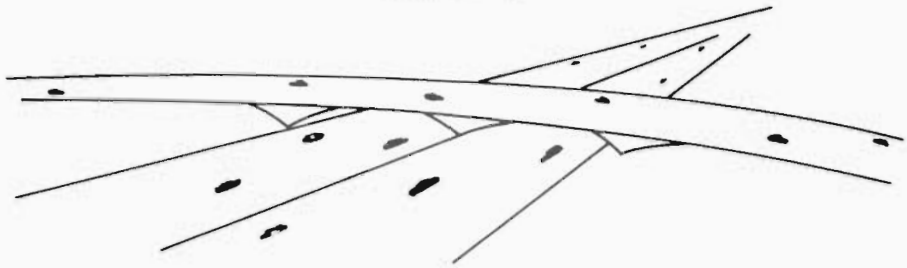


DEPARTMENTAL RESEARCH

Report Number SS 5.4

NOISE STUDY OF A TWO-LEVEL FREEWAY

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-TX-79-SS-5.4		

4. Title and Subtitle	5. Report Date
Noise Study of a Two-Level Freeway	April, 1979
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
R. C. Rutland	SS 5.4

9. Performing Organization Name and Address	10. Work Unit No.
State Department of Highways and Public Transportation Highway Design Division 11th & Brazos Austin, Texas 78701	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
same	Final January 1972-April, 1979
	14. Sponsoring Agency Code

15. Supplementary Notes

Report published in cooperation with FHWA

16. Abstract

This is a noise study of a two-level freeway in Austin, Texas. In January 1972, when plans were underway to construct the second level, 17 traffic noise measurement sites were selected at both rights of way lines from 12th street north to 38½ street. At the same time, 13 additional sites (for a total of 30 sites) were selected one block east and west of the facility. Traffic noise measurements were made at each site using an "A" weighted, Type 2 sound level meter connected to a graphic level recorder. The information from the recorder was digitized using an x-y plotter and analyzed by a computer to produce the histogram and to determine the L10, L50, and L90 exceedence levels. Noise measurements were taken in January 1972, June 1975, and December 1976. Plans were made to repeat measurements in late 1978 or early 1979. A study at these dates revealed too few sites still existed. This report describes the results of the noise study.

17. Key Words	18. Distribution Statement
traffic noise	no restriction

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
unclassified	unclassified	27	

Form DOT F 1700.7 (8-69)

NOISE STUDY
OF A
TWO LEVEL FREEWAY

BY

Robert C. Rutland

State Department of Highways

and Public Transportation

Special Study Report
SS 5.4

April, 1979

DISCLAIMER

The opinions expressed and the conclusions reached herein are those of the author and do not necessarily reflect the views of the State Department of Highways and Public Transportation.

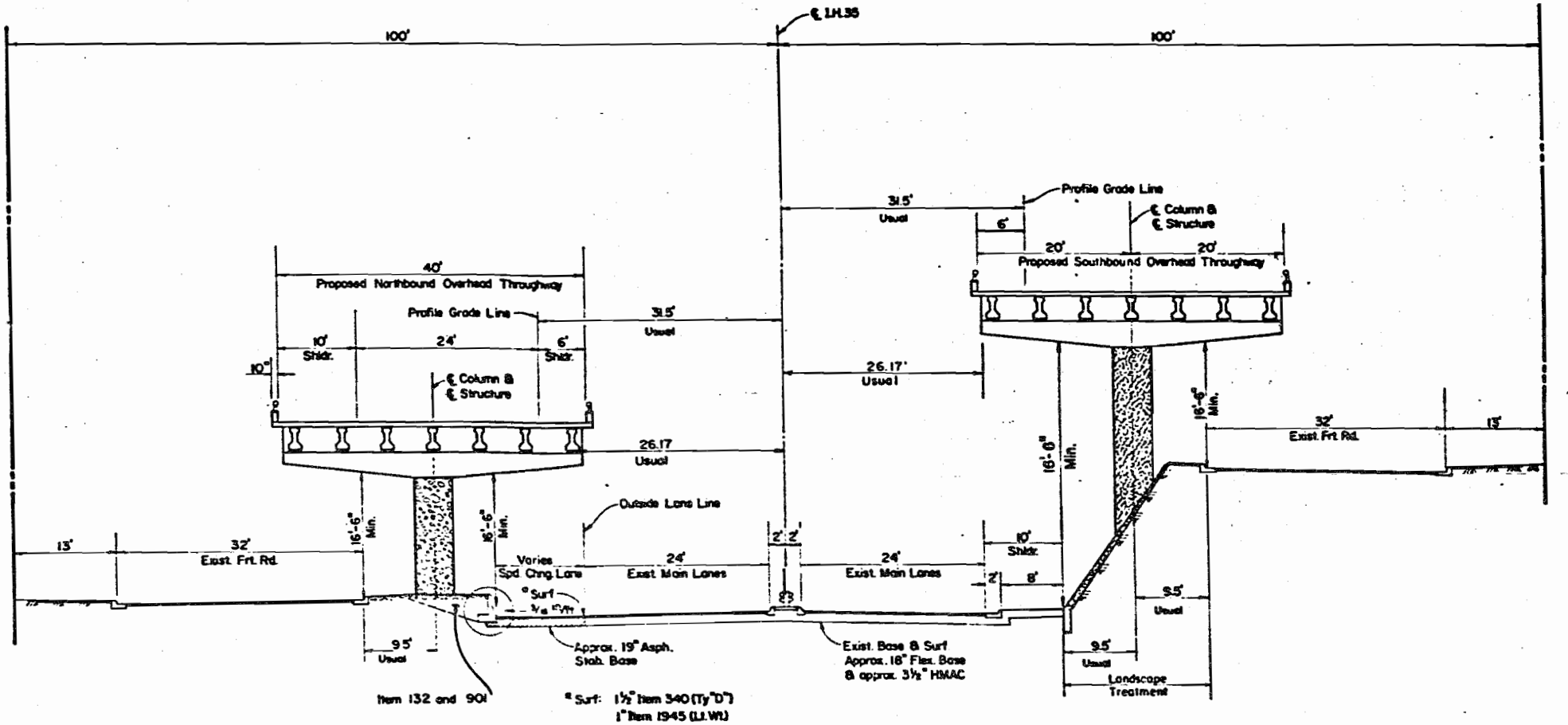
NOISE STUDY OF A TWO LEVEL FREEWAY

Introduction

This is a study of a freeway in Austin, Texas which was converted to a two level facility. The lower level was rapidly approaching a congested condition due to Austin's increasing population growth. Lateral expansion of the freeway was impossible because of, among other considerations, the cost of acquiring additional right of way, the displacements which would result and the handling of existing traffic during reconstruction. The freeway, Interstate 35, traverses Austin in a North-South direction on the east edge of the central business district and is the principal route from San Antonio on the south to the Dallas-Fort Worth Metroplex on the north. In 1972 the single level facility carried approximately 70,000 vehicles per day on the main lanes.

Description of Facility and Adjacent Land Use

Interstate Highway 35 consists of two traffic lanes in each direction. Continuous two lane frontage roads exist on both sides. The main lanes are generally at natural ground between interchanges and, except for one cross street, are depressed to pass under cross street structures which are at-grade. The overhead structure's grade line is flat for purposes of this study and generally has two lanes in each direction. Each set of lanes is supported independently by single columns embedded in the area between the frontage road and main lanes of the lower level. Consequently, the upper deck overhangs the frontage roads to some degree. Configuration of the lower level was not disturbed by the placement of the upper level except during the construction period and at the south end of the upper level. Prestressed concrete beams 4'-6" deep support the overhead between supports. There are no on or off ramps to the upper level within the limits of this study except at its south end. The upper level extends from approximately East 20½ Street on the south to Airport Boulevard (outside study area) on the north. Figure 1 shows typical sections of the facility.



TYPICAL HALF SECTION
AT PROPOSED SPEED CHANGE LANE

TYPICAL HALF SECTION
AT EXISTING RETAINING WALL

TYPICAL CROSS SECTIONS

FIGURE 1

Property abutting the frontage road on the west side primarily consists of commercial and public buildings. This land use extends to or past the first parallel street.

Land use abutting the frontage road on the east side is a mixture of commercial buildings and private residences. The area one block east is almost all residencies.

Site Selection and Sequence of Measurements

In January 1972, plans were under way to construct the second level. 17 traffic noise measurement sites were selected at both right of way lines from 12th Street, north to 38½ Street. At the same time 13 additional sites (for a total of 30 sites for the project) were selected one block east and west of the facility. These latter sites were carefully chosen such that each had an unobstructed line of site to the freeway down an east-west city street. The line of site view was, of course, a finite section. Traffic noise measurements were made at each site using an "A" weighted, Type 2 sound level meter connected to a graphic level recorder (see Instrumentation). No construction was in progress at the time. The information from the recorder was digitized using an x-y plotter and analyzed by a computer to produce the histogram and to determine the L_{10}, L_{50} and L_{90} exceedence levels. (see Reduction of Data)

Of the 17 sites at the right of way, 11 were in the region of the proposed overhead and 6 were outside the region. Of the 13 one-block-distance sites, 9 were in the region of the proposed overhead and 4 were outside.

In June, 1975 measurements were again taken. The overhead structure had been completed but traffic had not been allowed to use the upper level. 14 sites were occupied at the right of way line and 6 at the one-block-distance sites. The remaining sites originally set up were either unoccupiable or had been altered

by construction to an extent that rendered them no longer acceptable.

By December, 1976, the upper deck had been opened to traffic for a period of time which allowed normal traffic patterns to develop. Measurements were repeated at 10 right of way sites and at 11 one-block distance sites. Some sites were now available which had to be excluded in the 1975 survey.

Plans were made to repeat the measurements in late 1978 or early 1979. A study of the project at these dates revealed that too few sites still existed in their original condition to allow the collection of meaningful data; therefore, the project was terminated as of the 1976 survey.

Instrumentation:

The following instrumentation was used in all measurement sequences.

1) GEN RAD model 1558-BP, "A" weighted, octave band analyzer and sound level meter, Type 2, slow response with internal batteries.
2) GEN RAD model P40, preamplifier.
3) GEN RAD model 2133, microphone with wind screen.
4) GEN RAD model 1567, multi-frequency acoustical calibrator.
5) GEN RAD tripod.
6) 100' cable from microphone-preamp to SLM.
7) GEN RAD model 1521-B, graphic level recorder directly coupled to SLM.
8) TRIPP LITE model PZ500B, 12 volt D.C. to 117 volt, 60 hertz, A.C., 500 watt inverter to power graphic level recorder. Two 12 volt vehicle batteries in parallel with the vehicle's battery, powered the inverter.
9) 0 to 60 minute timer, temperature-relative humidity indicator and miscellaneous equipment.
10) Dodge, model 100, 1971 Van, especially outfitted for sound measuring.

Calibration

The entire instrumentation chain was calibrated before each day's set of measurements and immediately following. A third calibration was normally effected once during each measurement set. An internal electronic calibration of the sound level meter was also performed at these times. The instrumentation chain was stable and rarely required adjustment.

Measurement Time, Duration and Technique

No effort was made to repeat measurements at a particular site at the same time of day. No measurements were conducted at any site before 9:00 A.M. or after 4:00 P.M. The lunch hour was also excluded. Measurements were not taken on weekends, Mondays or Fridays.

Each site was monitored for 15 minutes. If unusual nonambient noises occurred which might influence the descriptors used, the period was repeated.

Care was taken on repeated measurements to duplicate as closely as possible the original placement of microphone, vehicle etc., since the primary object of this study was to establish the amount of change in the noise atmosphere rather than the magnitude of the noise level. However the magnitude itself is important in its own right.

Reduction of Field Data

When a set of measurements involving all occupiable sites was complete, the tape from the graphic level recorder was digitized on a x-y plotter which produced computer punch cards. A computer program, written for this purpose, recreated the sound profile and extracted sufficient points to construct a histogram and a listing of exceedence levels in one decibel increments. From this listing the values of L_{10}, L_{50} and L_{90} were obtained. Since this process could involve some human error in the digitizing process some of the later measurements were checked

against the output of a GEN RAD Model 1945, Community Noise Analyzer (a Type 1 instrument which monitors the noise atmosphere about five time a second and at the end of a preset period displays exceedence levels from L0.1 to L99 including LMAX and LMIN.) The dBA value differences ranged from a maximum of 2 decibels (rarely) to a minimum of zero decibels. The average difference was less than one decibel.

Observations

Inasmuch as the average human ear cannot detect a change in time-varying noise of three decibels (nor can it detect the change involved in hearing x decibels today and x±5 decibels tomorrow) the author will consider a 3 decibel or less change as insignificant.

It is noted from a study of Chart 1 that the increase in traffic volumes between 1972 and 1975 was 32% while the L_{10} noise level at those sites at the frontage road where the overhead was constructed rose an average of 1 decibel (range = -1 to +6). During the same period the noise level at those sites one block distant from the frontage where the overhead was constructed rose an average of 3 decibels (range = -2 to +9).

During the period between 1972 and 1976 traffic volumes on the lower level decreased about 50% (½ the previous traffic was now using the upper level) while the noise level at the sites dropped an average of 2 decibels and 1 decibel respectively. (ranges = -5 to +4 and -4 to +3). This change can be expected at the sites by the frontage road because of the decreased traffic on the lower level and the shielding effect of the upper level. However at those sites one block distant the noise level would be expected to rise significantly since the source height had been increased. In this study only 3 of the sites showed a significant change and all those changes but one were negative. Probing further, it is found these changes almost exactly match the changes at those sites where an overhead was not constructed.

The change in L_{10} noise levels between 1975 and 1976 is very evident. Of the 12 sites (at the frontage road and one block distant) where the upper level was constructed all but one site showed a decrease, 4 of which were significant. The single increase was not significant.

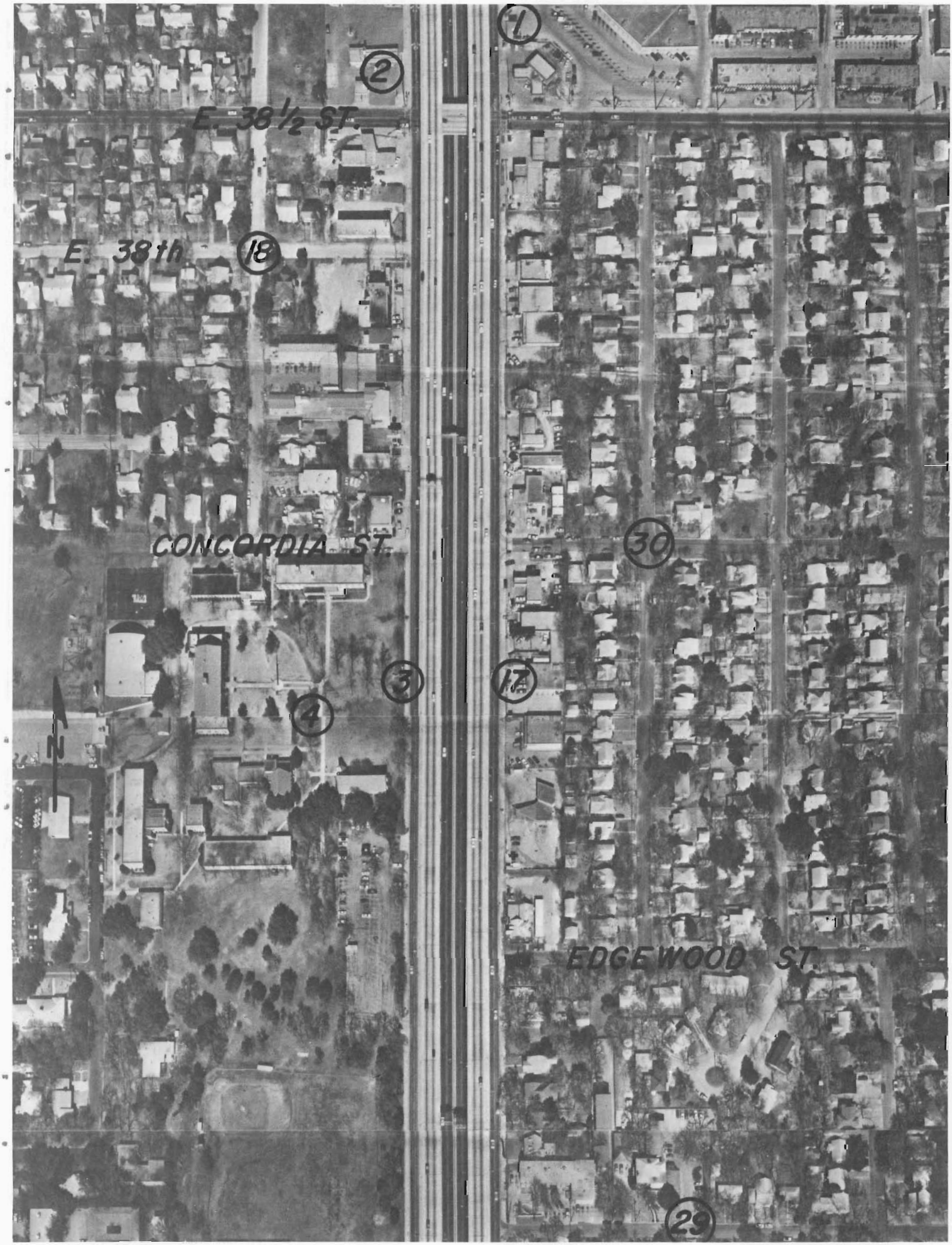
Conclusion:

It is concluded that for this project, raising the source height through the construction of an upper level when a lower level freeway already exists does not significantly affect the existing noise levels in the area of the facility.

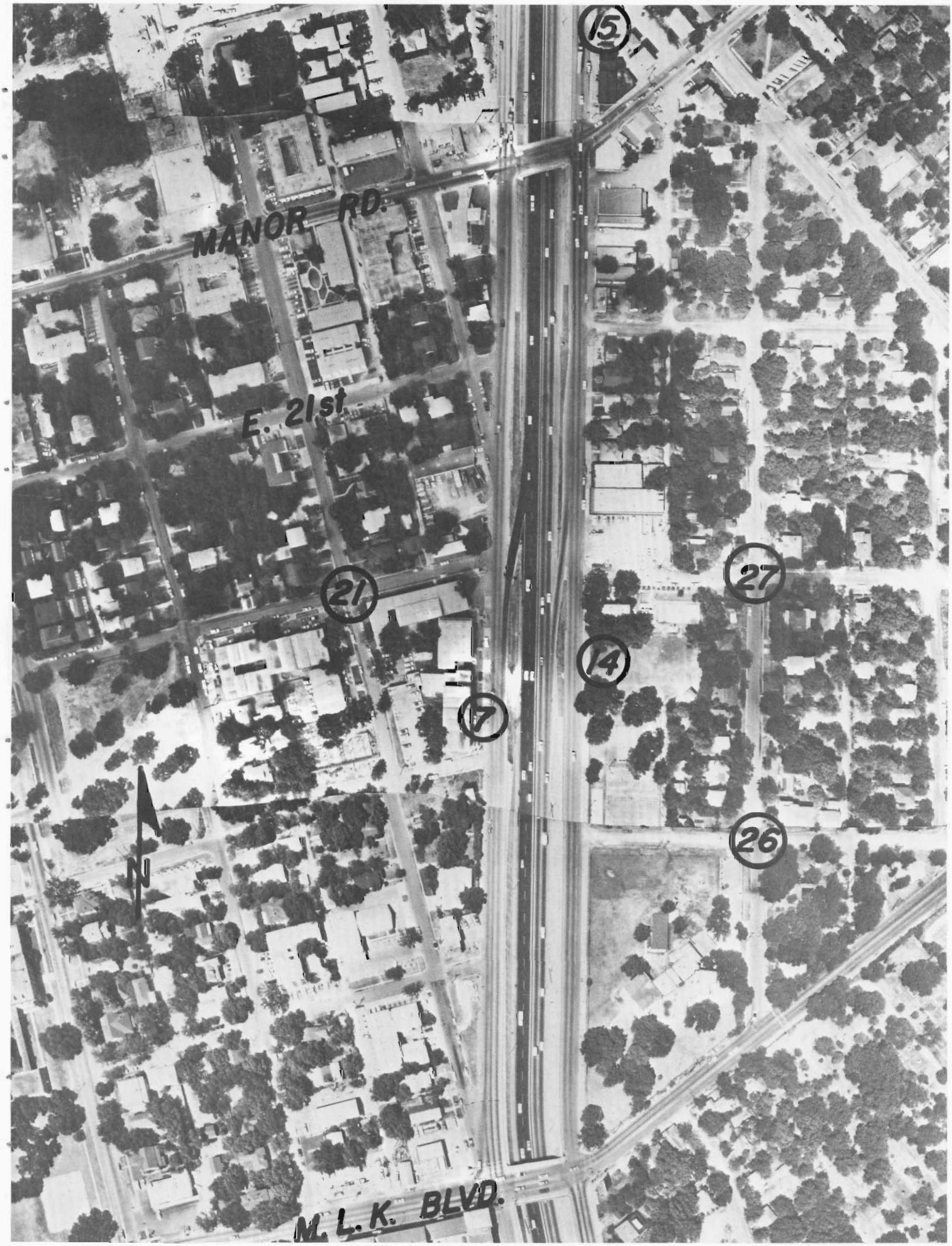
Others may wish to study individual sites to arrive at other conclusions. Sufficient data has been included to allow such a study.

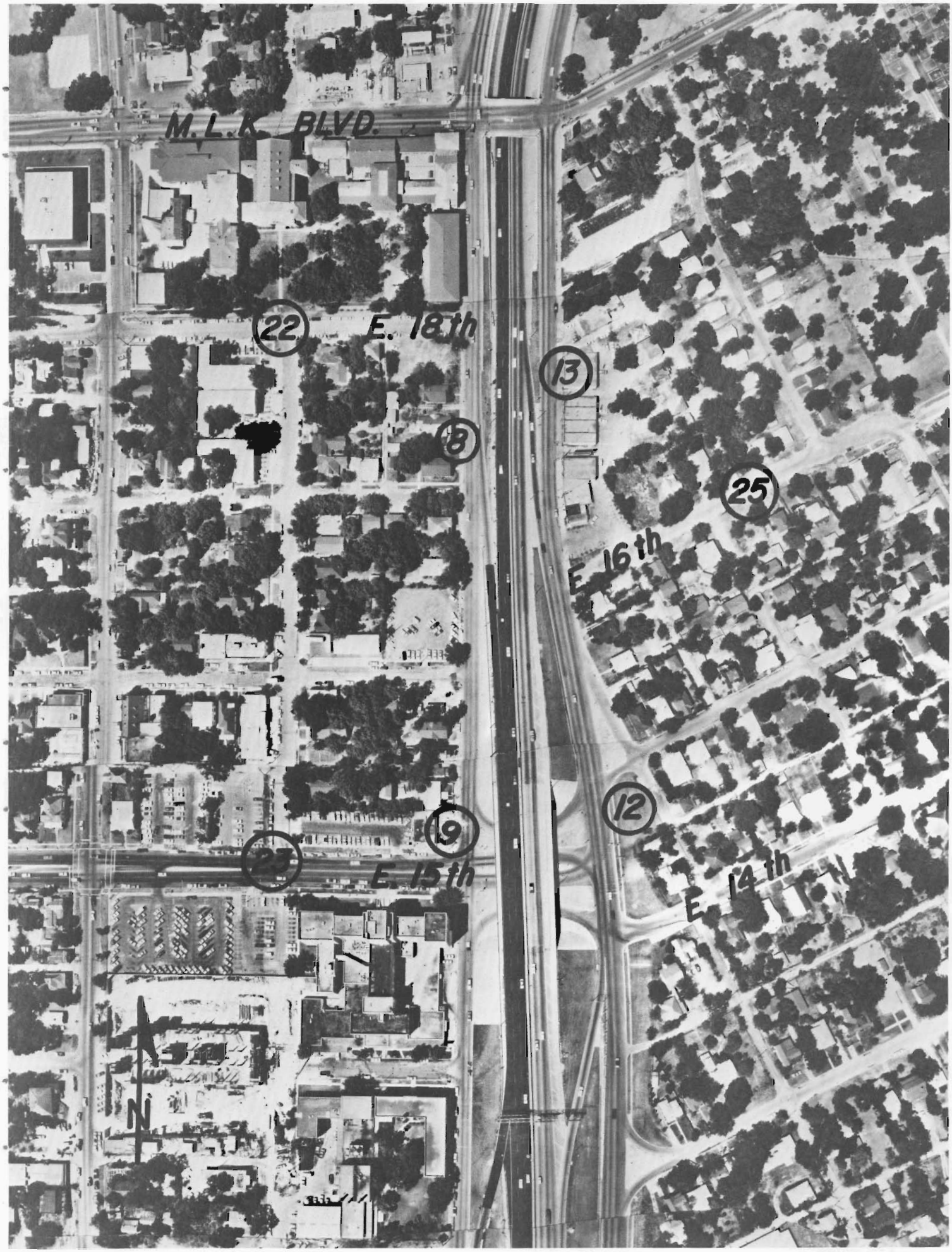
AERIAL MOSIAC
OF IH 35
BEFORE CONSTRUCTION
OF UPPER LEVEL

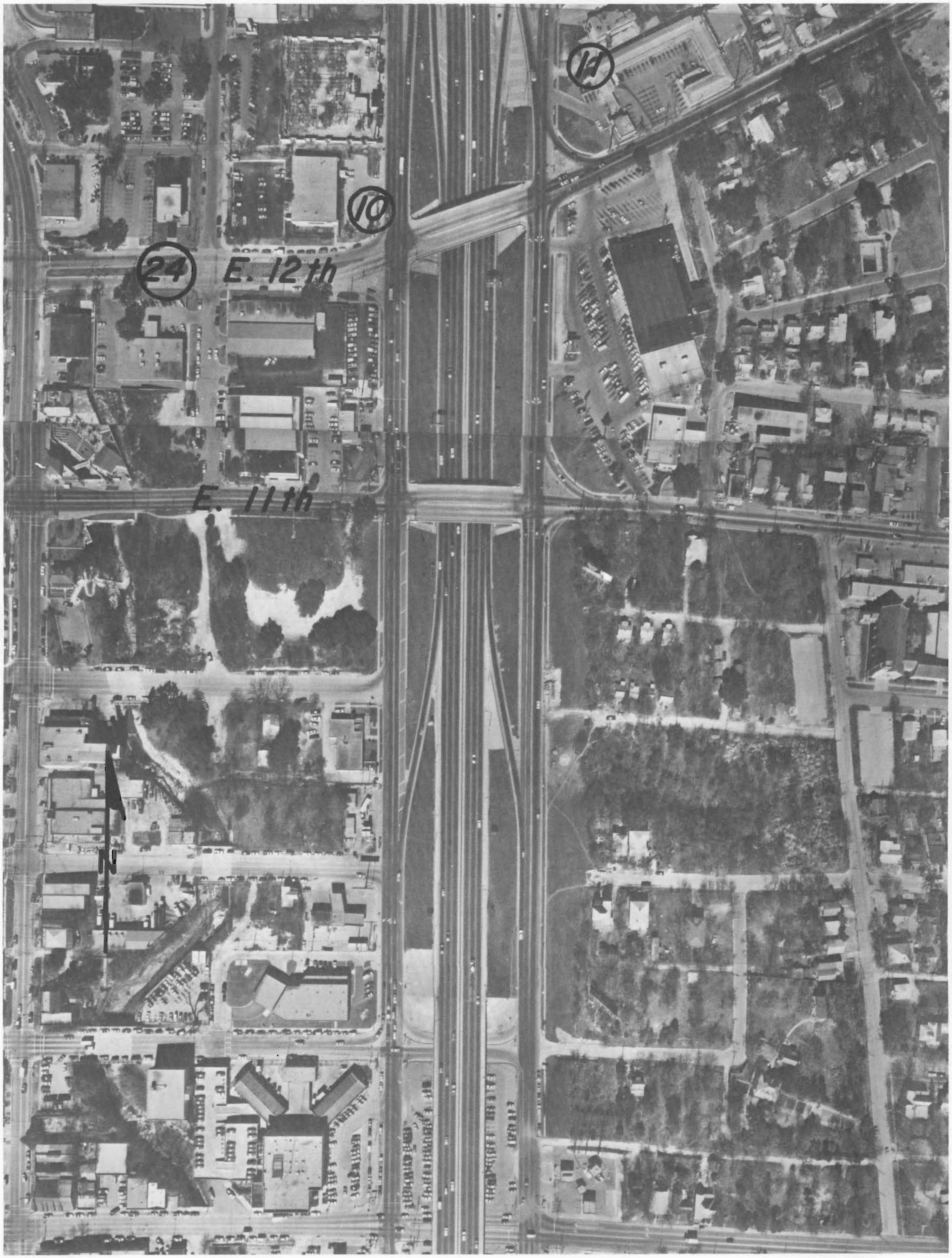
NUMBERS IN CIRCLES ARE
MEASUREMENT SITES


E. 38 1/2 ST.
E. 38th
CONCORDIA ST.
EDGEWOOD ST.
N
1
2
3
4
17
18
29
30


E. 24th
E. 26th
E. 32nd
E. 37st
E. 28th
20
9
5
8
16
28


MANOR RD.
E. 21st
M. L. K. BLVD.
N
15
21
27
14
7
26


M.L.K. BLVD.
22
E. 18th
13
8
25
E. 16th
12
19
23
E. 15th
E. 14th



11
10
24
E. 12th
E. 11th
N

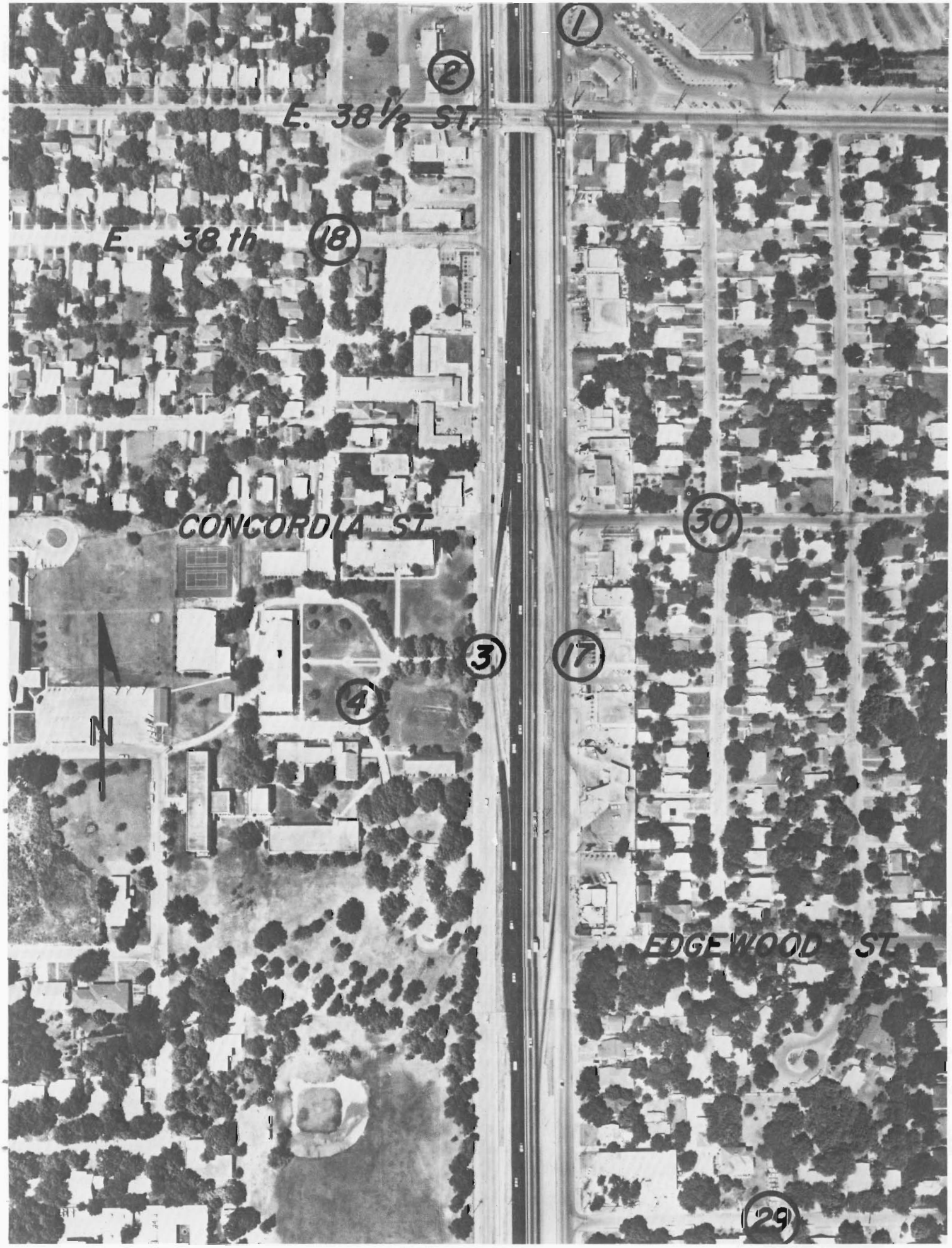
AERIAL MOSIAC

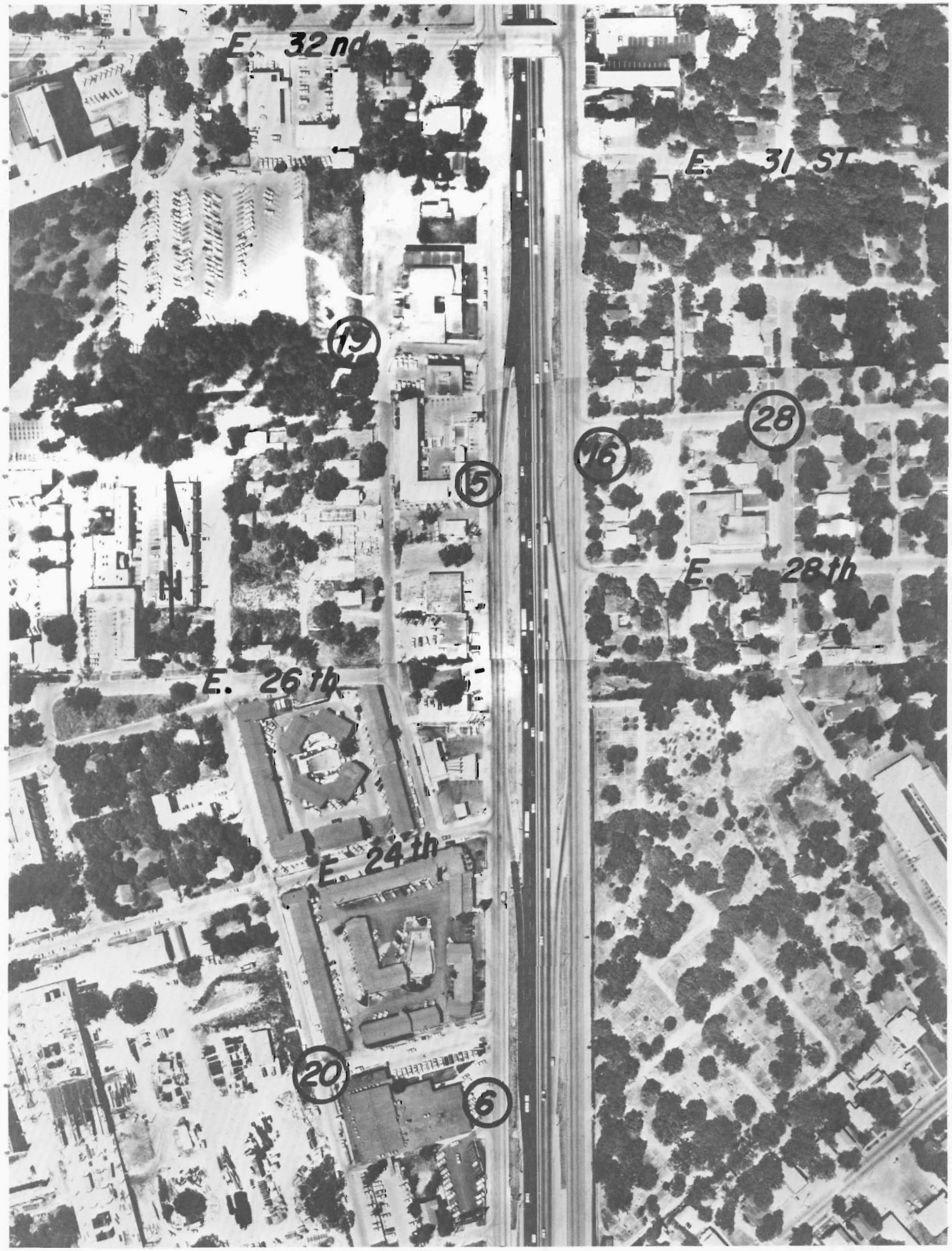
OF IH 35

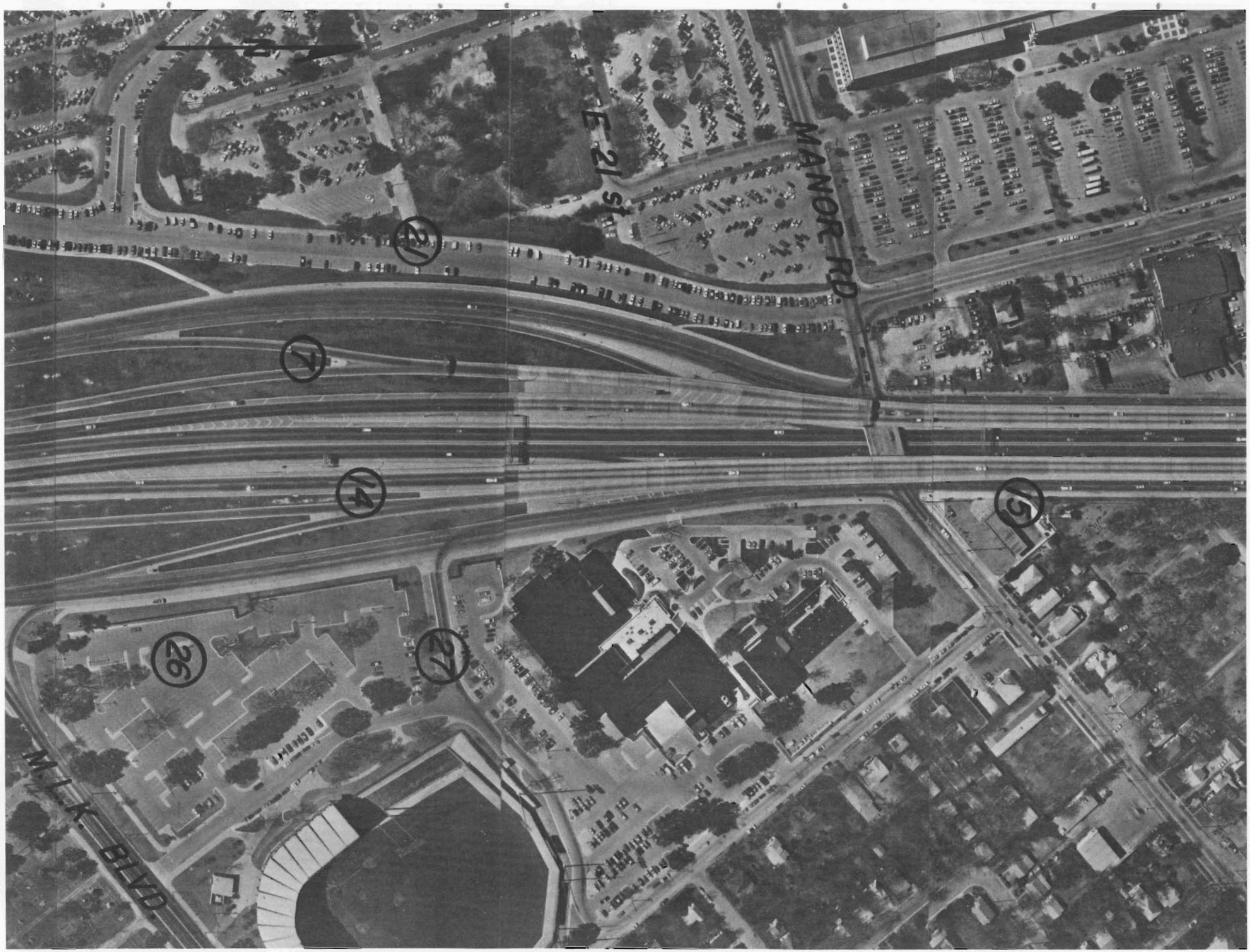
AFTER CONSTRUCTION

OF UPPER LEVEL

NUMBERS IN CIRCLES ARE
MEASUREMENT SITES


1
2
E. 38 1/2 ST.
E. 38th
18
CONCORDIA ST.
30
3
17
4
N
EDGEWOOD ST.
29


E. 32nd
E. 31 ST
19
28
16
5
E. 28th
E. 26 th
E. 24th
20
6


E. 21 St.
MANOR RD.
M.L.K. BLVD.
21
7
14
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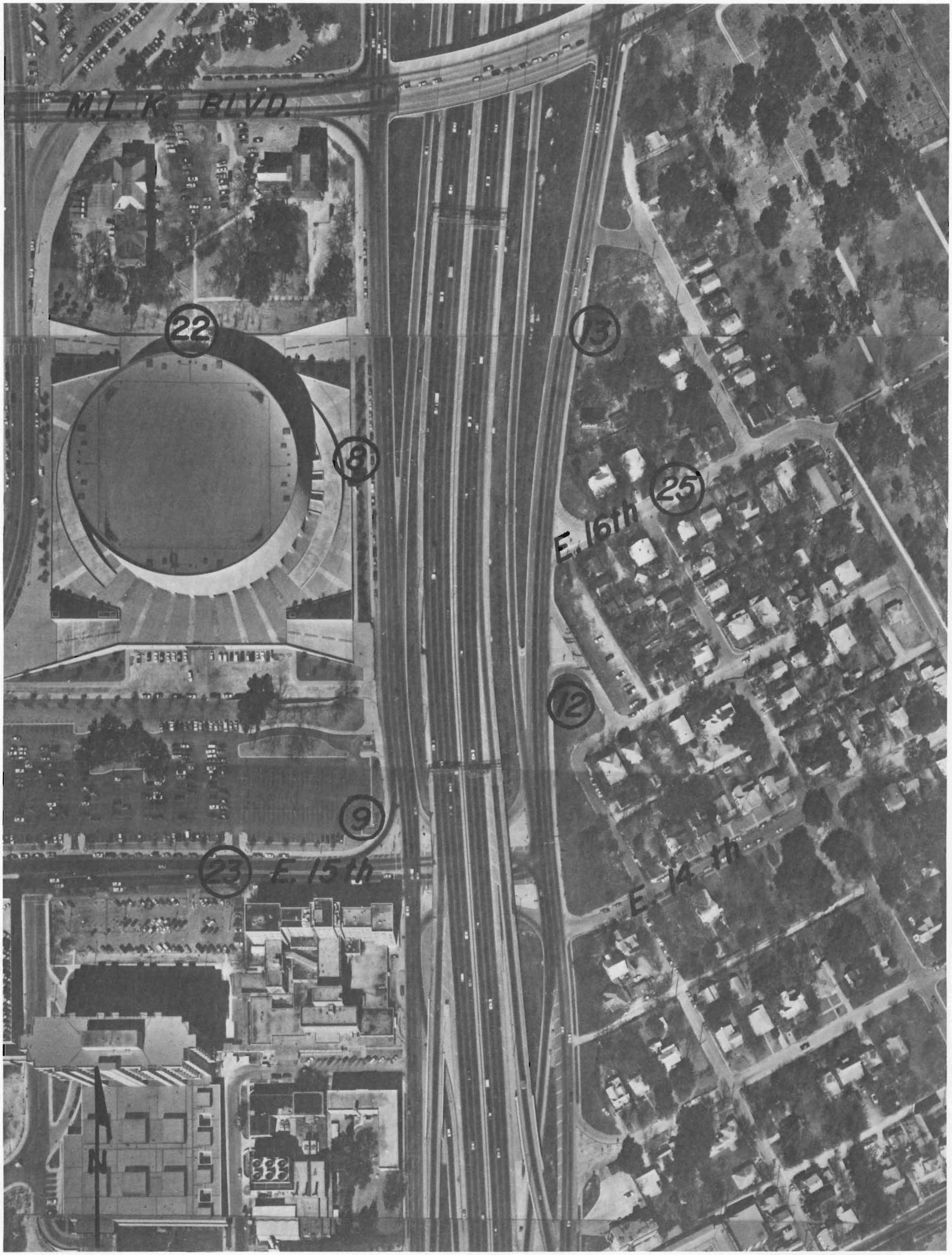
26
27


M.L.K. BLVD.
22
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E. 16th
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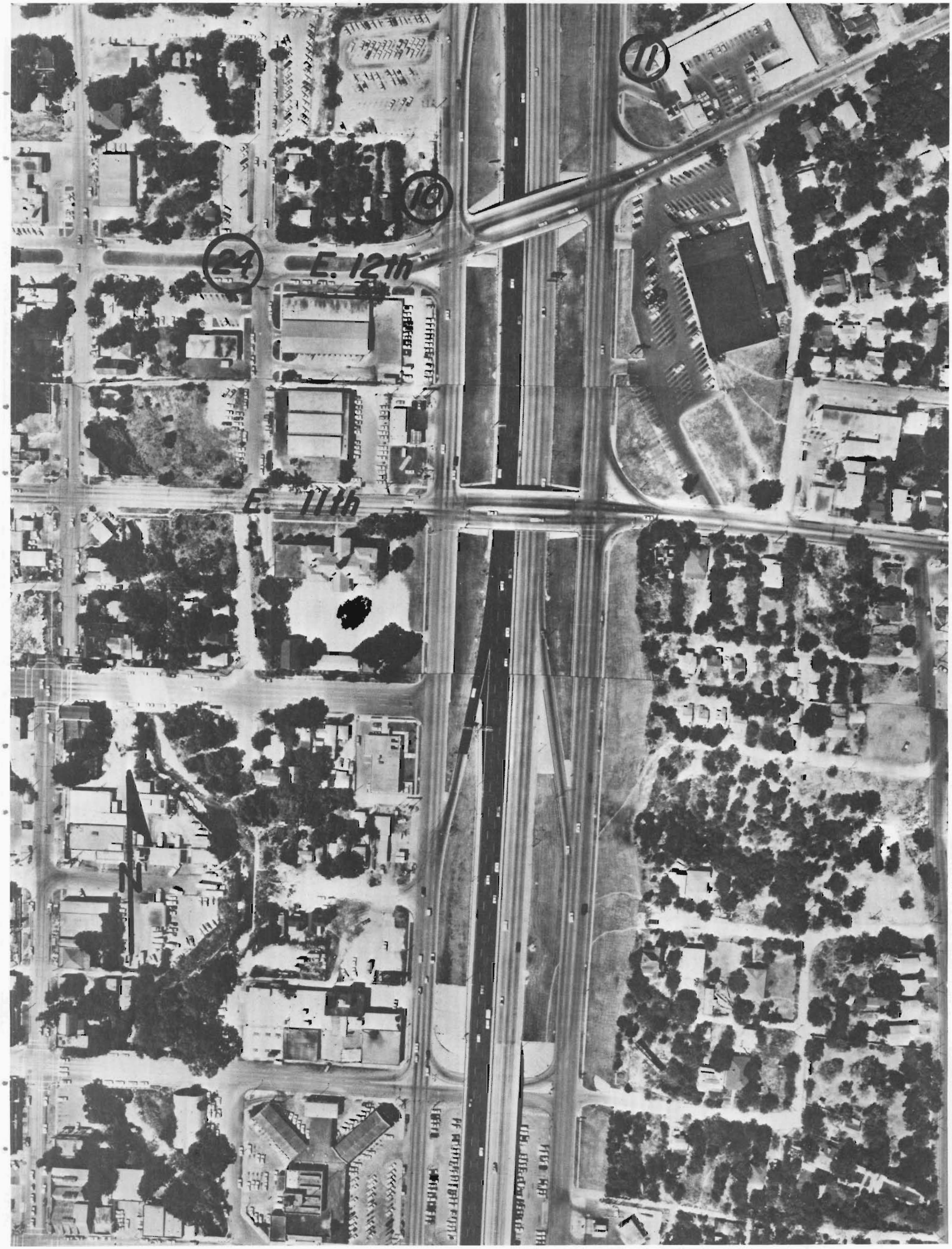
E. 15th
E. 14 th
N


11
10
24
E. 12th
E. 11th
N

AVERAGE DAILY TRAFFIC

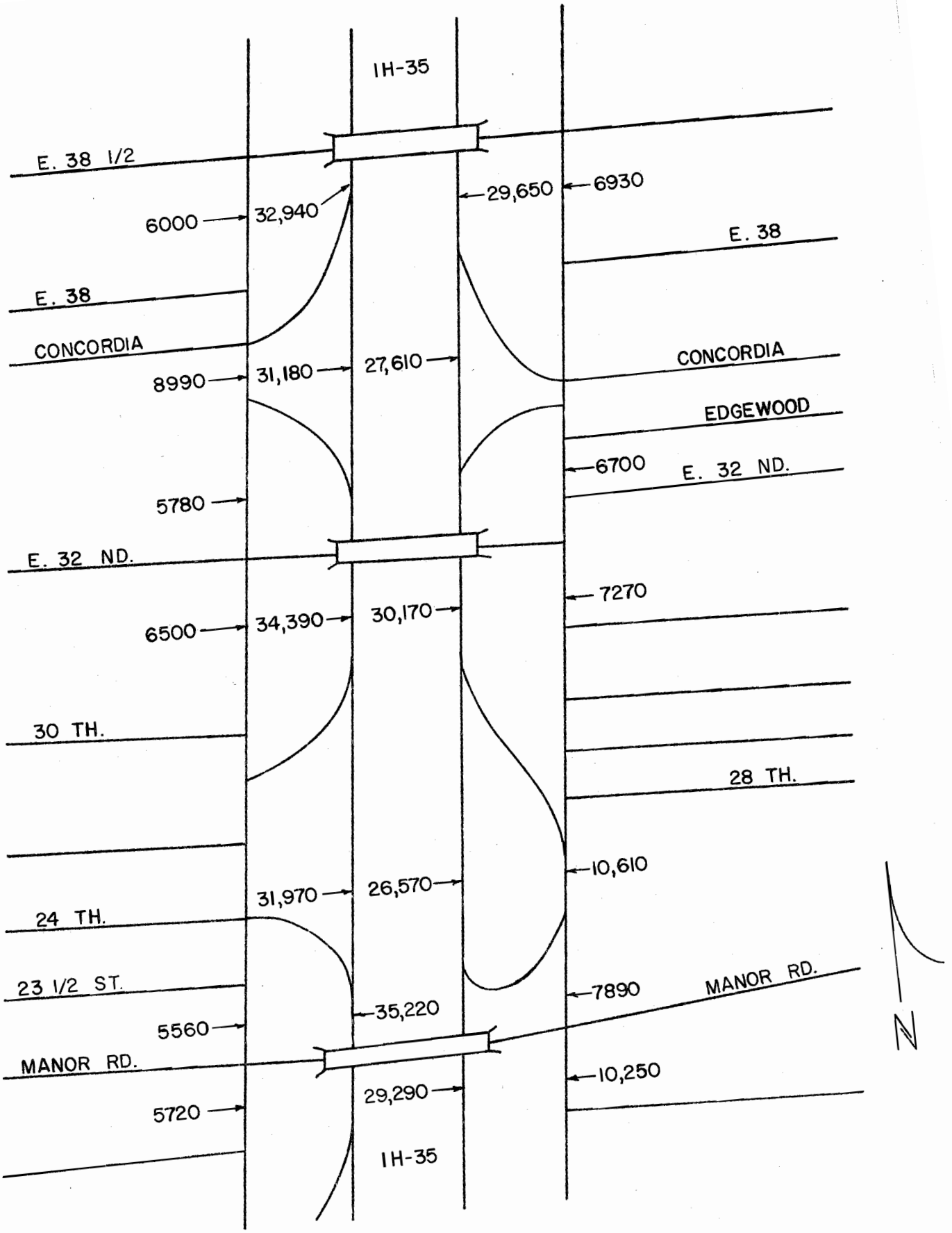
FOR

JANUARY, 1972,

JUNE, 1975

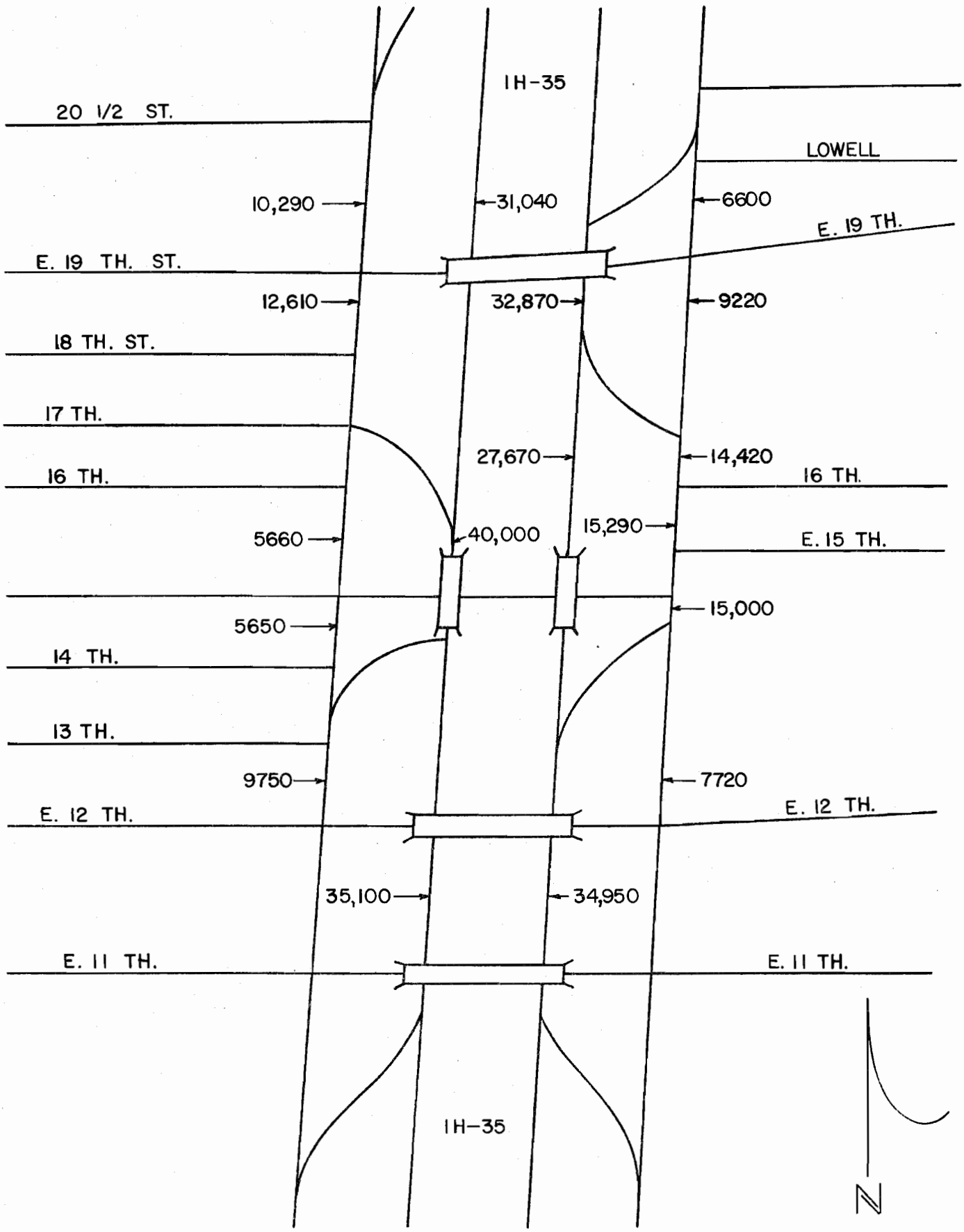
AND

DECEMBER, 1976



AVERAGE DAILY TRAFFIC
JANUARY, 1972

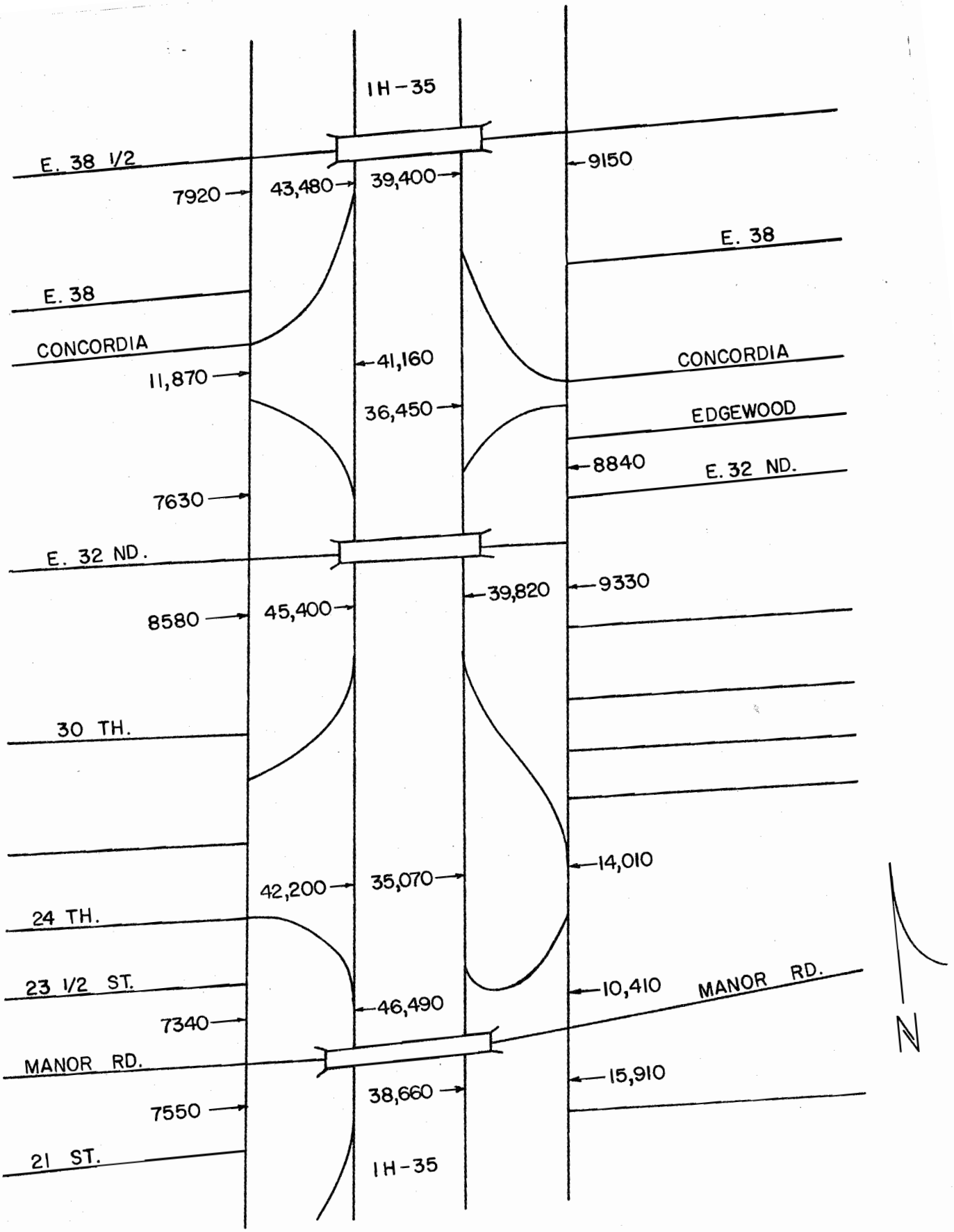
1 OF 2



AVERAGE DAILY TRAFFIC

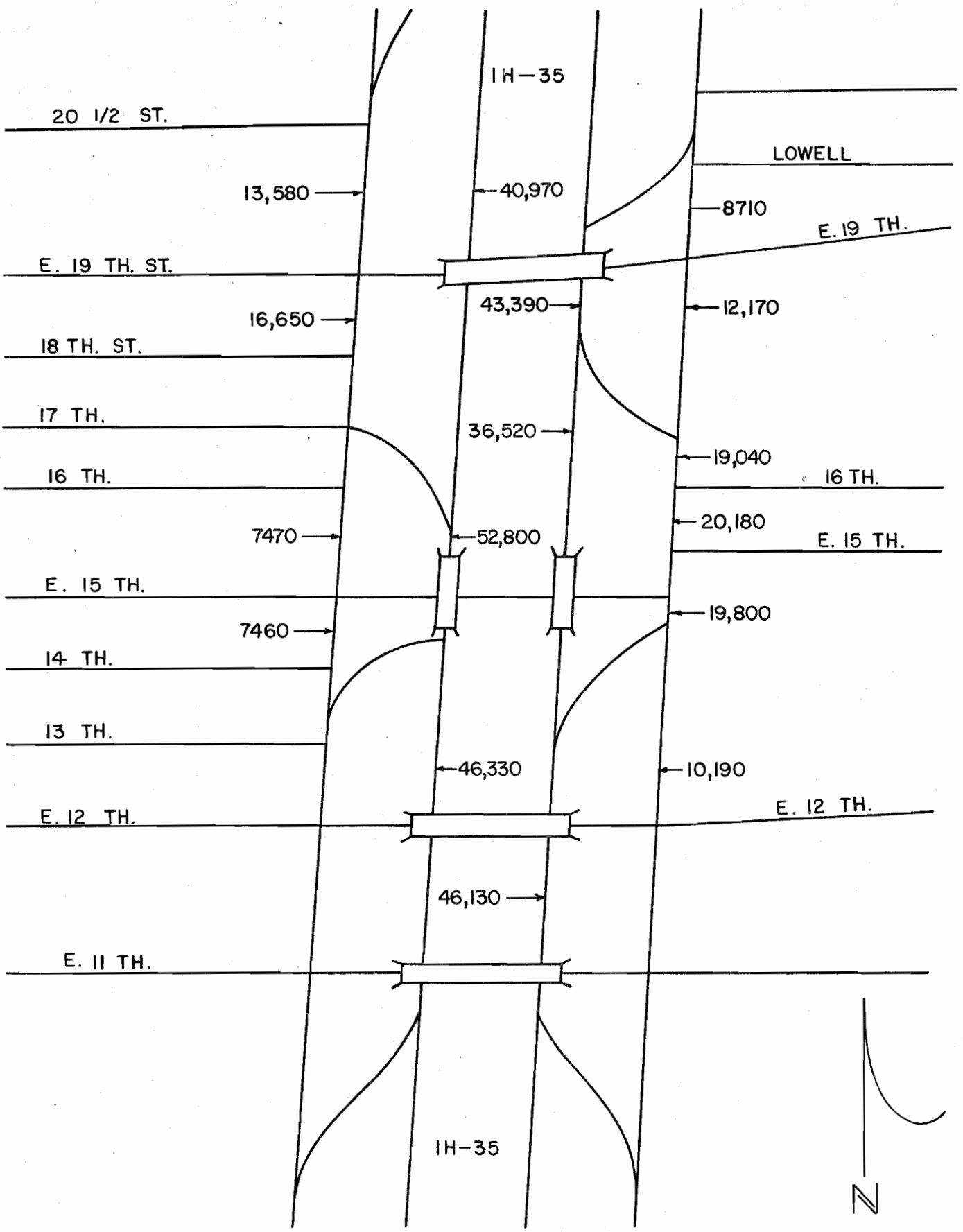
JANUARY, 1972

2 OF 2



AVERAGE DAILY TRAFFIC
JUNE, 1975

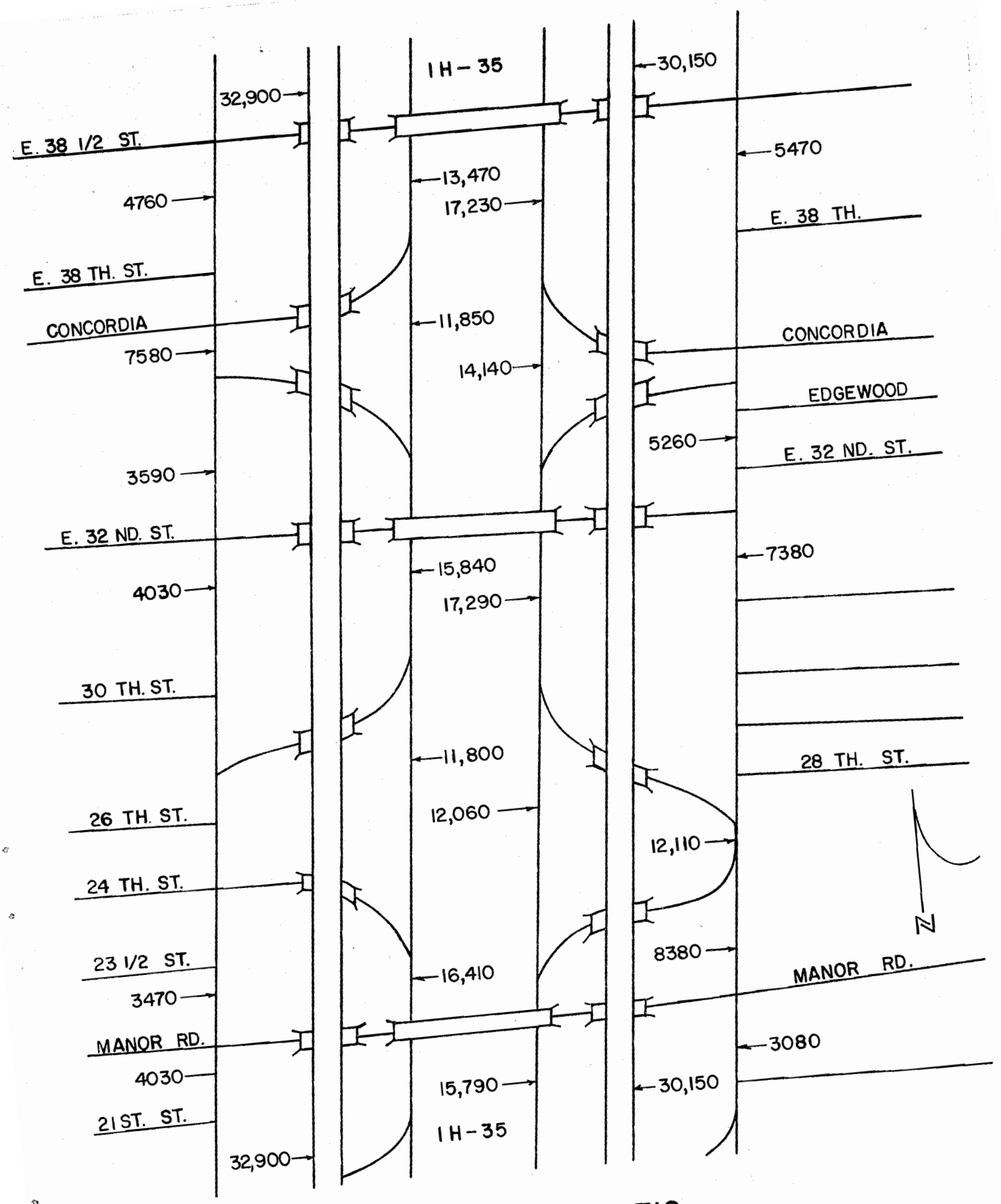
1 OF 2



AVERAGE DAILY TRAFFIC

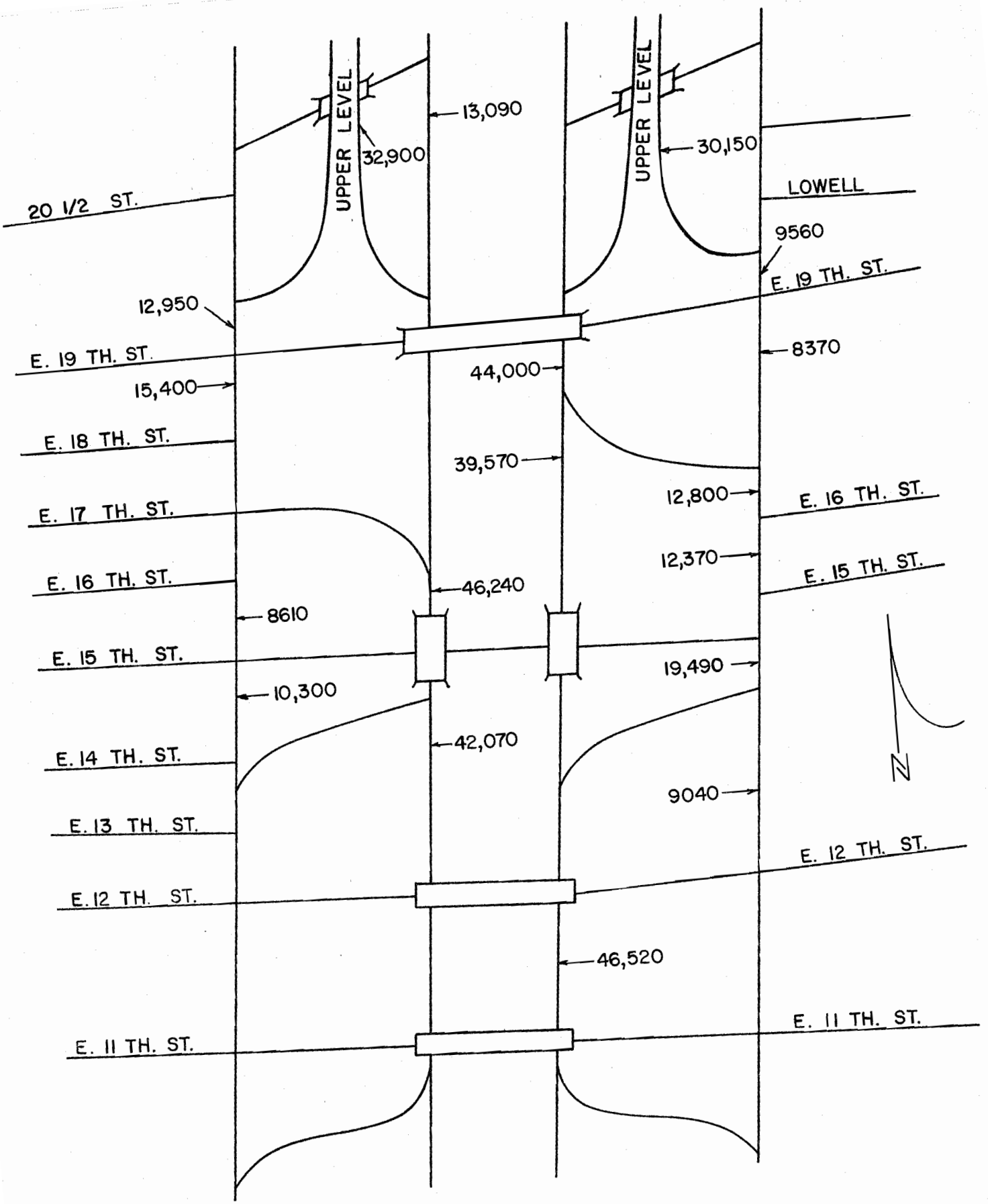
JUNE, 1975

2 OF 2



AVERAGE DAILY TRAFFIC
DECEMBER, 1976

1 OF 2



AVERAGE DAILY TRAFFIC
DECEMBER, 1976

2 OF 2

CHART 1

IH 35 OVERHEAD NOISE STUDY
DATA CHART

	Site Number		1972(1)* dBA $L_{10}/L_{50}/L_{90}$	1975(2)* dBA $L_{10}/L_{50}/L_{90}$	1976(3)* dBA $L_{10}/L_{50}/L_{90}$	'72 to '75 dBA Change $L_{10}/L_{50}/L_{90}$/ & % T**	'72 to '76 dBA Change $L_{10}/L_{50}/L_{90}$/ & % T**	'75 to '76 dBA Change $L_{10}/L_{50}/L_{90}$
Measured at frontage road	1E	OVERHEAD	72/67/64	78/75/65	76/70/67	+6/+8/+1/+32	+4/+3/+3/-38	-2/-5/+2
	2W		74/70/67	78/74/64	74/70/67	+4/+4/-3/+32	0/ 0/ 0/-53	-4/-4/-3
	3W		75/71/67	77/74/67	79/73/69	+2/+3/ 0/+32	+4/+2/+2/-52	+2/-1/+2
	4W		68/55/63	68/55/60				
	5W		79/74/71	78/75/67	74/70/67	-1/+1/-4/+32	-5/-4/-4/-53	-4/-5/0
	6W		77/73/69	78/74/65	72/69/66	+1/+1/-4/+32	-5/-4/-3/-51	-6/-5/-1
	7W		77/72/68	77/72/64		0/ 0/-4/+32		
	8W	NO OVERHEAD	77/74/71					
	9W		72/68/65					
	10W		72/69/66	72-68-62		0/-1/-4/+32		
	11E		71/67/63	70/66/65	73/69/67	-1/-1/+2/+32	+2/+2/+4/+23	-3/+3/+2
	12E		74/71/68	77/70/65	72/67/64	+3/-1/-3/+32	-2/-4/-4/+43	-5/-3/-1
	13E							
	14E		78/73/70	77/73/67		-1/ 0/-3/+32		
	15E		75/70/67	77/72/66	76-72-69	+2/+2/-1/+32	+1/+2/+2/-49	-1/ 0/+3
	16E	OVERHEAD	78/74/70	77/73/63	74/70/67	-1/-1/-7/+32	-4/-4/-3/-53	-3/-3/+4
	17E		78/73/70	77/73/63	75/71/68	-1/ 0/-7/+32	-8/-2/-2/-43	-2/-2/+5
Measured one block from F.R.	18W		63/58/55	65/60/56	63/56/53	+2/+2/+1/+32	0/-2/-2/-56	-2/-4/-3
	19W		62/58/55	71/65/59	63/58/55	+9/+7/+4/+32	-1/ 0/ 0/-59	-8/-7/-4
	20W		66/63/61	66/61/56	63/58/54	0/-2/-5/+32	-3/-5/-7/-59	-3/-3/-2
	21W		63/58/55					
	22W	NO OVERHEAD	67/61/57					
	23W		69/64/61					
	24W		68/61/58	68/63/53	64/60/57	0/+2/-5/+32	-4/-1/-1/+14	-4/-3/+4
	25E		66/62/58	68/61/57	63/58/55	+2/-1/-1/+32	-3/-4/-3/+43	-5/-3/-2
	26E		62/58/55		63/60/58		+1/+2/+3/-41	
	27E		66/60/57		64/60/57		-2/ 0/ 0/-52	
	28E	OVERHEAD	63/57/49		66/62/58		+3/+5/+9/-53	
	29E		64/57/54		63/54/52		-1/-3/-2/-39	
	30E		63/58/55	61/55/51	59/53/50	-2/-3/-4/+32	-4/-5/-5/-43	-2/-2/-1

*(1) Before Construction
(2) Construction Complete - No Traffic on Overhead
(3) Construction Complete - Traffic on Overhead
** % Change in Traffic on Near Lower Level & Near Frontage Road