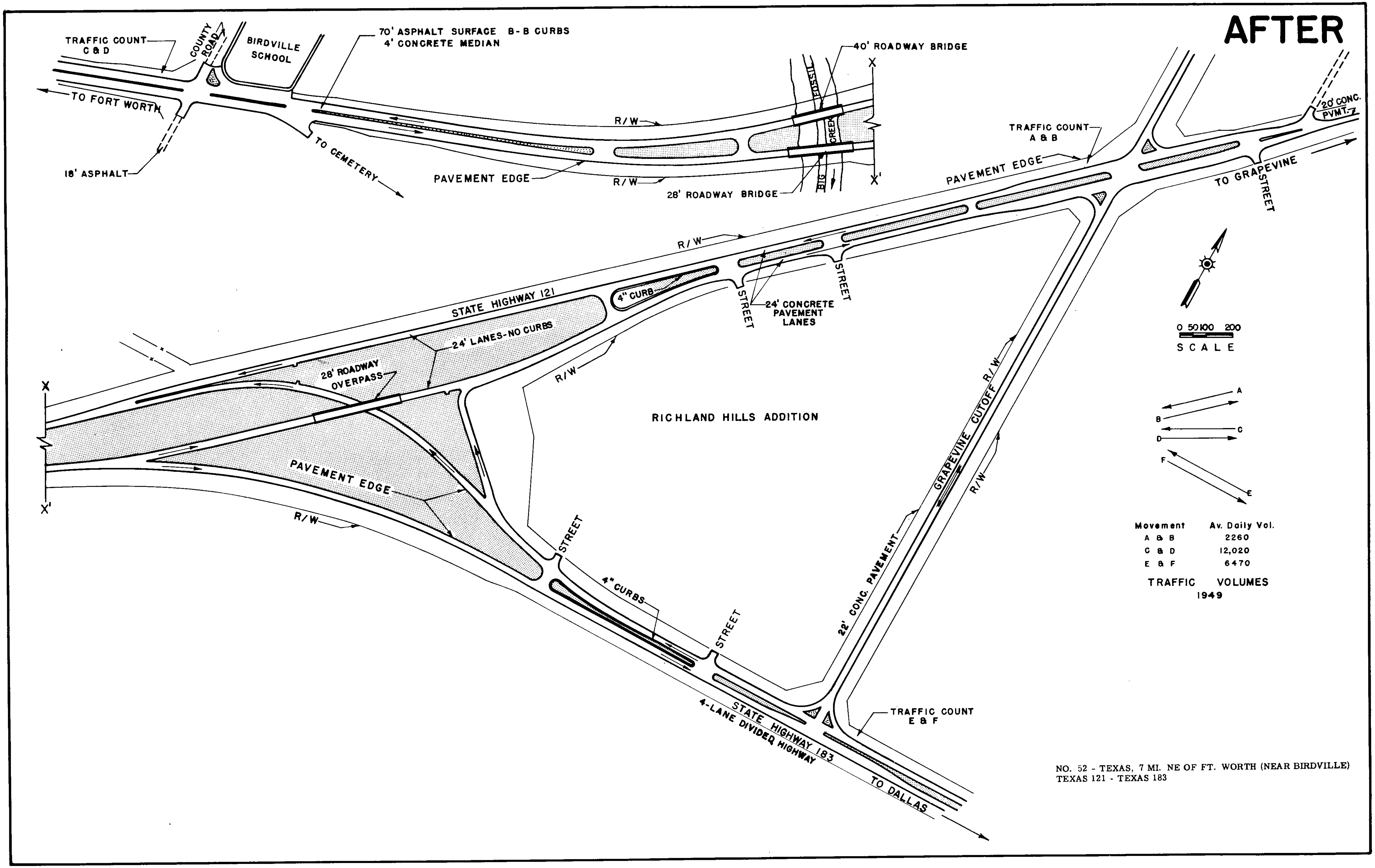
Traffic flows through the intersection without difficulty during peak hours. The high-speed Fort Worth-bound traffic from both highways is efficiently merging southwest of the overpass. To date the large number of median openings along the highways adjacent to the Richland Hills area has, surprisingly, not proved undesirable. In fact the openings have served to reduce the concentration of local traffic at any one point to such an extent that there is little or no interference with through traffic. However, it is entirely possible that in the years to come, we may find that the openings present the usual problems.

After completion of the intersection we anticipated some difficulty when commercial establishments were constructed along S. Highway 183 in the Richland Hills area but so far we have been very fortunate in working with the developer and obtaining the proper channelization with respect to entrances to parking areas, etc.

BEFORE



NO. 52 - TEXAS, 7 MI. NE OF FT. WORTH (NEAR BIRDVILLE)
TEXAS 121 - TEXAS 183



NO. 52 - TEXAS, 7 MI. NE OF FT. WORTH (NEAR BIRDVILLE)
TEXAS 121 - TEXAS 183

Figure 1. Three-way Y-type intersection near Fort Worth, Texas, with 2-way, 2-lane legs before reconstruction.

Figure 2. Intersection after reconstruction with Y-type interchange and with certain features of highway channelization.

Figure 3. Close-up of interchange area with details of channelizing islands.

Example 53

Location

NEW YORK, New York City
Columbus Circle (Broadway - W. 59th St. - 8th Avenue - Central Park W. - Central Park S. - N. Park Drive)

Submitted by

T. T. Wiley, Director,
Department of Traffic Engineering,
100 Gold Street,
New York 7, New York

Type of Intersection

Multiway

Date Constructed

Proposed Revision dated July 15, 1949

Physical Data

1. a. "Before": plan evident on "After" plan
3. Surface Type
   c. Shoulders: curbed
7. Abutting Property
   a. Character of Land Use: business.

Comments by Committee Members

1. FRED W. HURD - In general, it seems to me that this is an excellent example of failure of the rotary principle caused by inadequate weaving distances. It is also a good example of "breaking" a large area up into a number of intersections in order to separate conflict points. Since signal control nullifies any advantages to be gained by the "steady flow" principle, channelization, as shown by the photograph, is probably the best treatment.

   Some of the small storage areas indicate that the signals must be timed very carefully, and that this solution cannot be applied arbitrarily at any small rotary. With heavy volumes on some of the channels having limited storage space this treatment would not be advisable unless signal timing could keep the roadways adjacent to storage areas from becoming blocked. I was quite interested in the reliance placed on the judgement of drivers through this design, although we repeatedly and erroneously refer to the driver as some sort of a moron. You will notice that drivers entering from Broadway, North, must plan their destinations in advance in order to enter the various slots available for each movement. The amount of local traffic and use of adequate destination markings would certainly be a factor in this case.

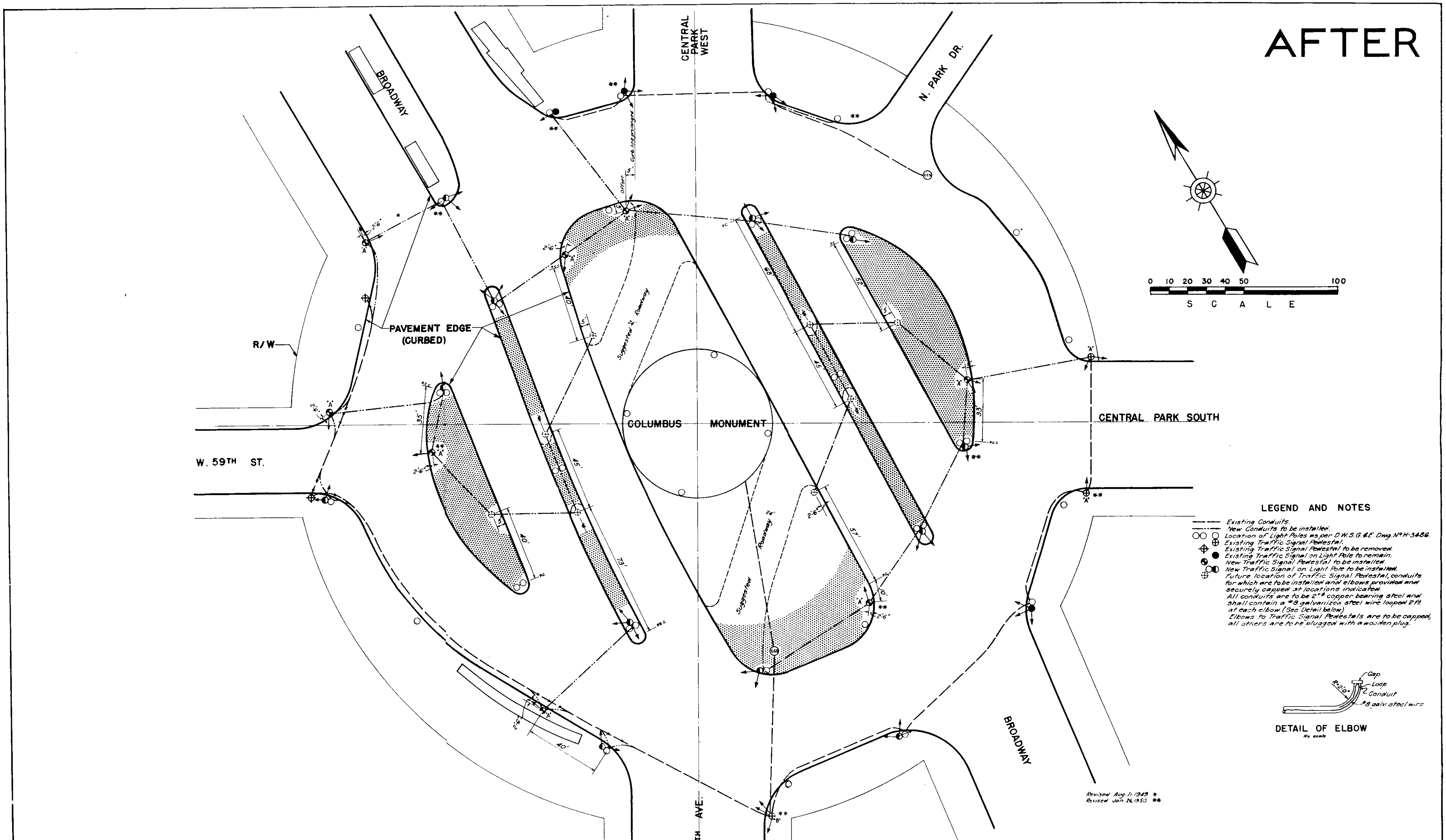
   This example is almost a "pure" case of a choice between steady flow and controlled flow through channelization design. It would be most interesting to have before and after volumes and capacity estimates as well as delay studies in order to compare these principles.

2. D. W. LOUTZENHEISER - This 1949 revision of Columbus Circle reduces the plan to a double split rotary. The original rotary at the flat X intersection of Broadway and 8th Avenue was converted to two pairs of parallel one-way roadways with rotary one-way connectors around the outside. In the first form internal roadways (see plan) permitted movements through on 8th Avenue. In this revised plan the "through" movements are Broadway north to 8th Avenue south (upper left in photo to left center) and 8th Avenue north to Broadway south (upper right to lower right). Movements continuing through on Broadway, 8th Avenue, 59th Street (or North Park Drive) all must utilize the outer circular roadway, crossing the double roadways under traffic signal control. It appears that this plan should well suit the present conditions and volumes.

   In a plan of this type in a downtown area the pedestrian movements must be penalized both by way-around paths and long waits at the signal areas. Proper control of pedestrian movements requires fences or rails running the length of the outer banana-shaped and the middle narrow islands to prevent indiscriminate crossings where not desired. The rows of squares on these islands probably are post bases for contemplated pedestrian fence.

   With a split-rotary traffic-signal layout it is difficult to prevent direct left turns at the ends of the narrow divisional islands. During off-peak hours these improper movements may not bother. But during peak-hour flow officer control probably is needed to prevent them.

Figure 1. Revised intersection at Broadway and 8th Avenue, New York. All turning movements are made on periphery of original circle, with double through movements across center. Traffic signal control is necessarily complex.



NO. 53 - NEW YORK, N. Y. CITY COLUMBUS CIRCLE -
BROADWAY-W. 59th-8th AVE.-CENTRAL PK S., CENTRAL PK. W., N. PARK DRIVE

Example 54

Location

IDAHO, Lewiston:
Bridge Approaches,
Clearwater River

Submitted by

J. A. Redman, Chief Locating Engineer,
Idaho Department of Highways,
Boise, Idaho

Type of Intersection

Multiway

Date Constructed

Under Construction 1950

Physical Data

1. b. "After": plan shown (Proposed)
   d. "After": photograph artist's sketch shown
2. a. Grades: some shown on plan - 1.35 percent, 0.20 percent, and 0.24 percent
3. Surface Type
   a. Roadways: compacted crushed gravel with bituminous surface; service roads compacted crushed gravel
   b. Islands; curbed; some show as park areas
   c. Shoulders: compacted crushed gravel or concrete sidewalks
4. Cross Section
   a. Not of unusual design
5. Traffic Control Devices
   a. Signs: Type: stop; destination and route, size: 4 by 10 ft. for route signs.
   b. Signals: Type: none
   d. Lighting: Type: 25 and 30 ft.
   e. Other Control Devices: Guide Posts: none
6. Landscaping
   a. None indicated except park areas for some islands
7. Abutting Property
   a. Character or Land Use: shown on "Before" plan as residential
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

3. Speeds
   a. Average Design: 35 mph.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation:
   a. See comment following.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion:
   a. See comment following.
3. Comments Regarding Over-all Operation of the Channelized Intersection:
   a. "This project is under construction, so no performance experience is available. For the volume of traffic involved this project is overdesigned. The plans include provision for a future grade separation structure at Main Street extended and for cross traffic movements under the river bridge at the north approach. From available data and forecasts, this ultimate design will not be required for some time, but was a basis of determining right-of-way requirements."

Comments by Committee Members

1. GUY KELCEY - This treatment appears to be more elaborate and costly than anticipated traffic requires and considerable property would have to be taken. Attached sketches (Fig. 2, 3, 4, 5 and 6), suggest a more simple approach to this problem that should serve traffic adequately, cost less and require substantially less property for right-of-way.

2. H. G. VAN RIPER - This is not an example of channelization treatment of an existing intersection, since the new location is about 1500 ft. east of the old river crossing. It is a good example of an effective channelization treatment on the approaches to a river bridge. However, we agree that for the volume of traffic involved the project is overdesigned.

Additional Comments by J. A. Redman

(1) All are in agreement that the project is overdesigned for the estimated traffic volumes, if we are thinking of a minimum design. The question to be answered is what volume can be handled satisfactorily on a design similar to the example? Are there undesirable features which should be eliminated? What improvements can be made in the design?

The question of whether good judgment was shown in designing beyond the 20 year traffic forecast is not at issue. Informationally it may be mentioned that traffic counted recently shows an increase of 200 percent in four years, against the forecast estimate of 50 percent in 20 years. Also, due to industrial development up the left bank of the Clearwater River, it is possible that the ultimate design (not shown with the submission) may become a reality sooner than anticipated.

(2) Getting back to basic design features, one feature not touched was whether the introduction of partial circles in a median can lead to a complete traffic tie-up with increased left turn volumes from the main highway. Under anticipated volume there seemed to be no problem but at what volume does this design fall down?

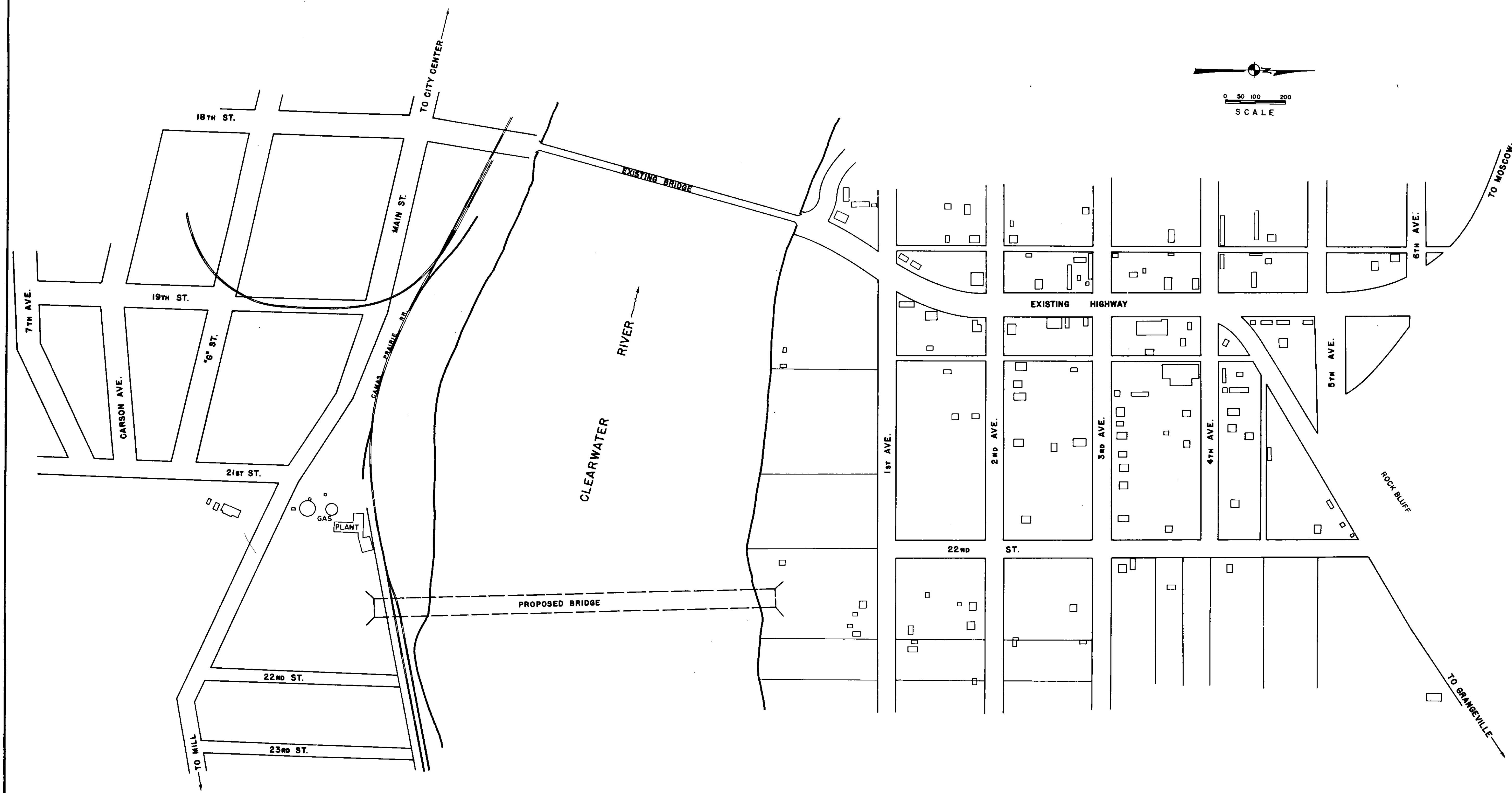
(3) Is the design balanced to the extent that the approach capacity is equal to the bridge capacity? Of course, there are formulas for checking this feature based on assumptions of traffic movements.

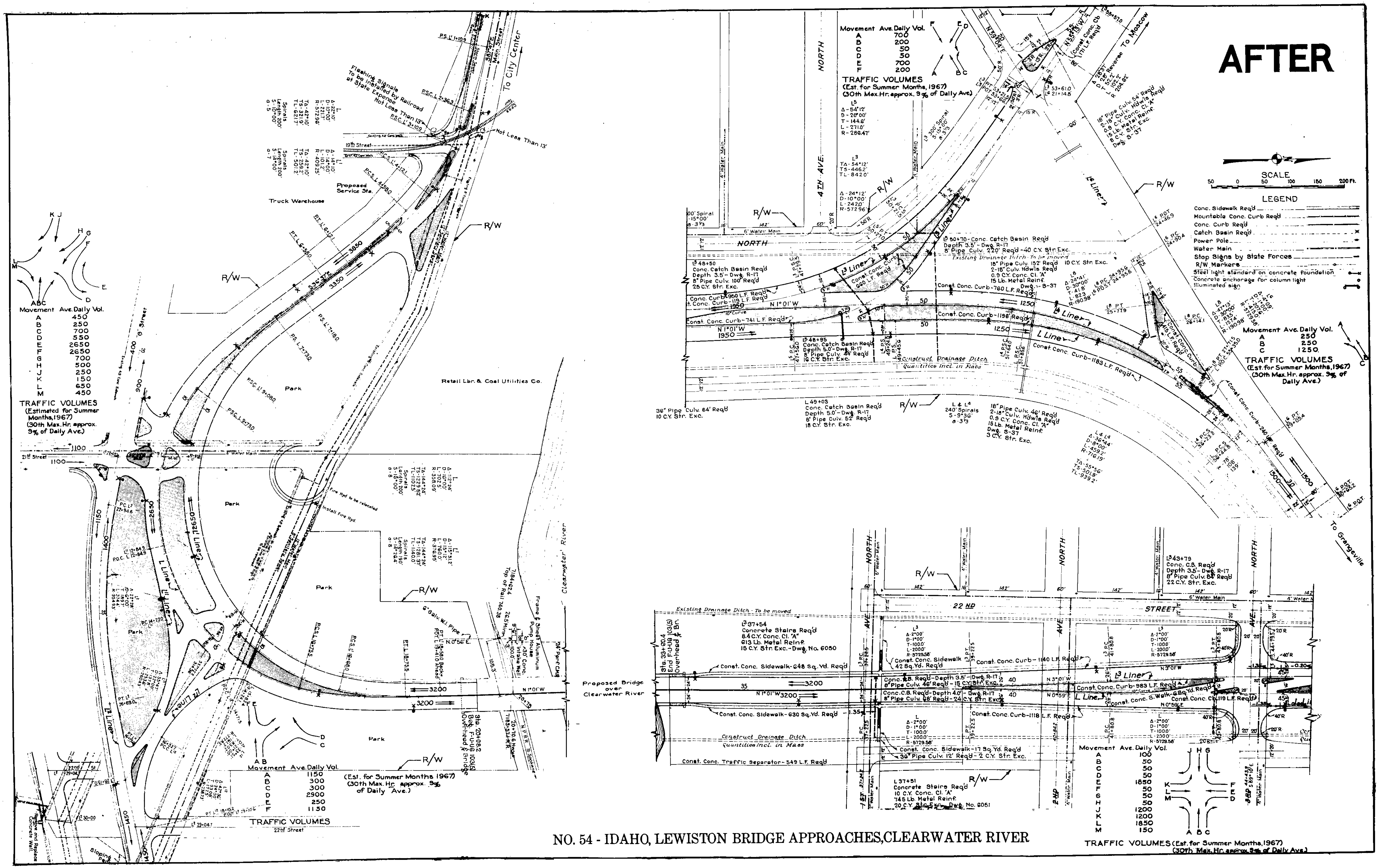
(4) Does the design favor major traffic movements to the extent possible?

Other questions of concern to the designer can be raised but the above illustrate the problem. This department expects to follow through with checks and observations on the above and on the projects to evaluate the various design features with experienced traffic movements, but will perhaps have no answers for any range of conditions. Perhaps this indicates the desirability of having the committee carry on a continuing study so that comparable designs carrying various combinations of traffic movements can be evaluated to determine the range of conditions which can be accommodated by any one type of channelization.

BEFORE

NO. 54 - IDAHO, LEWISTON: BRIDGE APPROACHES,CLEARWATER RIVER





NO. 54 - IDAHO, LEWISTON BRIDGE APPROACHES, CLEARWATER RIVER

Figure 1. Proposed channelization of multiway intersections at bridge approaches, Lewiston, Idaho.

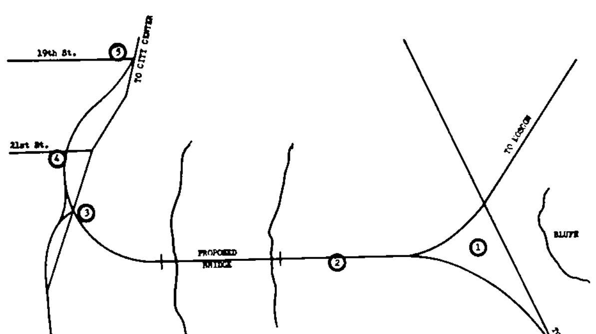


Figure 2.

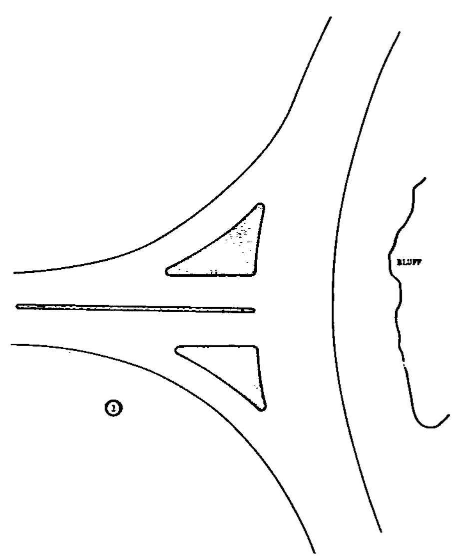


Figure 3.

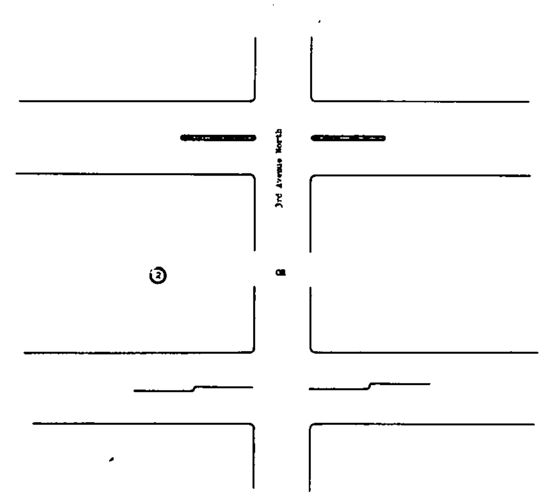


Figure 4.

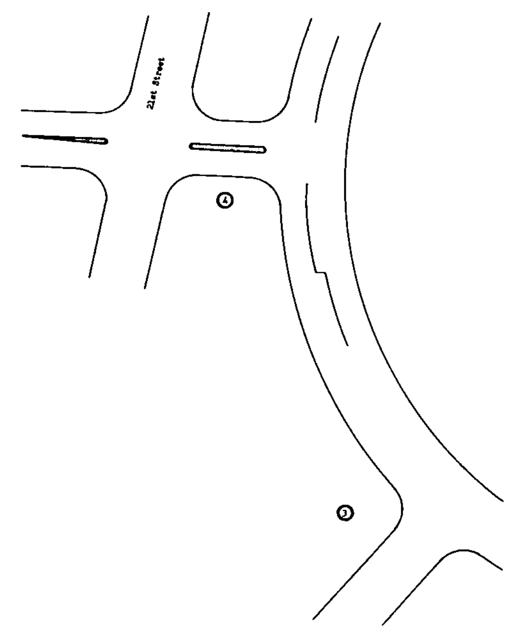


Figure 5.

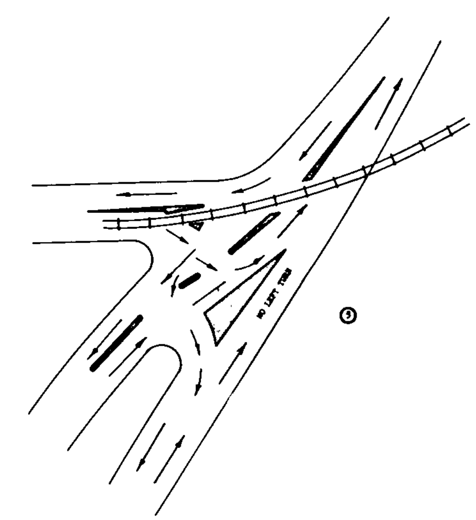


Figure 6.

Example 55

Location

OHIO, Akron: N. Main Street (Route 8) - Cuyahoga Falls Avenue

Submitted by

Herbert B. Woodling, Safety Engineer, 506 Munic Bldg., Akron 8, Ohio

Type of Intersection

4-Way, Oblique

Physical Data

5. Traffic Control Devices
   c. Markings: Type: painted crosswalks, center-lines, and striping on center islands.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. See general comment below.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. See general comment below
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. Quoted from article in the October, 1950, issue of the "American City", entitled "Killer Intersection Tamed by Channels and Crosswalks", by Ray J. Myers, Superintendent Police and Fire Signal Systems, Akron: "Although this area had a high accident rate, the traffic-safety improvements shown here faced almost solid opposition . . . The large island was the bull's-eye for the ridicule . . . But the entire intersection was the target . . . 'A Tank Trap' and 'City Engineers Design Obstacle Course on New North Main Highway', said the newspaper . . . (But) now that the project is completed, the same North Hill merchants are solidly in favor of this method of channelization and this particular improvement on the basis of results. It is still too soon for accident statistics. Donald McNeil of Pittsburgh says crosswalk islands should be four feet wide so people won't be pushed in front of cars traveling in front and back of them. The Akron islands are two feet wide, but Akron's streets are wider than those in Pittsburgh, with generally wider lanes, so that the drivers don't come within two feet of the pedestrian's haven."

Comments by Committee Members

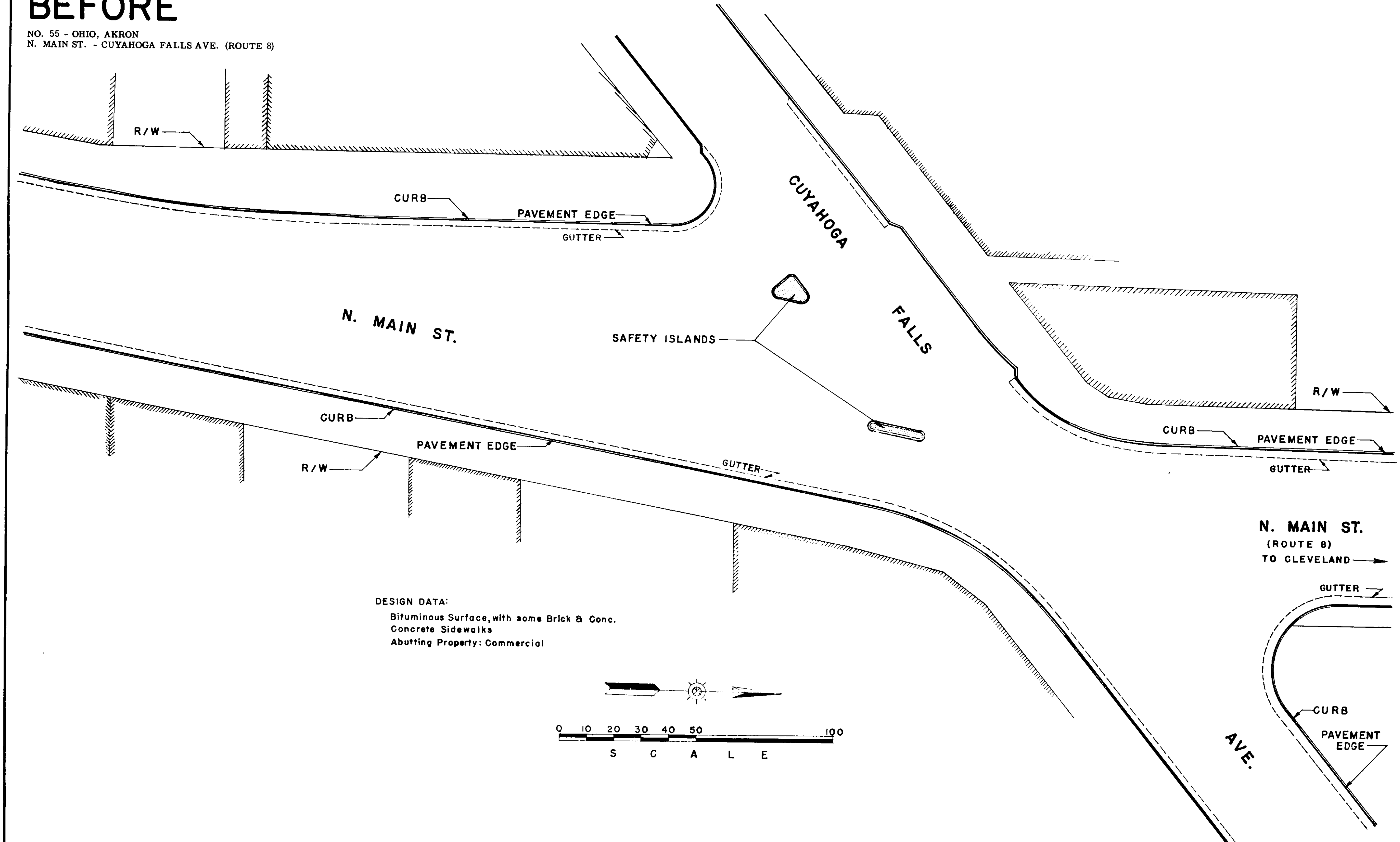
1. FRED W. HURD - The channelization layout for this intersection is rather typical of that recommended for a four-way oblique intersection where signal control is warranted. The barrier type island construction would suggest high speeds and few pedestrians which does not seem to fit the impression that I get from the photograph. Certainly the cross section could be moved nearer to the center of the intersection; and in my opinion, four ft. pedestrian islands and narrower lanes would be desirable.

2. H. G. VAN RIPER - Channelization treatment for the above described intersection is considered very effective. However, the design of the barrier type islands does not add anything to the appearance of the street. Also, in place of the upright bumpers at the end of the islands a nose with a gradual up-slope would be just as effective, more pleasing in appearance and less destructive to an automobile or truck.

   Regarding the precast concrete traffic dividers it is suggested that the angle of the traffic dividers be increased gradually so as to obtain full width crosswise at the traffic island.

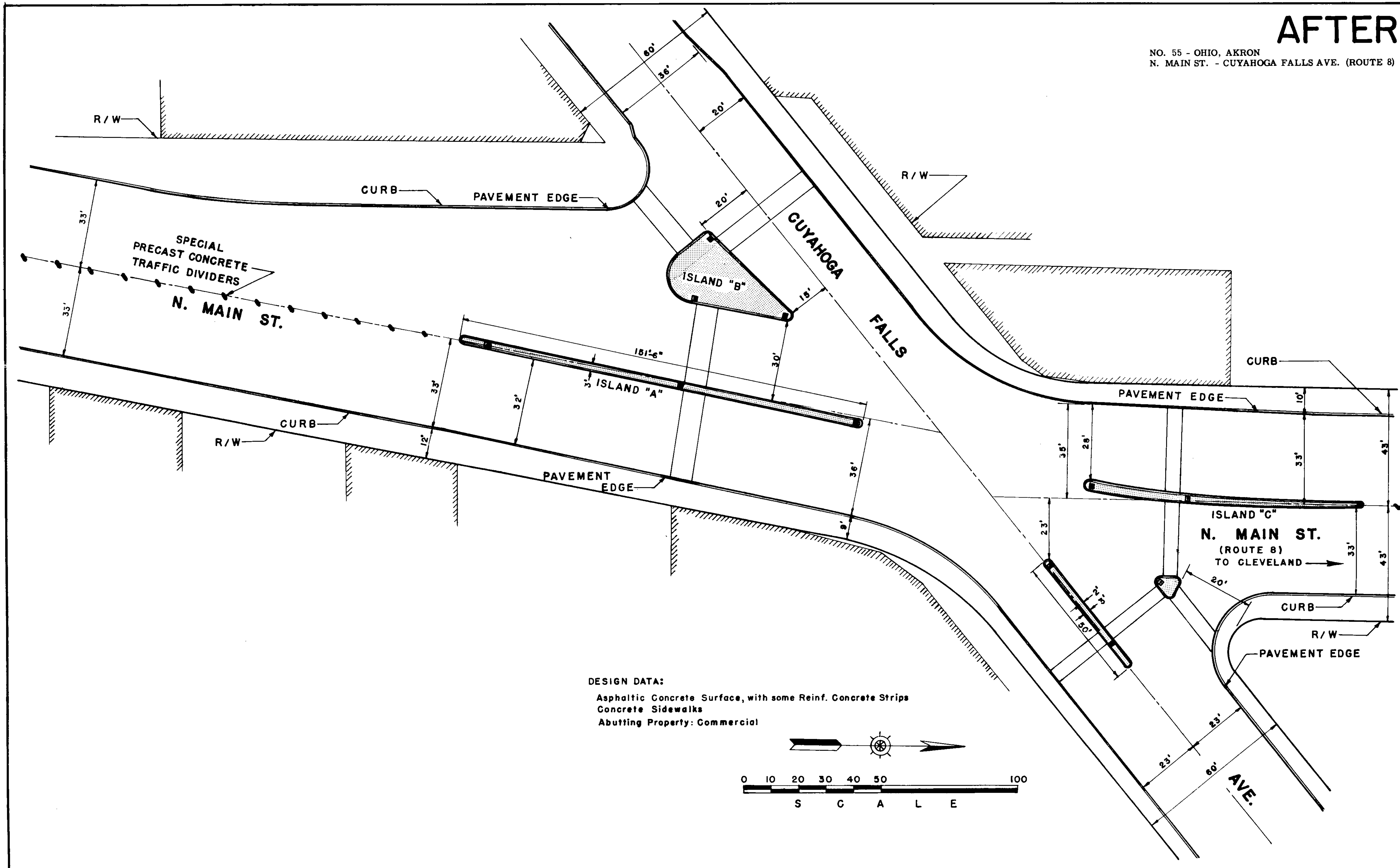
BEFORE

NO. 55 - OHIO, AKRON
N. MAIN ST. - CUYAHOGA FALLS AVE. (ROUTE 8)



DESIGN DATA:

Bituminous Surface, with some Brick & Conc.
Concrete Sidewalks
Abutting Property: Commercial



AFTER
NO. 55 - OHIO, AKRON
N. MAIN ST. - CUYAHOGA FALLS AVE. (ROUTE 8)
R/W
CURB
PAVEMENT EDGE
SPECIAL PRECAST CONCRETE TRAFFIC DIVIDERS
N. MAIN ST.
ISLAND "A"
ISLAND "B"
ISLAND "C"
181'-6"
CUYAHOGA FALLS AVE.
N. MAIN ST. (ROUTE 8) TO CLEVELAND
DESIGN DATA:
Asphaltic Concrete Surface, with some Reinf. Concrete Strips
Concrete Sidewalks
Abutting Property: Commercial
0 10 20 30 40 50 100
S C A L E

Figure 1. Channelization of a 4-way oblique intersection controlled by traffic signals and with a barrier type of median. Intersection of North Main Street and Cuyahoga Falls Avenue (Route 8), Akron, Ohio.

Example 56

Location

TENNESSEE, 3 miles N. of Clarksville,
New Providence Intersection:
US 79-US 41A

Submitted by

W. W. Phillips, Tennessee Department of Highways and Public Works, Nashville, Tennessee

Type of Intersection

3-Way, Y

Economic Data

1. Estimated Cost of New Installation
   a. Labor and material for barrier lines and other pavement markings: $150.

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "There have been innumerable property damage accidents at this intersection involving automobiles approaching the intersection from the direction of Clarksville traveling in the direction of Dover and automobiles approaching the intersection from the direction of Hopkinsville traveling in the direction of Clarksville. You need only to glance at the plan before modification to see that the confusion caused by this crossing traffic was the major problem which confronted us in the selection of a means of traffic segregation and regulation. You will note that highway barrier line painting proved to be the solution at this particular intersection and I would also like to add that we have experienced pleasing results at other intersections in the State using similar design and applications. We have found that barrier line painting affords a low cost of application for which we receive better results due to the fact that the motorists reaction to this mode of traffic segregation is more or less uniform."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "You will note on the plans that traffic traveling in the direction of Hopkinsville on US 41A has a continuous movement and traffic traveling south on US 41A in the direction of Clarksville also has a continuous movement. These are the two major lines of traffic. Traffic traveling US 79 in the direction of Dover is required to stop; the stop limit line is located as near the approaching cross traffic traveling 41A as is practicable. This affords the stopped traffic clear vision of the approaching interfering traffic and at the same time orders traffic traveling this route to stop. This seems to solve the past problem of confusion on the part of both of these lines of traffic in that one is definitely given the right-of-way while the other is definitely ordered to stop and proceed when the way is clear. The stop being located in the position that it is affords the motorist a chance to cross a line of traffic approaching with less hazard and less time than before the barrier lines were laid down.

      There is also confusion on the part of motorists traveling US 79 in the direction of Clarksville particularly at the point where US 79 traffic, southbound, and US 41A traffic, southbound, converge. In the past this has resulted in considerable property damage due to the side-swiping of automobiles. The solution to this problem has been to move the stop limit line, stop sign, and to paint pavement marking -STOP- on the pavement surface at a point where the motorist has clear vision of approaching traffic, and can select the proper time to enter the intersection with less hazard and a minimum of doubt and confusion. The reasons as explained for the location of the stop limit line for traffic traveling US 79 in the direction of Dover apply to the traffic traveling US 79 in the direction of Clarksville in that it affords the motorist less hazard due to the fact that he has less space to travel before converging with traffic traveling US 41A in the direction of Clarksville. Traffic counts and observations show that the gaps in the traffic following US 79 and 41A provide ample time for safe crossing and entering, which ever the case need be without additional control devices."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Labor and materials to put the barrier line and other pavement marking at this intersection is estimated at a cost of $150. At the present time, it is impossible to estimate the monetary value of traffic accidents for any period before construction, however, we are keeping close check on a period after construction. The operational characteristics offered in this design feature the large volume of traffic at the separation of these roadways to have the right-of-way at all times."

Comments by Committee Members

1. H. G. VAN RIPER - The "After" treatment provides for the use of four stop signs, which is considered excessive. By granting US 79 right-of-way preference, the number of stop signs could be reduced from four to two; one stop sign on the eastbound lane of US 41A near its intersection with US 79, and the other stop sign to remain as is for left turns from US 79 entering US 41A.

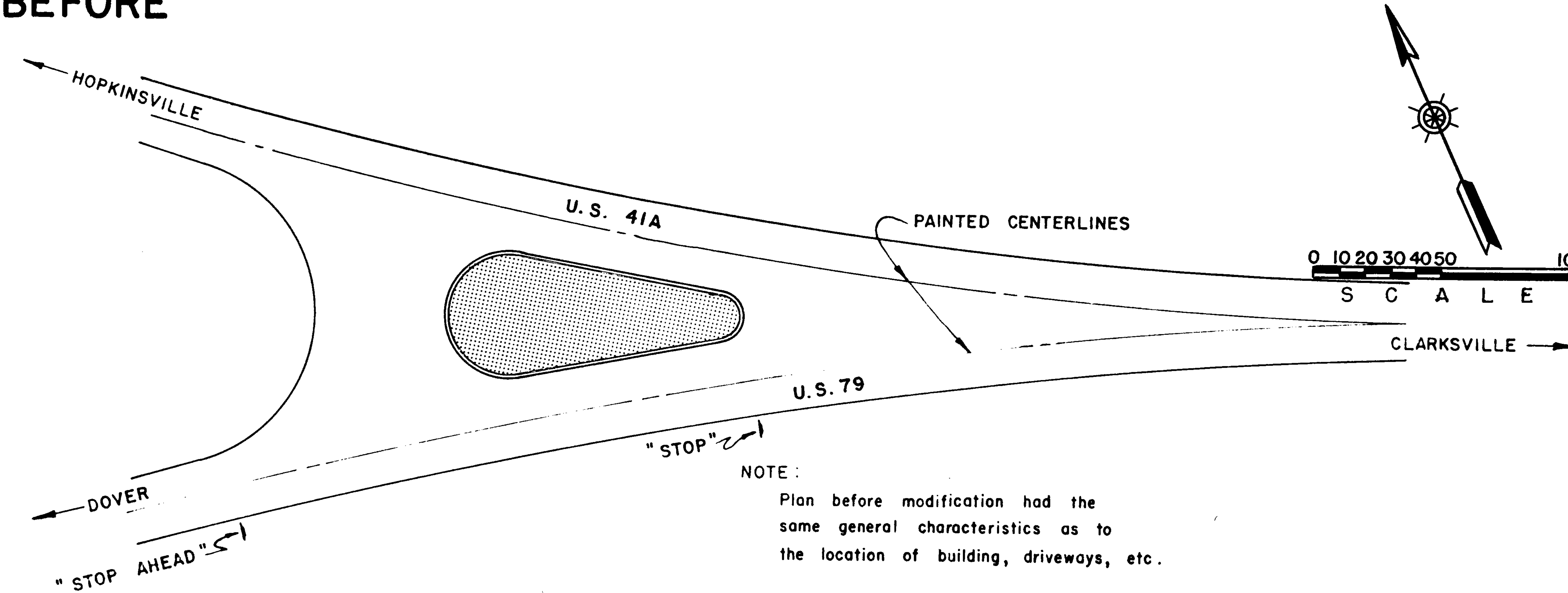
   The suggested plan would (a) operate just as safely as the "After" treatments; (b) greatly reduce the maintenance of pavement markings; (c) would cause no additional inconvenience to traffic, as the volumes of stopped traffic under either plan are approximately equal (1140 under the "After" plan and 1245 under the proposed plan).

   Suggest that the main island be extended to provide for a maximum radius of 5 ft. at the east end. This will eliminate some of the pavement markings and thereby reduce the maintenance cost.

2. J. C. YOUNG - This treatment (paint) seems simple and, at least on a paper drawing, affective for channelizing the head-on conflict which occurs at all acute Y's. The most effective thing about it has been to give the Clarksville to Dover (westbound) motorist an official place to wait for a gap in the eastbound Hopkinsville to Clarksville stream. We occasionally have had trouble where we have inserted islands in two-lane roads, leaving only one lane on either side, and perhaps this idea of only painting the island would solve this trouble.

   Stopping westbound Route 79, (the straight movement) and not stopping eastbound Route 41 (the entering or angling movement) is unorthodox and it seems not too worthwhile to reverse the expected procedure for such small volumes (40 and 123 per hour). With a high volume on Route 41 (say over 500 per hr.) it would be necessary to do this, however. California submitted one such case (Fair Oaks and Howe Avenue, Example 10), which in the "Before" version was very similar to this one except that the hourly volume of conflicting movements was 985 vehicles instaed of 157. The outbound conflicting system (corresponding to westbound Route 79) did mill around in the area covered with painted bars in the Tennessee example, but in spite of this and the large volume of traffic (22,000 vpd.) there

BEFORE

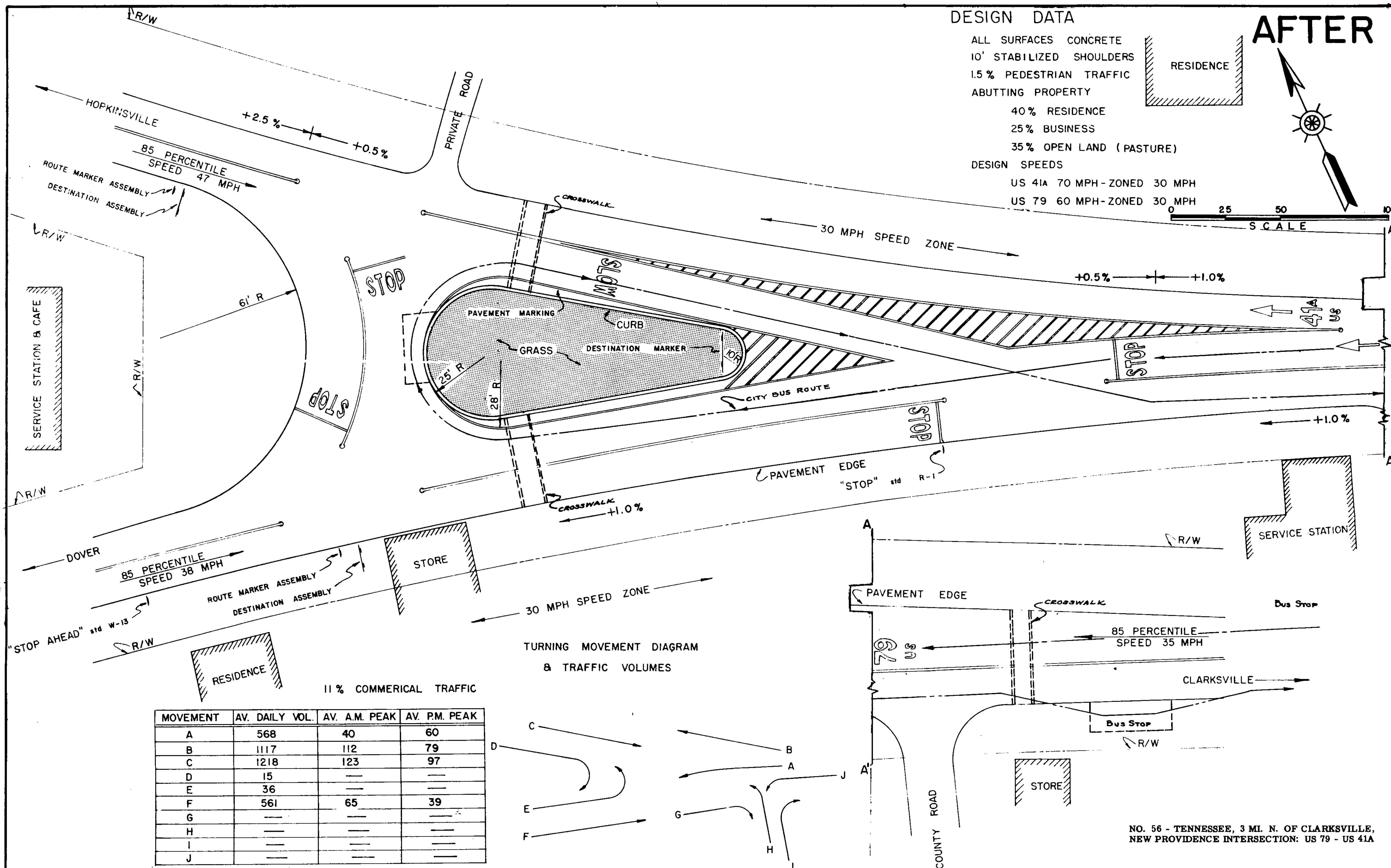


NOTE:

Plan before modification had the same general characteristics as to the location of building, driveways, etc.

PLAN BEFORE MODIFICATION

NO. 56 - TENNESSEE, 3 MI. N. OF CLARKSVILLE, NEW PROVIDENCE INTERSECTION: US 79 - US 41A



MOVEMENT	AV. DAILY VOL.	AV. A.M. PEAK	AV. P.M. PEAK
A	568	40	60
B	1117	112	79
C	1218	123	97
D	15	—	—
E	36	—	—
F	561	65	39
G	—	—	—
H	—	—	—
I	—	—	—
J	—	—	—

NO. 56 - TENNESSEE, 3 MI. N. OF CLARKSVILLE,
NEW PROVIDENCE INTERSECTION: US 79 - US 41A

were extremely few accidents.

The area east of the stop line facing westbound Route 79 traffic will only hold about 5 cars, but this should be sufficient up to around 500 an hr. on the major leg and 200 per hr. on the minor leg.

Figure 1. Channelized intersection of US 79 and US 41A, near Clarksville, Tennessee.

Figure 2. Channelization accomplished with pavement markings. The maintenance of the pavement markings during periods of inclement weather would be difficult.

Example 57

Location

WYOMING, Ranchester:
US 87 - US 14

Submitted by

G. T. Bath, Planning Engineer,
Wyoming Highway Department,
Cheyenne, Wyoming

Type of Intersection

3-Way, Y

Date Constructed

1946

Physical Data

6. Landscaping
   a. None
7. Abutting Property
   a. Character or Land Use: Open Land
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

2. Type
   b. Percent Commercial: 28 percent
3. Speeds
   a. Average Design: 80 and 50 mph.

Economic Data

1. Estimated Cost of New Installation
   a. $190,000

Operational Characteristics

3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "As there is nothing unusual about this design, there is not much we can say about it."

Comments by Committee Members

1. JAMES L. SHOTWELL - This is an excellent example of a bulb treatment to a Y type of intersection. The main roadway has been separated sufficiently to permit storage of turning vehicles at the intersection. It would be better if the entrance roadways at each approach end of the median were made wider than the exit roadways. While the 17-ft. width is desirable for the exit roadways 24 ft. would be better for the entrances.

   Adequate radii have been provided at the bulb to permit easy turning for trucks. A short section of tangent along the left edge of pavement of the southeast roadway approaching the bulb would enhance the appearance.

   Proper shoulder widths have been provided on both the right and left edges of pavement. It will be difficult to differentiate between the pavement and shoulder area.

   The signing for this project is considered good.

   This design should serve the estimated traffic volumes and volumes even several times higher than those indicated for 1960 adequately and safely.

2. EDWARD G. WETZEL - The geometric design of the channelization at this intersection appears to be ideal. The acceleration and deceleration lanes, the minimum turning radii, the funneling lanes, and the separating island through the intersection appear to be quite adequate for considerably greater traffic volumes.

   However, the painted markings would be better if 6 in. rather than 4 in. in width. The signs appear satisfactory as to size and location. It is questionable whether the additional wording is necessary on the sign such as "left-hand lane" and "right-hand lane". It is believed that this would be better to read "keep left" or "left", or "keep right" or "right", particularly in view of the fact that the roadways are actually more than two lanes in width including the shoulder. The guide posts which define the limits of the channelization islands actually obscure the intersection from a distance. The motorist would have difficulty getting a view of this intersection until right at the point of turning. Guide posts should not be used to delineate channelization.

   Traffic volumes through this intersection certainly do not warrant the extensive channelization as shown by the "After" sketch. No accident record is provided and if this indicates no accidents, it is further evidence that this channelization is uncalled for at this point.

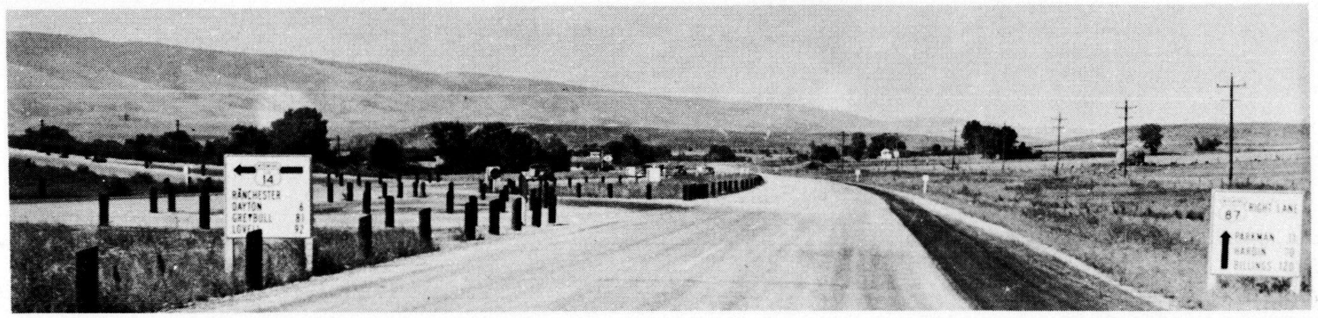
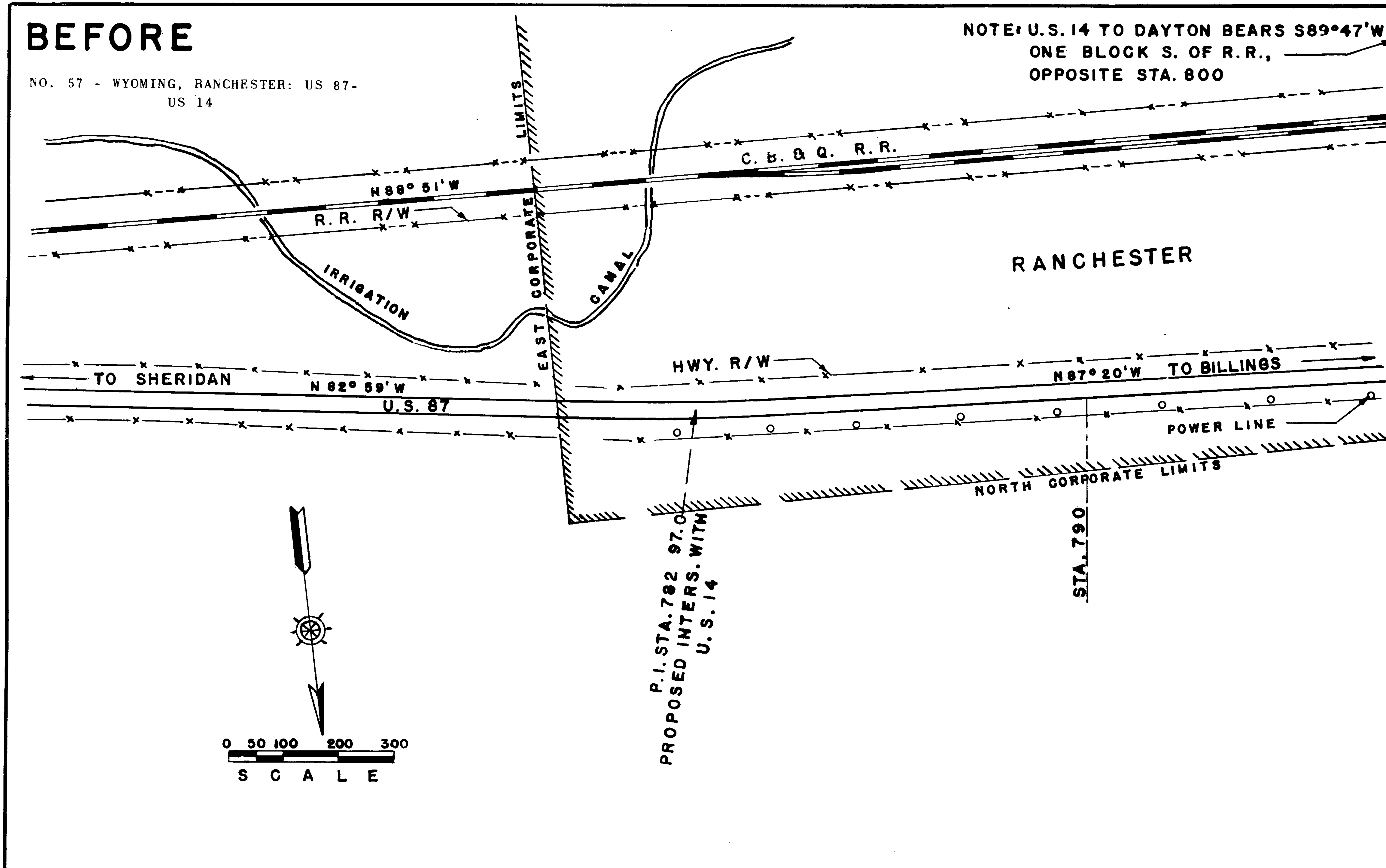


Figure 1. Good channelization design for Y-type intersection of US 87 and US 14 near Ranchester, Wyoming. Note the extensive use of guide post to delineate islands.

BEFORE

NO. 57 - WYOMING, RANCHESTER: US 87-
US 14



AFTER

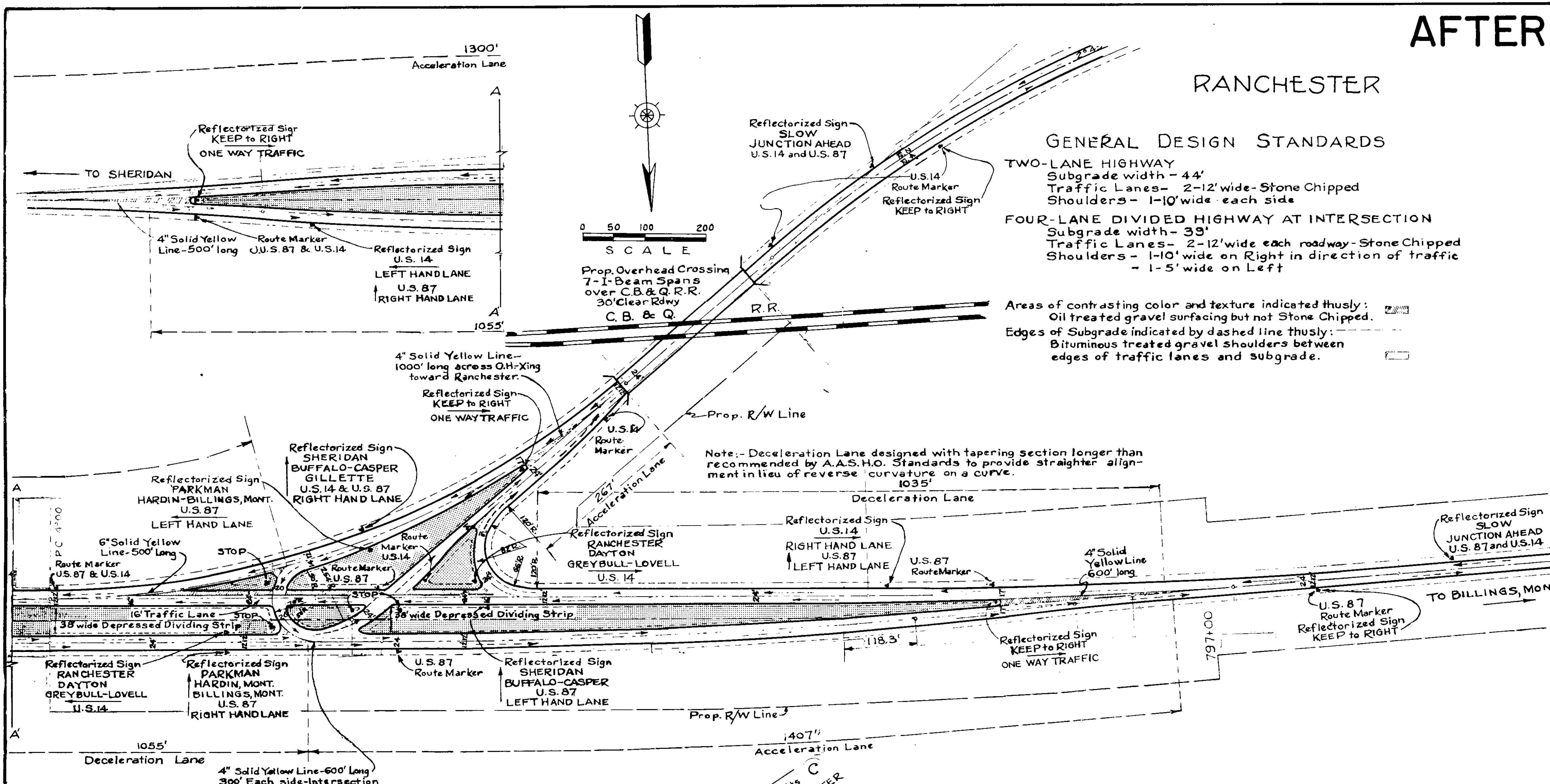
RANCHESTER

GENERAL DESIGN STANDARDS

TWO-LANE HIGHWAY
Subgrade width – 44'
Traffic Lanes – 2-12' wide - Stone Chipped
Shoulders – 1-10' wide each side

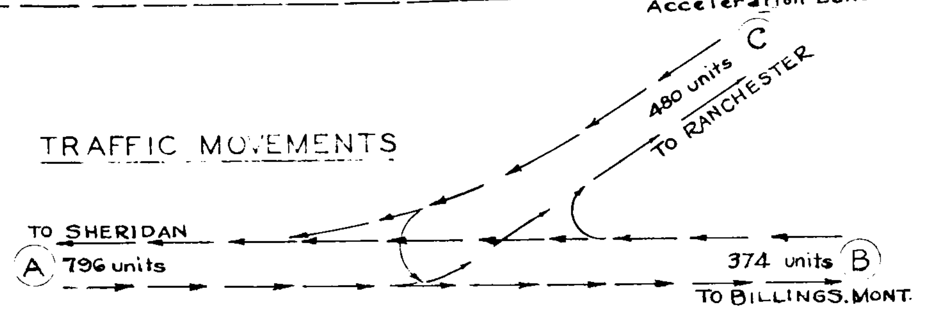
FOUR-LANE DIVIDED HIGHWAY AT INTERSECTION
Subgrade width – 39'
Traffic Lanes – 2-12' wide each roadway - Stone Chipped
Shoulders – 1-10' wide on Right in direction of traffic
– 1-5' wide on Left

Areas of contrasting color and texture indicated thusly: Oil treated gravel surfacing but not Stone Chipped.
Edges of Subgrade indicated by dashed line thusly:
Bituminous treated gravel shoulders between edges of traffic lanes and subgrade.



Traffic Movements	1940 Annual Average 24-hour Volume		Average Hourly Volume for Peak Hours during year		Est. 1960 Average Hourly Volume (2.2x.14 x 1940 An. Ave.) Design Traffic Density	
	Total	% Trucks	Total	% Trucks	Total	% Trucks
AB	172	20	24	20	53	20
BA	173	20	24	20	53	20
AC	226	22	32	22	70	22
CA	225	22	32	22	69	22
BC	14	21	2	21	4	21
CB	15	21	2	21	5	21

TRAFFIC MOVEMENTS



NO. 57 - WYOMING, RANCHESTER: US 87 - US 14

Example 58

Location

PENNSYLVANIA, Bedford County:
US 30 - Penn. 31

Submitted by

C. R. Forbes, District 9,
Pennsylvania Department of Highways,
Hollidaysburg, Pennsylvania

Type of Intersection

3-Way, Y

Date Constructed

Opened to traffic September 29, 1947

Physical Data

5. Traffic Control Devices
6. Landscaping
   a. Grasses
7. Abutting Property
   a. Character or Land Use: Cultivated land, and several adjacent residences
8. Transit Operations
   a. Location of Bus or Street Car Routes Through Intersection: none

Traffic Data

6. Pedestrian
   a. Volumes: none, rural intersection

Economic Data

1. Estimated Cost of New Installation
   a. $6,000

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The design of the intersection is satisfactory in our opinion with the exception of Island No. 2, which we believe should be reduced to a 30 in. white reflecting traffic divisor; to be placed along the eastbound lane."
      Another suggestion, by whom is not indicated, is to place a sign "US KEEP RIGHT" about 300 ft. in advance of intersection and also a pavement word marking "LEFT TURN ONLY" approaching the intersection end of this island.
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "With the elimination of Island No. 2 and the specified changes made as outlined above, the problems of congestion will be reduced."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Over-all Operation will be satisfactory after above changes are made."

Comments by Committee Members

1. NORMAN KENNEDY - Although the accident record is not given for this intersection before channelization, it is noted that one fatal accident has occurred after.
   The angle of intersection for major movements A and D is such that the relative speeds are high and the area of conflict is larger than it need be. This condition might be corrected by closing the present opening for movement D and constructing a new one farther to the west (assuming that north is at the top of the plan) to permit crossing of movement A at approximately a right angle.
   Movement E, although minor, also intersects major movement A at an oblique angle which may introduce a hazard. This might be corrected by shortening the radius of the pavement edge adjacent to movement B from its present 75 ft. to 50 ft. Movements B and D away from the intersection would then be made in the same lane, and movement E would cross A at a right angle.
   A more definitely delineated left-turn lane with end protection for vehicles waiting to make movement D should be provided on US 30. The solid white lane line is not sufficient protection.
   The sight distance for eastbound traffic appears to be adequate but that for westbound traffic on US 30 is limited for the approach speeds. Consideration might be given to further treatment of the approach for westbound traffic.
   Widening of the eastbound lane of US 30 to permit merging of traffic movements A and F would be desirable to eliminate the necessity of movement F having to stop on a relatively steep grade.

2. J. A. REDMAN - The flat angle of intersection used in combination with a stop sign deviates from the basic concept of bringing stopping traffic into a main arterial highway as nearly to 90 degrees as is practical for visibility or of providing a separate lane for blending without a stop sign.
   The low traffic volumes would be adequately served with the former design.
   The short sight distance along US 30 should contribute to increased accidents.

Additional Comments by C. R. Forbes

In reference to comments by Norman Kennedy and J. A. Redman, the fatal accident which occurred at this intersection was attributed to the driver falling asleep and running into the historical sign in the island at the junction of the two routes.

Several minor accidents occurred due to traffic moving in "D" lane and brushing the concrete strip of the island directly ahead, but this condition seems to have corrected itself since traffic is now familiar with the turning movements at this location.

We agree that this intersection could be improved by bringing it in farther toward the west at a 90 degree angle. This, however, was not considered feasible since it would have necessitated the demolition of a historical building known as the Old Forks Inn, built in 1764, which is located at the southwest corner of this intersection, at an elevation approximately 10 ft. below the level of the highway.

Since making our first report an additional directional sign, 3 by 6 with 8 in. letters, has been placed on the right side of lane "A", together with a US 30 Route Marker and US Shield.

We believe the suggestion of Mr. Kennedy to widen the eastbound lane of US 30 to permit merging of traffic movements A and F would be desirable, but no trouble is experienced at this location.

Figure 1. Three-way, Y-type channelized intersection of US 30 and Pennsylvania 31 looking southwest.

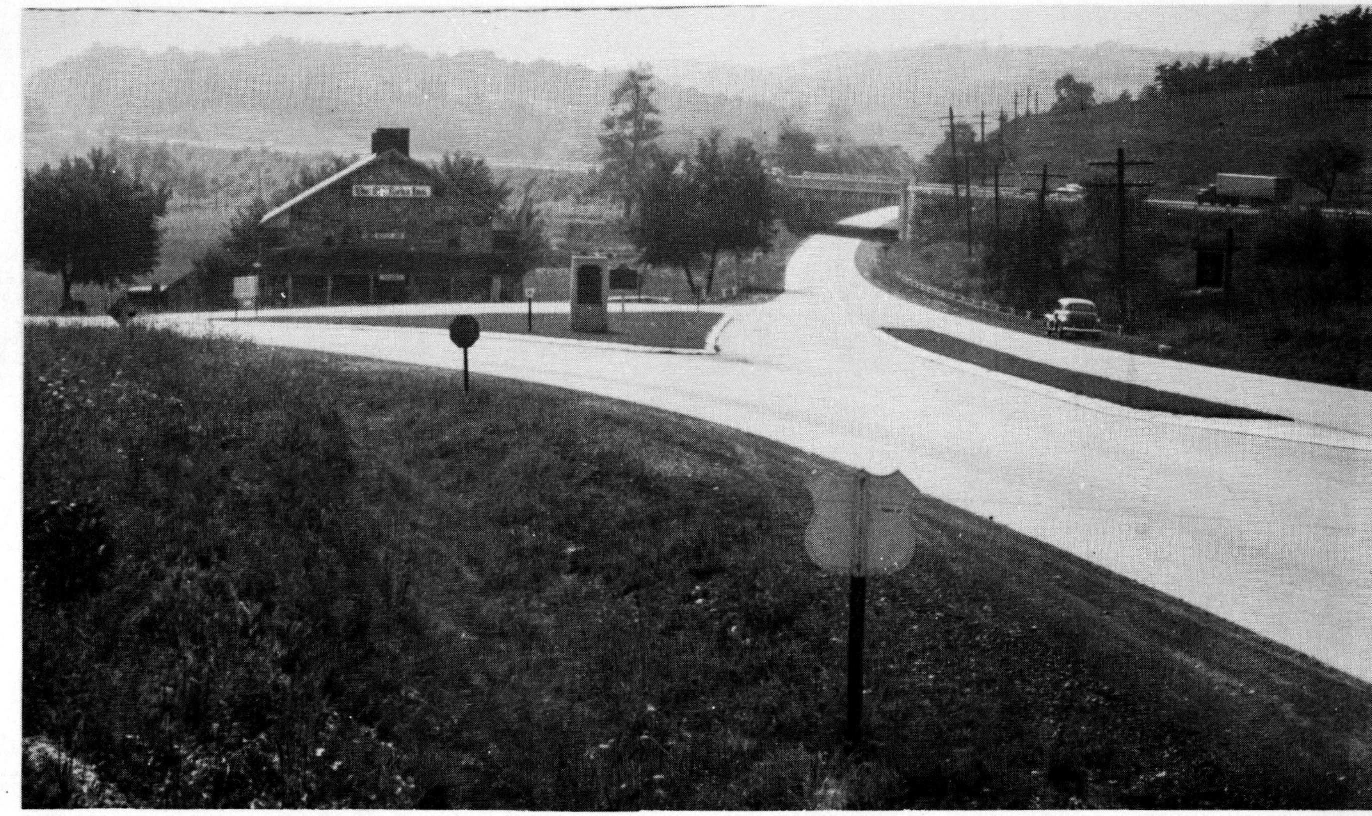
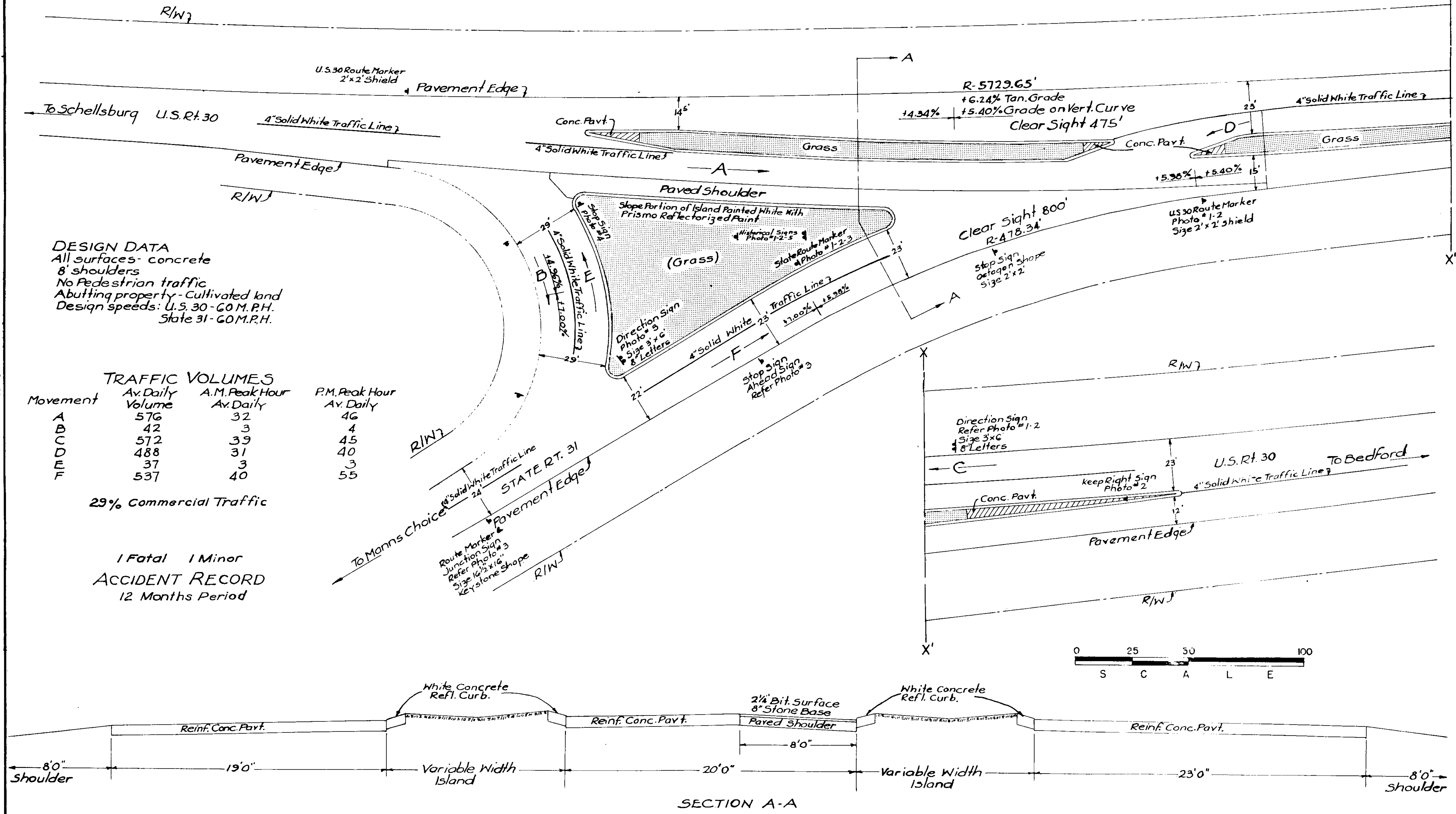


Figure 2. Sloping curbs around islands painted with white reflectorized paint to improve contrast and night visibility.

AFTER



DESIGN DATA
All surfaces - concrete
8' shoulders
No Pedestrian traffic
Abutting property - Cultivated land
Design speeds: U.S. 30 - 60 M.P.H.
State 31 - 60 M.P.H.

TRAFFIC VOLUMES

Movement	Av. Daily Volume	A.M. Peak Hour Av. Daily	P.M. Peak Hour Av. Daily
A	576	32	46
B	42	3	4
C	572	39	45
D	488	31	40
E	37	3	3
F	537	40	55

29% Commercial Traffic

1 Fatal 1 Minor
ACCIDENT RECORD
12 Months Period

Example 59

Location

NEW YORK, US 9
Mechanicville Road (Route 236)

Submitted by

E. B. Shrope, Principal Civil Engineer, Department of Public Works, 353 Broadway, Albany 1, New York

Type of Intersection

3-Way, Y

Physical Data

1. a. "Before": no plan; new intersection
5. Traffic Control Devices
   b. Signals: Type: none
   d. Lighting: Type: none
7. Abutting Property
   a. Character or Land Use: Farm land
   b. Location and Importance of Entrances: none

Economic Data

1. Estimated Cost of New Installation
   a. $45,000

Operational Characteristics

1. Design Features Which Contribute to Safe Operation; to Unsafe Operation
   a. "The method of bringing one-way traffic into the main road at right angles forces traffic on the secondary roadway to stop to make the turn into Route 9. This reduces the chance of accidents."
2. Design Features Which Relieve Congestion; Which Contribute to Congestion
   a. "Traffic traveling north on Route 9 can turn off to the right on the deceleration lane without slowing up following cars."
3. Comments Regarding Over-all Operation of the Channelized Intersection
   a. "Designed for no left turns from US 9. Left turning traffic would use connections farther north. From an over-all operation standpoint, traffic operation is very satisfactory. The connection with Route 9 is new - the road (Mechanicville Road - Route 236) never connected with Route 9 before at this place."

Comments by Committee Members

1. EUGENE MAIER - Noteworthy features of this channelized three-way intersection includes: (a) Treatment of the approach end of the island on Route 236 by the use of lines painted on the pavement; (b) The design of the generous speed change area for traffic traveling northwest on US 9 and turning right onto Route 236. Good definition is afforded this speed change area by the contrast in surface type.

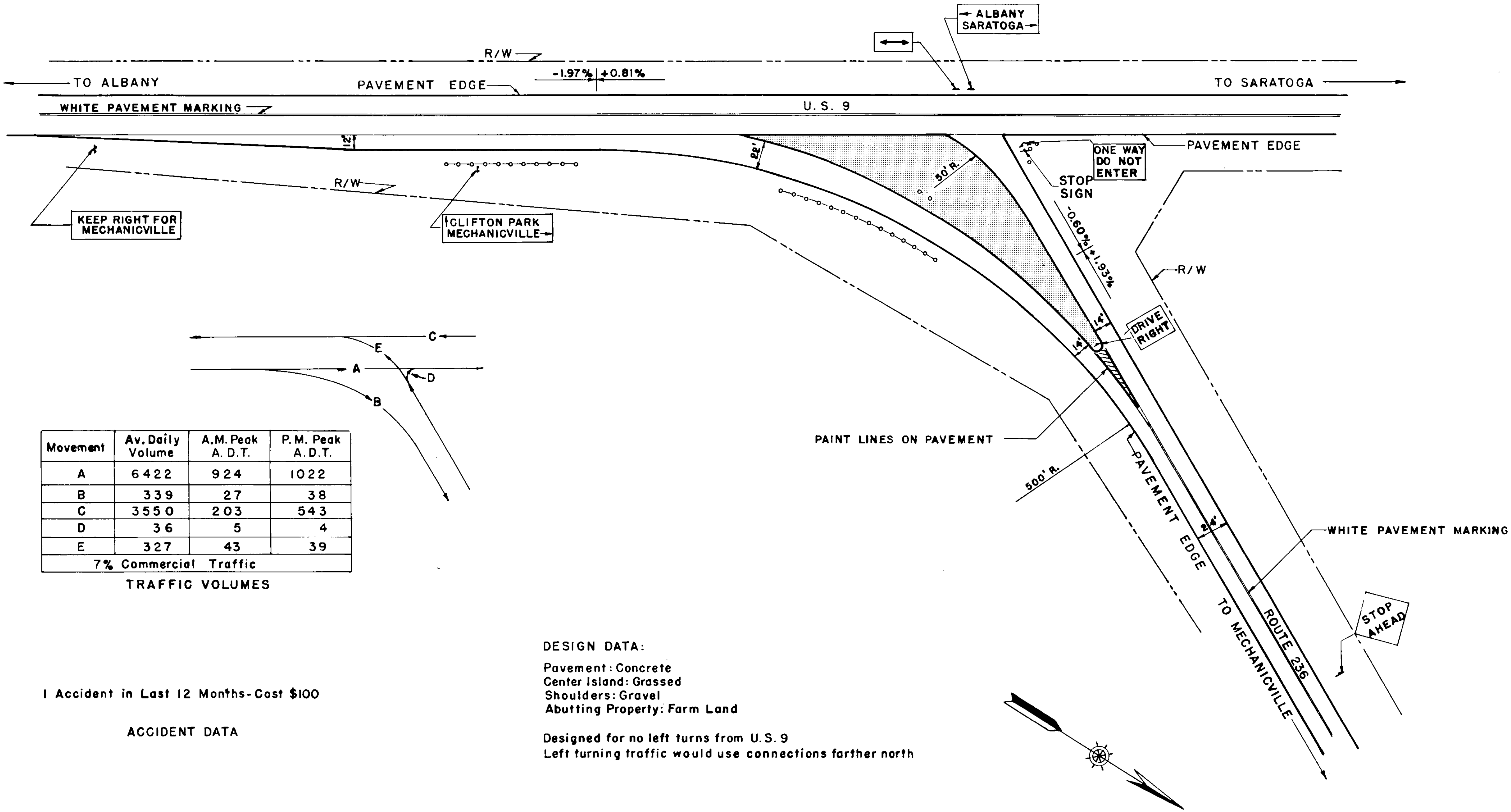
   A suggested addition to this design would be the widening along the northeast side of US 9 between the separated roadways on Route 236. The widening should vary in width from approximately 6 ft. to the southeast point of the island to zero at the northwest point of the island. It appears in the photograph that this area has been subject to travel either by vehicles traveling northwest on US 9 or by southeastbound traffic on US 9 negotiating a prohibited left turn into Route 236.

2. J. A. REDMAN - This design is good and adequate in all respects. The restriction in number of turns makes a simple intersection possible. The use of grass for the island area without use of curbs is attractive in appearance and makes passing of stalled vehicle possible.

Figure 1. Channelized intersection of US 9 and Mechanicville Road (New York 236), looking south.

AFTER

NO. 59 - NEW YORK: US 9 - MECHANICVILLE RD. (ROUTE 236)



Movement	Av. Daily Volume	A.M. Peak A.D.T.	P.M. Peak A.D.T.
A	6422	924	1022
B	339	27	38
C	3550	203	543
D	36	5	4
E	327	43	39
7% Commercial Traffic			

TRAFFIC VOLUMES

1 Accident in Last 12 Months-Cost $100

ACCIDENT DATA

DESIGN DATA:

Pavement: Concrete
Center Island: Grassed
Shoulders: Gravel
Abutting Property: Farm Land

Designed for no left turns from U.S. 9
Left turning traffic would use connections farther north