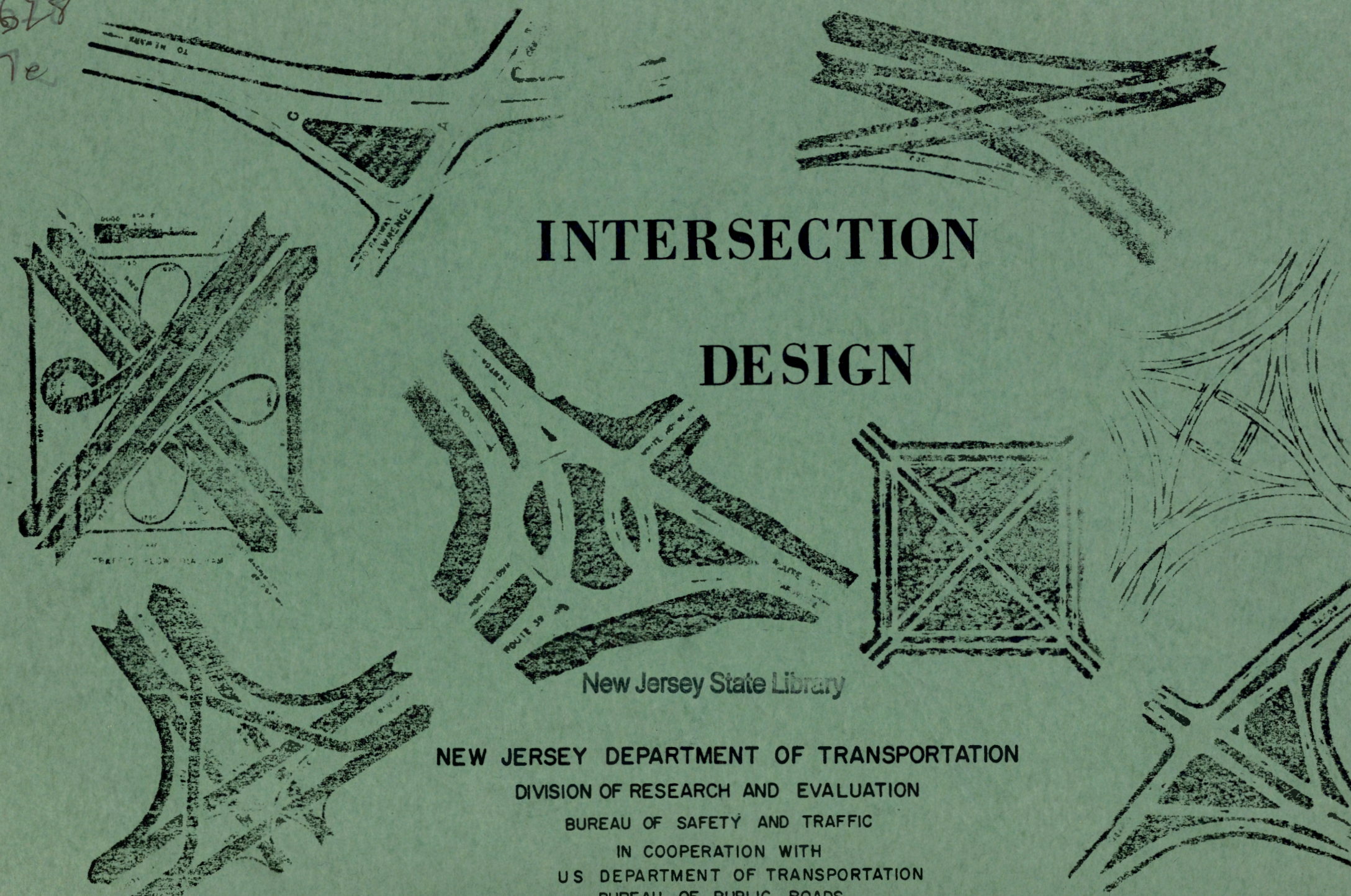


10
R678
1967e



INTERSECTION DESIGN

New Jersey State Library

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC
IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
BUREAU OF PUBLIC ROADS
FALL-1967

A B S T R A C T

INTERSECTION DESIGN

Ten sites, representing four intersection design types are presented in this paper to provide better traffic engineering tools to the highway designer. Physical features, signing and collision diagrams, coupled with AADT and 30th peak hour volumes and travel time equations and accident experience, are presented.

Future plans provide for an additional twenty sites to be studied for more comprehensive graphical travel time predictions as well as more exhaustive accident exposure relationships.

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INTRODUCTION

A research program to analyze the various types of intersection designs in the State of New Jersey has been undertaken by the Bureau of Safety and Traffic, Division of Research and Evaluation, New Jersey Department of Transportation, with the cooperation of the Bureau of Public Roads. During the summer of 1966, ten sites were selected for study -- three signalized at-grade intersections, four cloverleaf designs and three traffic circles.

An additional 20 sites were studied in 1967 -- nine signalized at-grade intersections, four two-quadrant cloverleaf designs, two traffic circles, one channelized traffic circle, two partial diamonds, and two at-grade intersections without signals. It is planned to restudy the two at-grade intersections after signal installation.

It is anticipated that other states will find value in the results of this study and will continue research in this area. The purpose of the report is to furnish designers with tools with which to plan more efficient intersection designs.

This purpose can be accomplished either graphically or with the use of a computer program.

The comparative findings of the 30 sites from the summers of 1966 and 1967 will furnish several observations of the prevalent intersections within New Jersey. Comparative travel times can then be combined for each movement within each design group as well as relating the design groups. This can also be done with accidents.

SCOPE OF REPORT

The crossing of traffic streams is generally accomplished by:

a. At-grade intersections

1. Channelized,
2. Signalized, or in
3. Combination

b. Grade-separated intersections

1. Cloverleaf,
2. Diamond,
3. Trumpet, or
4. Directional

Theoretically, there is an economic benefit to the user when impedences are reduced. Time savings, accident experience, operating costs and comfort and conveniences are the principal measures of benefit for comparison of efficiency.

The object of this study is to provide a method of analysis of various type intersections. The principal items for comparison are travel time and accident data. Each of the intersections presented are accompanied by comments covering its overall efficiency.

The extent of influence of a road on another road's traffic stream is not easily determined. Backups from one may extend several hundred or thousand feet upstream. Ramp terminals of grade-separated crossings may be 500 feet from the projected crossing of the connected roads. For these reasons, all data has been collected at points 1000 feet in advance of, and 1000 feet beyond the intersection point produced by projecting the center lines of the two roads.

Travel time and accident experience are the most accurate determinations of design efficiency, followed closely by operating costs.

To completely evaluate the efficiency of each type design, several traffic and design parameters are presented herein: design elements consist of horizontal and vertical alignment, pavement type, lane markings, signing, lighting and roadside features; traffic elements include travel time and accident experience.

INTERSECTIONS

1966 · STUDY

PHOTO 1

U.S. Route 1 & Milltown Road

Cloverleaf



Photographed 6/1/67 - 1735 hours
500' Altitude, Looking West



Photographed 6/1/67 - 1735 hours
700' Altitude, Looking West

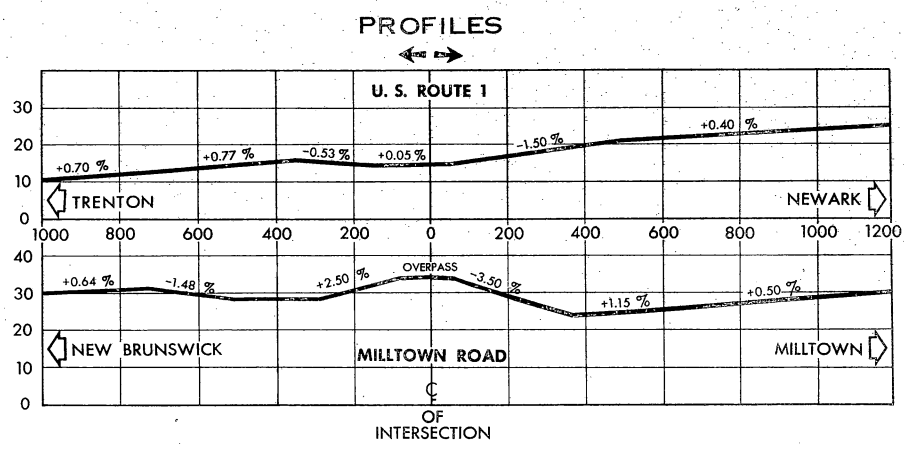
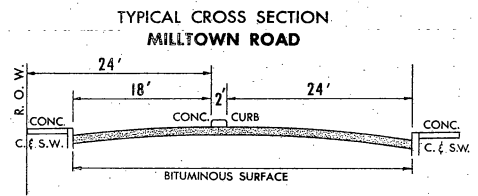
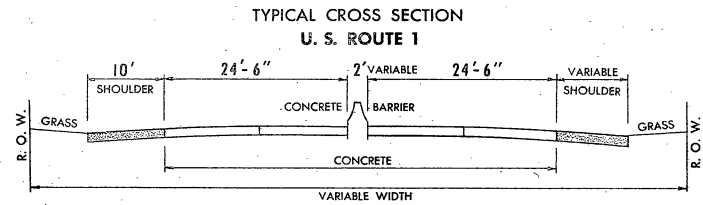
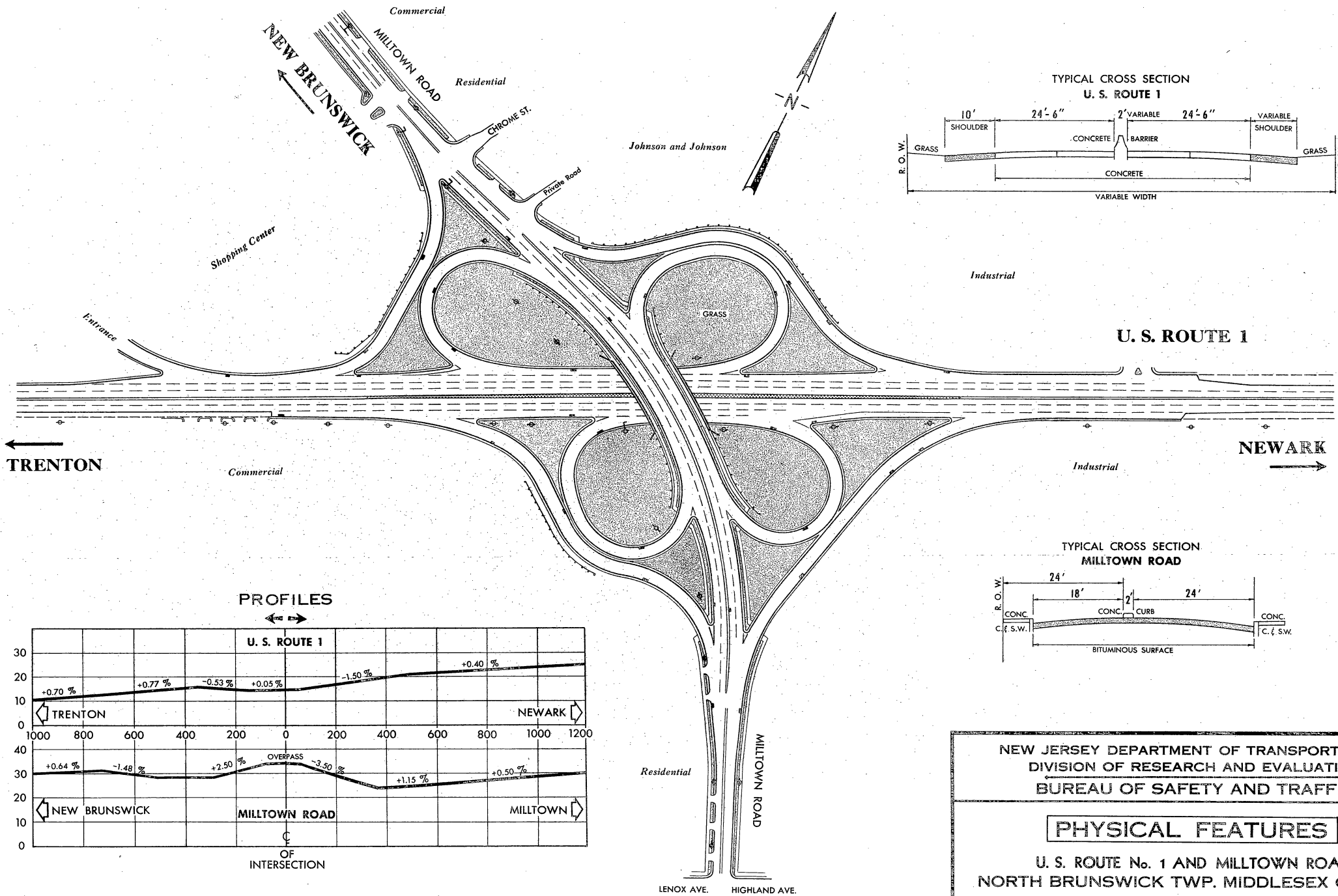


FIG 10

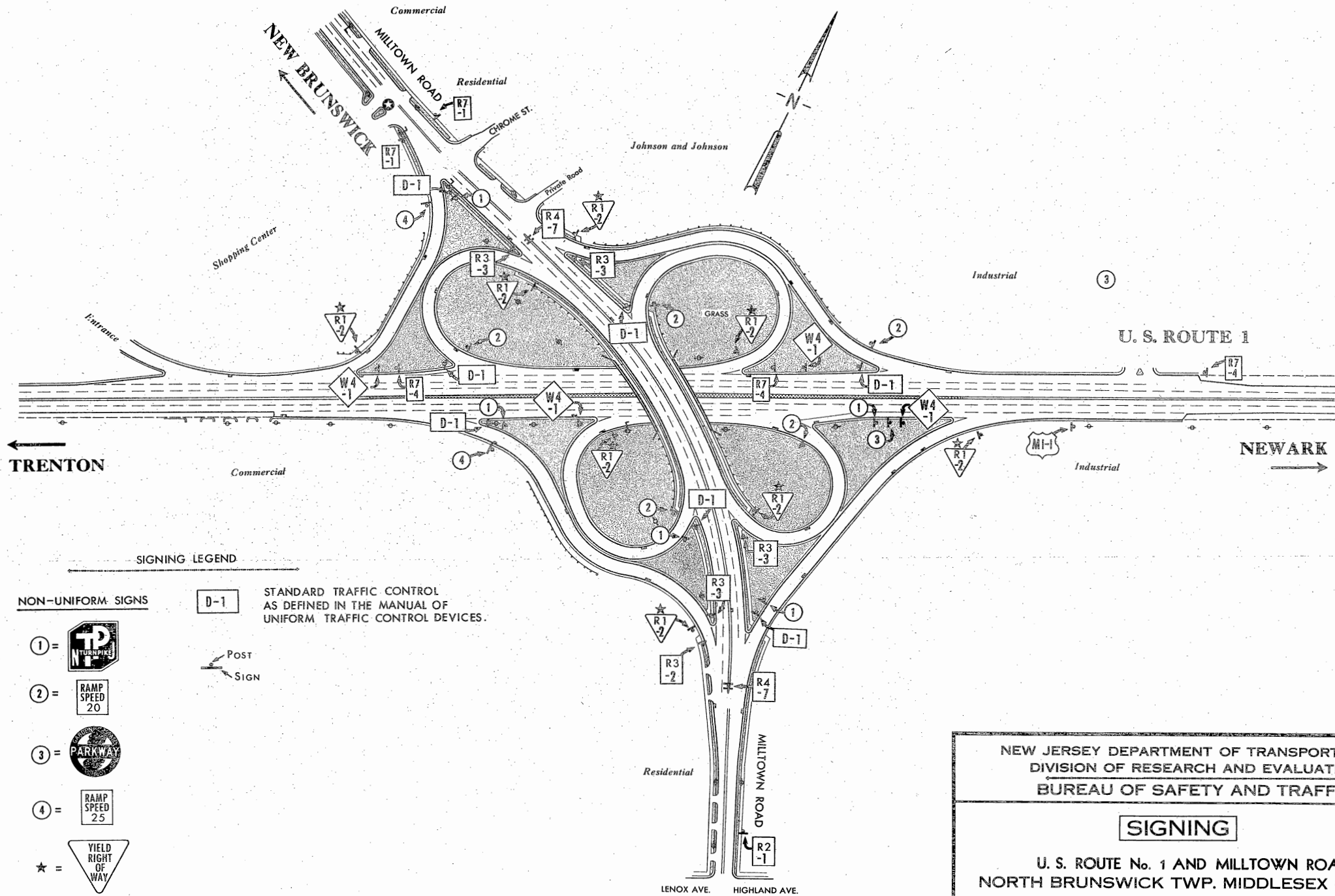
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE No. 1 AND MILLTOWN ROAD
NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

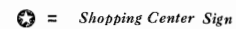
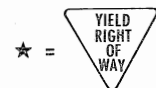
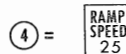
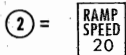
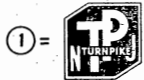
0 100 200 300
SCALE IN FEET

JANUARY, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS



STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.



Post Sign

FIG 1b

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 AND MILLTOWN ROAD
NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JANUARY, 1967

| (1962-1964) ACCIDENT SUMMARY | | | | | | |
|------------------------------|-----------|-----------|-----------|--------------|-----------------|----|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | SEVERITY | NO. ACCIDENTS | |
| ↘↔ | 6 | 0 | 6 | FATAL | 0 | |
| ↔↔ | 14 | 5 | 19 | INJURY | 17 | |
| ↔X | 1 | 1 | 2 | | PROPERTY DAMAGE | 23 |
| ↔↔ | 0 | 0 | 0 | | | |
| ↔↔ | 0 | 0 | 0 | | | |
| ↔↔ | 3 | 1 | 4 | | | |
| ↔↔ | 3 | 6 | 9 | | | |
| TOTAL | 27 | 13 | 40 | TOTAL | 40 | |

NOTE: ○ = NUMBER OF ACCIDENTS AT EACH LOCATION

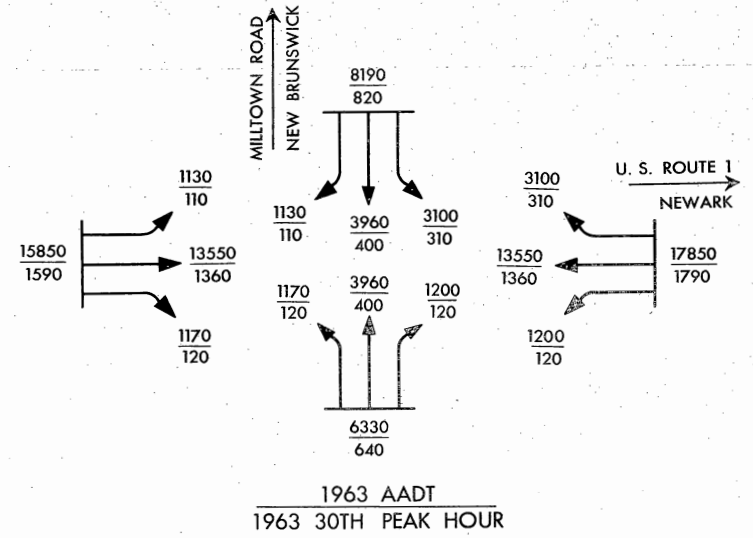
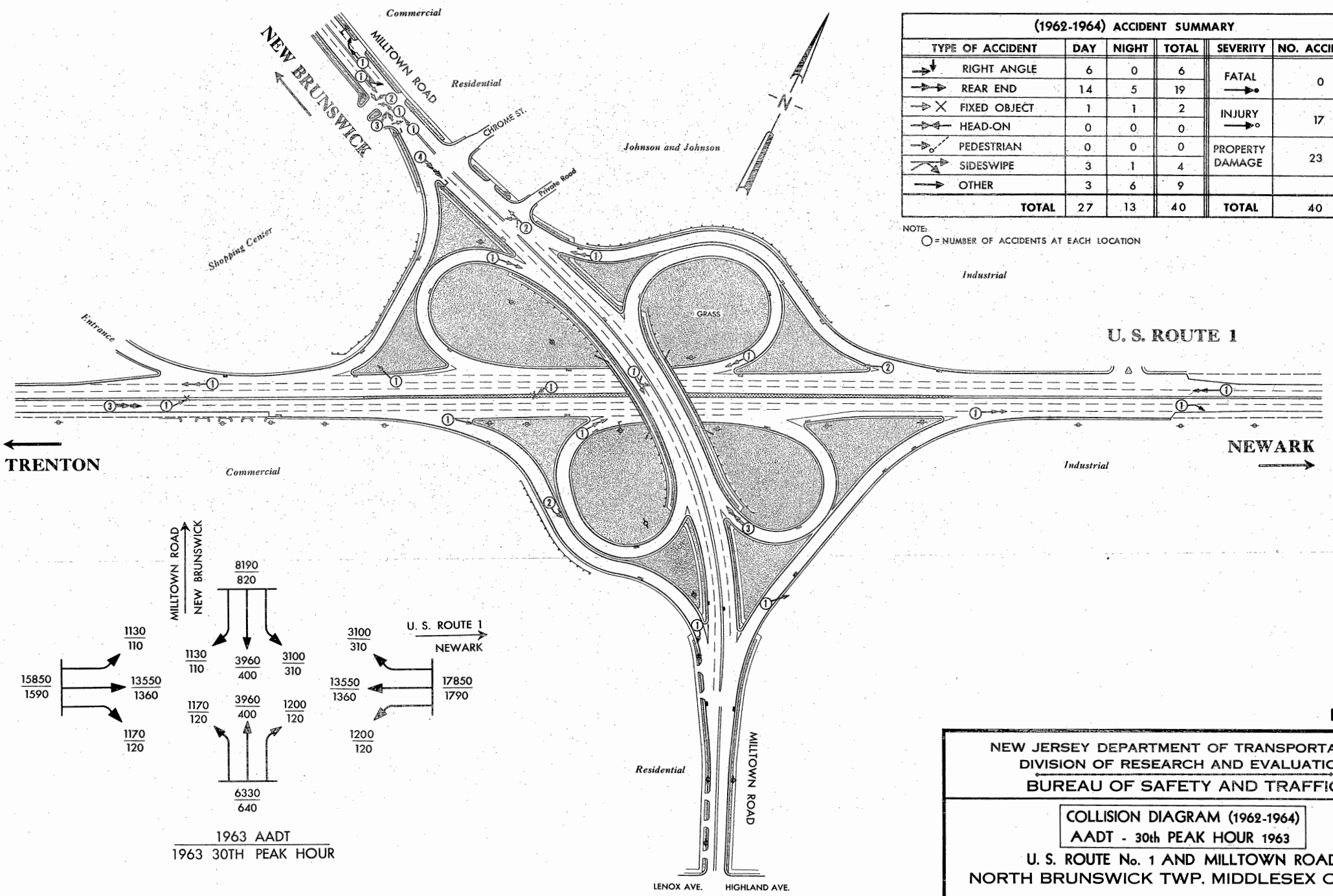


FIG 1c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
 AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 AND MILLTOWN ROAD
 NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

JANUARY, 1967

TABLE 1

TRAVEL TIMES

For

U. S. Route 1 and Milltown Road

Cloverleaf

Year of Construction: 1960

Speed Limits

Major - 50 Mph

Minor - 40 Mph

Independent Variables

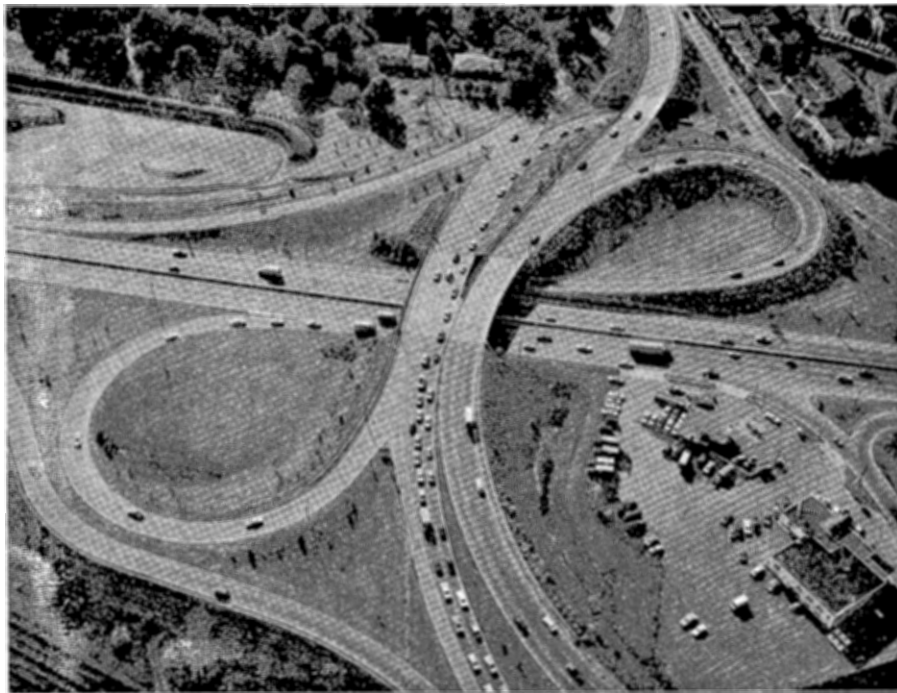
- X₁ = Approach Volume (By Lane)
- X₂ = % Trucks (By Lane)/100
- X₃ = % Left Turns (By Lane)/100
- X₄ = % Right Turns (By Lane)/100
- X₅ = Right Hand Lane Volume from Left App.
- X₆ = Right Hand Lane Volume from Opposed App.
- X₇ = Right Hand Lane Volume from Right App.

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. | | | | |
|-----------------------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|--|---|---|------------------------|----------------|---------------|---------------------|--------------------|------|-------|-----|---|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | | | | | |
| Major Leg 2 lanes Com. | 25 | 0 | 0 | 0 | 5 | 45 | 25 | Shp. Lt. Ctr. St. Und. Rt. | Y = 58.85 - 180.54 X ₄ + 1.23 X ₅ + .33 X ₇ Y = 39.66 + 8.43 X ₂ + 33.32 X ₃ + .32 X ₅ - .15 X ₆ Y = 29.81 + .19 X ₁ - 44.53 X ₂ + .28 X ₆ | 75.34 | 0.30 | 28.58 | 60 | 1 | | | | | |
| | to | to | to | to | to | to | to | | | | | | | | 35.49 | 0.32 | 5.06 | 117 | 1 |
| | 95 | .35 | .15 | .30 | 30 | 110 | 85 | | | | | | | | 55.88 | 0.23 | 17.26 | 77 | 1 |
| Minor Leg 1 lane Res. | 20 | 0 | .05 | 0 | 40 | 5 | 55 | Com. Lt. Shp. St. Ctr. Rt. Und. Rt. | Y = 49.38 + .11 X ₁ - 35.77 X ₂ + .27 X ₅ Y = 37.85 + 58.13 X ₂ - 18.76 X ₃ - 9.01 X ₄ Y = 48.17 - 61.16 X ₂ - 46.36 X ₃ + .73 X ₆ | 71.24 | 0.11 | 14.17 | 59 | 1 | | | | | |
| | to | to | to | to | to | to | to | | | | | | | | 35.44 | 0.26 | 5.40 | 60 | 1 |
| | 85 | .15 | .35 | .35 | 90 | 30 | 95 | | | | | | | | 46.38 | 0.20 | 16.70 | 55 | 1 |
| Major Leg 2 lanes Und. | 40 | 0 | 0 | 0 | 25 | 40 | 5 | Res. Lt. Com. St. Shp. Rt. Ctr. Rt. | Y = 50.28 + .56 X ₁ - 63.42 X ₂ - .26 X ₅ + .15 X ₆ Y = 10.66 + .17 X ₁ + .19 X ₆ Y = 60.27 - 36.26 X ₂ - 41.77 X ₃ - 27.74 X ₄ | 76.83 | 0.36 | 15.17 | 71 | 1 | | | | | |
| | to | to | to | to | to | to | to | | | | | | | | 34.69 | 0.41 | 6.28 | 117 | 1 |
| | 95 | .30 | .20 | .35 | 85 | 95 | 30 | | | | | | | | 44.97 | 0.14 | 16.46 | 78 | 1 |
| Minor Leg 2 lanes Shp. Ctr. | 5 | 0 | 0 | 0 | 55 | 25 | 40 | Und. Lt. Res. St. Com. Rt. | Y = 46.30 + .10 X ₅ + .18 X ₇ Y = 12.82 + 8.59 X ₃ + .23 X ₆ + .29 X ₇ Y = 4.68 - 57.11 X ₄ + .51 X ₅ + .27 X ₇ | 66.20 | .18 | 8.38 | 107 | 1 | | | | | |
| | to | to | to | to | to | to | to | | | | | | | | 48.33 | .27 | 12.03 | 117 | 1 |
| | 45 | .35 | .60 | .20 | 100 | 85 | 95 | | | | | | | | 56.78 | .10 | 36.67 | 51 | 1 |

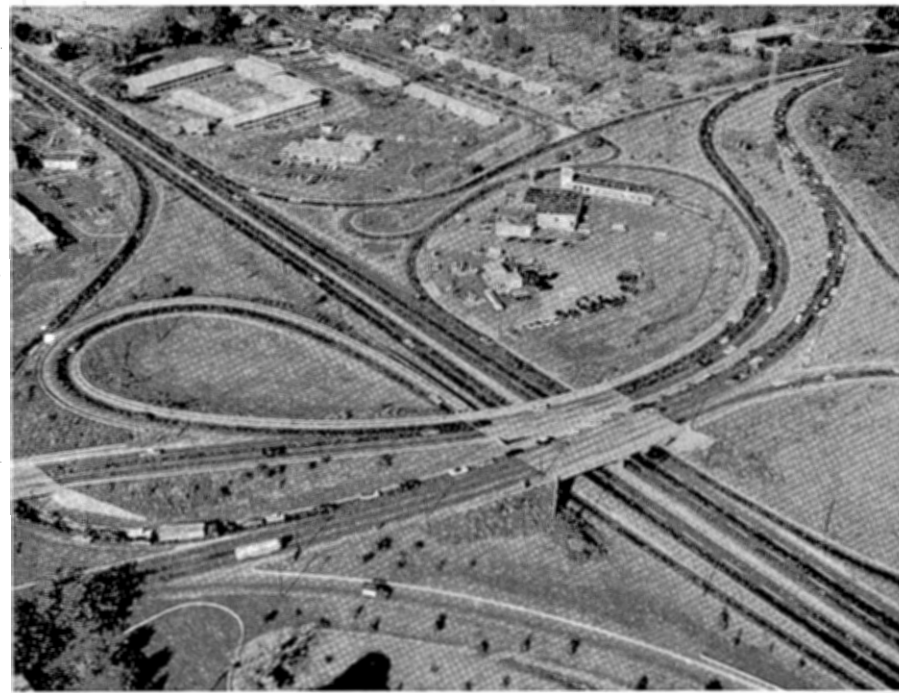
PHOTO 2

U.S. Route 1 and New Jersey Route 18

Cloverleaf



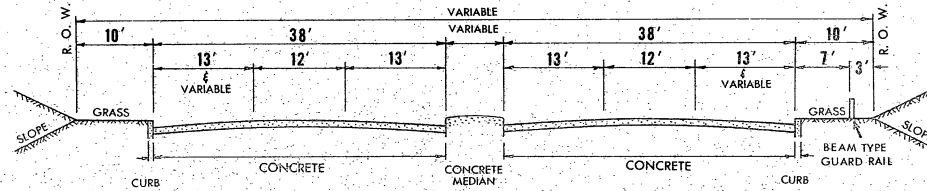
Photographed 6/1/67 - 1730 hours
600' Altitude, Looking West



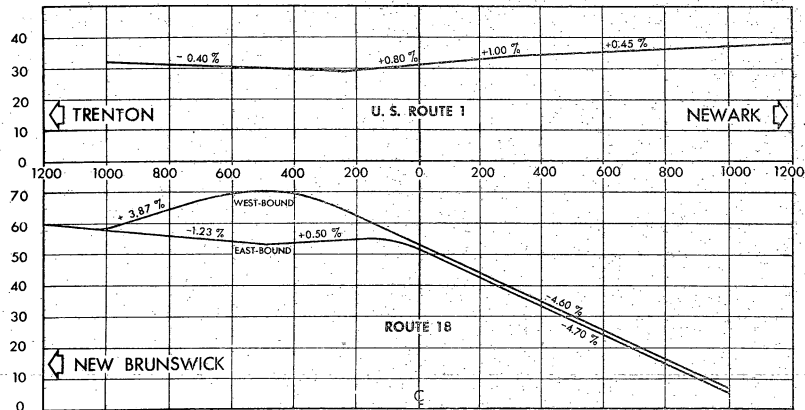
Photographed 6/1/67 - 1730 hours
800' Altitude, Looking Northeast

TYPICAL CROSS SECTION

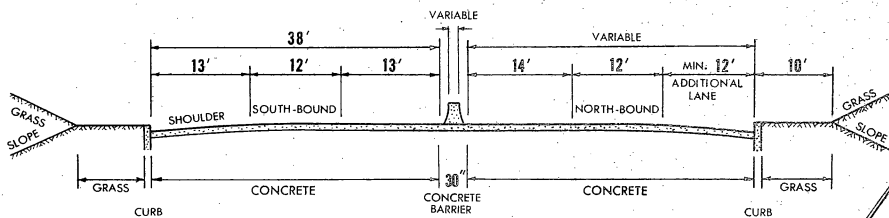
ROUTE 18



PROFILES



U. S. ROUTE 1
TYPICAL CROSS SECTION



SIGNALS
ROUTE 18 AND WEST SERVICE ROAD
90 SECOND CYCLE

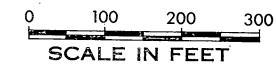
| | PED. GREEN | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|----------------|------------|-------|-------|---------|-------|-----------|
| RTE. 18 | — | 53-65 | 5 | 0 | 20-32 | 20-32 |
| W. SERVICE RD. | 27 | 15-27 | 3 | 2 | 58-70 | 60-72 |

FLASHING SIGNALS
 ① ③ FLASHING RED
 ② " AMBER

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
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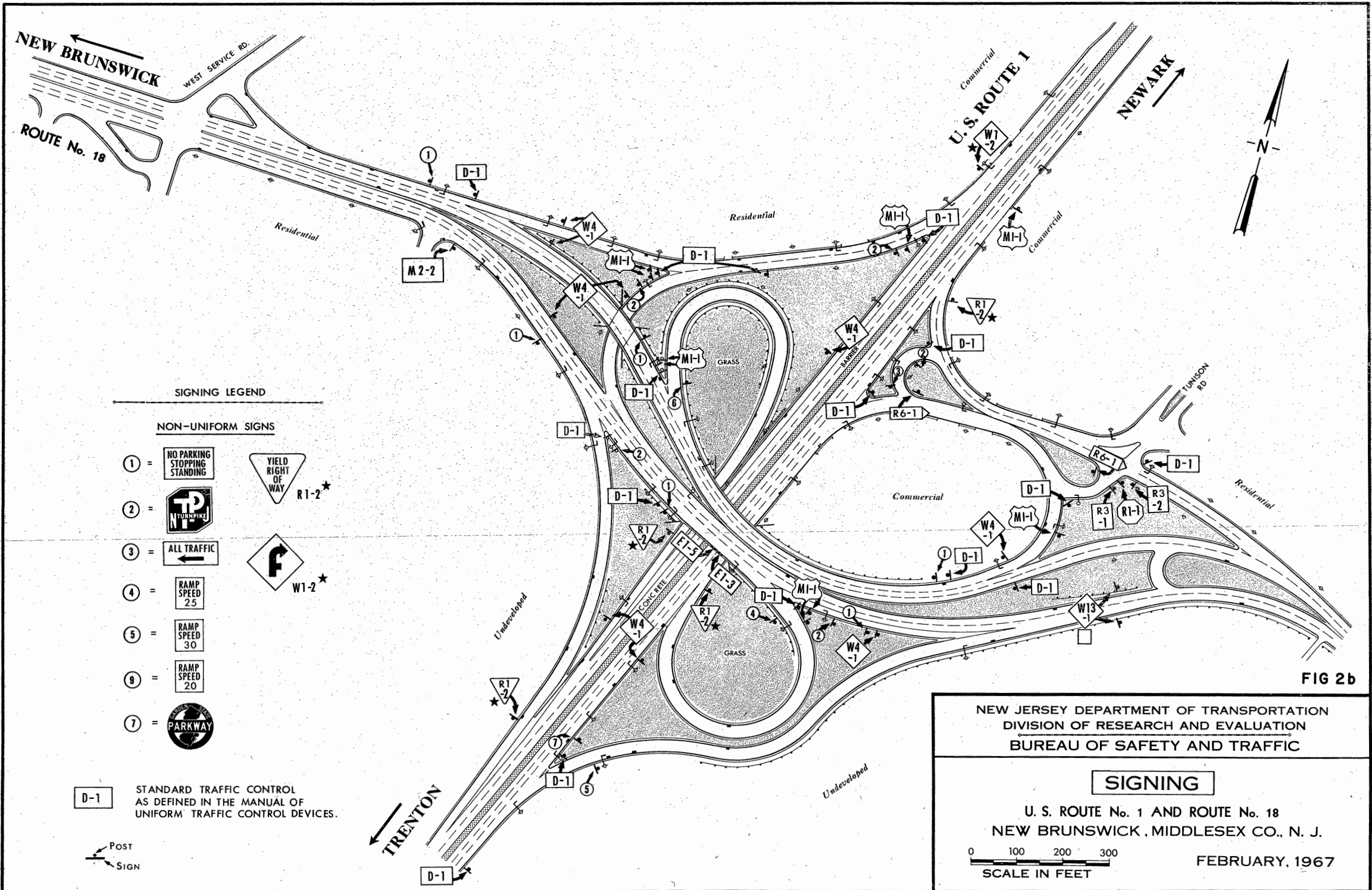
PHYSICAL FEATURES

U. S. ROUTE No. 1 AND ROUTE No. 18
 NEW BRUNSWICK, MIDDLESEX CO., N. J.



FEBRUARY, 1967

FIG 2a



SIGNING LEGEND

NON-UNIFORM SIGNS

- ① = NO PARKING STOPPING STANDING
 - ② = TURNPIKE
 - ③ = ALL TRAFFIC
 - ④ = RAMP SPEED 25
 - ⑤ = RAMP SPEED 30
 - ⑨ = RAMP SPEED 20
 - ⑦ = PARKWAY
- YIELD RIGHT OF WAY R1-2*
 - F W1-2*

D-1 STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.

Post
SIGN

FIG 2b

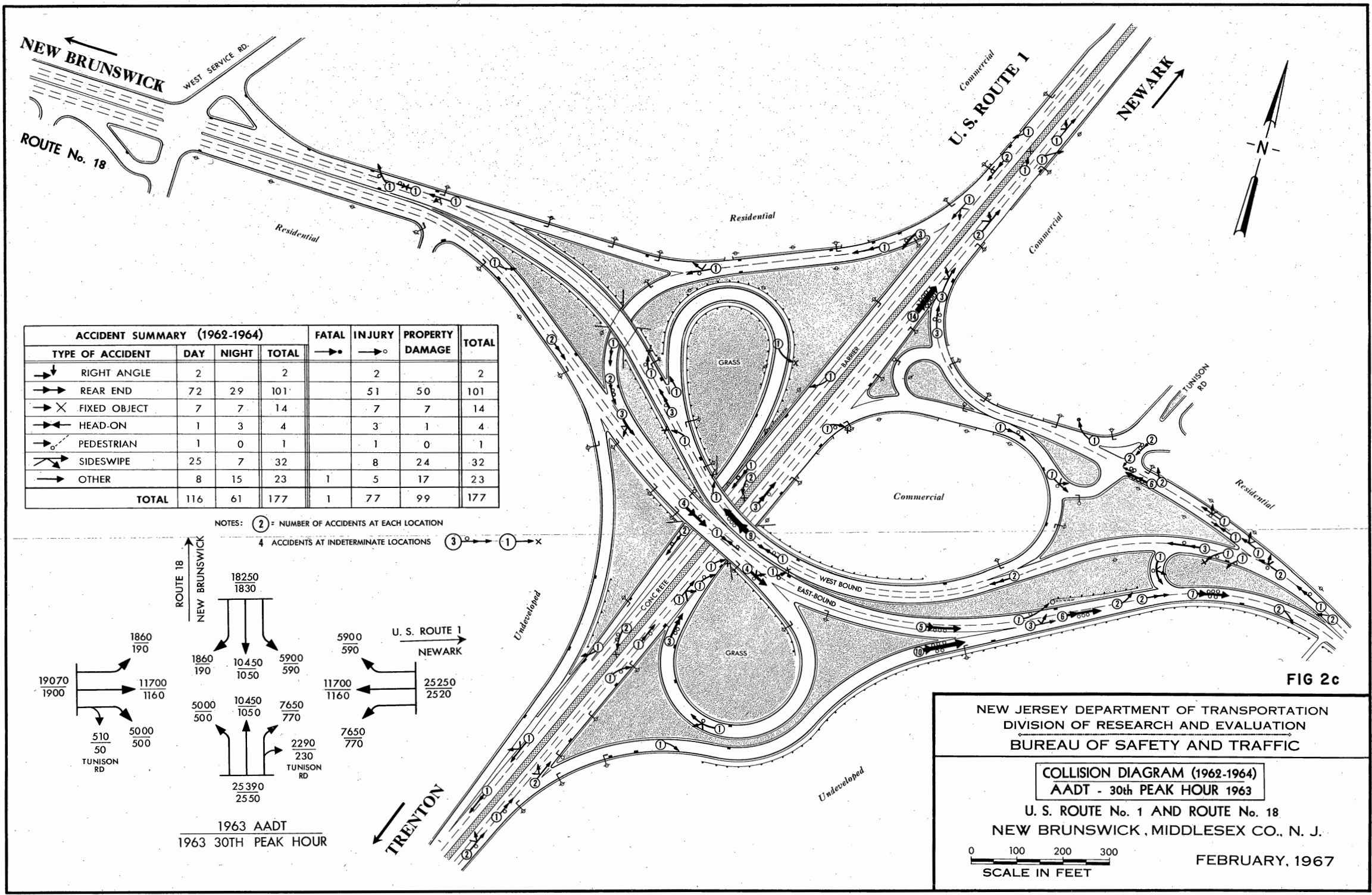
NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 AND ROUTE No. 18
 NEW BRUNSWICK, MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

FEBRUARY, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE | TOTAL |
|------------------------------|------------|-----------|------------|----------|-----------|-----------------|------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | → | → | | |
| ↘↗ RIGHT ANGLE | 2 | | 2 | | 2 | | 2 |
| ↘↘ REAR END | 72 | 29 | 101 | | 51 | 50 | 101 |
| ↘ X FIXED OBJECT | 7 | 7 | 14 | | 7 | 7 | 14 |
| ↔ HEAD-ON | 1 | 3 | 4 | | 3 | 1 | 4 |
| ↘ PEDESTRIAN | 1 | 0 | 1 | | 1 | 0 | 1 |
| ↘↗ SIDESWIPE | 25 | 7 | 32 | | 8 | 24 | 32 |
| ↘ OTHER | 8 | 15 | 23 | 1 | 5 | 17 | 23 |
| TOTAL | 116 | 61 | 177 | 1 | 77 | 99 | 177 |

NOTES: (2) = NUMBER OF ACCIDENTS AT EACH LOCATION
 4 ACCIDENTS AT INDETERMINATE LOCATIONS (3) → (1) → X

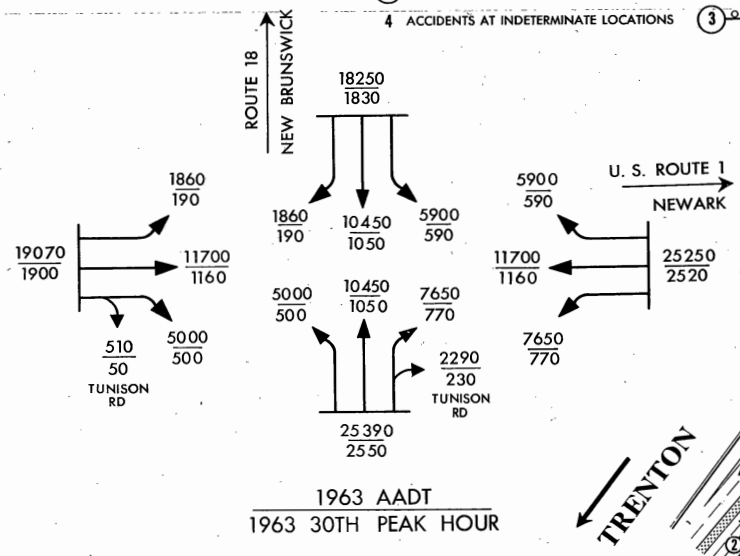


FIG 2c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 AND ROUTE No. 18
 NEW BRUNSWICK, MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

FEBRUARY, 1967

PHOTO 3

New Jersey Routes 4 & 17

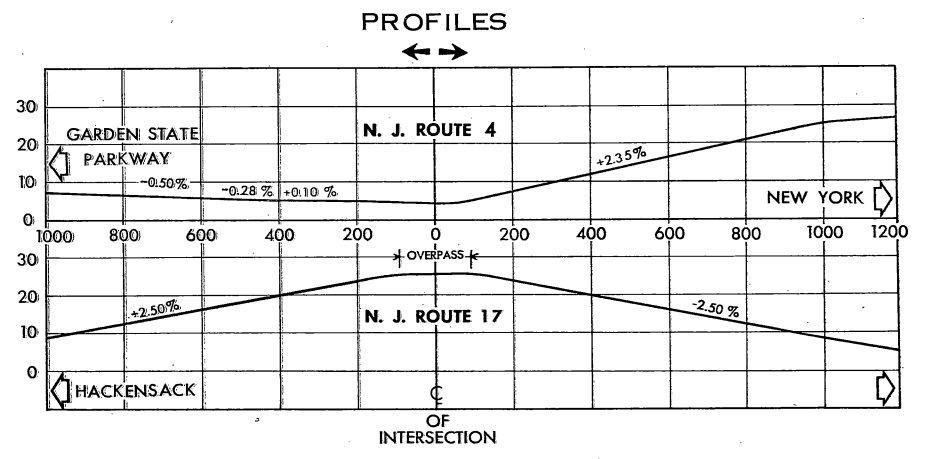
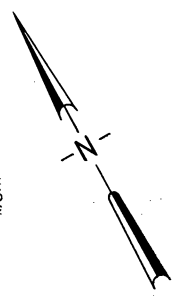
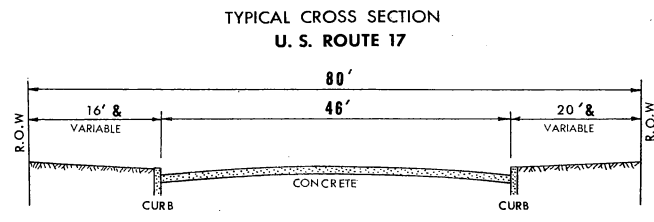
Cloverleaf



Photographed 6/1/67 - 1635 hours
600' Altitude, Looking Northwest



Photographed 6/1/67 - 1635 hours
800' Altitude, Looking West



GARDEN STATE PARKWAY ROUTE 4

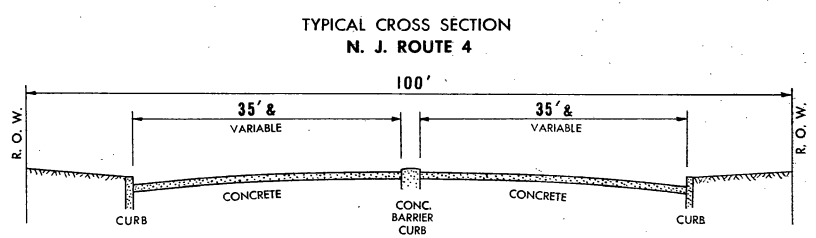
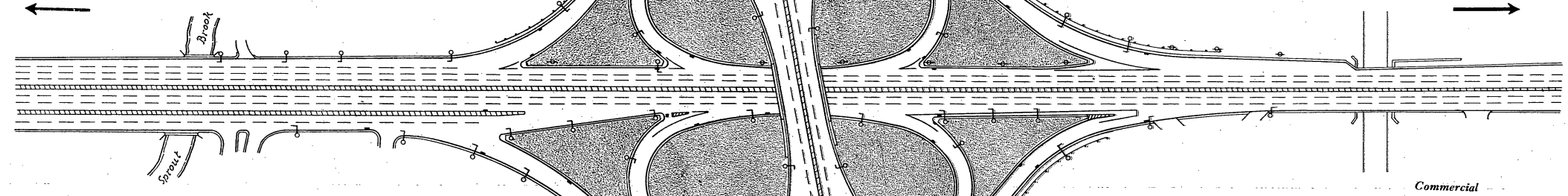


FIG. 3a

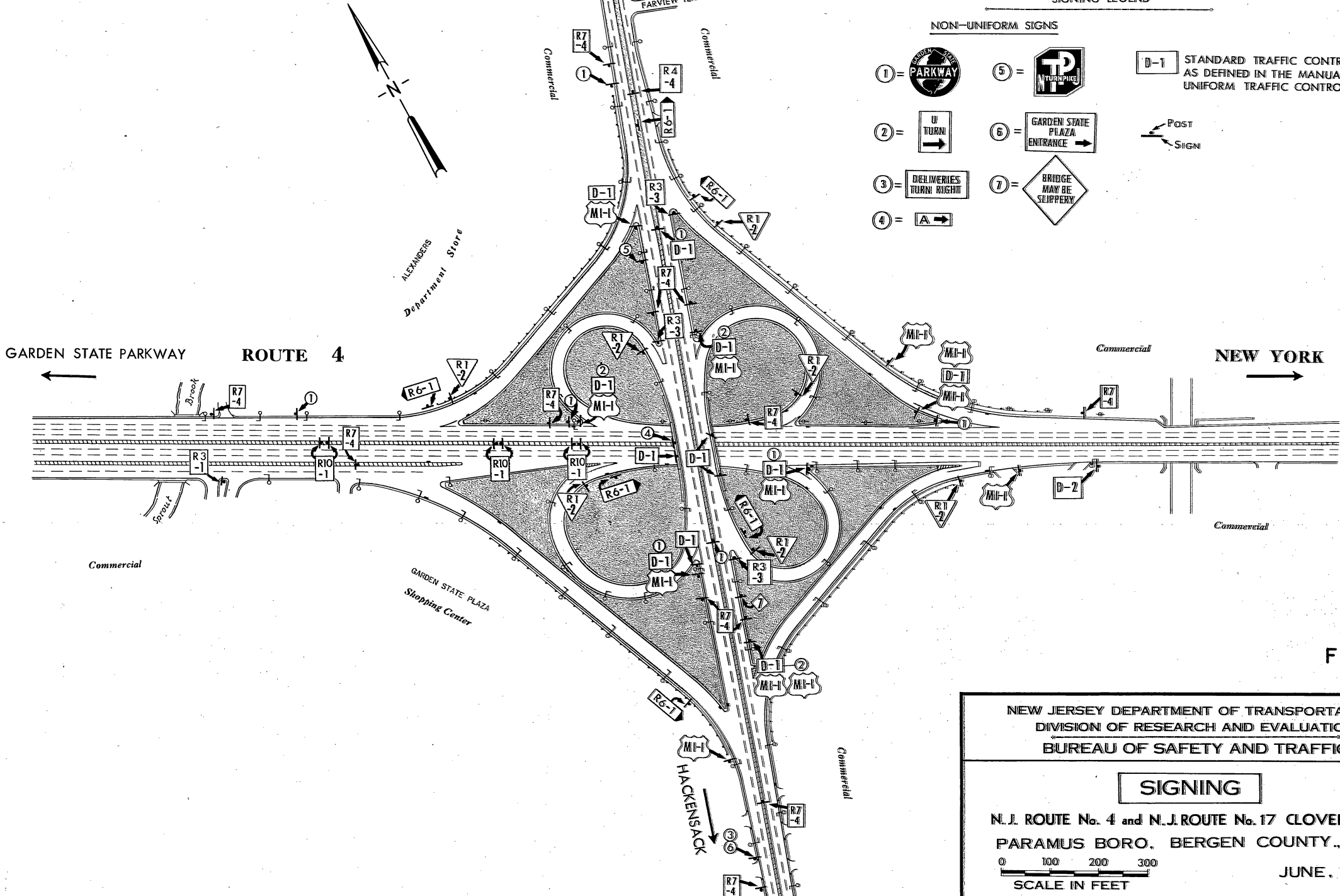
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

N. J. ROUTE No. 4 and N. J. ROUTE No. 17 CLOVERLEAF
PARAMUS BORO., BERGEN COUNTY., N. J.

0 100 200 300
SCALE IN FEET

JUNE, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS

- 1 =
- 2 =
- 3 =
- 4 =
- 5 =
- 6 =
- 7 =
- D-1 = STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.

POST SIGN

FIG. 3b

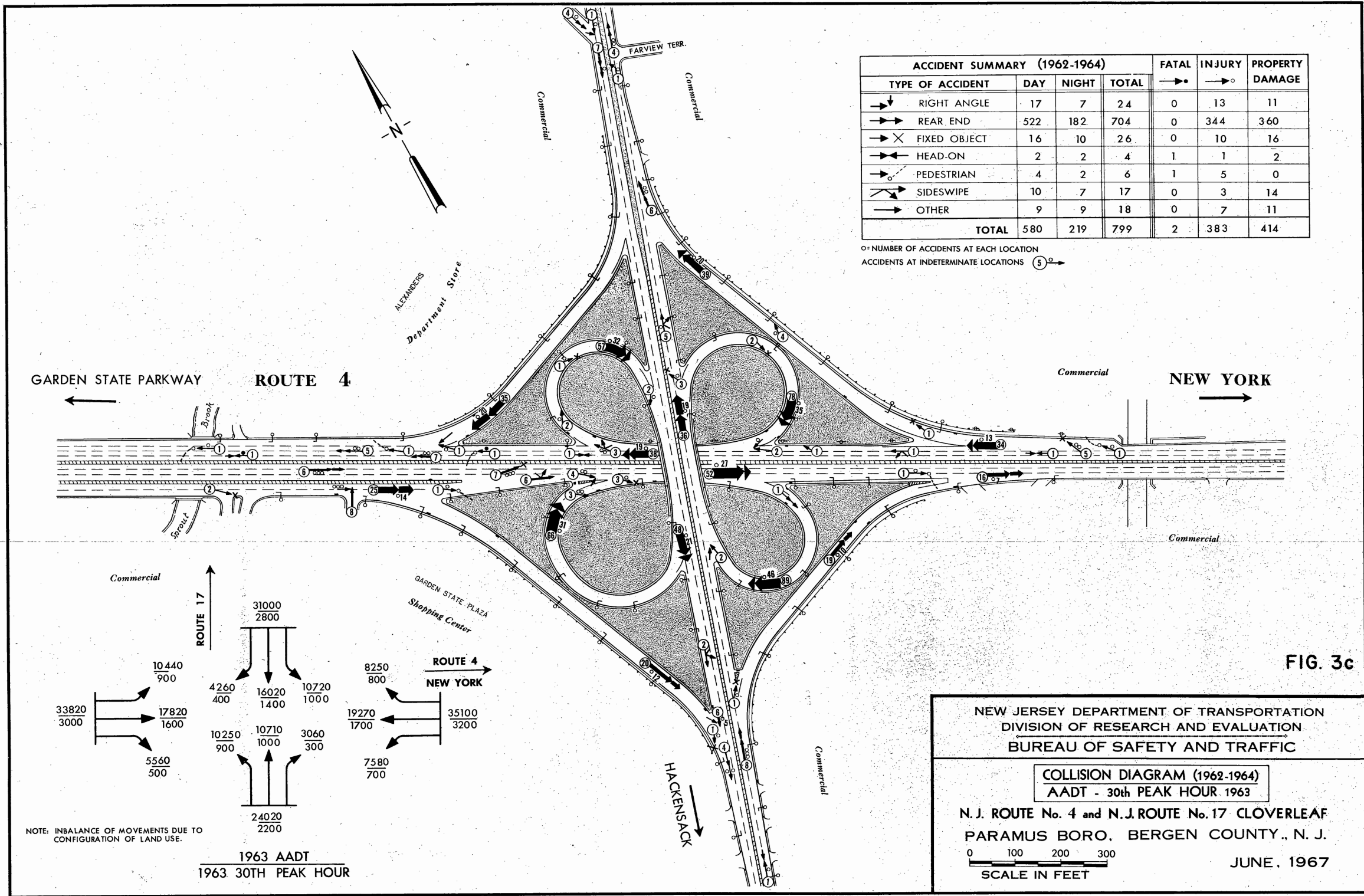
NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

SIGNING

N. J. ROUTE No. 4 and N. J. ROUTE No. 17 CLOVERLEAF
 PARAMUS BORO, BERGEN COUNTY, N. J.

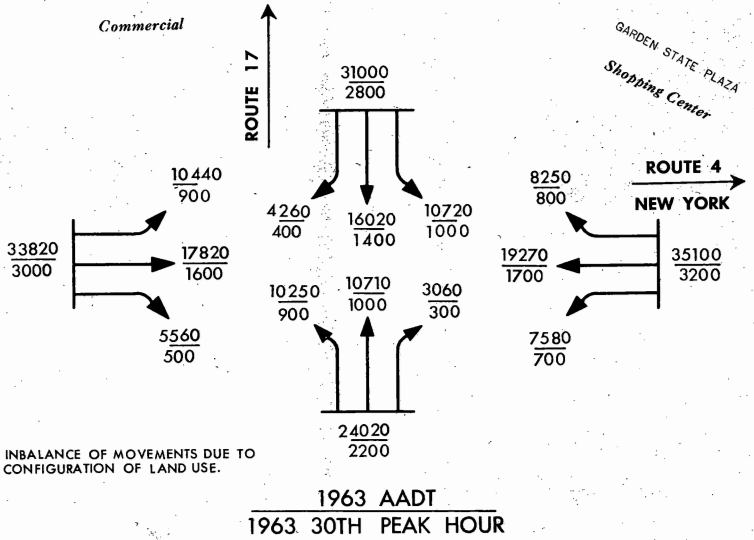
0 100 200 300
 SCALE IN FEET

JUNE, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|------------|------------|------------|----------|------------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| ↘→ | 17 | 7 | 24 | 0 | 13 | 11 |
| →→ | 522 | 182 | 704 | 0 | 344 | 360 |
| →X | 16 | 10 | 26 | 0 | 10 | 16 |
| ↔↔ | 2 | 2 | 4 | 1 | 1 | 2 |
| →○ | 4 | 2 | 6 | 1 | 5 | 0 |
| ↔↔ | 10 | 7 | 17 | 0 | 3 | 14 |
| → | 9 | 9 | 18 | 0 | 7 | 11 |
| TOTAL | 580 | 219 | 799 | 2 | 383 | 414 |

○ = NUMBER OF ACCIDENTS AT EACH LOCATION
 ○ = ACCIDENTS AT INDETERMINATE LOCATIONS



NOTE: INBALANCE OF MOVEMENTS DUE TO CONFIGURATION OF LAND USE.

FIG. 3c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
 AADT - 30th PEAK HOUR 1963

N. J. ROUTE No. 4 and N. J. ROUTE No. 17 CLOVERLEAF
 PARAMUS BORO. BERGEN COUNTY, N. J.

0 100 200 300
 SCALE IN FEET

JUNE, 1967

Independent Variables

- X_1 = Approach Volume (By Lane)
 X_2 = % Trucks (By Lane)/100
 X_3 = % Left Turns (By Lane)/100
 X_4 = % Right Turns (By Lane)/100
 X_5 = Right Hand Lane Volume from Left App.
 X_6 = Right Hand Lane Volume from Opposed App.
 X_7 = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For

New Jersey Routes 4 and 17

Cloverleaf

Year of Construction: 1933

Speed Limits

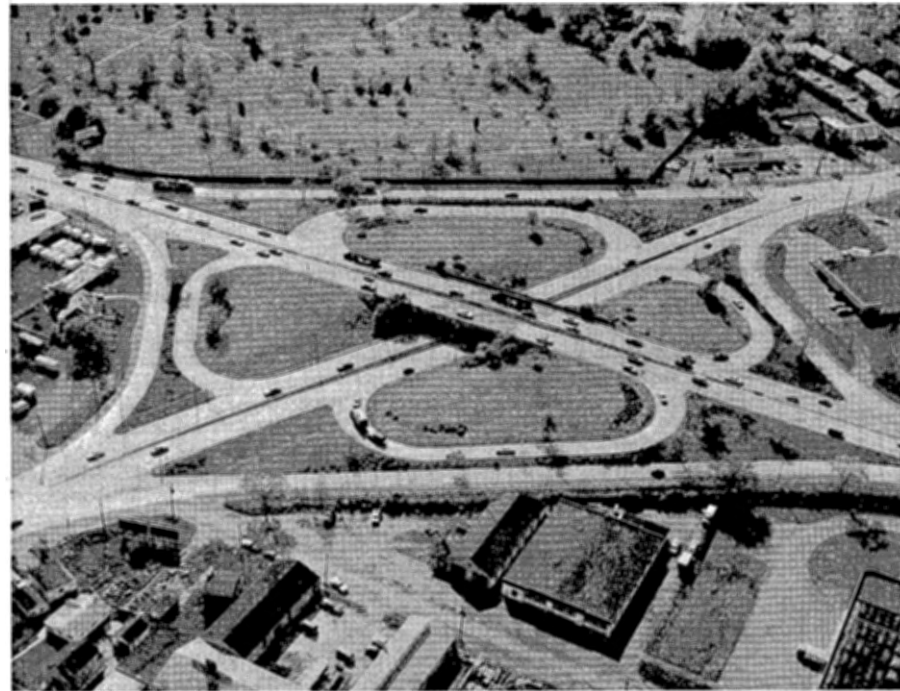
Both Major Legs - 50 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|--|--|----------------|----------------|----------------|----------------|----------------|----------------|--|-------------------|---|------------------------|----------------|---------------|---------------------|--------------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | |
| Major Leg 2 lanes Shp. Ctr. | 40 | 0 | 0 | 0 | 20 | 75 | 40 | Shp. Ctr. Shp. Ctr. Com. | Lt. St. Rt. | $Y = 37.69 - 0.91 X_5 + 1.16 X_7$ | 83.40 | 0.52 | 18.35 | 75 | 1 |
| | to | to | to | to | to | to | to | | | $Y = 21.96 + 0.48 X_1 - 0.91 X_5 + 1.03 X_7$ | 50.68 | 0.76 | 14.72 | 80 | 1 |
| | 110 | .25 | .35 | .30 | 45 | 135 | 85 | | | $Y = 52.59 + 0.65 X_1 + 0.89 X_7$ | 58.43 | 0.71 | 14.36 | 39 | 1 |
| Major Leg 3 lanes Com. | 40 | 0 | 0 | 0 | 60 | 15 | 75 | Shp. Ctr. Shp. Ctr. Shp. Ctr. | Lt. St. Rt. | $Y = 49.58 + 31.82 X_3 + 0.33 X_5 - 0.59 X_6$ | 64.42 | 0.30 | 12.08 | 83 | 1 |
| | to | to | to | to | to | to | to | | | $Y = 19.27 + 40.67 X_2 + 7.76 X_4 + 0.13 X_5$ | 34.55 | 0.25 | 7.18 | 118 | 1 |
| | 90 | .15 | .25 | .80 | 110 | 45 | 135 | | | $Y = 32.65 - 71.54 X_2 + 0.15 X_5$ | 40.98 | 0.16 | 9.66 | 76 | 1 |
| Major Leg 2 lanes Shp. Ctr. | 30 | 0 | .10 | 0 | 45 | 65 | 20 | Com. Shp. Ctr. Shp. Ctr. | Lt. St. Rt. | $Y = 47.53 + 11.78 X_3 + 0.18 X_5 + 0.19 X_6$ | 79.73 | 0.16 | 11.73 | 70 | 1 |
| | to | to | to | to | to | to | to | | | $Y = 16.74 - 52.12 X_2 + 16.13 X_3$ | 40.28 | 0.26 | 9.93 | 77 | 1 |
| | 140 | .20 | .60 | .40 | 90 | 113 | 40 | | | $Y = 21.13 - 0.09 X_1 + 23.35 X_4 + 0.38 X_5$ | 43.45 | 0.36 | 9.13 | 51 | 1 |
| Major Leg 5 lanes (Separated) Shp. Ctr. | 15 | 0 | 0 | 0 | 75 | 40 | 60 | Shp. Ctr. Com. Shp. Ctr. | Lt. St. Rt. | $Y = 47.78 + 23.00 X_4 + 0.26 X_7$ | 73.19 | 0.22 | 13.97 | 113 | 1 |
| | to | to | to | to | to | to | to | | | $Y = 26.97 + 10.45 X_3 + 17.07 X_4 + 0.09 X_7$ | 39.09 | 0.25 | 8.26 | 157 | 1 |
| | 85 | .15 | .65 | .55 | 135 | 85 | 110 | | | $Y = 40.87 - 0.12 X_1 + 21.27 X_2 - 12.50 X_3$ | 32.47 | 0.15 | 4.71 | 40 | 1 |
| | 20- | 0- | 0- | .30- | 75- | 40- | 60- | | | | | | | | |
| | 40 | .15 | .15 | .90 | 135 | 85 | 110 | | | $- 0.05 X_5$ | | | | | |

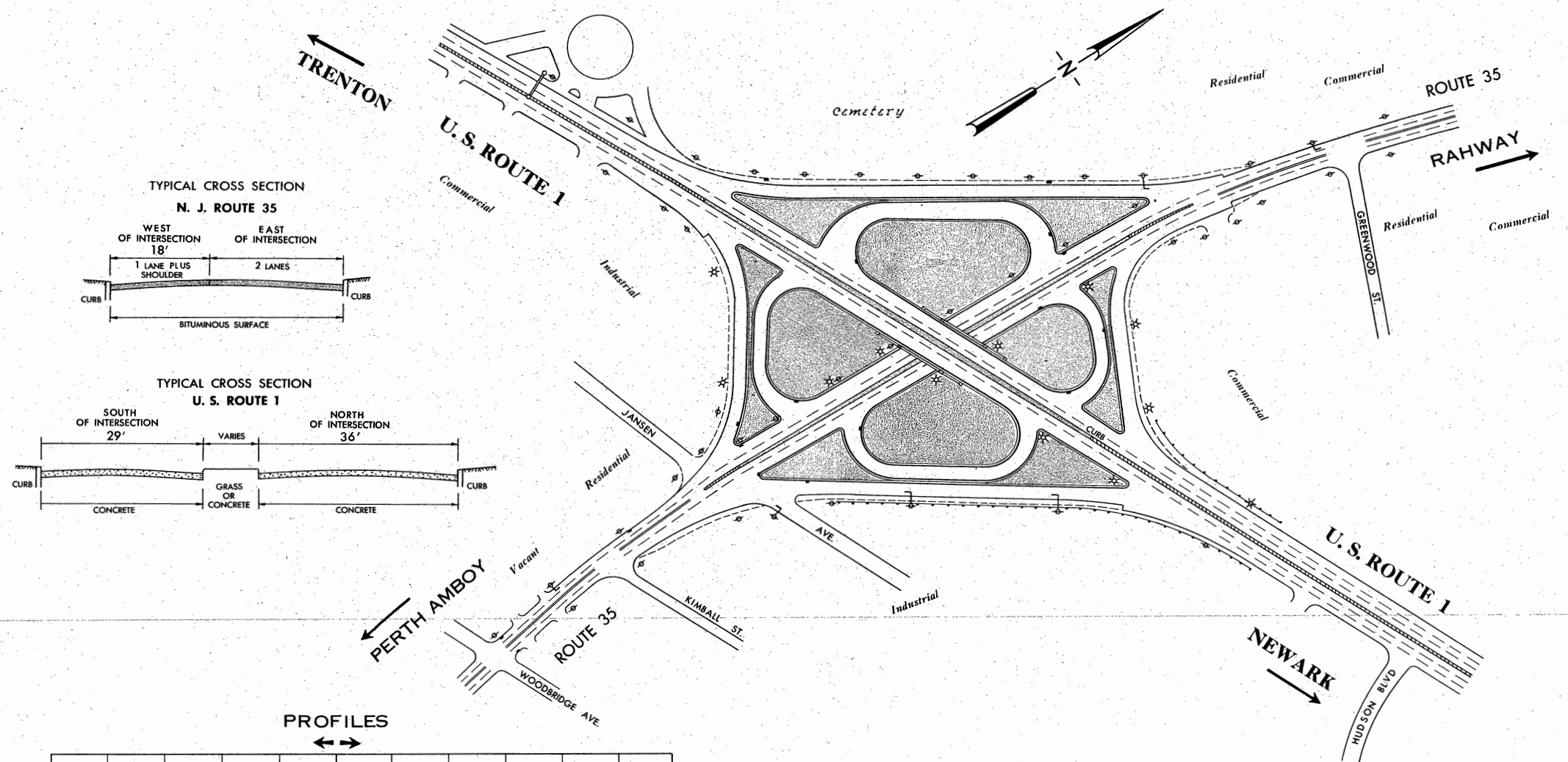
PHOTO 4

U.S. Routes 1 & 9 and New Jersey Route 35

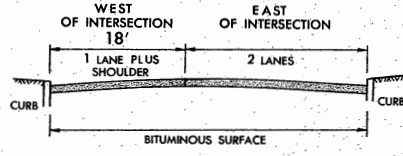
Cloverleaf



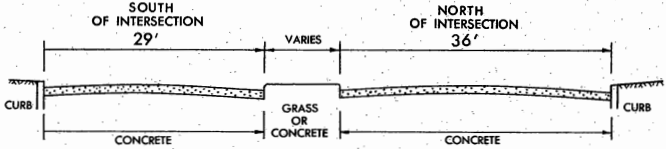
Photographed 5/18/67 - 1655 hours
600' Altitude, Looking West



TYPICAL CROSS SECTION
N. J. ROUTE 35



TYPICAL CROSS SECTION
U. S. ROUTE 1



PROFILES

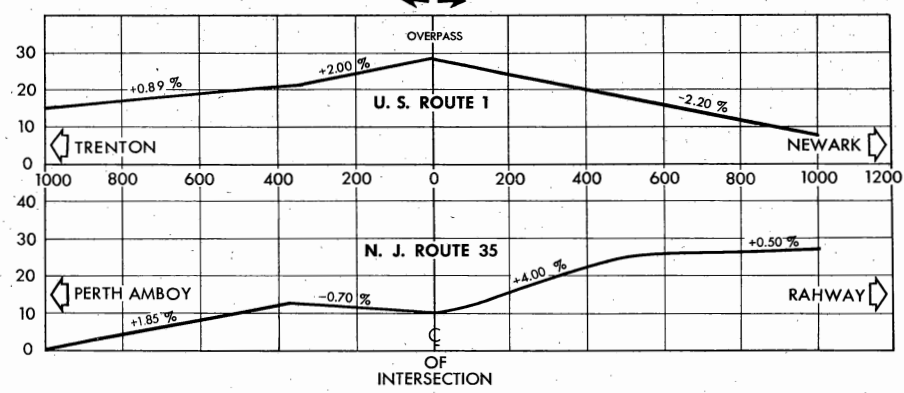


FIG 4a

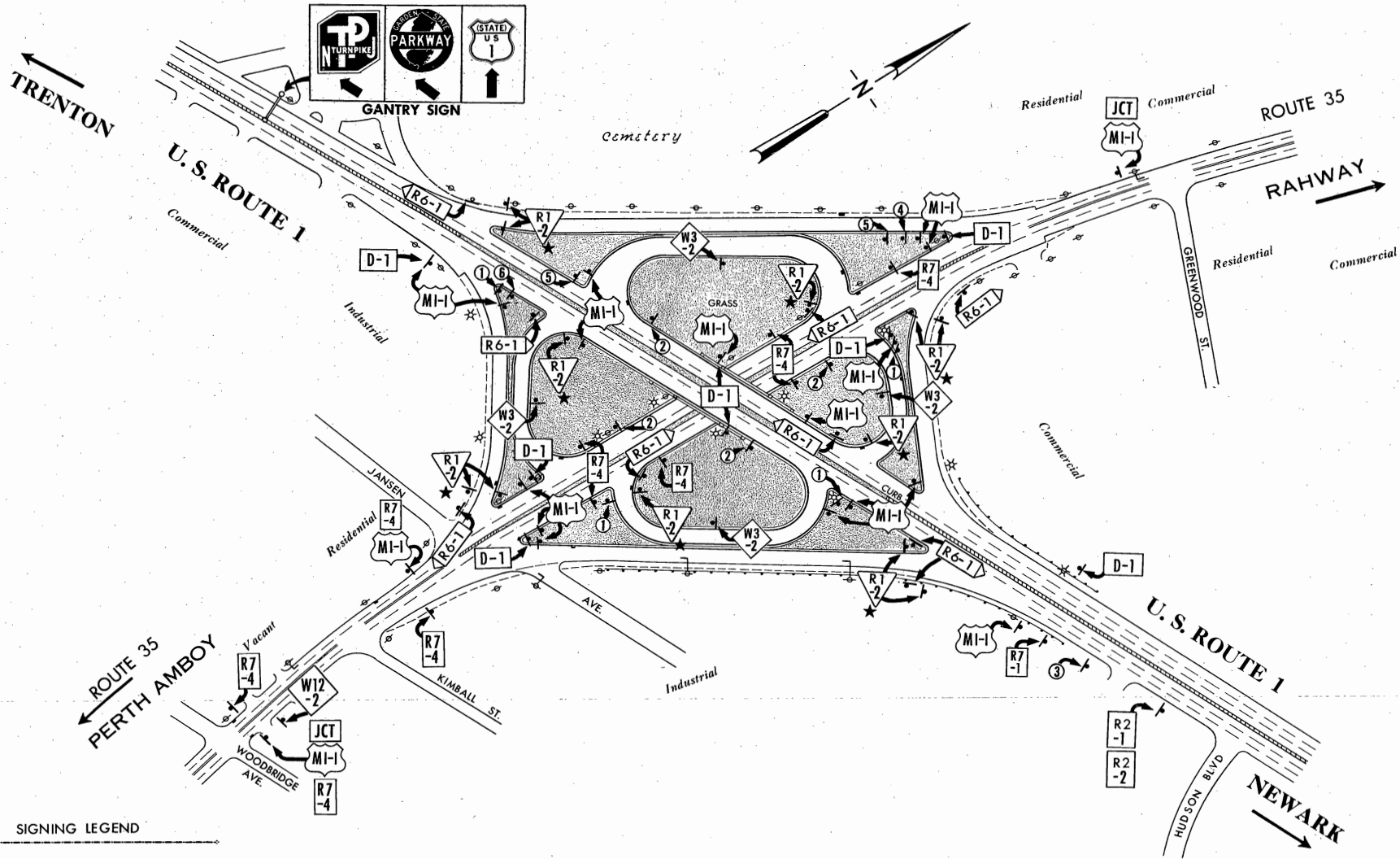
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE No. 1 and N. J. ROUTE No. 35 CLOVERLEAF
WOODBRIDGE, MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

MARCH, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS

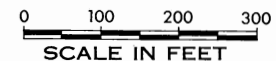
- ① = FOR U TURN FOLLOW BLUE SIGN
 - ② = RAMP SPEED 15
 - ③ = SPEEDERS LOSE LICENSES
 - ④ = TURNPIKE
 - ⑤ = PARKWAY
 - ⑥ = BRIDGE MAY BE SLIPPERY
- D-1 = STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.
- POST SIGN
- YIELD RIGHT OF WAY

FIG 4b

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 and N.J. ROUTE No. 35 CLOVERLEAF
 WOODBRIDGE, MIDDLESEX CO., N. J.



MARCH, 1967

| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|-----------|-----------|-----------|----------|-----------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| ↘↔ | 0 | 3 | 3 | 0 | 2 | 1 |
| ↘→ | 40 | 19 | 59 | 1 | 28 | 30 |
| ↘X | 0 | 2 | 2 | 0 | 2 | 0 |
| ↔↔ | 0 | 1 | 1 | 0 | 1 | 0 |
| ↘○ | 0 | 0 | 0 | 0 | 0 | 0 |
| ↘↔ | 12 | 6 | 18 | 0 | 10 | 8 |
| → | 4 | 8 | 12 | 0 | 8 | 4 |
| TOTAL | 56 | 39 | 95 | 1 | 51 | 43 |

○ NUMBER OF ACCIDENTS AT EACH LOCATION
 ○ ACCIDENTS AT INDETERMINATE LOCATIONS

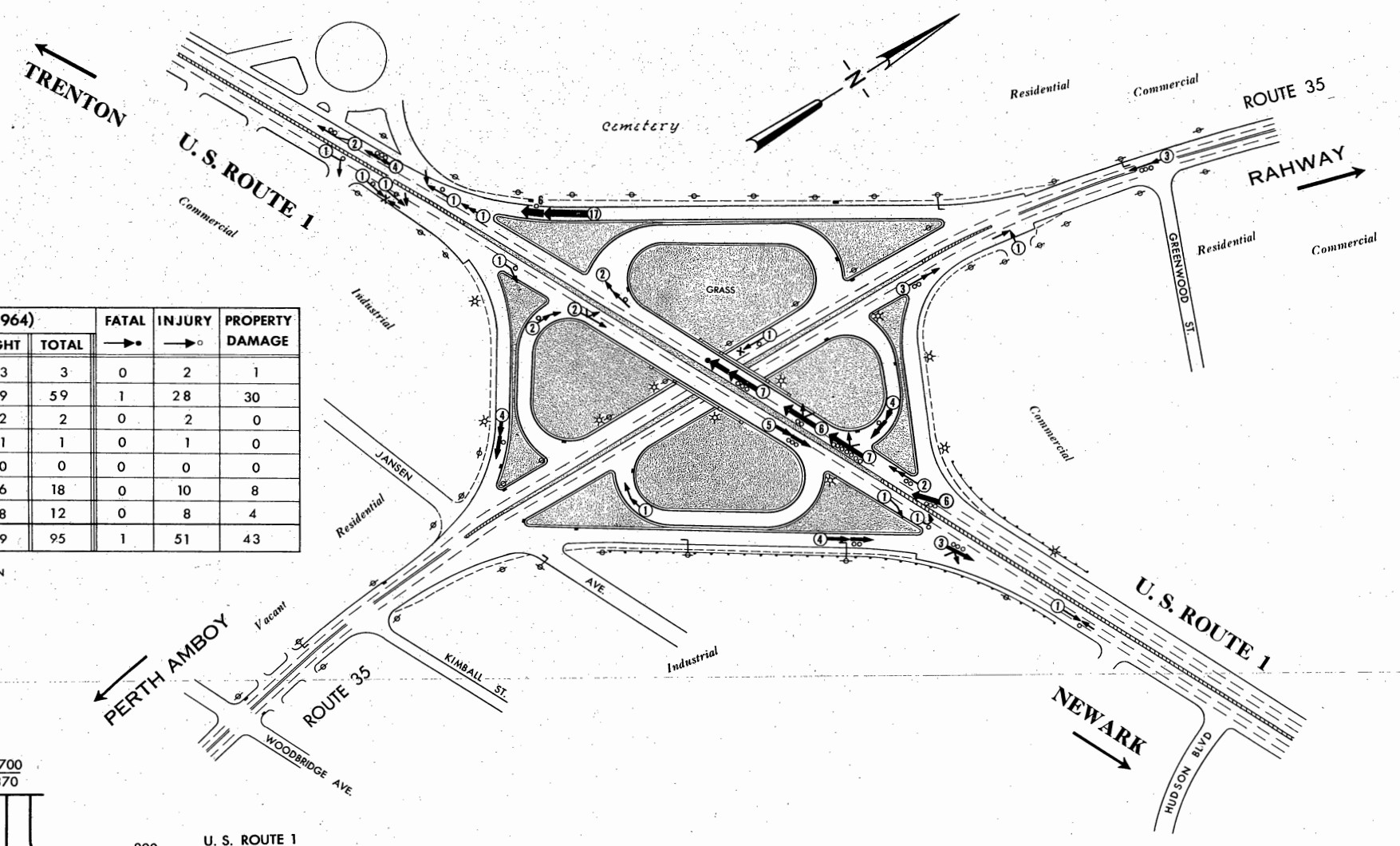
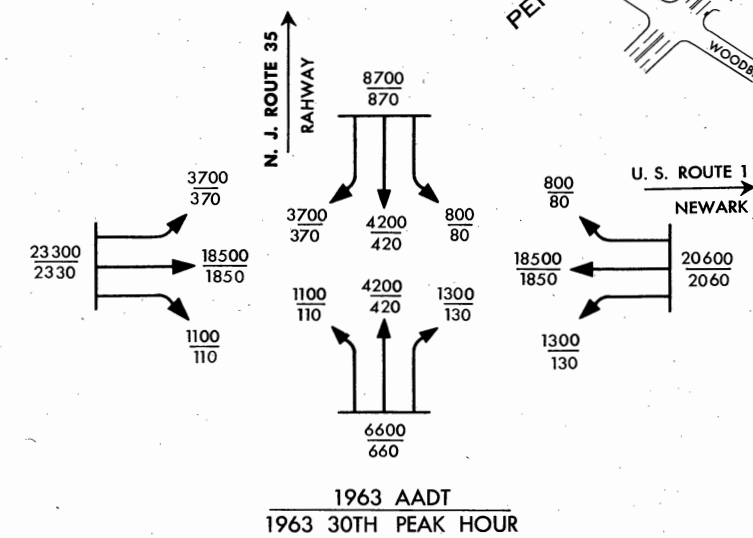


FIG 4c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
 AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 and N. J. ROUTE No. 35 CLOVERLEAF
 WOODBRIDGE, MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

MARCH, 1967

TABLE 4

Independent Variables

- X₁ = Approach Volume (By Lane)
- X₂ = % Trucks (By Lane)/100
- X₃ = % Left Turns (By Lane)/100
- X₄ = % Right Turns (By Lane)/100
- X₅ = Right Hand Lane Volume from Left App.
- X₆ = Right Hand Lane Volume from Opposed App.
- X₇ = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For

U. S. Routes 1 & 9 and New Jersey Route 35

Cloverleaf

Year of Construction: 1938

Speed Limits

Major Leg - 50 Mph

Minor Leg - 40 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|-------------------------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------------------|-------------------|--|------------------------|----------------|---------------|---------------------|--------------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | |
| Major Leg 2 lanes Com. | 45 | 0 | 0 | 0 | 45 | 10 | 15 | Com. Res. Com. Ind. Res. | Lt. St. Rt. | Y = 61.12 + 17.27 X ₂ + 11.79 X ₃ | 65.58 | 0.09 | 8.30 | 114 | 1 |
| | to 110 | to .30 | to .35 | to .25 | to 90 | to 35 | to 40 | | | Y = 26.53 + .08 X ₁ + 7.75 X ₃ | 33.83 | 0.15 | 5.15 | 120 | 1 |
| | | | | | | | | | | Y = 30.94 + 6.57 X ₃ + 0.31 X ₆ | 39.47 | 0.06 | 9.05 | 83 | 1 |
| Minor Leg 2 lanes Ind. & res. | 15 | 0 | 0 | 0 | 70 | 45 | 10 | Com. Res. Com. | Lt. St. Rt. | Y = 82.72 + 31.75 X ₂ + 26.17 X ₃ - 0.22 X ₆ + 0.79 X ₇ | 70.93 | 0.16 | 16.71 | 102 | 1 |
| | to 40 | to .20 | to .30 | to .40 | to 100 | to 90 | to 35 | | | Y = 29.25 + 11.08 X ₃ + 19.74 X ₄ + 0.15 X ₇ | 37.79 | 0.21 | 6.22 | 120 | 1 |
| | | | | | | | | | | Y = 29.69 - 26.69 X ₂ + 13.20 X ₄ + 0.51 X ₇ | 42.84 | 0.07 | 14.07 | 91 | 1 |
| Major Leg 3 lanes Com. | 05 | 0 | 0 | 0 | 15 | 70 | 40 | Ind. Res. Com. Res. Com. | Lt. St. Rt. | Y = 71.40 + 28.60 X ₃ .28 X ₅ - .18 X ₆ + .12 X ₇ | 74.43 | 0.08 | 13.16 | 106 | 1 |
| | to 80 | to .60 | to .25 | to .15 | to 40 | to 100 | to 90 | | | Y = 41.13 - .25 X ₁ + 14.70 X ₂ | 33.01 | 0.37 | 10.94 | 180 | 1 |
| | | | | | | | | | | Y = 30.12 + .29 X ₁ + 38.73 X ₃ | 46.53 | 0.20 | 14.51 | 73 | 1 |
| Minor Leg 2 lanes Com. & res. | 45 | 0 | 0 | .30 | 10 | 15 | 70 | Com. Res. Ind. Com. | Lt. St. Rt. | Y = 84.86 + .43 X ₁ - 99.90 X ₄ + 1.20 X ₅ - .72 X ₆ | 78.96 | 0.29 | 22.67 | 50 | 1 |
| | to 90 | to .20 | to .10 | to .55 | to 35 | to 40 | to 100 | | | Y = 44.23 + .08 X ₁ + .25 X ₅ - .16 X ₇ | 41.67 | 0.24 | 4.61 | 60 | 1 |
| | | | | | | | | | | Y = 31.45 - 28.48 X ₃ + .56 X ₅ | 42.92 | 0.24 | 6.83 | 60 | 1 |

PHOTO 5

U.S. Routes 1 & 9 and Green Street
Circle

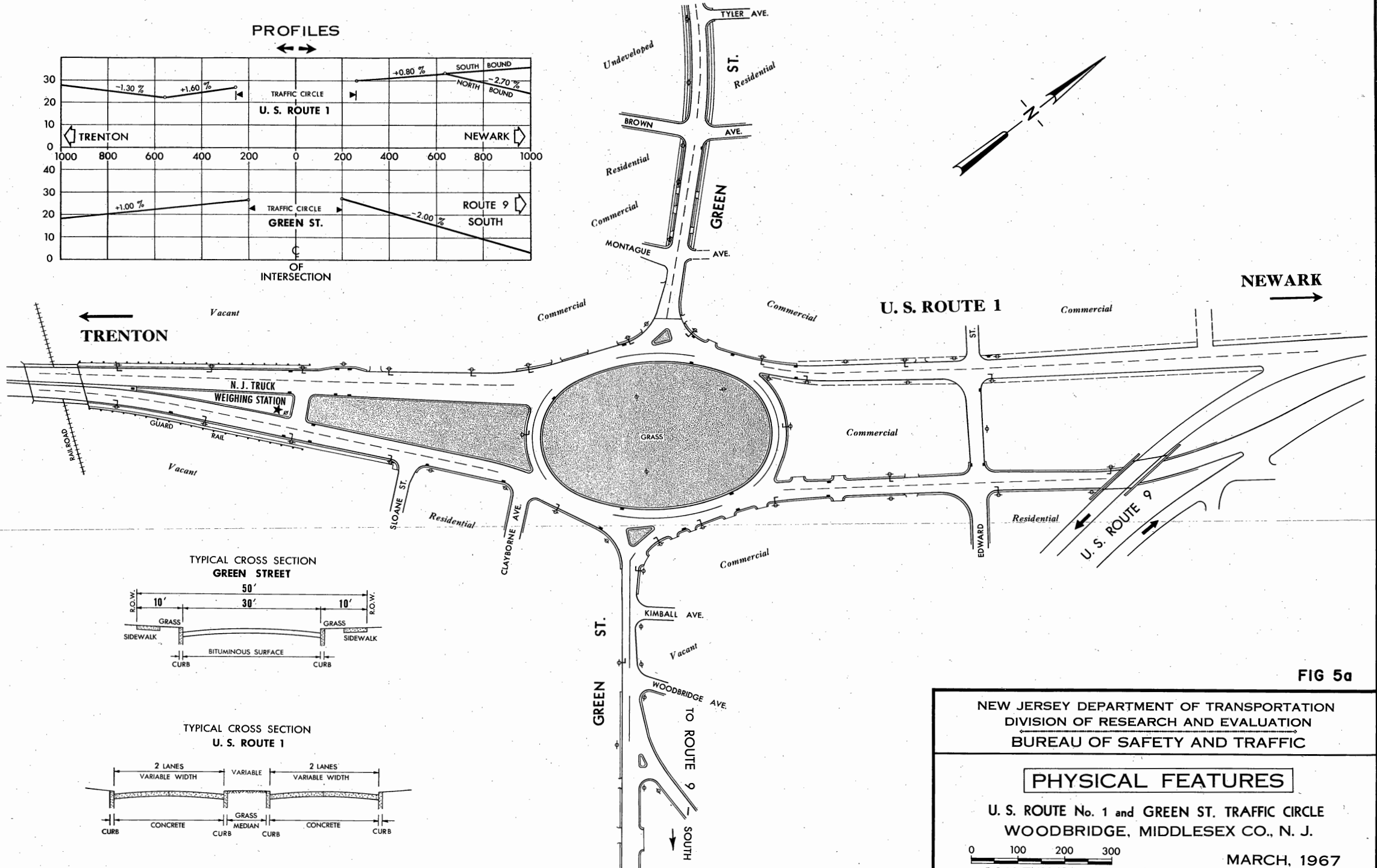
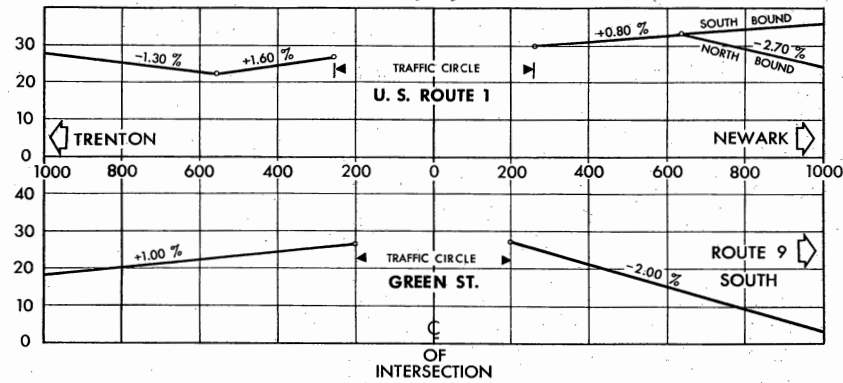


Photographed 6/29/67 - 1655 hours
500' Altitude, Looking South

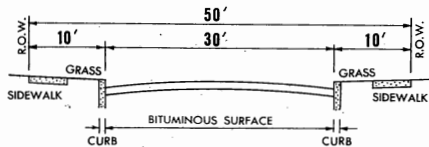


Photographed 6/29/67 - 1655 hours
700' Altitude, Looking West

PROFILES



TYPICAL CROSS SECTION
GREEN STREET



TYPICAL CROSS SECTION
U. S. ROUTE 1

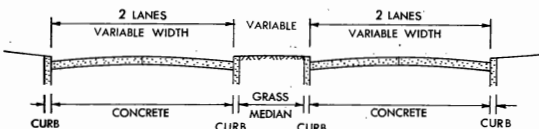
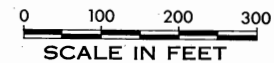


FIG 5a

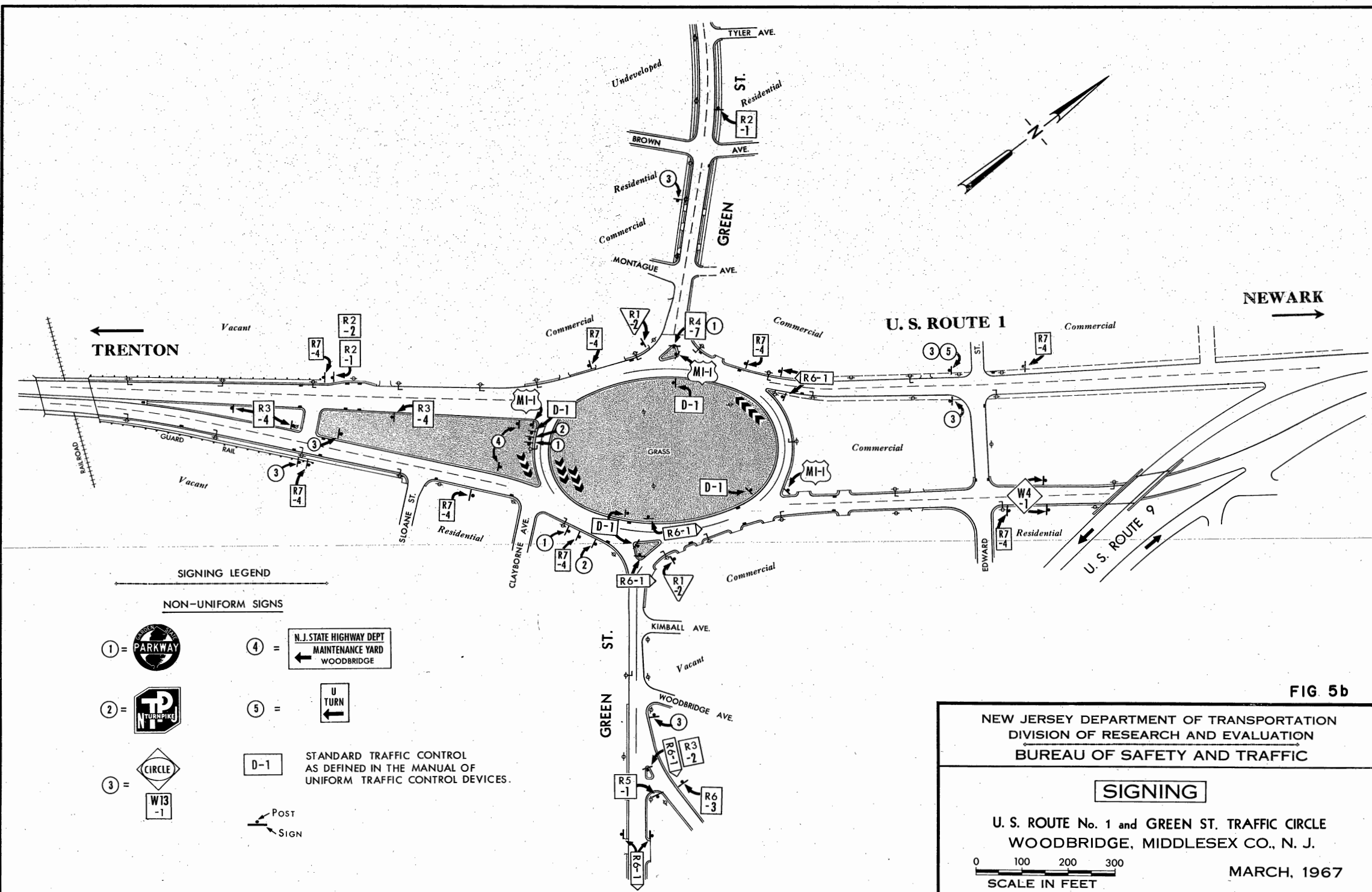
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE No. 1 and GREEN ST. TRAFFIC CIRCLE
WOODBRIDGE, MIDDLESEX CO., N. J.



MARCH, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS






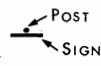
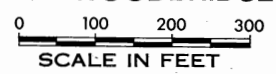
- ① = 
- ② = 
- ③ = 
- ④ = 
- ⑤ = 
- D-1 = STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.
-  Post
Sign

FIG 5b

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 and GREEN ST. TRAFFIC CIRCLE
WOODBRIDGE, MIDDLESEX CO., N. J.



MARCH, 1967

| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|------------|-----------|------------|----------|-----------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| →↘ RIGHT ANGLE | 9 | 4 | 13 | 0 | 1 | 12 |
| →→ REAR END | 70 | 32 | 102 | 0 | 59 | 43 |
| →X FIXED OBJECT | 0 | 2 | 2 | 0 | 0 | 2 |
| →→ HEAD-ON | 2 | 1 | 3 | 0 | 2 | 1 |
| →/ PEDESTRIAN | 1 | 1 | 2 | 1 | 1 | 0 |
| ↔ SIDESWIPE | 35 | 18 | 53 | 0 | 14 | 39 |
| → OTHER | 2 | 11 | 13 | 1 | 6 | 6 |
| TOTAL | 119 | 69 | 188 | 2 | 83 | 103 |

NOTES

NUMBER OF ACCIDENTS AT EACH LOCATION
 ACCIDENTS AT INDETERMINATE LOCATIONS

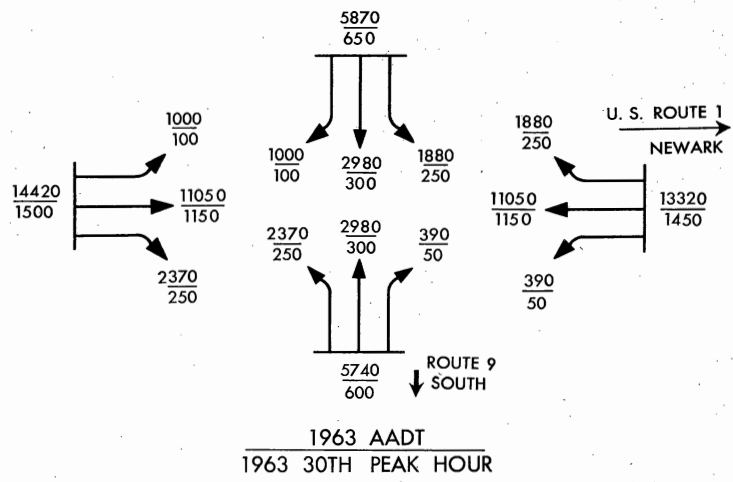
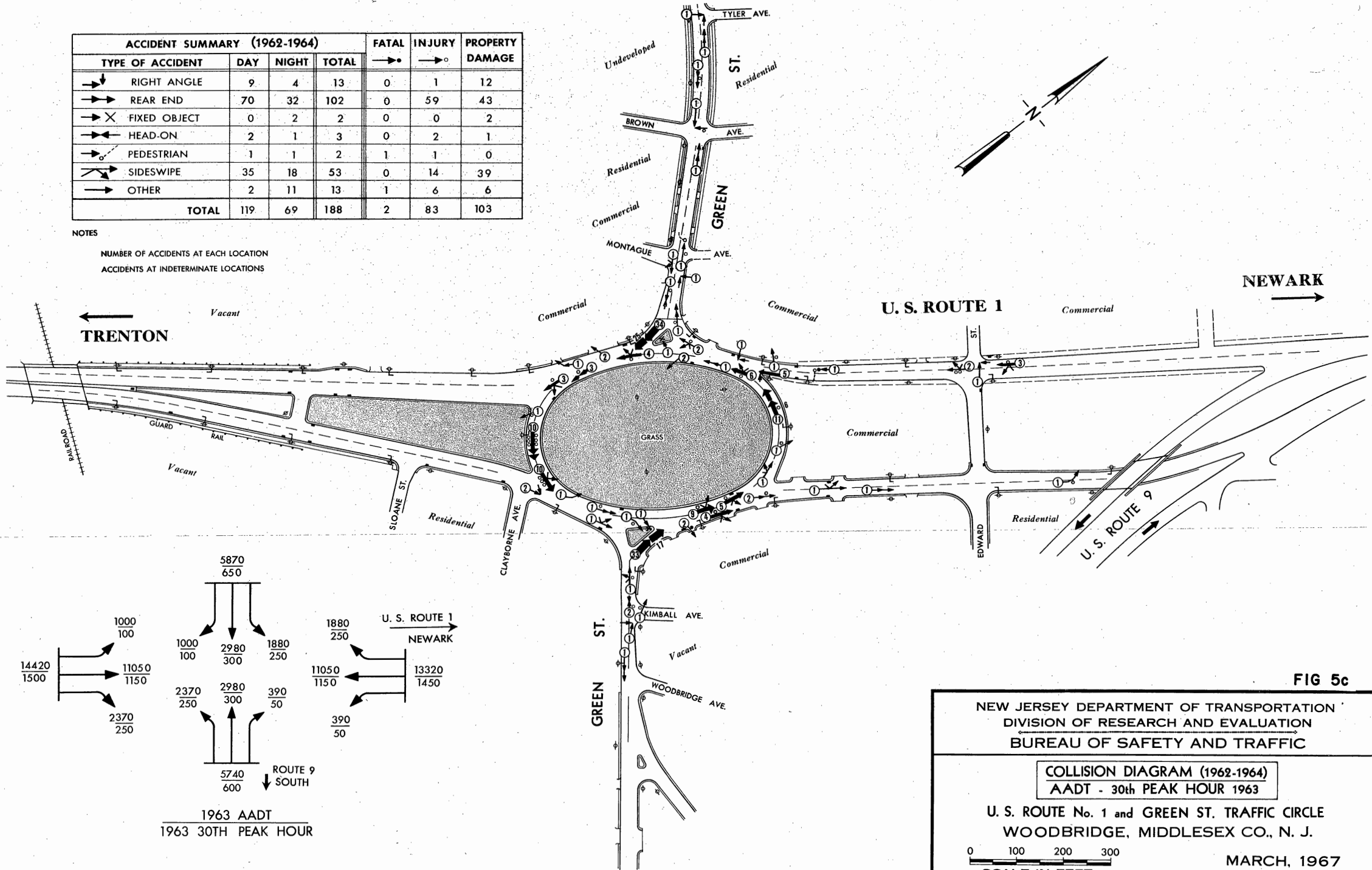


FIG 5c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
 AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 and GREEN ST. TRAFFIC CIRCLE
 WOODBRIDGE, MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

MARCH, 1967

Independent Variables

- X_1 = Approach Volume (By Lane)
 X_2 = % Trucks (By Lane)/100
 X_3 = % Left Turns (By Lane)/100
 X_4 = % Right Turns (By Lane)/100
 X_5 = Right Hand Lane Volume from Left App.
 X_6 = Right Hand Lane Volume from Opposed App.
 X_7 = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For

U. S. Route 1 & 9 & Green Street

Circle

Year of Construction: 1929

Speed Limits

Major Leg - 50 Mph

Minor Leg - 25 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|-------------------------------------|--|-----------|-----------|-----------|-----------|-----------|----------|---------------------|---------------|---|------------------------|----------------|---------------|---------------------|--------------------|
| | X_1 | X_2 | X_3 | X_4 | X_5 | X_6 | X_7 | | | | | | | | |
| Major Leg 2 lanes Vac. | 35 | 0 | 0 | 0 | 25 | 60 | 25 | Com. | Lt. | $Y = 115.35 + 1.24 X_1 - 1.20 X_6$ | 86.29 | 0.48 | 19.34 | 44 | 1 |
| | to 70 | to .10 | to .20 | to .10 | to 50 | to 100 | to 60 | Res. Com. | St. | $Y = 27.07 + 16.10 X_2 + 0.14 X_6$ | 40.67 | 0.23 | 5.20 | 96 | 1 |
| | | 0-.50 | | 0-.50 | | | | Vac. | Rt. | $Y = 26.69 + 0.19 X_1 - 8.51 X_2$ | 35.21 | 0.11 | 7.10 | 72 | 1 |
| Minor Leg 1 lane Vac. | 30 | 0 | .40 | 0 | 40 | 25 | 60 | Vac. | Lt. | $Y = 59.77 + 0.08 X_1 + 70.23 X_2$ | 71.58 | 0.24 | 7.72 | 48 | 1 |
| | to 60 | to .20 | to .75 | to .10 | to 65 | to 50 | to 95 | Com. Res. | St. | $Y = 87.28 - 44.60 X_3 + 0.27 X_7$ | 82.71 | 0.29 | 12.40 | 47 | 1 |
| Major Leg 2 lanes Com. | 10 | 0 | 0 | 0 | 30 | 40 | 25 | Vac. | St. | $Y = 63.23 - 44.65 X_3 - 0.28 X_6$ $- 0.23 X_7$ | 39.13 | 0.29 | 4.58 | 95 | 1 |
| | to 90 | to .35 | to .05 | to .30 | to 60 | to 65 | to 50 | Com. Res. | Rt. | $Y = 70.79 - 18.94 X_2 - 0.12 X_5$ $- 0.17 X_6 - 0.19 X_7$ | 46.00 | 0.20 | 5.93 | 54 | 1 |
| Minor Leg 1 lane Com. Res. | 25 | 0 | .10 | .05 | 60 | 25 | 45 | Com. | Lt. | $Y = 13.77 + 0.63 X_1 + 58.25 X_2$ $+ 0.28 X_5 + 0.35 X_6$ | 77.70 | 0.35 | 9.85 | 45 | 1 |
| | to 45 | to .15 | to .45 | to .40 | to 100 | to 60 | to 65 | Vac. | St. | $Y = - 32.46 - 399.82 X_2 + 2.11 X_5$ | 100.80 | 0.55 | 34.54 | 47 | 1 |
| | | | | | | | | Vac. | Rt. | $Y = 54.91 + 0.53 X_1 - 0.50 X_7$ | 47.46 | 0.19 | 10.60 | 44 | 1 |

PHOTO 6

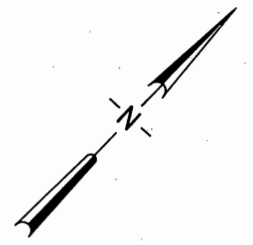
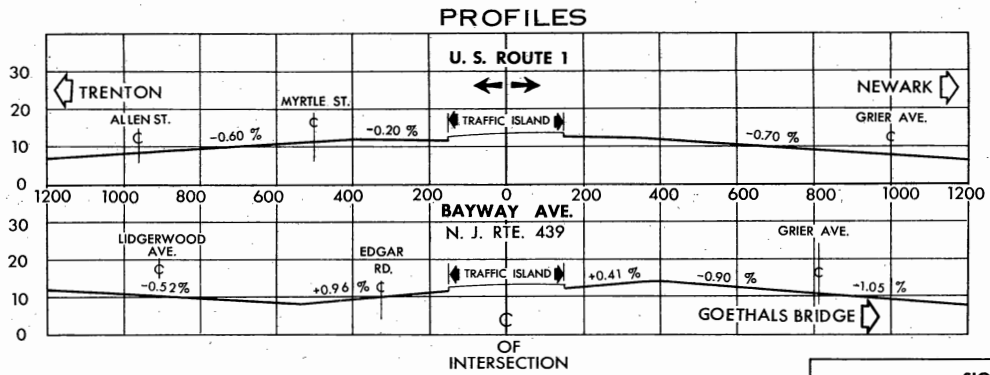
New Jersey Routes 1 & 9 and Bayway Avenue
Circle



Photographed 5/18/67, 1655 hours
500' Altitude, Looking Southeast



Photographed 5/18/67 - 1655 hours
700' Altitude, Looking West



SIGNALS
U. S. ROUTE 1&9 and MYRTLE ST.
112-128 SECONDS VARIABLE CYCLE
(SEMI-ACTUATED)

| | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|---------------|-------|-------|---------|-------|-----------|
| U. S. 1 & 9 ★ | 86-78 | 5 | 0 | 29-37 | 29-37 |
| MYRTLE ST. | 24-32 | 3 | 2 | 91-83 | 93-85 |

★ 67 SECOND G-G OFFSET WITH GRIER AVE.

SIGNALS
N. J. ROUTE 439 & GRIER AVE.
120 SECOND CYCLE (FIXED)

| | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|---------------|-------|-------|---------|------|-----------|
| N. J. RTE 439 | 48.0 | 4.8 | 0 | 67.2 | 67.2 |
| GRIER AVE. | 63.6 | 3.6 | 0 | 52.8 | 52.8 |

SIGNALS
N. J. RTE. 439 and EDGAR ROAD
120 SECOND CYCLE (FIXED)

| | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|-------------------|-------|-------|---------|-----|-----------|
| N. J. RTE 439 N B | 68 | 5 | 0 | 47 | 47 |
| N. J. RTE 439 E B | 48 | 5 | 0 | 67 | 67 |
| ★ EDGAR ROAD | 43 | 4 | 0 | 73 | 73 |

★ 77 SECOND G-G OFFSET WITH U. S. RTE 1 & 9 AT MYRTLE ST.

SIGNALS
N. J. ROUTE 1 & 9 and GRIER AVE.
120 SECOND CYCLE (FIXED)

| | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|---------------------|-------|-------|---------|-----|-----------|
| ★ U. S. ROUTE 1 & 9 | 74 | 5 | 0 | 41 | 41 |
| GRIER AVE. | 35 | 4 | 2 | 79 | 81 |

★ 67 SECOND G-G OFFSET WITH MYRTLE ST.

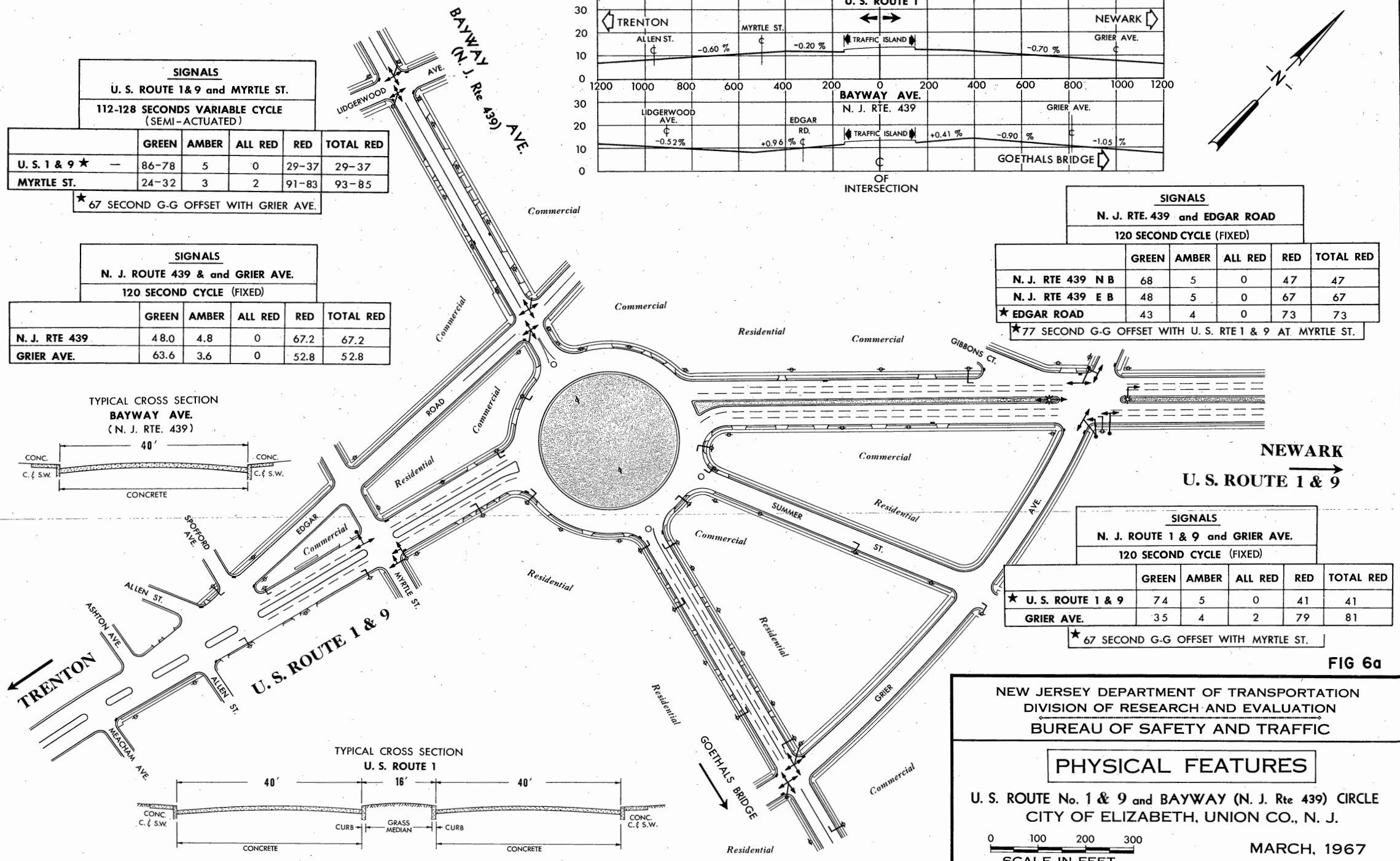
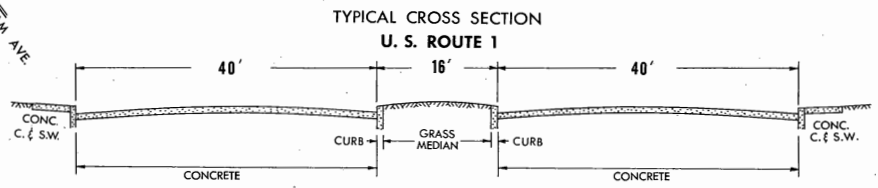
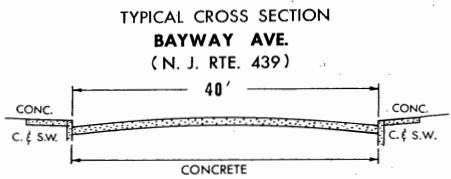


FIG 6a

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE No. 1 & 9 and BAYWAY (N. J. Rte 439) CIRCLE
CITY OF ELIZABETH, UNION CO., N. J.

MARCH, 1967

SIGNING LEGEND

NON-UNIFORM SIGNS

- | | |
|-----|-----|
| ① = | ⑥ = |
| ② = | ⑦ = |
| ③ = | ⑧ = |
| ④ = | ⑨ = |
| ⑤ = | |
| | |

Post
SIGN

D-1 STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.

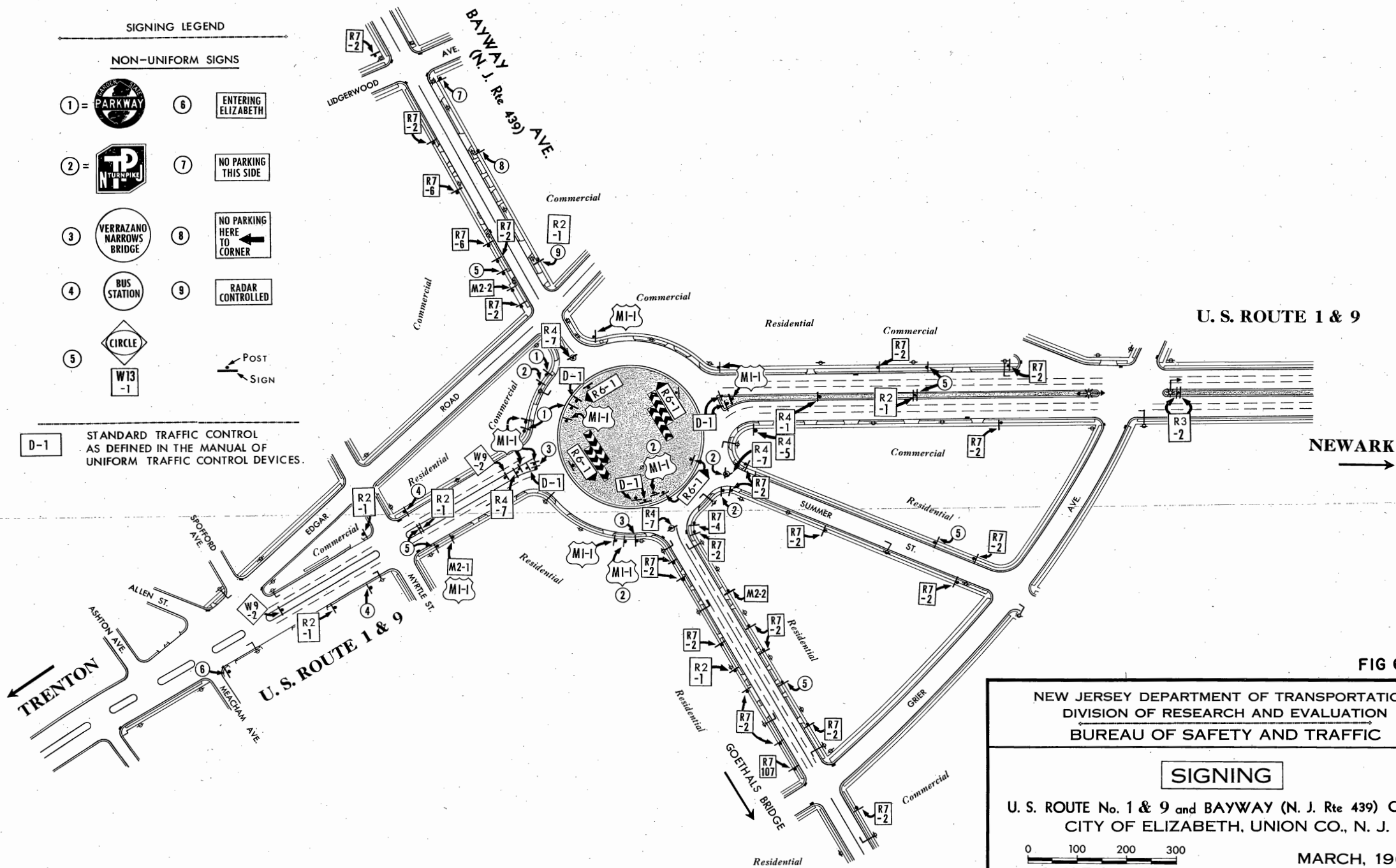


FIG 6b

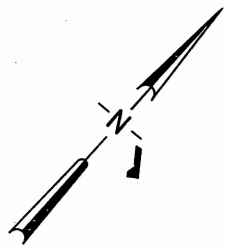
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 & 9 and BAYWAY (N. J. Rte 439) CIRCLE CITY OF ELIZABETH, UNION CO., N. J.

0 100 200 300
SCALE IN FEET

MARCH, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|------------|------------|------------|----------|------------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →• | →○ | |
| ↘→ RIGHT ANGLE | 58 | 29 | 87 | 0 | 33 | 54 |
| →→ REAR END | 118 | 58 | 176 | 0 | 67 | 109 |
| → X FIXED OBJECT | 1 | 2 | 3 | 0 | 0 | 3 |
| →→ HEAD-ON | 0 | 1 | 1 | 0 | 0 | 1 |
| →○ PEDESTRIAN | 7 | 3 | 10 | 1 | 9 | 0 |
| ↘→ SIDESWIPE | 106 | 39 | 145 | 0 | 28 | 117 |
| → OTHER | 11 | 39 | 50 | 0 | 16 | 34 |
| TOTAL | 301 | 171 | 472 | 1 | 153 | 318 |

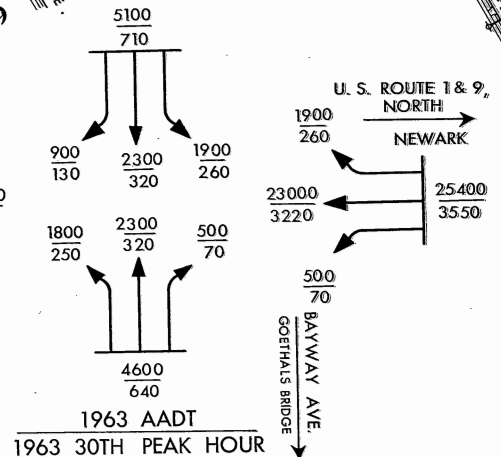
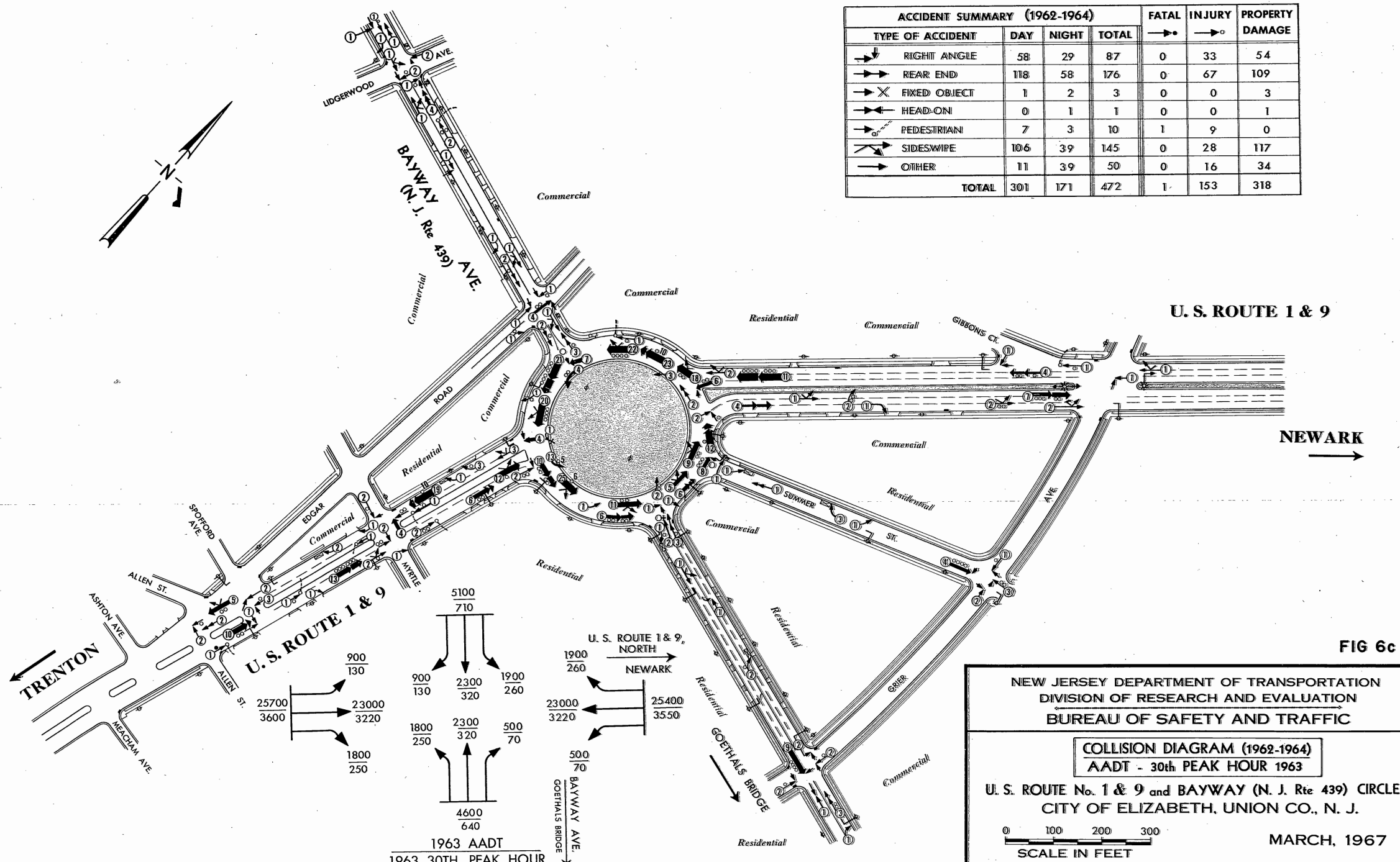


FIG 6c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 & 9 and BAYWAY (N. J. Rte 439) CIRCLE
CITY OF ELIZABETH, UNION CO., N. J.

0 100 200 300
SCALE IN FEET

MARCH, 1967

TRAVEL TIMES

For

U.S. Routes 1 & 9 and Bayway Avenue

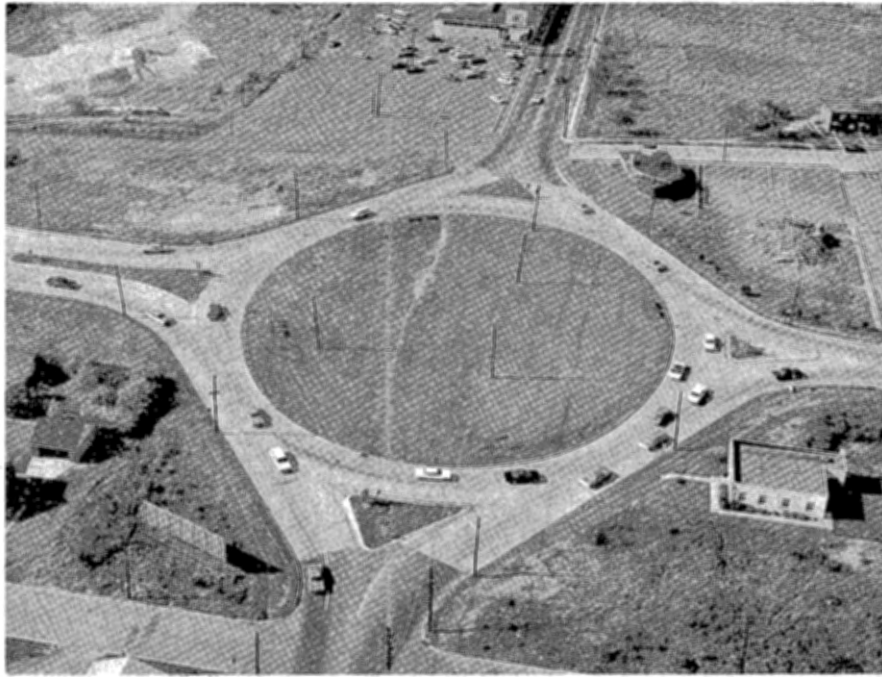
Circle

Year of Construction: 1929

PHOTO 7

New Jersey Routes 35 & 440

Circle

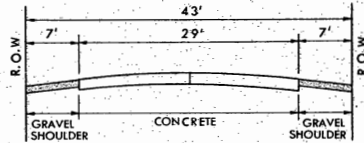


Photographed 5/18/67 - 1700 hours
500' Altitude, Looking North

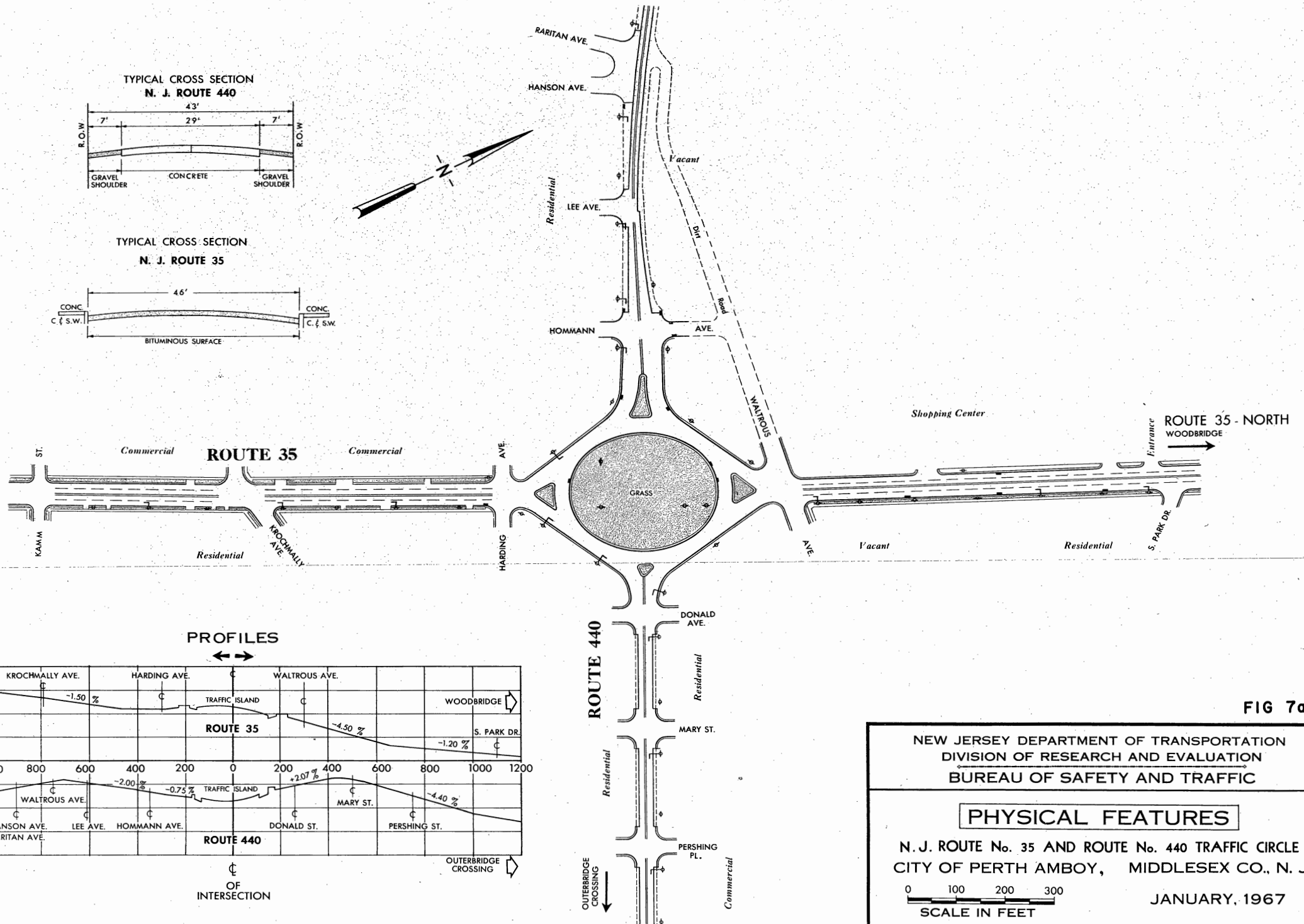
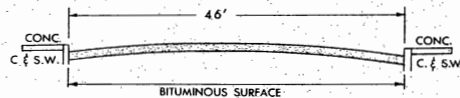


Photographed 5/18/67 - 1700 hours
700' Altitude, Looking Southwest

TYPICAL CROSS SECTION
N. J. ROUTE 440



TYPICAL CROSS SECTION
N. J. ROUTE 35



PROFILES

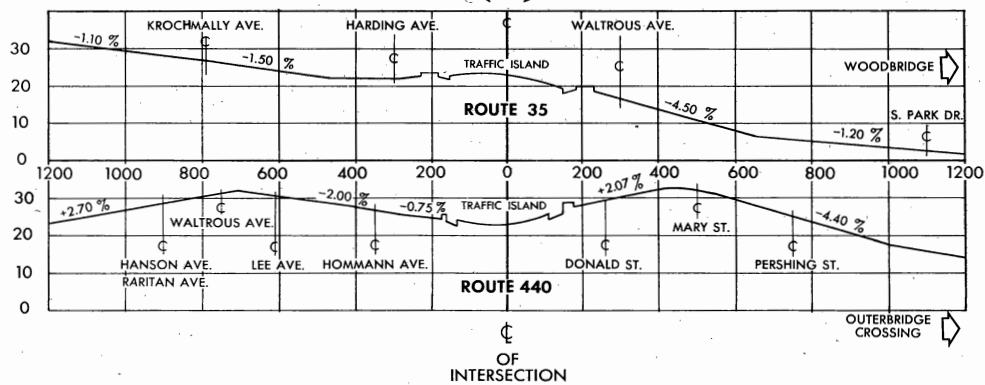


FIG 7a

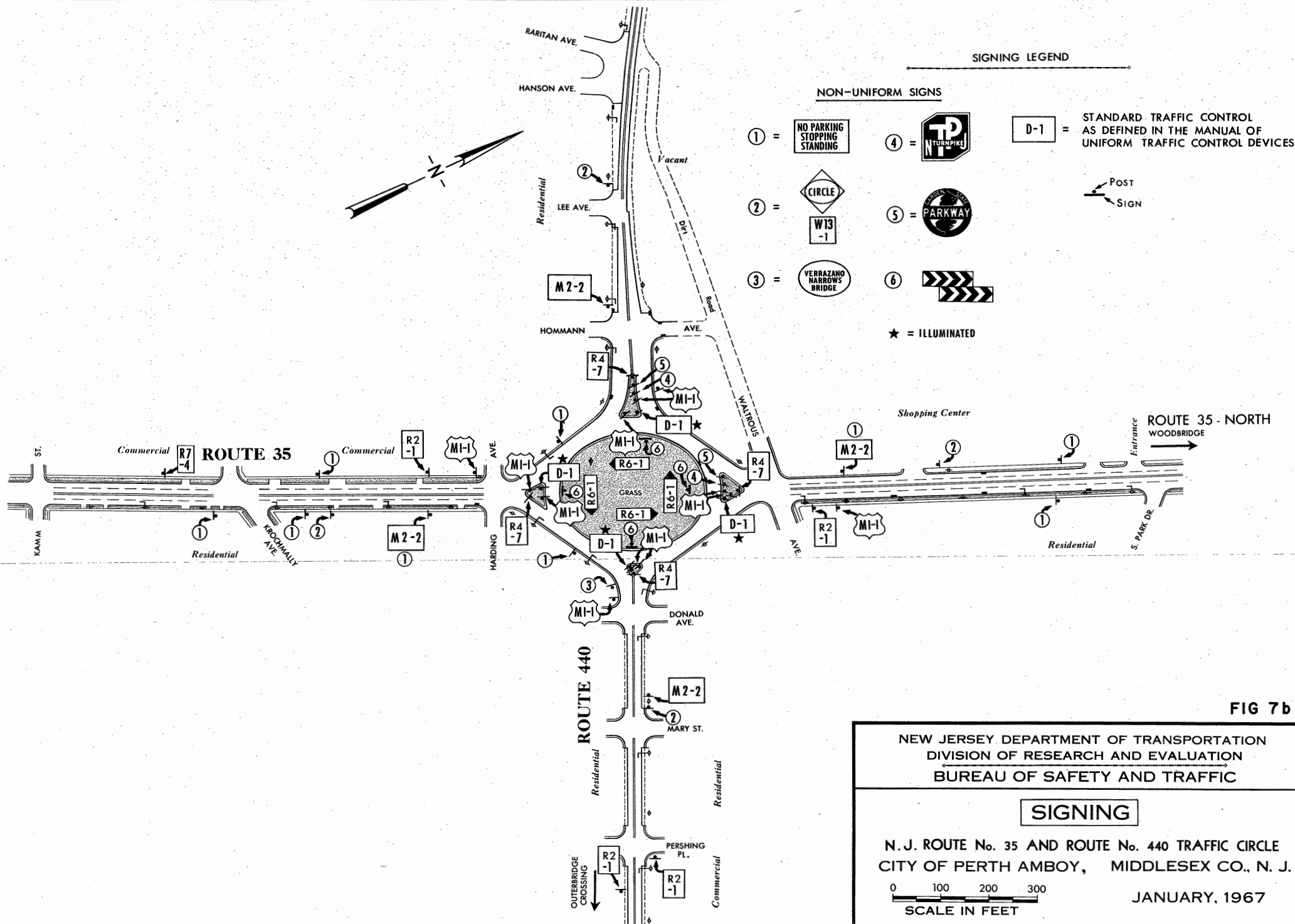
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

N. J. ROUTE No. 35 AND ROUTE No. 440 TRAFFIC CIRCLE
CITY OF PERTH AMBOY, MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JANUARY, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS

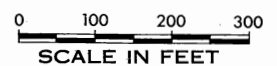
- ① = NO PARKING STOPPING STANDING
- ② = CIRCLE W13-1
- ③ = VERRAZANO NARROWS BRIDGE
- ④ = TURNPIKE
- ⑤ = PARKWAY
- ⑥ = [Chevron sign]
- D-1 = STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.
- ★ = ILLUMINATED
- Post Sign

FIG 7b

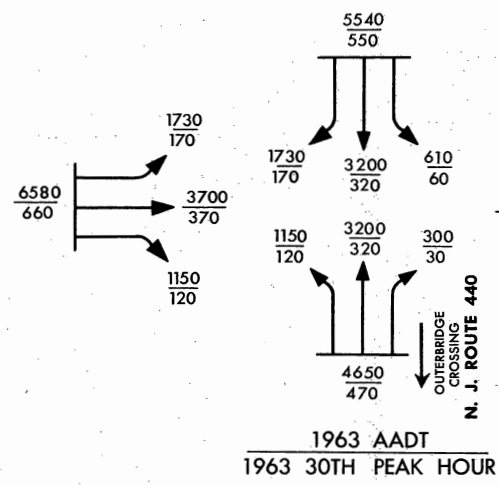
NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

SIGNING

N. J. ROUTE No. 35 AND ROUTE No. 440 TRAFFIC CIRCLE
 CITY OF PERTH AMBOY, MIDDLESEX CO., N. J.



JANUARY, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|-----------|-----------|-----------|----------|-----------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| ↔↔ RIGHT ANGLE | 12 | 7 | 19 | | 12 | 7 |
| →→ REAR END | 16 | 8 | 24 | | 13 | 11 |
| → X FIXED OBJECT | 0 | 9 | 9 | | 4 | 5 |
| ↔↔ HEAD-ON | 3 | 3 | 6 | | 3 | 3 |
| →○ PEDESTRIAN | 2 | 1 | 3 | 1 | 2 | |
| ↔↔ SIDESWIPE | 3 | 3 | 6 | | 3 | 3 |
| →→ OTHER | 7 | 17 | 24 | 1 | 10 | 13 |
| TOTAL | 43 | 58 | 91 | 2 | 47 | 42 |

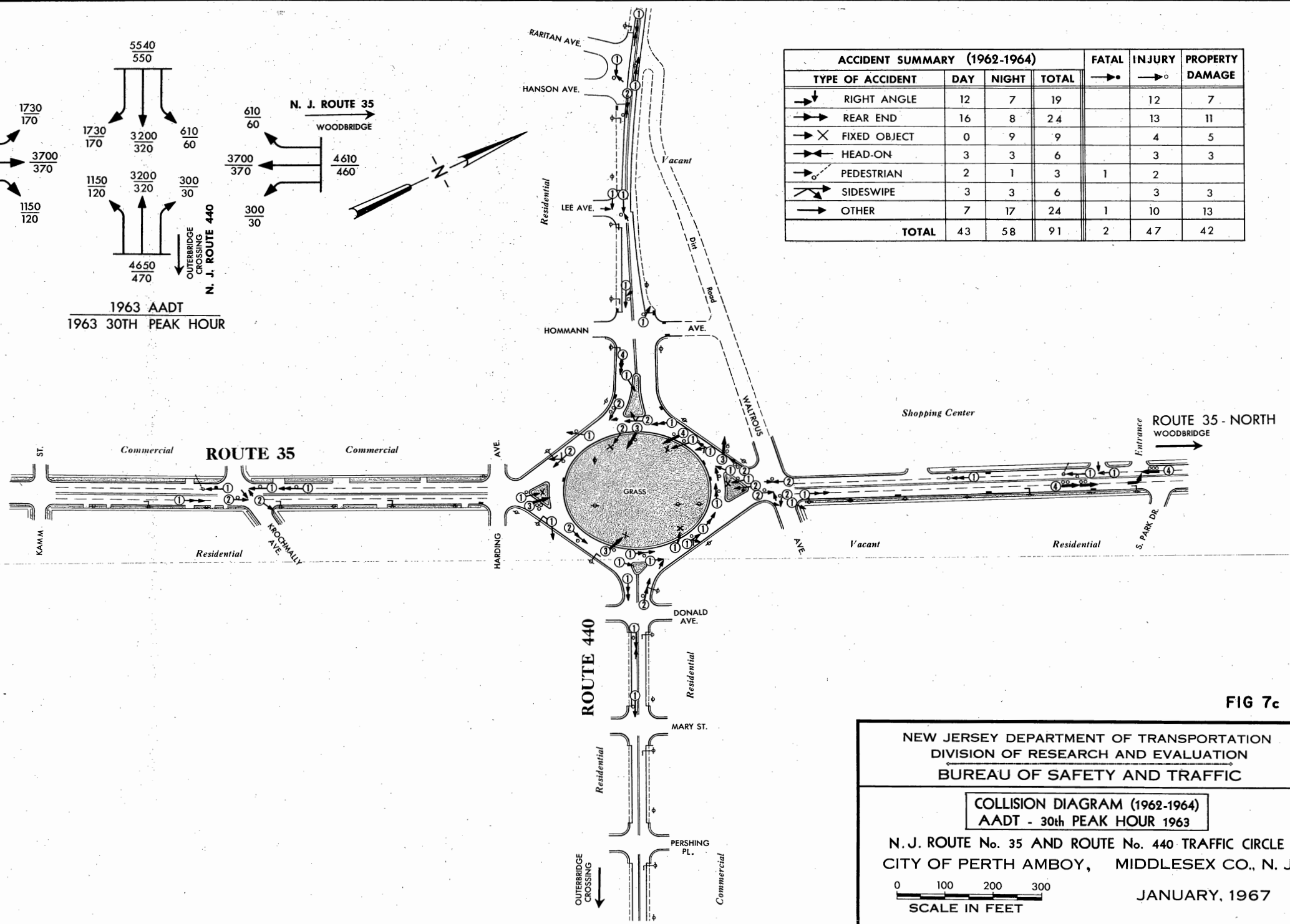


FIG 7c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

N. J. ROUTE No. 35 AND ROUTE No. 440 TRAFFIC CIRCLE
CITY OF PERTH AMBOY, MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JANUARY, 1967

TABLE 7

Independent Variables

- X₁ = Approach Volume (By Lane)
- X₂ = % Trucks (By Lane)/100
- X₃ = % Left Turns (By Lane)/100
- X₄ = % Right Turns (By Lane)/100
- X₅ = Right Hand Lane Volume from Left App.
- X₆ = Right Hand Lane Volume from Opposed App.
- X₇ = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For
New Jersey Routes 35 and 440
Traffic Circle
Year of Construction: 1940

Speed Limits

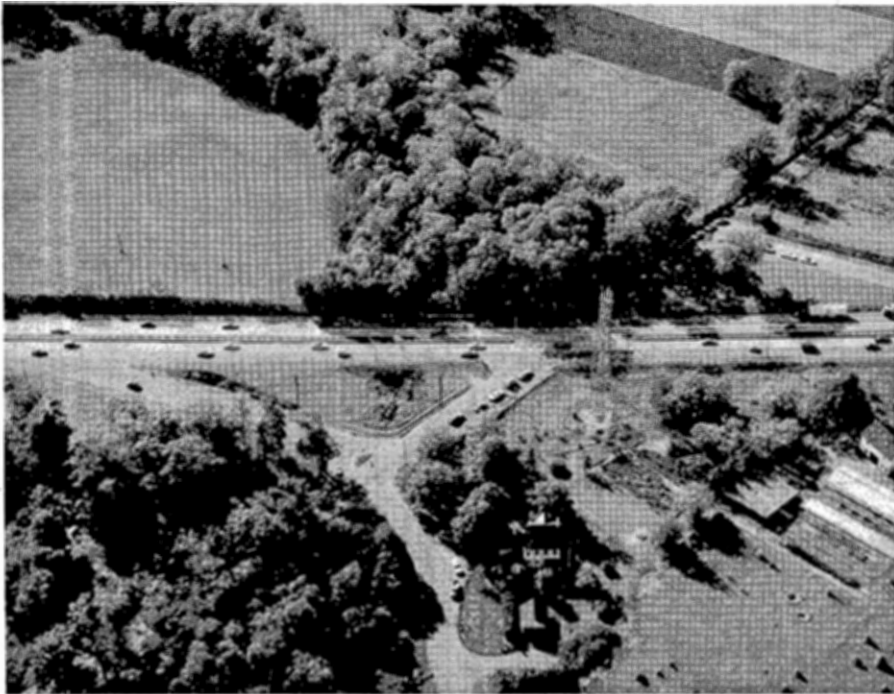
Major Leg - 45 Mph
Minor Leg - 35 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|-------------------------------------|--|----------------|----------------|----------------|----------------|----------------|----------------|--|-------------------|--|------------------------|----------------|---------------|---------------------|--------------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | |
| Major Leg 2 lanes Com. & res. | 10 | 0 | 0 | 0 | 30 | 10 | 30 | Res. Vac. Shp. Ctr. Res. | Lt. St. Rt. | Y = 23.11 + 0.78 X ₁ + 0.31 X ₇ | 60.69 | 0.25 | 16.44 | 96 | 1 |
| | to | to | to | to | to | to | to | | | Y = 36.23 + 0.23 X ₁ + 28.64 X ₂ + 0.08 X ₇ | 48.49 | 0.12 | 9.00 | 119 | 1 |
| | 40 | .20 | .45 | .45 | 80 | 25 | 85 | | | Y = 25.56 + 32.46 X ₂ - 19.92 X ₄ + 0.33 X ₇ | 43.27 | 0.15 | 13.52 | 83 | 1 |
| Minor Leg 1 lane Res. | 30 | 0 | .15 | 0 | 15 | 30 | 10 | Com. Res. Res. Vac. Shp. Ctr. | Lt. St. Rt. | Y = 53.20 + 0.19 X ₁ + 35.30 X ₄ | 66.57 | 0.15 | 8.87 | 60 | 1 |
| | to | to | to | to | to | to | to | | | Y = 46.77 + 0.17 X ₁ + 0.21 X ₇ | 60.40 | 0.20 | 7.05 | 60 | 1 |
| | 85 | .15 | .40 | .25 | 40 | 80 | 25 | | | Y = 105.24 - 125.97 X ₃ - 73.94 X ₂ + 0.71 X ₅ - 1.06 X ₇ | 66.54 | 0.13 | 29.96 | 53 | 1 |
| Major Leg 2 lanes Shp. Ctr. | 10 | 0 | 0 | 0 | 30 | 15 | 35 | Res. Com. Res. Res. Vac. | Lt. St. Rt. | Y = 27.44 + 0.77 X ₁ + 48.32 X ₄ + 0.29 X ₅ | 68.16 | 0.21 | 20.34 | 61 | 1 |
| | to | to | to | to | to | to | to | | | Y = 11.19 + 28.89 X ₄ + 0.38 X ₅ + 0.30 X ₇ | 53.66 | 0.44 | 11.61 | 120 | 1 |
| | 35 | .25 | .25 | .30 | 90 | 40 | 75 | | | Y = 19.59 - 44.92 X ₃ + 0.31 X ₅ + 0.37 X ₇ | 54.77 | 0.17 | 25.27 | 94 | 1 |
| Minor Leg 1 lane Res. & vac. | 30 | 0 | 0 | .10 | 5 | 30 | 15 | Shp. Ctr. Res. Com. Res. | Lt. St. Rt. | Y = 26.50 + 47.29 X ₃ + 23.90 X ₄ - 0.26 X ₆ + 0.50 X ₇ | 67.86 | 0.15 | 17.25 | 53 | 1 |
| | to | to | to | to | to | to | to | | | Y = 40.98 - 1.29 X ₅ + 0.62 X ₆ | 61.51 | 0.59 | 14.30 | 60 | 1 |
| | 80 | .20 | .20 | .55 | 25 | 85 | 40 | | | Y = 23.38 + 0.38 X ₁ - 82.29 X ₃ + 0.25 X ₆ | 50.52 | 0.49 | 11.40 | 60 | 1 |

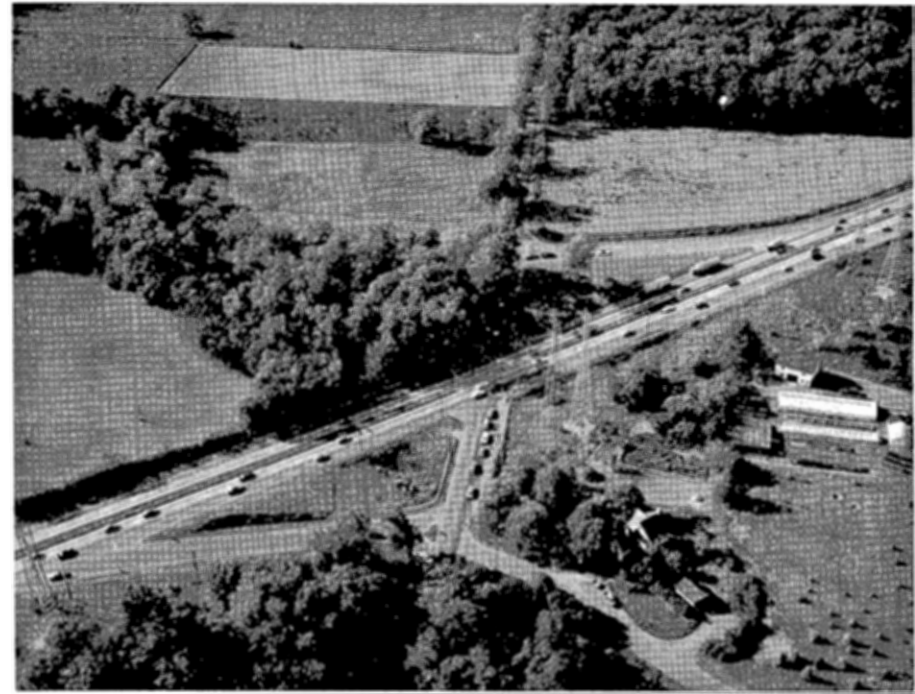
PHOTO 8

U.S. Route 1 and Ryders Lane

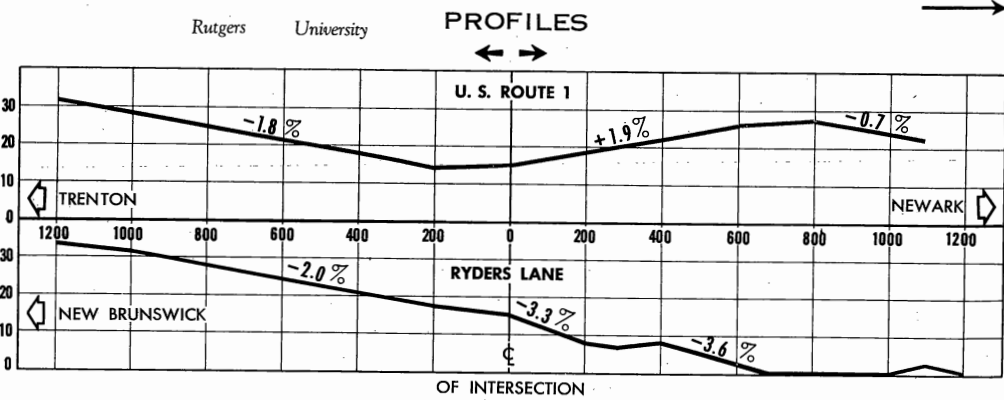
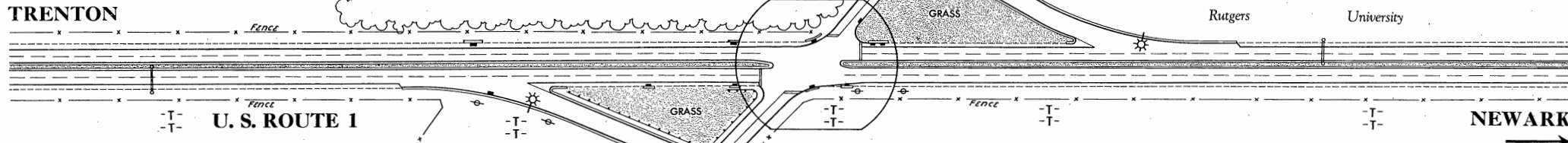
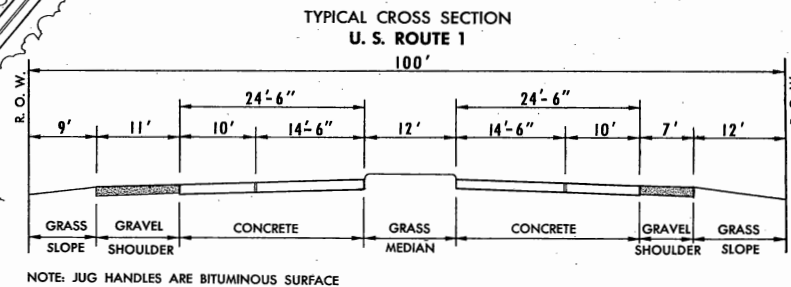
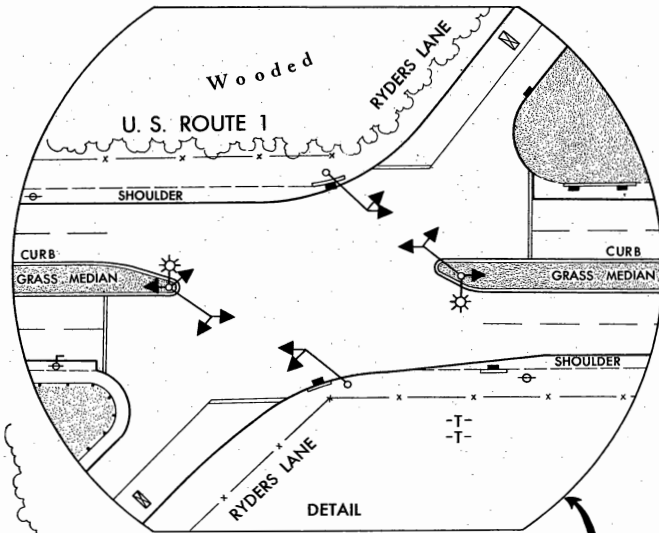
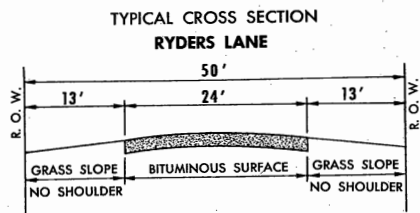
Signalized Jughandle



Photographed 6/1/67 - 1732 hours
500' Altitude, Looking Southwest



Photographed 6/1/67 - 1732 hours
700' Altitude, Looking West



GANTRY SIGNS ON U. S. ROUTE 1

SIGNALS AHEAD
RED

"SIGNALS AHEAD" IS ALWAYS LIT.

"SIGNALS AHEAD" RED

IS ACTUATED 12 SECONDS BEFORE AMBER ON U. S. RTE. 1, ALTERNATING 60 FLASHES PER MINUTE.

IT IS DE-ACTIVATED AT END OF RYDERS LANE GREEN.

107-127 SECONDS VARIABLE CYCLE
SEMI-ACTUATED

| | GREEN | AMBER | ALL RED | RED | TOTAL RED |
|---------------|-------|-------|---------|-------|-----------|
| U. S. ROUTE 1 | 80 | 5 | 2 | 20-40 | 22-42 |
| RYDERS LANE | 15-35 | 3 | 2 | 87 | 89 |

NEW JERSEY STATE HIGHWAY DEPARTMENT
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE No. 1 & RYDERS LANE
NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

DECEMBER, 1966

FIG 8a

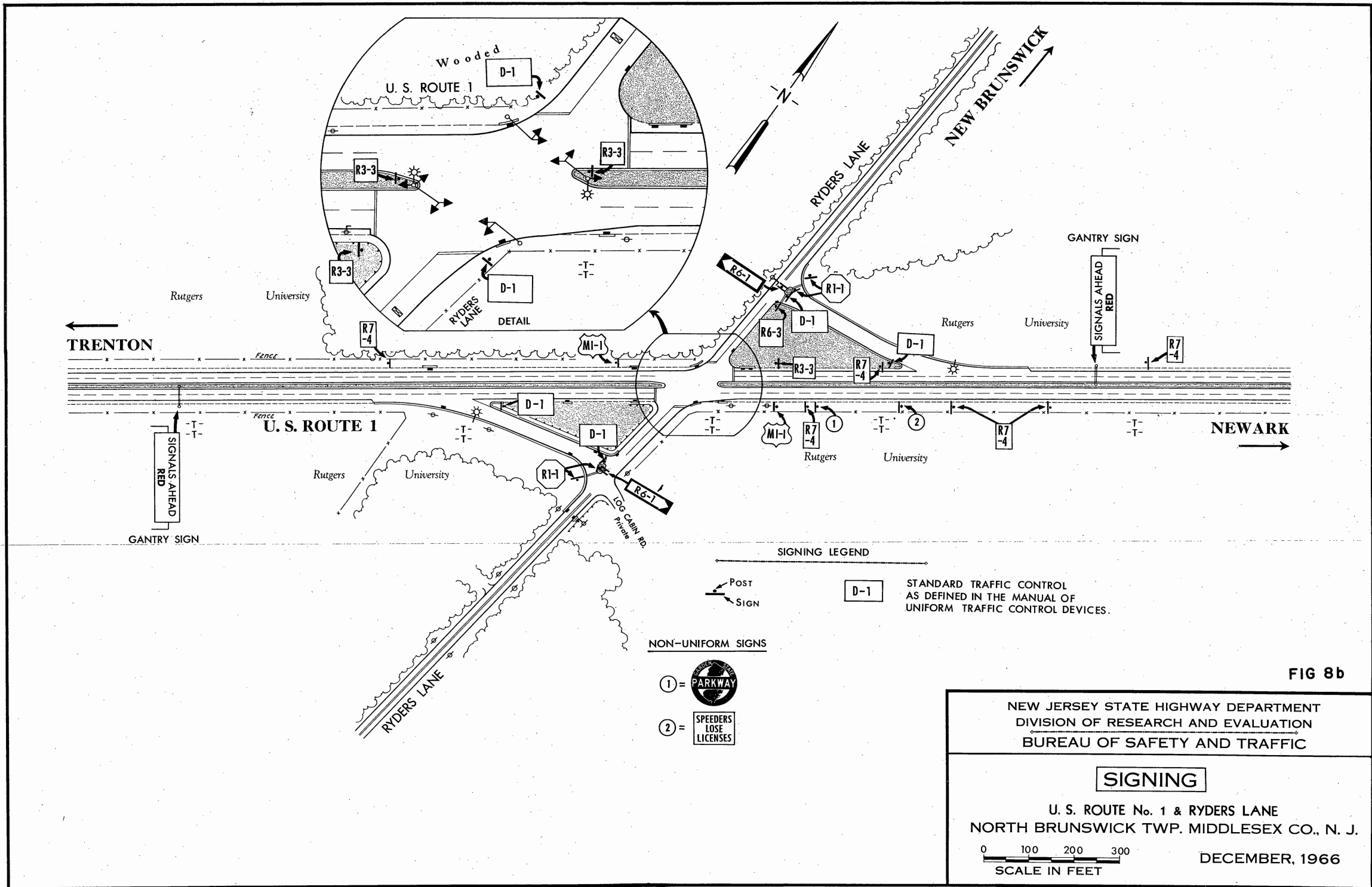


FIG 8b

NEW JERSEY STATE HIGHWAY DEPARTMENT
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

SIGNING

U. S. ROUTE No. 1 & RYDERS LANE
 NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

DECEMBER, 1966

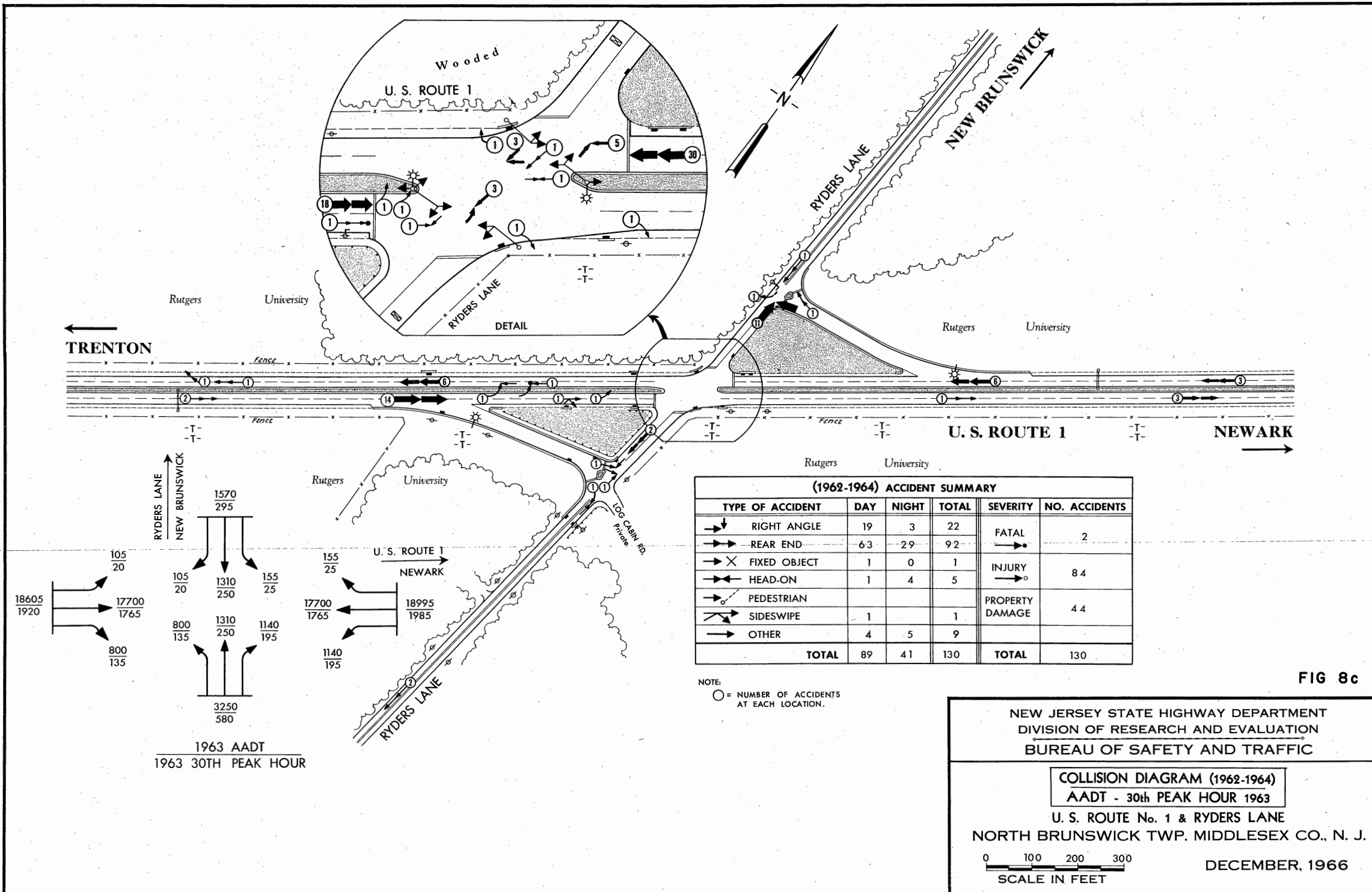


FIG 8c

NEW JERSEY STATE HIGHWAY DEPARTMENT
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

U. S. ROUTE No. 1 & RYDERS LANE
 NORTH BRUNSWICK TWP. MIDDLESEX CO., N. J.

0 100 200 300
 SCALE IN FEET

DECEMBER, 1966

TABLE 8

Independent Variables

- X_1 = Approach Volume (By Lane)
 X_2 = % Trucks (By Lane)/100
 X_3 = % Left Turns (By Lane)/100
 X_4 = % Right Turns (By Lane)/100
 X_5 = Right Hand Lane Volume from Left App.
 X_6 = Right Hand Lane Volume from Opposed App.
 X_7 = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For

U. S. Route 1 and Ryders Lane

Signalized Jughandle

Year of Construction: 1941

Jughandles Added: 1960

Speed Limits

Major Leg - 50 Mph

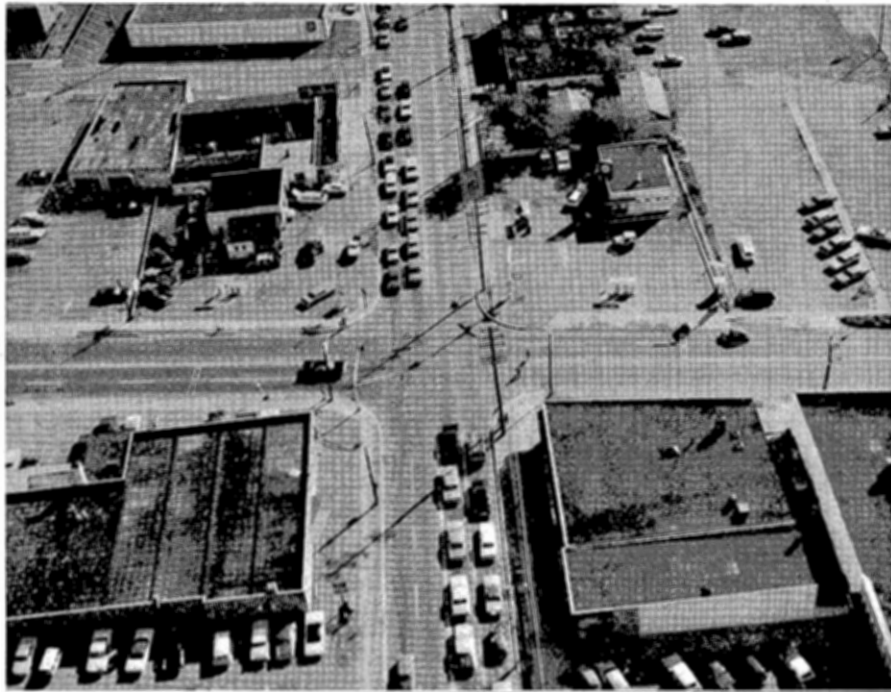
Minor Leg - 35 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|--|--|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|---------------|---|------------------------|----------------|---------------|---------------------|--------------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | |
| Major Leg 2 lanes Und. | 25 | 0 | 0 | 0 | 5 | 50 | 5 | Und. | Lt. | $Y = 132.76 + 435.09 X_3 - 0.86 X_6$ | 100.28 | 0.42 | 27.45 | 21 | 1 |
| | to | to | to | to | to | to | to | Und. | St. | $Y = 30.78 + 0.11 X_1 + 0.69 X_5 + 0.14 X_7$ | 48.64 | 0.43 | 7.35 | 120 | 1 |
| | 90 | .35 | .15 | .20 | 20 | 95 | 50 | Und. | Rt. | $Y = 20.87 + 0.40 X_1 - 57.86 X_2 - 35.96 X_4 + 0.33 X_7$ | 39.97 | 0.52 | 8.92 | 53 | 1 |
| Minor Leg 1 lane w/ added lane Und. | 5 | 0 | .10 | .10 | 40 | 5 | 50 | Und. | Lt. | $Y = 56.32 - 0.74 X_1 + 116.73 X_2 - 280.60 X_3 + 0.82 X_7$ | 90.09 | 0.26 | 19.00 | 60 | 1 |
| | to | to | to | to | to | to | to | Und. | St. | $Y = 93.83 + 199.44 X_2 - 52.94 X_4$ | 83.59 | 0.22 | 19.01 | 60 | 1 |
| Major Leg 2 lanes Und. | 40 | .10 | 0 | 0 | 5 | 40 | 5 | Und. | Lt. | $Y = 130.29 - 0.31 X_1 - 101.23 X_4 + 0.54 X_5 - 0.26 X_6$ | 103.86 | 0.09 | 23.35 | 62 | 1 |
| | to | to | to | to | to | to | to | Und. | St. | $Y = 22.32 + 0.22 X_1 + 27.86 X_2 + 0.24 X_5$ | 48.58 | 0.63 | 6.04 | 120 | 1 |
| | 100 | .40 | .25 | .15 | 50 | 70 | 20 | Und. | Rt. | $Y = 36.91 + 0.27 X_1 + 35.44 X_2 - 0.40 X_6$ | 42.98 | 0.19 | 13.73 | 43 | 1 |
| Minor Leg Und. | 5 | 0 | 0 | 0 | 45 | 5 | 35 | Und. | Lt. | $Y = 170.70 - 51.49 X_3 - 0.45 X_6 - 1.03 X_7$ | 89.51 | 0.14 | 31.54 | 38 | 1 |
| | to | to | to | to | to | to | to | Und. | St. | $Y = 80.42 + 36.92 X_3 + 86.15 X_4$ | 95.64 | 0.25 | 21.98 | 60 | 1 |
| | 25 | .20 | .40 | .40 | 95 | 50 | 80 | Und. | Rt. | $Y = 66.55 + 1.81 X_1 - 102.06 X_3 + 0.36 X_6$ | 88.73 | 0.20 | 35.41 | 36 | 1 |

PHOTO 9

New Jersey Route 27 and Plainfield Avenue

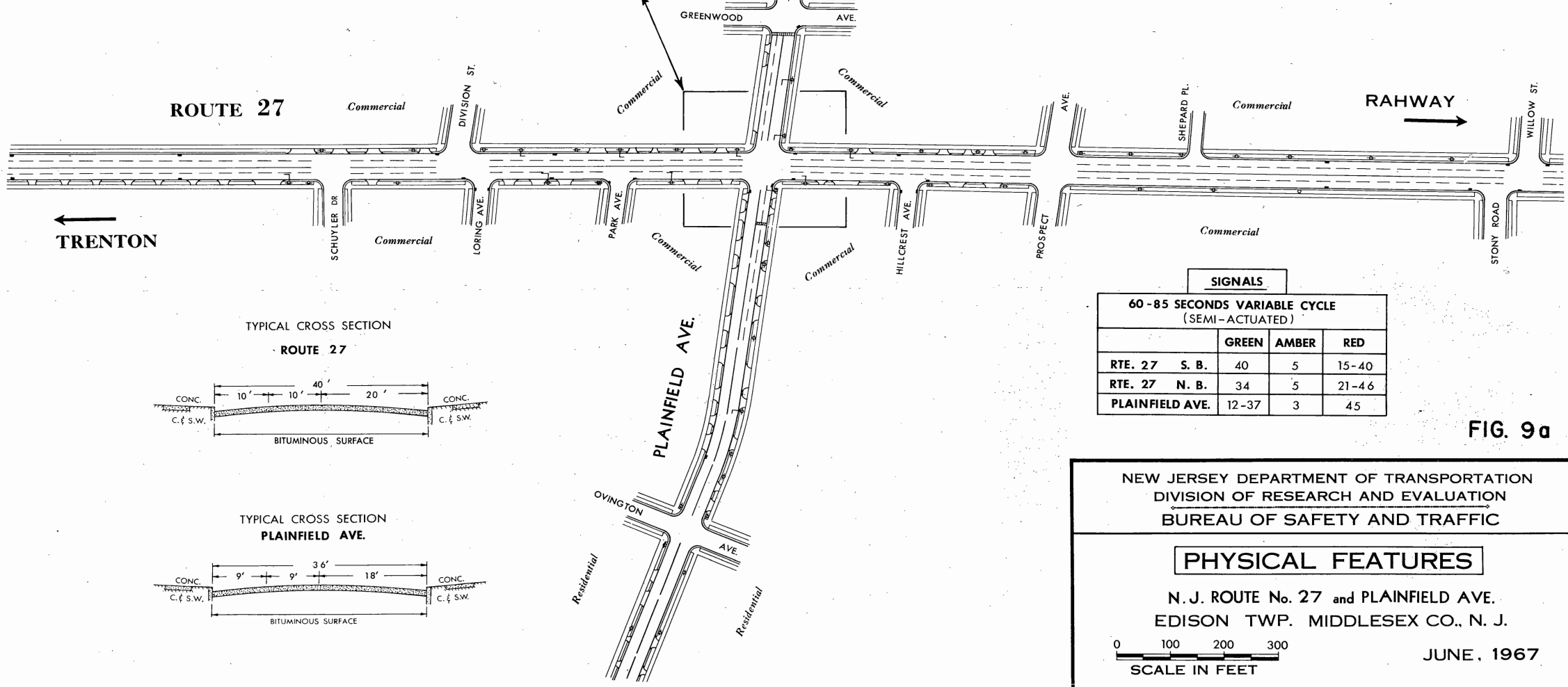
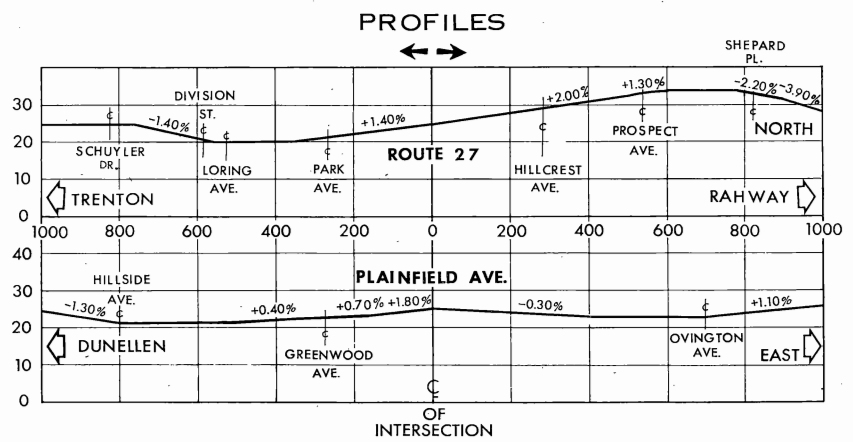
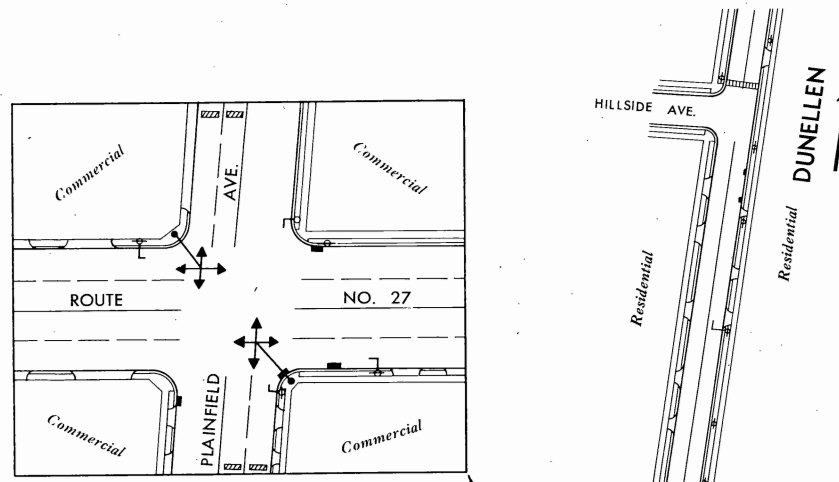
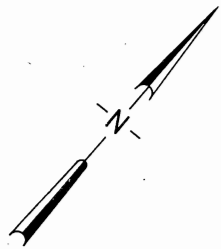
Signalized Intersection



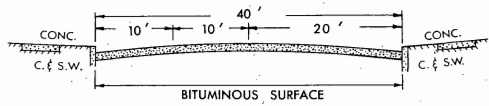
Photographed 6/1/67 - 1725 hours
500' Altitude, Looking South



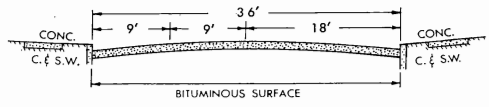
Photographed 6/1/67 - 1725 hours
700' Altitude, Looking Northwest



TYPICAL CROSS SECTION
ROUTE 27



TYPICAL CROSS SECTION
PLAINFIELD AVE.



| SIGNALS | | | |
|---|-------|-------|-------|
| 60-85 SECONDS VARIABLE CYCLE (SEMI-ACTUATED) | | | |
| | GREEN | AMBER | RED |
| RTE. 27 S. B. | 40 | 5 | 15-40 |
| RTE. 27 N. B. | 34 | 5 | 21-46 |
| PLAINFIELD AVE. | 12-37 | 3 | 45 |

FIG. 9a

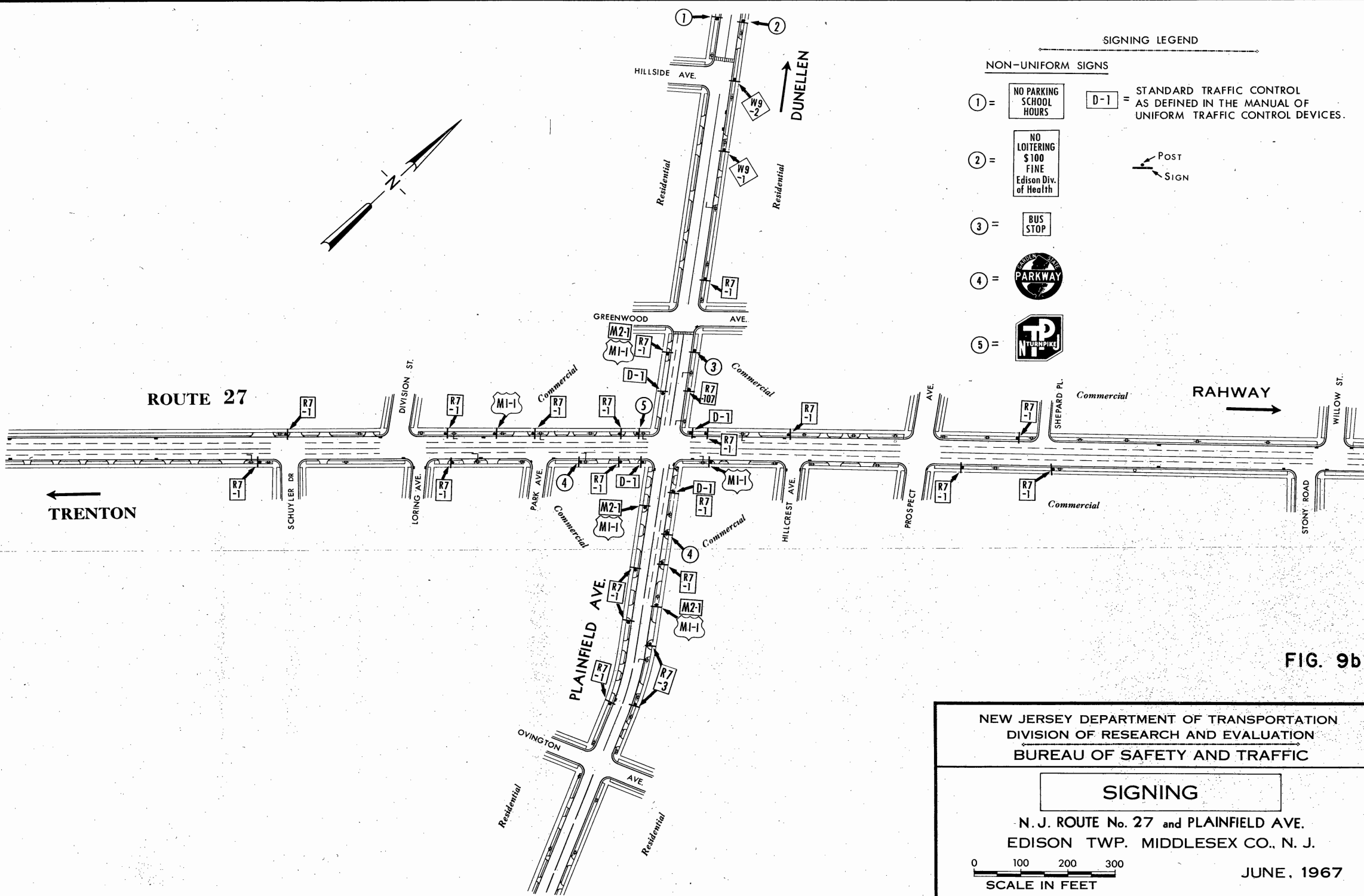
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

N. J. ROUTE No. 27 and PLAINFIELD AVE.
EDISON TWP. MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JUNE, 1967



SIGNING LEGEND

NON-UNIFORM SIGNS

- ① = NO PARKING SCHOOL HOURS
- ② = NO LOITERING \$100 FINE Edison Div. of Health
- ③ = BUS STOP
- ④ = PARKWAY
- ⑤ = TURNPIKE
- D-1 = STANDARD TRAFFIC CONTROL AS DEFINED IN THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.
- POST SIGN

FIG. 9b

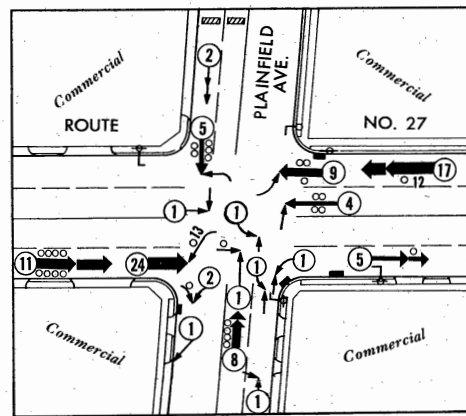
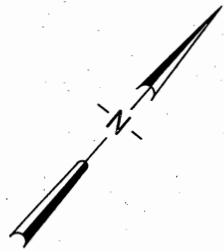
NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

SIGNING

N. J. ROUTE No. 27 and PLAINFIELD AVE.
EDISON TWP. MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JUNE, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|------------|-----------|------------|----------|------------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| ↘↗ RIGHT ANGLE | 65 | 47 | 113 | 1 | 46 | 66 |
| →↘ REAR END | 70 | 33 | 103 | 0 | 56 | 47 |
| → X FIXED OBJECT | 1 | 0 | 1 | 0 | 2 | 0 |
| ↔ HEAD-ON | 3 | 0 | 3 | 0 | 1 | 2 |
| ↘↗ PEDESTRIAN | 6 | 2 | 8 | 0 | 8 | 0 |
| ↔ SIDESWIPE | 0 | 0 | 0 | 0 | 0 | 0 |
| → OTHER | 5 | 4 | 9 | 0 | 5 | 4 |
| TOTAL | 150 | 86 | 237 | 1 | 118 | 119 |

○ = NUMBER OF ACCIDENTS AT EACH LOCATION

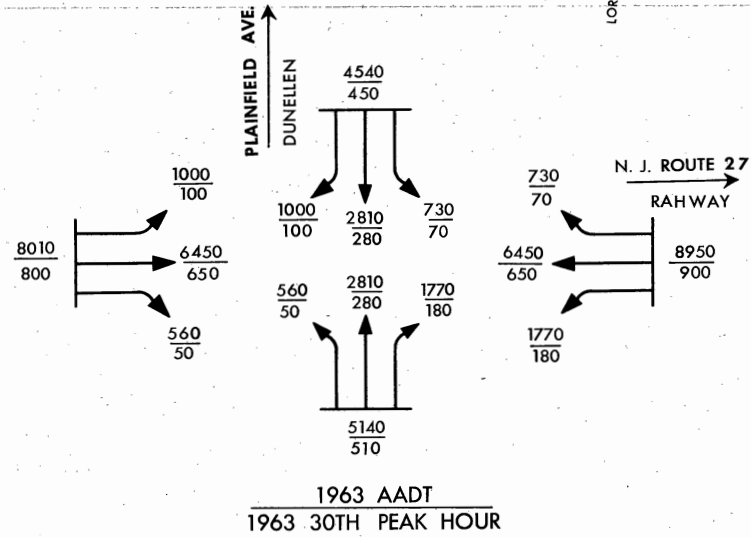
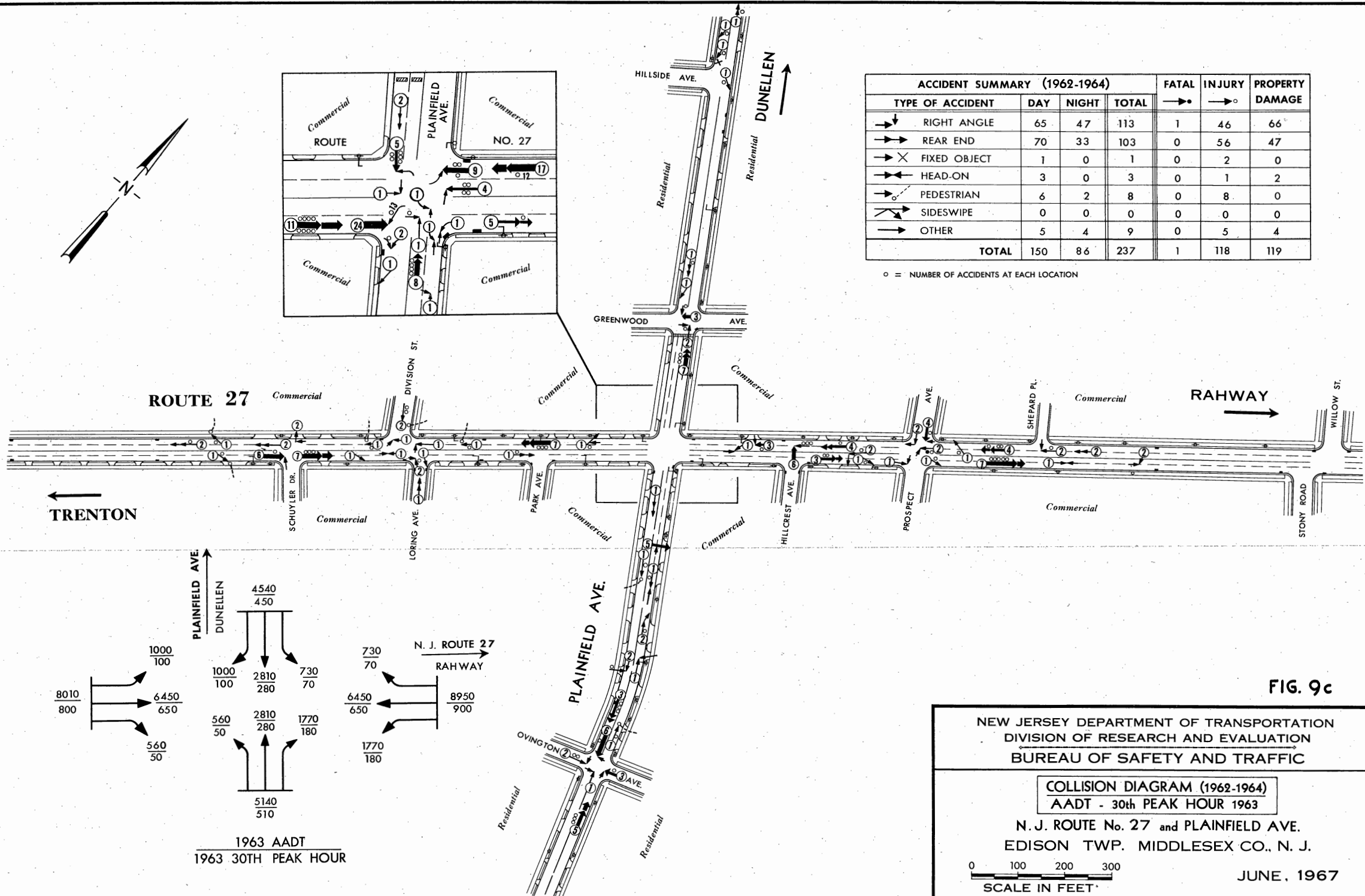


FIG. 9c

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

N. J. ROUTE No. 27 and PLAINFIELD AVE.
EDISON TWP. MIDDLESEX CO., N. J.

0 100 200 300
SCALE IN FEET

JUNE, 1967

TABLE 9

Independent Variables

- X_1 = Approach Volume (By Lane)
 X_2 = % Trucks (By Lane)/100
 X_3 = % Left Turns (By Lane)/100
 X_4 = % Right Turns (By Lane)/100
 X_5 = Right Hand Lane Volume from Left App.
 X_6 = Right Hand Lane Volume from Opposed App.
 X_7 = Right Hand Lane Volume from Right App.

TRAVEL TIMES

For

New Jersey Route 27 and Plainfield Avenue

Signalized Intersection

Year of Construction: 1955

Speed Limits

Major Leg - 40 Mph

Minor Leg - 35 Mph

| From | Range of Independent Variables 1.5 x Std. Deviation | | | | | | | To (Land Use) | Move- ment | Multiple Regression Equation for Travel Time | Mean Travel Time | R ² | Std. Error | No. Time Obs. | No. of Apps. |
|--|--|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|---------------|---|------------------------|----------------|---------------|---------------------|--------------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | X ₆ | X ₇ | | | | | | | | |
| Major Leg 2 lanes Com. | 15 | 0 | 0 | 0 | 25 | 15 | 25 | Res. | Lt. | $Y = 56.54 + 0.51 X_1 - .35 X_5 + 1.02 X_6$ | 83.30 | 0.10 | 24.62 | 171 | 2 |
| | to | to | to | to | to | to | to | Com. | St. | $Y = 61.46 + 0.59 X_1 - .34 X_5 + 0.39 X_6 - .13 X_7$ | 65.98 | 0.13 | 14.91 | 240 | 2 |
| | 45 | .20 | .50 | .35 | 75 | 45 | 75 | Res. | Rt. | $Y = 52.44 + 0.30 X_1 - 14.94 X_3 + 0.68 X_6 - 0.16 X_7$ | 73.72 | 0.09 | 23.00 | 139 | 2 |
| Minor Leg 1 lane w/ added lane at inter- section Res. | 25 | 0 | 0 | .05 | 15 | 5 | 15 | Com. | Lt. | $Y = 50.71 + 106.65 X_2 - 40.07 X_3 + 63.53 X_4 + 0.50 X_7$ | 78.42 | 0.11 | 21.77 | 54 | 1 |
| | to | to | to | to | to | to | to | Res. | St. | $Y = 60.40 + .25 X_1 + 19.90 X_2 - 0.10 X_6$ | 70.40 | 0.12 | 12.36 | 120 | 2 |
| | 75 | .20 | .25 | .50 | 50 | 80 | 45 | Com. | Rt. | $Y = 76.38 + 37.73 X_4 - 0.35 X_7$ | 76.55 | 0.11 | 15.80 | 119 | 2 |

PHOTO 10

U.S. Routes 1 & 9 Truck and Communipaw Avenue
Signalized Intersection



Photographed 6/29/67 - 1610 hours
700' Altitude, Looking West



Photographed 6/29/67 - 1610 hours
500' Altitude, Looking East

PROFILES

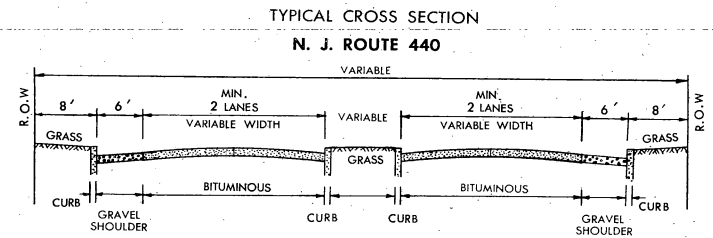
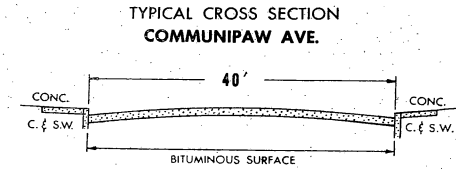
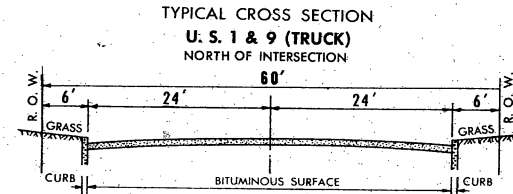
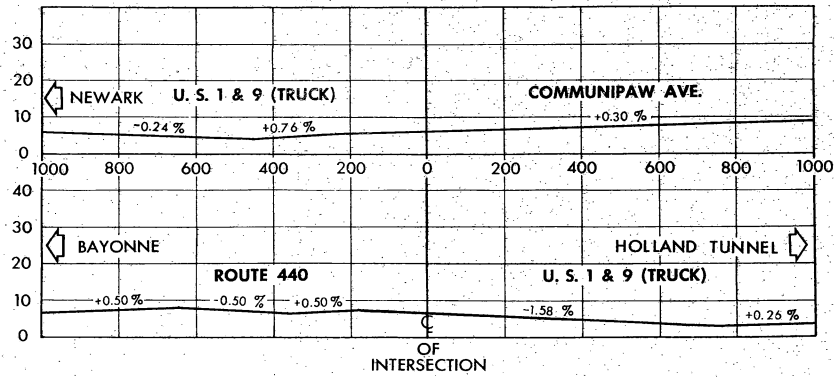
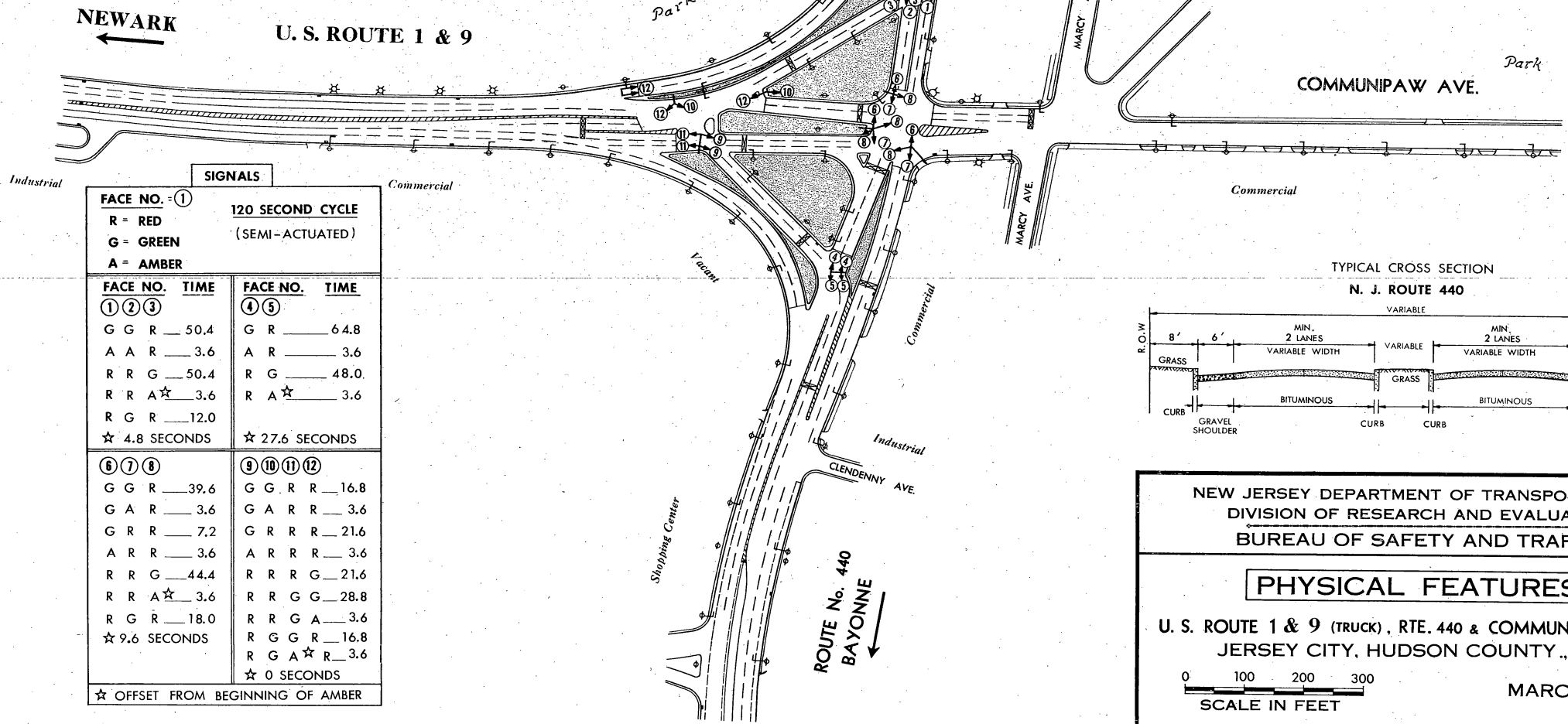


FIG 10a



SIGNALS

| | | | |
|----------------------------------|----------------|------------------|-----------------|
| FACE NO. = ① | | 120 SECOND CYCLE | |
| R = RED | | (SEMI-ACTUATED) | |
| G = GREEN | | | |
| A = AMBER | | | |
| FACE NO. TIME | FACE NO. TIME | FACE NO. TIME | FACE NO. TIME |
| ① ② ③ | ④ ⑤ | ⑥ ⑦ ⑧ | ⑨ ⑩ ⑪ ⑫ |
| G G R — 50.4 | G R — 64.8 | G G R — 39.6 | G G R R — 16.8 |
| A A R — 3.6 | A R — 3.6 | G A R — 3.6 | G A R R — 3.6 |
| R R G — 50.4 | R G — 48.0 | G R R — 7.2 | G R R R — 21.6 |
| R R A ☆ — 3.6 | R A ☆ — 3.6 | A R R — 3.6 | A R R R — 3.6 |
| R G R — 12.0 | | R R G — 44.4 | R R R G — 21.6 |
| ☆ 4.8 SECONDS | ☆ 27.6 SECONDS | R R A ☆ — 3.6 | R R G G — 28.8 |
| | | R G R — 18.0 | R R G A — 3.6 |
| | | ☆ 9.6 SECONDS | R G G R — 16.8 |
| | | | R G A ☆ R — 3.6 |
| | | | ☆ 0 SECONDS |
| ☆ OFFSET FROM BEGINNING OF AMBER | | | |

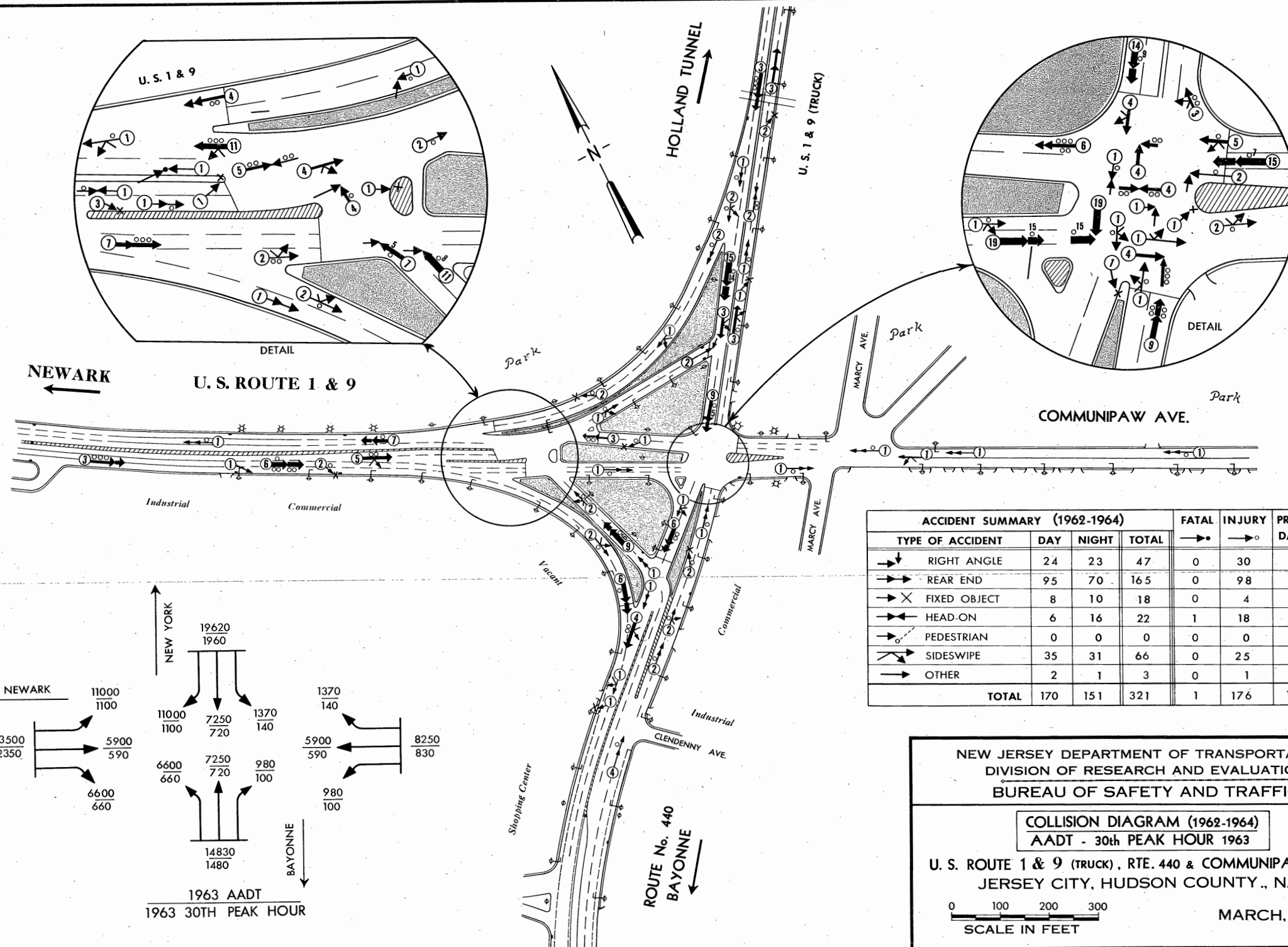
NEW JERSEY DEPARTMENT OF TRANSPORTATION
 DIVISION OF RESEARCH AND EVALUATION
 BUREAU OF SAFETY AND TRAFFIC

PHYSICAL FEATURES

U. S. ROUTE 1 & 9 (TRUCK), RTE. 440 & COMMUNIPAW AVE.
 JERSEY CITY, HUDSON COUNTY., N. J.

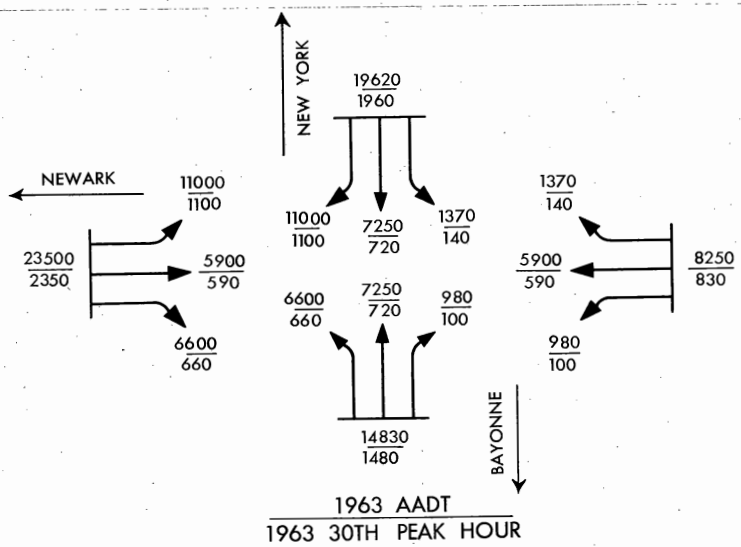
0 100 200 300
 SCALE IN FEET

MARCH, 1967



| ACCIDENT SUMMARY (1962-1964) | | | | FATAL | INJURY | PROPERTY DAMAGE |
|------------------------------|------------|------------|------------|----------|------------|-----------------|
| TYPE OF ACCIDENT | DAY | NIGHT | TOTAL | →● | →○ | |
| ↔ | 24 | 23 | 47 | 0 | 30 | 17 |
| →→ | 95 | 70 | 165 | 0 | 98 | 67 |
| →X | 8 | 10 | 18 | 0 | 4 | 14 |
| →↔ | 6 | 16 | 22 | 1 | 18 | 3 |
| →○ | 0 | 0 | 0 | 0 | 0 | 0 |
| ↔↔ | 35 | 31 | 66 | 0 | 25 | 41 |
| → | 2 | 1 | 3 | 0 | 1 | 2 |
| TOTAL | 170 | 151 | 321 | 1 | 176 | 144 |

FIG 10c



NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND EVALUATION
BUREAU OF SAFETY AND TRAFFIC

COLLISION DIAGRAM (1962-1964)
AADT - 30th PEAK HOUR 1963

U. S. ROUTE 1 & 9 (TRUCK), RTE. 440 & COMMUNIPAW AVE.
JERSEY CITY, HUDSON COUNTY., N. J.

0 100 200 300
SCALE IN FEET

MARCH, 1967

TRAVEL TIMES

For

U.S. 1 & 9 Truck and Communipaw Avenue

Signalized Intersection

Year of Construction: 1954

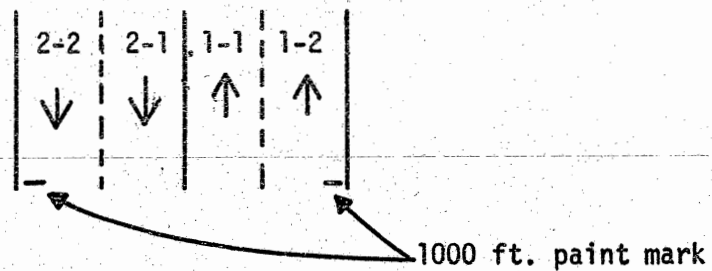
APPENDIX A

TRAVEL TIME STUDY PROCEDURE

FIELD PROCEDURE

At each of the ten sites, white paint markings were placed 1000' from the point of intersection of each of the legs. Measurements were taken with a measuring wheel. Schedules of field days were drawn up and stations were assigned. All inbound stations were given odd numbers, and outbound stations even numbers, and each lane itself was numbered. For example:

Station 2-1 outbound lefthand lane Station 1-1 inbound left-hand lane
 Station 2-2 outbound right-hand lane Station 1-2 inbound right-hand lane



In addition, field personnel were designated as Timers.

These men, with the use of Kodak timers, furnished the men at numbered stations with the time to the nearest second. This timing equipment was calibrated in the office prior to each field day.

During the study hours, each traffic collector recorded the first three numerals or letters and the time to the nearest second of each vehicle passing over his station. A "T" for truck was recorded prior to the first three digits for any vehicle with more than four tires. Panel trucks (pick-ups) were included with passenger cars for vehicle classification. Buses have been included with commercial vehicles. All misses were recorded as "X" or, in the case of a truck miss, "T-X." This is necessary to classify the entering and exiting volumes.

To avoid constraining the recorder within lines or margins, pre-drawn data sheets were not used.

In addition, a state vehicle traversed the intersection and was recorded entering and exiting the intersection. Travel time, for all movements, was taken by the driver with the aid of a stop watch and later compared with field data as a check on the Kodak timers.

FIELD PERSONNEL

College students temporarily employed for the summer were utilized as both traffic collectors and timers. Supervision was furnished by one Research Engineer II and one Assistant Engineer

FIELD EQUIPMENT

Kodak timers - Clip boards - Legal size pads

During the summer of 1967, tape recorders were used instead of field sheets. Each station (e.g. 1-1) was covered by a man equipped with a tape recorder and Kodak timer. Coding was done in the field as well as the office in the same format as 1966.

FIELD SCHEDULE

| | |
|--|---|
| 1 U.S. 1 & 9 Truck & Communipaw Ave. Jersey City, Hudson County | Monday, August 7, 1967 Weather: hot, humid |
| 2 N.J. 35 & Rt. 440 Perth Amboy, Middlesex County | Thursday, June 30, 1966 Weather: hot, humid |
| 3 U.S. 1 & Milltown Rd. New Brunswick Twp., Middlesex Co. | Tuesday, July 7, 1966 Weather: clear, warm |
| 4 U.S. 1 & Ryders Lane North Brunswick Township, Midd. Co. | Tuesday, July 12, 1966 Weather: Hot, humid |
| 5 U.S. 1 & 9 & Rt. 35 Woodbridge Twp., Middlesex Co. | Thursday, July 14, 1966 Weather: hot, overcast |
| 6 U.S. 1 & 9 & Bayway Circle Elizabeth, Union Co. | Thursday, July 21, 1966 Weather: clear, warm |
| 7 Rt. 27 & Plainfield Ave. Edison Twp., Middlesex Co. | Tuesday, July 26, 1966 Weather: hot, humid |
| 8 U.S. 1 & Green Street Circle Woodbridge, Middlesex County | Thursday, July 28, 1966 Weather: overcast, intermittent light rain |
| 9 U.S. 1 & Rt. 18 New Brunswick, Middlesex Co. | Tuesday, August 2, 1966 Weather: overcast, intermittent light rain in late afternoon |
| 10 Rts. 4 & 17 Paramus Borough, Bergen County | Thursday, August 4, 1966 Weather: clear, warm |

The study hours were from 7 - 9 a.m.
11 - Noon
2 - 3 p.m.
4 - 6 p.m.

With the exceptions of sites: #1 - 7:30 - 8:30 a.m.
12:30 - 1:30 p.m.
4:30 - 5:30 p.m.

#8 - 8:00 - 9:00 a.m.
12:00 - 2:00 p.m.
4:00 - 6:00 p.m.

#10 - 7:00 - 9:00 a.m.
11:00 - Noon
2:00 - 3:00 p.m.
4:00 - 5:00 p.m.

OFFICE PROCEDURE

The travel times for all movements were formulated in regression equations, using seven independent variables.

Data sheets were coded and submitted to the computer center to be punched and sorted.

Volumes and vehicle classification (% trucks) were tabulated by six-minute intervals. After the license plates were matched by Program I (see explanation of Program I), data sheets for Program II (see explanation) were coded using the dependent variable, travel time, obtained in Program I. The independent variables for Program II are approach volume per lane, % trucks per lane, % left turns, % right turns, and the right lane volumes from the three other approaches. Approach

W. R. Bellis, F. Melton, E. F. Reilly

volume, % trucks and approach volumes from other directions are obtained from field data; % left and % right turns are obtained from the print-out of Program I.

Program I - License Plate Matching

Purpose: This program prints out the average time it takes for vehicles to pass between preset points in an intersection of four legs. Travel times for each inbound lane are given for all possible movements through the intersection from each of its approaches. The average times are classified separately for cars and commercial vehicles, and the maximum and minimum times between points are similarly presented.

Method: Travel times are determined by matching the license plates which have been field-recorded at the intersection. If these characters are identical for an approach and exit point, and the difference in time between the two points is within the range from twenty seconds to five minutes, this event is recorded as a match and the travel time is stored. This procedure continues until all the data for a given period (one or two hours) has been computer-read.

Besides being classified according to vehicle type, output is further broken down into six-minute intervals. Thus, for a one-hour study, there will be ten average travel times for cars and for trucks, one for each six-minute period.

Input (Punched Cards): Location points on the intersection are punched in Cols. 1-2, lane number in Col. 4, vehicle type in Col. 6, license plate characters in Cols. 11-13, time passing the point in Cols. 18-23 (military time to nearest second), and date in Cols. 28-31.

Program II - Step-wise Regression Analysis

Regression analysis is the study of correlations between observed data and the formation of equations relating one dependent variable with several independent variables. In our study, the dependent variable (Y = travel time) is related to the seven independent variables stated in the office procedure.

A program has been utilized to perform a step-wise output. Each step contains the following information:

- 1) Step number,
- 2) Number of variable entering the equation,

- 3) Pure constant in the equation,
- 4) Standard error of estimate of "Y"
- 5) "F" value for entering variable,
- 6) Regression coefficients for each variable
in the equation,
- 7) Standard error of each coefficient, and
- 8) R^2 or square of multiple correlation
coefficient for the equation at this step.

Item #8 was selected as the criteria for acceptance of an equation. For example, if the increase in R^2 from steps 3 to 4 was less than 10%, step 3 was selected.

APPENDIX B

ACCIDENT ANALYSIS

ACCIDENT DATA COLLECTION & PRESENTATION FORMAT

Traffic accident data was furnished by the New Jersey Motor Vehicle Division for the years 1962, 1963, and 1964 for the ten intersections studied in 1966. This data is shown both pictorially and in tabular form on the Collision Diagrams for each intersection.

By utilizing the standardized drawing of each intersection, exact location of accidents, their type (rear end, side swipe, etc.) and the number of each type of accident is shown.

The accident type is tabulated by severity and night or day.

EXPOSURE INDICES FOR ACCIDENTS

The usual procedure for comparing accident experience at various sites is the use of a service volume and length base (given in vehicle-miles). Using this procedure in the present study, the approach volumes (service volumes) would be summed for an intersection and used for the base of an accident rate comparison. Length is superflous, since all intersecting roads are 2000 feet in length. The latter modification of the

rate is not satisfactory, however, for comparisons of several intersections. The traffic patterns differ from one intersection to another, emphasizing a difference in exposure for similar type movements. It is this difference in exposure between similar movements that must be equated before a comparison of two or more intersections can be studied. An example of the need for equating movements, rather than just volumes is as follows:

2000 approach vehicles (A) 500 exit, w/6 accs. @ ramp.
(B) 100 exit, w/6 accs. @ ramp.

Base: 1. Approach volume

$$\text{Rate (A)} = \frac{6 \text{ acc.}}{2000} = 3 \text{ acc./}10^3 \text{ veh.}$$

$$\text{Rate (B)} = \frac{6}{2000} = 3/10^3$$

2. Ramp exit volume

$$\text{Rate (A)} = \frac{6 \text{ acc.}}{500} = 12/10^3$$

$$\text{Rate (B)} = \frac{6}{100} = 60/10^3$$

3. Exposure Index

$$\text{Rate (A)} = \frac{6}{(500 \times 1500)} = 8/10^6$$

$$\text{Rate (B)} = \frac{6}{(100 \times 1900)} = 31.6/10^6$$

The rates calculated under bases 1 and 2 give no consideration to the conflicts which exist. If anything, they are measures of the approach roadway and ramp designs, respectively. But even in this capacity, they are inaccurate, since the accidents used for the rate involve both roadway volumes. The exposure index base accounts for the potential conflicts of the diverging streams. In this capacity, its use is justified. For equal approach volumes and accidents, the rate varies as the inverse of the product of through and exiting traffic volumes.

The derivation of the index for each type interchange studied under this project is developed in the following subsections. The three-year accident data was averaged to eliminate annual fluctuations.

1. Signalized At-grade Intersections

The analysis of at-grade intersections accidents was considered in two steps. The first step considered the approach to the intersection. Using the multiple regression technique, five independent variables were used. These variables were:

X_1 = number of combinations of any two vehicles conflicting within the length of time of a cycle.

Using figure B1, we can graphically interpret the number of conflicts per cycle. Enter the chart with known cycle length, come down to AADT, come across to combination curve and read down to the number of conflicts.

X_2 = left turn conflicts, which is the multiple of the AADTs of left-turn and straight through movements/1000.

X_3 = right turn conflicts.

X_4 = number of lanes on approach (not at the intersection).

X_5 = speed limit on the approach.

The dependent variable Y = number of accidents per year.

The accidents considered were rear end, side-swipe and fixed objects. Seven signalized intersections with twenty-eight approaches were used to develop the equation (See table B1). The resulting regression equation is:

$$Y = - 0.127 + .025 X_1 + 0.235 X_3$$

with

$$\text{Error of Est.} = 3.42$$

$$R^2 = 0.802$$

$$F = 5.62$$

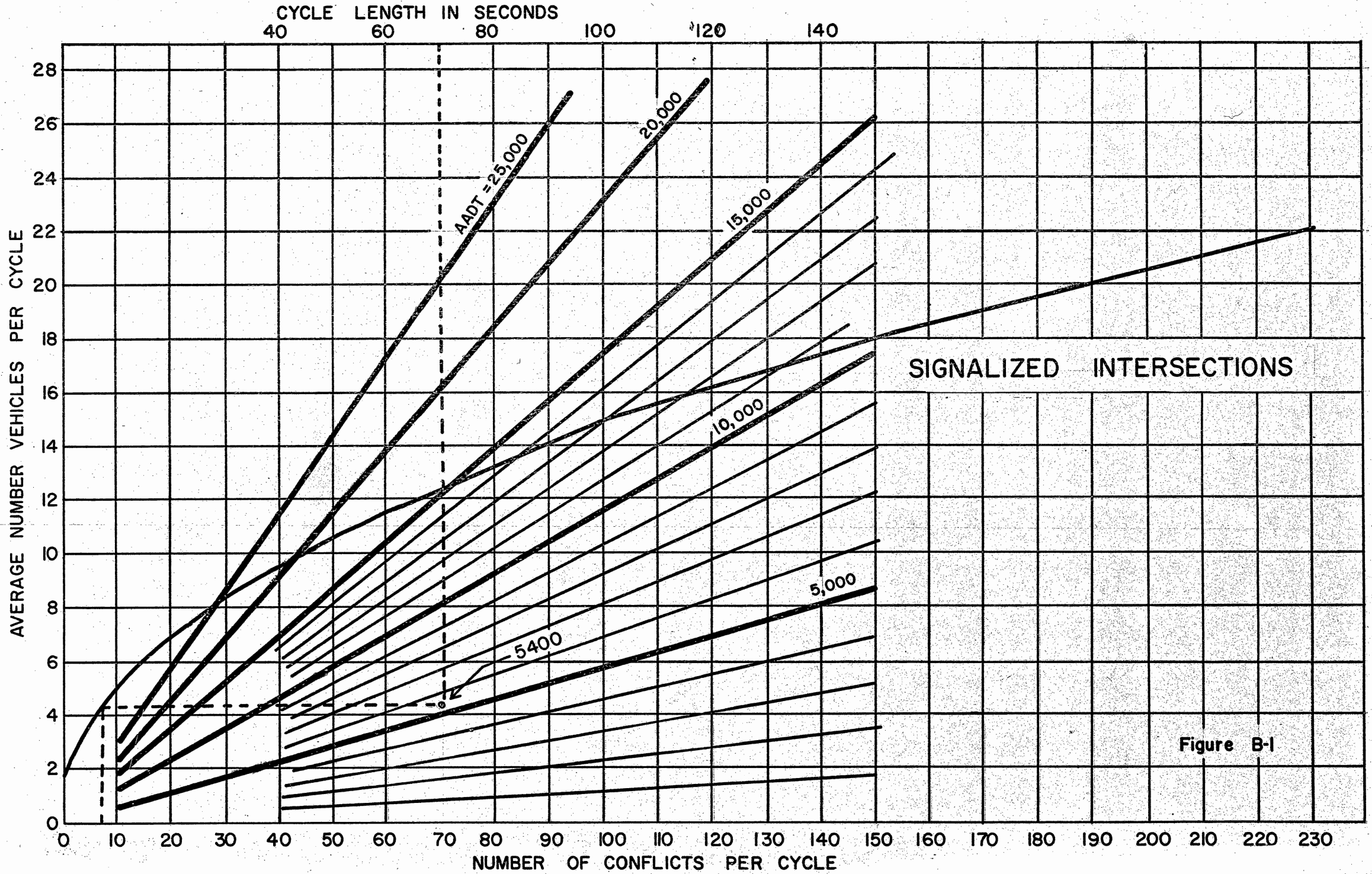


Figure B-1

TABLE B1

Signalized Intersection Data Used to Develop
Accident Equation for Approach Legs

| Intersection | Independent Variables | | | | | Dep. Var. Y | Intersection | Independent Variables | | | | | Dep. Var. Y |
|---------------------|-----------------------|----------------|----------------|----------------|----------------|-------------|---------------------|-----------------------|----------------|----------------|----------------|----------------|-------------|
| | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | | | X ₁ | X ₂ | X ₃ | X ₄ | X ₅ | |
| Rt. 27 - Plainfield | 18 | 6.45 | 3.61 | 2 | 40 | 3.67 | Rt. 31 - Olden | 17 | 6.75 | 2.50 | 2 | 35 | 1.00 |
| | 23 | 11.42 | 4.71 | 2 | 40 | 5.67 | | 24 | 13.75 | 2.00 | 2 | 35 | 2.67 |
| | 6 | 1.57 | 4.97 | 1 | 35 | 2.67 | | 35 | 3.20 | 7.60 | 2 | 40 | 2.00 |
| | 5 | 2.05 | 2.81 | 1 | 35 | 0.67 | | 24 | 2.56 | 8.64 | 2 | 40 | 0.67 |
| Rt. 35 - Smith | 41 | 0.96 | 19.68 | 2 | 45 | 3.00 | Rt. 82 - Stuyvesant | 100 | - | 15.50 | 1 | 25 | 1.00 |
| | 29 | 7.20 | 6.72 | 2 | 35 | 4.33 | | 91 | - | 12.00 | 1 | 25 | 1.67 |
| | 38 | 3.53 | 4.95 | 1 | 25 | 3.33 | | 164 | - | 18.70 | 1 | 30 | 3.00 |
| | 10 | 4.62 | 0.66 | 1 | 25 | 2.67 | | 167 | - | 20.20 | 2 | 30 | 4.67 |
| Rt. 35 - Main | 23 | 4.35 | 8.27 | 2 | 35 | 1.33 | Rt. 1-9 - Wood | 516 | 17.63 | 11.86 | 3 | 35 | 11.00 |
| | 21 | 5.51 | 5.45 | 2 | 35 | 3.00 | | 557 | 20.62 | 28.82 | 3 | 35 | 18.67 |
| | 11 | 4.50 | 3.00 | 1 | 25 | 2.67 | | 15 | 1.48 | 2.58 | 1 | 25 | 1.33 |
| | 7 | 2.97 | 2.37 | 1 | 25 | 2.00 | | 20 | 3.60 | 2.20 | 1 | 25 | 1.00 |
| | | | | | | | Rt. 1-9 - Stiles | 585 | 4.07 | 15.47 | 3 | 35 | 17.00 |
| | | | | | | | | 571 | 4.97 | 42.80 | 3 | 35 | 35.00 |
| | | | | | | | | 6 | 1.33 | 0.43 | 1 | 25 | 1.33 |
| | | | | | | | | 26 | 3.67 | 3.35 | 1 | 25 | 1.67 |

The second step in this procedure is to determine the right angle and left turn accidents within an intersection. Using the same seven intersections as in step one, the conflict approach developed by Grossman, HRB proceedings, 1954, and Surti, Traffic Engineering, 12/65, accidents are plotted vs. potential conflicts. The potential conflict is the multiple of the AADT of two crossing streams divided by 10⁶. Because 98% of the intersection accidents were right angle and left turn accidents, only they were considered. Figure B2 graphically shows the results of this analysis.

It is apparent that the relationship between potential conflicts and left turn accidents is affected by:

- a) Number of lanes on the approach leg,
- b) Addition of a lane at the intersection, and
- c) A lead green.

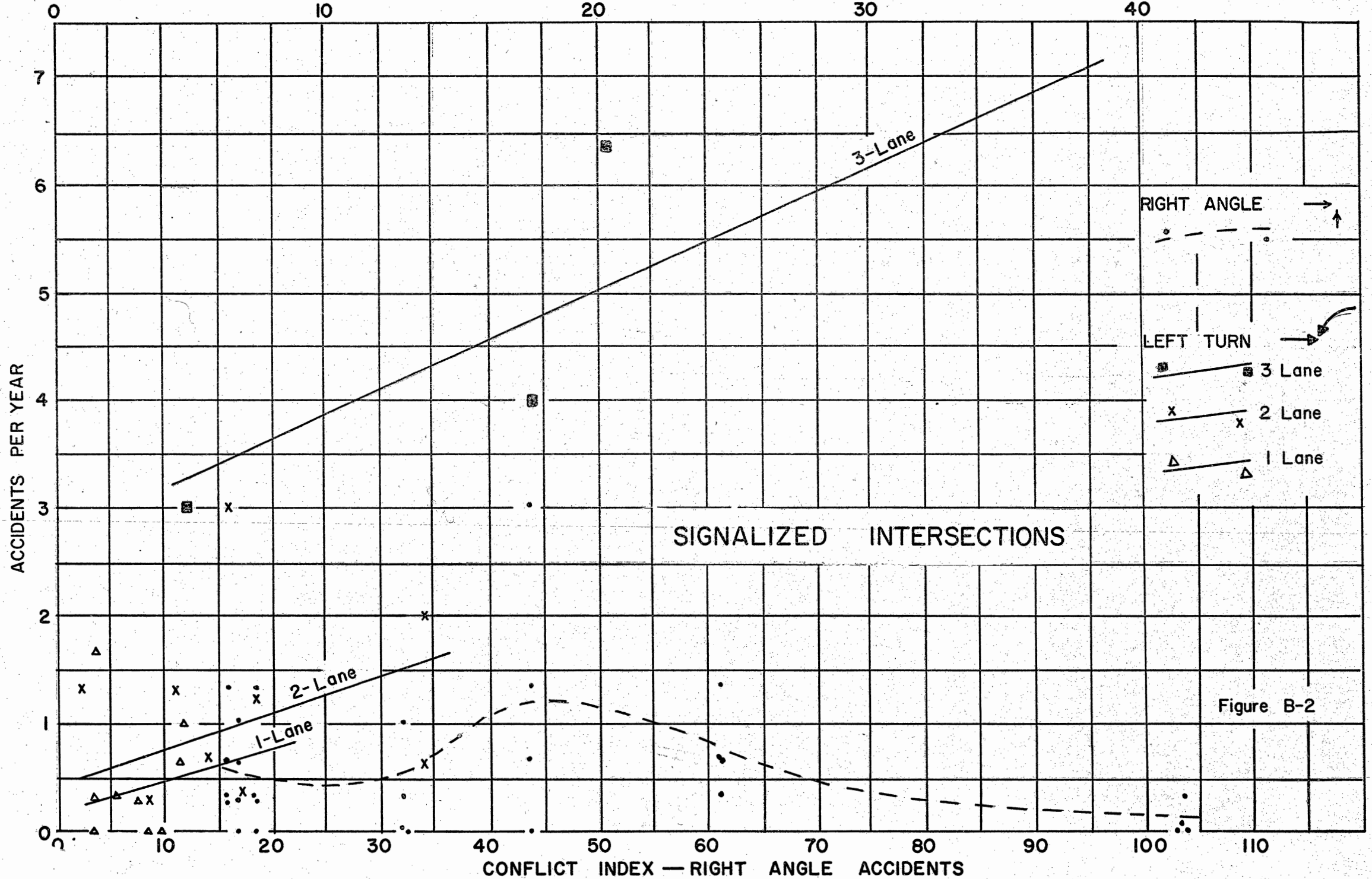
The range of the conflict index is directly proportionate to the number of lanes. The sample size used to develop the curve for a particular number of lanes is:

- 3 lanes - 4 samples
- 2 lanes - 11 samples
- 1 lane - 9 samples

The observations for the 1-lane legs are further complicated by the addition of another lane at the intersection for 5 of the 9 samples. The lead green at one of the 2-lane legs reduces this sample to 10. Without a sufficient sample size and range of conflict index values for these various designs, only a hand fitted curve can be shown for the left-turn accidents within an intersection.

Similar results are evident when the right angle accidents are analyzed. Because of the balanced AADT flow at an intersection, any one site will yield the same potential conflict for all four possible right angle accidents. The seven sites used for this study tend to show a high point in the accident index curve at the intermediate values for the index. However, only one site falls in the intermediate index range -- and inferences cannot be drawn at this time.

The additional data that can be obtained from other sites will be added to these seven to verify a technique of predicting accidents at signalized at-grade intersections.



2. Cloverleaf Design

The accident exposure index previously developed has again been utilized to mathematize accident experience at cloverleaves. After attempting several approaches to devise a useful technique, the cloverleaf was separated into the segments depicted in figure B3. The accidents attributed to each of the three movements (left, straight, and right) are included in the appropriate shaded or clear areas.

The accident experience is directly related to the exposure index. The exposure index is the multiple of the two diverging or merging traffic streams. For this technique, the following procedure was developed for determining the exposure index for a movement. The example is for the movements from the south leg.

$$\text{Left Turn Index} = V_L [V_S + V_{\text{East (Lt.)}} + V_{\text{West (Lt.)}}]$$

$$\text{Right Turn Index} = V_R [V_S + V_L] + V_{\text{West (St.)}} + V_{\text{North (Lt.)}}$$

$$\text{Straight Thru Index} = V_S [V_L + 2V_{\text{East (Lt.)}} + V_{\text{West (Rt.)}}]$$

The nomenclature for these equations is:

V_S - Volume straight thru from South leg

V_R - Volume turning right from South leg

V_L - Volume turning left from South leg

$V_{\text{North (Lt.)}}$ - Volume from North turning left

$V_{\text{West (St.)}}$ - Volume from West going straight

$V_{\text{East (Lt.)}}$ - Volume from East turning left

All Volumes divided by 1000

Using the four cloverleaves reported in this study with a total of sixteen legs, table B2 tabulates the results of the least squares regression equation, which is graphically shown in figure B4.

CLOVERLEAF

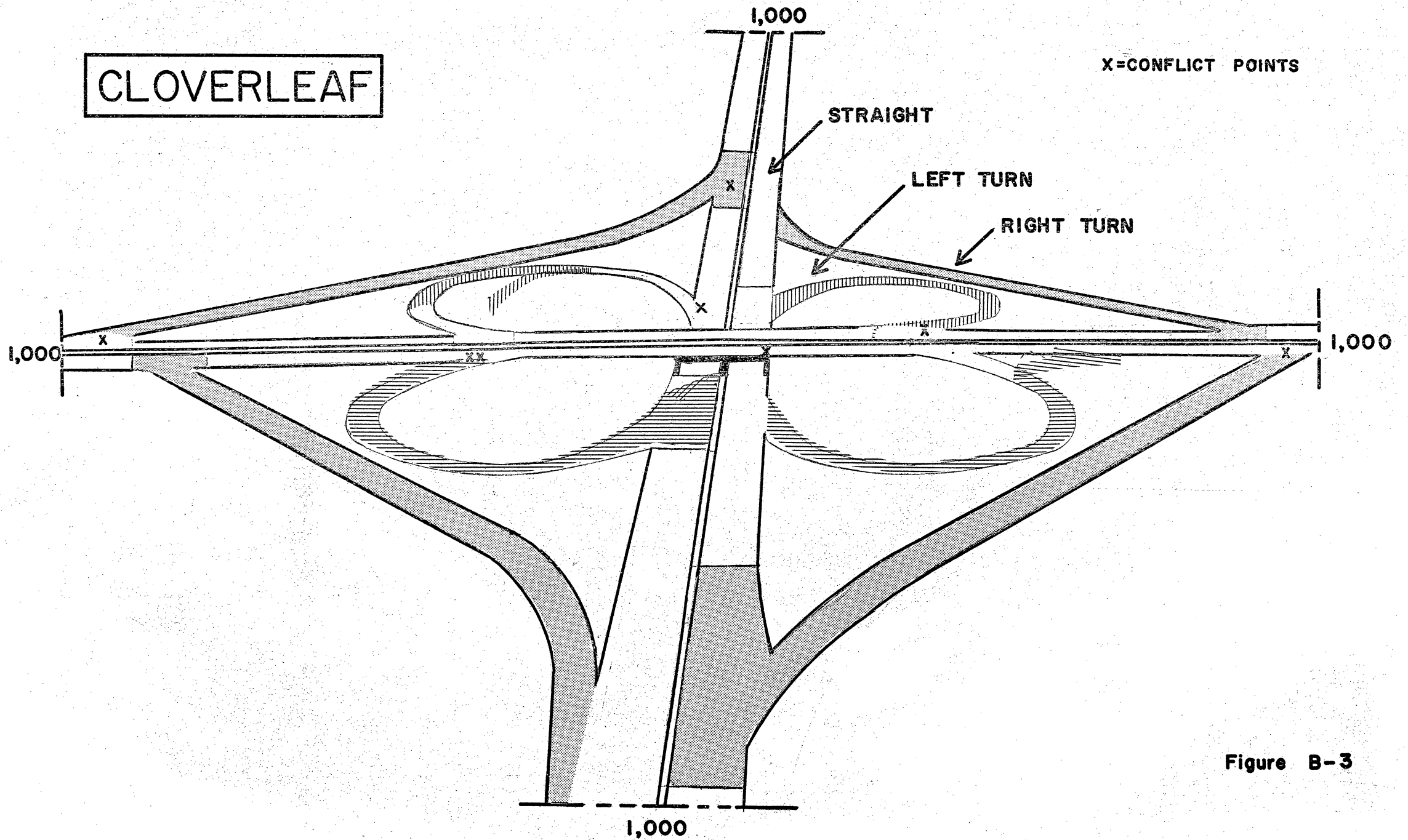


Figure B-3

TABLE B2

Cloverleaf Regression Equations

| Movement: | Land Use Activity | Number of Samples | Constant A_0 | Coefficient A_1 | S_{yx} | r |
|-----------|-------------------|-------------------|----------------|-------------------|----------|------|
| Right | Light | 10 | - 0.05 | 0.87 | 0.72 | 0.43 |
| | Heavy | 6 | - 57.61 | 30.68 | 2.88 | 0.89 |
| Left | Light | 10 | - 1.04 | 1.58 | 0.65 | 0.72 |
| | Heavy | 6 | -139.96 | 70.08 | 2.52 | 0.97 |
| Straight | All | 13 | - 4.91 | 3.79 | 0.89 | 0.91 |

TABLE B3

Data Used to Develop Accident Equation for Cloverleaf

| <u>Intersection</u> | <u>From</u> | <u>M O V E M E N T</u> | | | | | |
|-----------------------|-------------|------------------------|-----------------|------------------|-----------------|------------------------|-----------------|
| | | <u>R I G H T</u> | | <u>L E F T</u> | | <u>S T R A I G H T</u> | |
| | | <u>Accidents</u> | <u>Exposure</u> | <u>Accidents</u> | <u>Exposure</u> | <u>Accidents</u> | <u>Exposure</u> |
| U.S. Rt. 1 & N.J. 18 | North | 1.167 | 186.6 | 2.500 | 259.6 | 3.000 | 89.6 |
| | South | 5.333 | 158.3 | 1.667 | 42.1 | 7.667 | 236.4 |
| | East | 3.333 | 252.7 | 5.667 | 120.0 | 4.333 | 153.4 |
| | West | 0.667 | 61.5 | 4.667 | 117.8 | 4.333 | 215.5 |
| U.S. 1 & 9 & N.J. 35 | North | 2.000 | 22.2 | 3.000 | 29.1 | 6.667 | 118.6 |
| | South | 1.667 | 30.5 | 2.000 | 82.7 | 2.667 | 111.4 |
| | East | 1.333 | 32.0 | 0.667 | 15.7 | 1.000 | 30.6 |
| | West | 6.667 | 91.1 | 0.667 | 11.5 | 0.333 | 16.1 |
| U.S. 1 & Milltown Rd. | North | 1.000 | 61.5 | 0.333 | 21.4 | 0.667 | 50.2 |
| | South | 1.333 | 23.2 | 1.000 | 20.1 | 0.667 | 80.8 |
| | East | 0.333 | 26.2 | 0.333 | 7.4 | 0.667 | 26.3 |
| | West | 1.333 | 24.5 | 0.333 | 19.4 | 0.333 | 26.6 |
| N.J. Rts. 4 & 17 | North | 14.000 | 246.9 | 40.000 | 380.2 | 4.000 | 602.6 |
| | South | 9.333 | 168.0 | 38.667 | 305.5 | 5.333 | 482.1 |
| | East | 26.000 | 404.5 | 34.333 | 329.2 | 7.333 | 704.9 |
| | West | 15.000 | 245.3 | 47.333 | 478.9 | 13.000 | 896.5 |

Note: Accidents are yearly average of 1962-1964 data.
Exposure based on 1963 AADT.

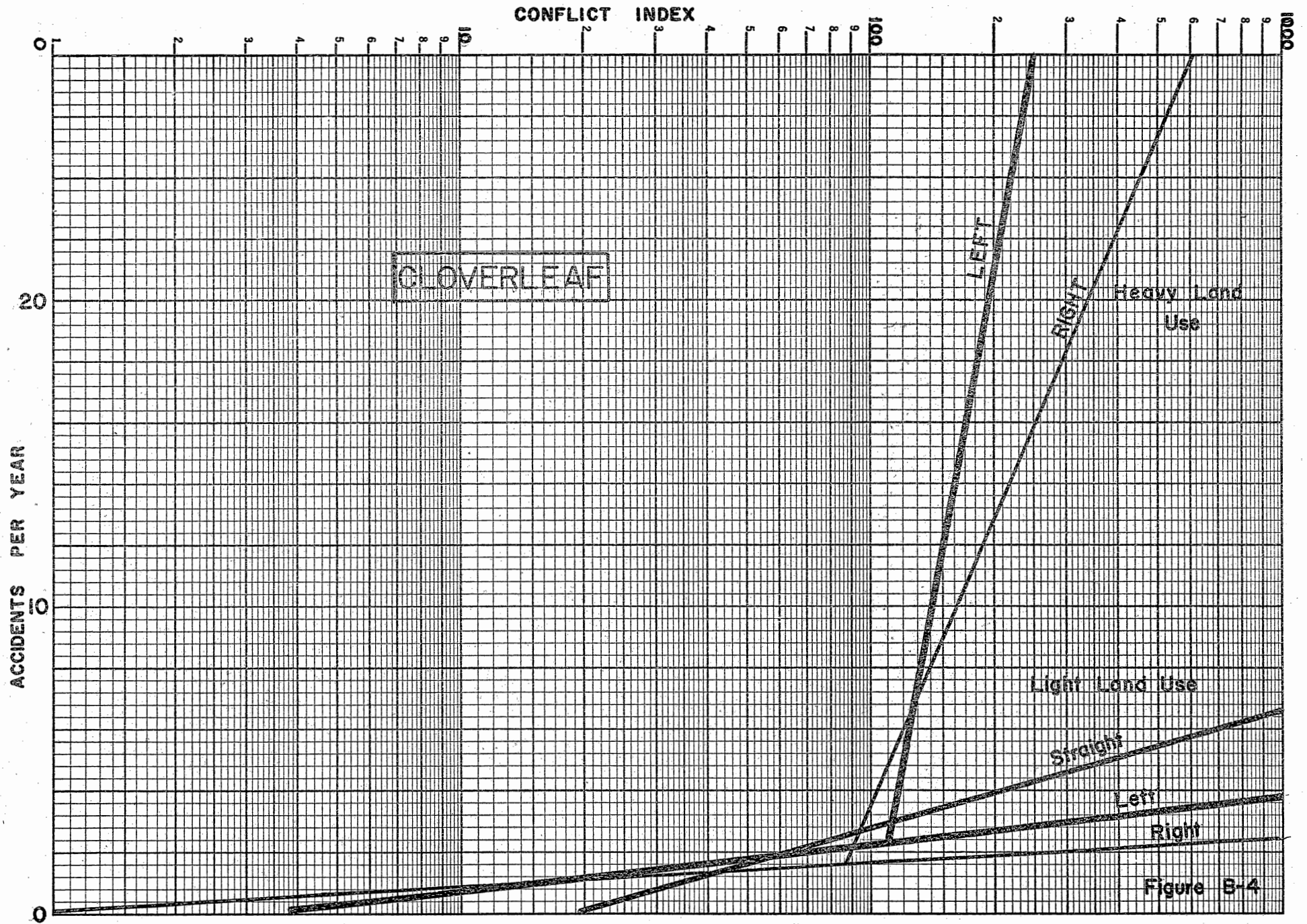




Figure B-4


APPENDIX C


LEGEND FOR PHYSICAL FEATURES PLANS


LEGEND FOR PHYSICAL FEATURES PLAN

Grass Area 


Mast Arm Signal Installation 


Signal Installation on Pole 


Curbing 

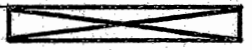
Edge of Shoulder 

Edge of Pavement 

Light Pole 

Public Utility Pole 


Public Utility Pole with Light 

8 Ft. Pressure Vehicle Detector 

Catch Basin 


Gantry Sign 

Edge of Woods 

Transmission Tower 

Fence 

Guardrail 

Concrete Median 

Median Barrier 

Land Use - Com. - Commercial Development
Und. - Undeveloped
Vac. - Vacant
Res. - Residential
Shp. Ctr. - Shopping Center
Ind. - Industrial

REFERENCES

REFERENCES

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