A MEDIAN STUDY
IN PLEASANTON, TEXAS

By

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FOREWORD

In September, 1958, a committee composed of members of the Texas Highway Department and the Texas Municipal League was formed to investigate and make recommendations on city-state median practices.

It was the intent of this committee to develop information on the effect that the addition of the median would have on a facility's ability to handle traffic more efficiently and safely and the effect that it would have on the local businesses. This information could then be used as a basis for evaluating future potential median sites to determine if a median-type facility should be installed.

The Texas Transportation Institute, as the official research agency of the Texas Highway Department, was asked to conduct the actual research program for the Committee. Three study sites, involving a heavily traveled route in a large city (San Antonio), a moderately traveled route in a medium sized city (Baytown), and a lightly traveled route in a small town (Pleasanton), were selected for the analysis.

Because of the variations in the conditions under observation, findings of these three studies are being released as separate reports. However, a statement of general conclusions concerning all three areas is included in each of the reports. For more detailed information, the other reports should be obtained.

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General Conclusions of Over-all Study
Pleasanton—Baytown—San Antonio

Although there were wide differences in the size, traffic density and community orientation of the three areas included in this study, certain conclusions concerning the effect of medians can be drawn. These conclusions point up both similarities and differences that were observed under the different sets of conditions.

ECONOMIC

From an economic standpoint, the stimulus to new growth was perhaps the most significant effect of the median program. The street improvement program created attractive and desirable commercial sites in each of the three areas. The desirability of these sites is attested by the rapid influx of new businesses which began immediately after construction was completed.

In general, the construction process itself provided the most severe shock to the economic system of the community. This shock was most severe in Baytown, the middle-sized city, where some businesses were completely isolated from traffic for varying lengths of time due to both the contractor's scheduling and inclement weather conditions. It was less severe in Pleasanton the smallest city where local customers had few alternative firms in which to shop. In San Antonio, the largest city, the effect was less uniform. Certain classes of firms such as service stations were severely affected but from the standpoint of the area as a whole, their losses were made up by gains in the nontraffic serving businesses. On the basis of these three experiences, then, it may be concluded that the effect of the construction process on a firm will depend upon:

1. The provisions in plans and specifications and the care exercised by the contractor to prevent firm isolation for extended periods.

2. The availability of alternative firms near the area under construction.

3. The character of the firm itself. That is, whether it is oriented toward a large number of low volume sales (such as a service station or coffee shop) or a smaller number of high volume sales (such as a furniture store or automobile dealer).

After the new facility was completed business as a whole began to rapidly recover the sales lost during construction. After a full year of operation with the median, total business volume was above the pre-construction level in both San Antonio and Baytown. Of course, some of this gain was due to the establishment of new businesses along the facility, and many old firms were still below their base volumes. In general the businesses operating in older, less modern, less well kept buildings were most severely affected and were not able to regain their lost sales volumes. More modern firms with vigorous, progressive management often increased their sales well above their base levels.

The assumptions that losses in left-turn customer traffic into businesses would be offset by increases in right-turn traffic was not completely borne out. Customer turns appear to be inversely related to city size and traffic volume. In both of the smaller cities there was a noticeable increase in right-turn customer traffic after the median was built. In San Antonio, however, where traffic volume was very heavy and speeds high, there was an actual reduction in right turns. This indicates that customer turns may be dependent upon both convenience and firm loyalty which is more pronounced in the smaller cities. In the three cities as a whole, the reduction in total customer traffic averaged about 10 percent after the median was installed.

TRAFFIC

Traffic studies were conducted at each of the three study locations to investigate the effect of introducing a median on the character of traffic operation and safety. In general, there were four types of traffic studies conducted in each of the study locations. These studies were:

1. Traffic volume studies.
2. Accident studies.
3. Operational studies.
4. Travel time studies.

Although the purpose of the studies was to determine the effect of the median on traffic operation and safety, it was generally difficult to relate changes in traffic operation to specific roadway elements. In general, improved traffic operation was attributable to the overall upgrading of the highway facility; however, there were cases where the effects of the median could be specifically evaluated. Brief results of the separate traffic studies are indicated in the following sections.

Traffic Volume Studies

Traffic volume studies conducted at each of the study locations indicated fairly static traffic volume conditions throughout the entire study period. In Baytown there was actually a slight decrease in traffic volume on S.H. 146 due to diversion to a new parallel facility. Cross street traffic in Baytown experienced normal increases as did S.H. 281 in the Pleasanton study. Traffic volumes in the study section in San Antonio, a section of Southwest Military Drive, remained static at approximately 20,000 vehicles per day.

Accident Studies

Accident studies conducted at each of the study locations indicated reductions in certain types of accidents and increases in other types. There was a significant reduction in rear-end collisions involving vehicles waiting or slowing to make left turns. Head-on collisions involving the opposing streams of traffic were also eliminated. These reductions were attributable to the installation of a median.

Increases were observed, however, in other types of accidents. In the Baytown study, right-angle collisions

increased due to an inefficient signal system, but later were reduced by re-design of the system. Also, there were increases observed in accidents involving vehicles making improper lane changes. In some instances fixed-object type accidents increased when medians were installed.

Operational Studies

Operational studies conducted at the study locations indicated a large number of irregular maneuvers before medians were installed. These irregular maneuvers were virtually eliminated by the installation of the median, but a great many U-turns were created at the median openings. Normally, the U-turn maneuver is not too hazardous under low traffic volume conditions; however, in some cases the median was not wide enough to make a legal U-turn.

Travel Time Studies

Travel time studies conducted in Baytown and San Antonio indicated a great deal of congestion and delay during the "before" period. Travel time studies for the "after" period indicated an increase in traffic speeds due to the improvement of the facility. Some of this increase can be attributed to the median since it provided separate left-turn lanes and eliminated delay due to vehicles waiting to make left turns. The increase is also attributable to the fact that congestion was relieved by the construction of additional traffic lanes. In Pleasanton, the travel time studies indicated a fairly high level of service in both the "before" and "after" conditions. Only minor delays were experienced in the "before" study and the majority of these were due to traffic signals rather than traffic congestion and vehicles waiting to make left turns.
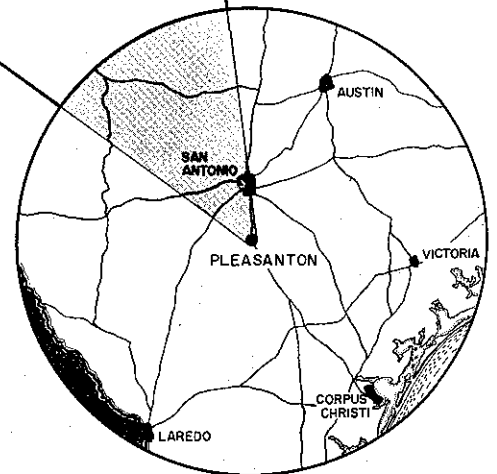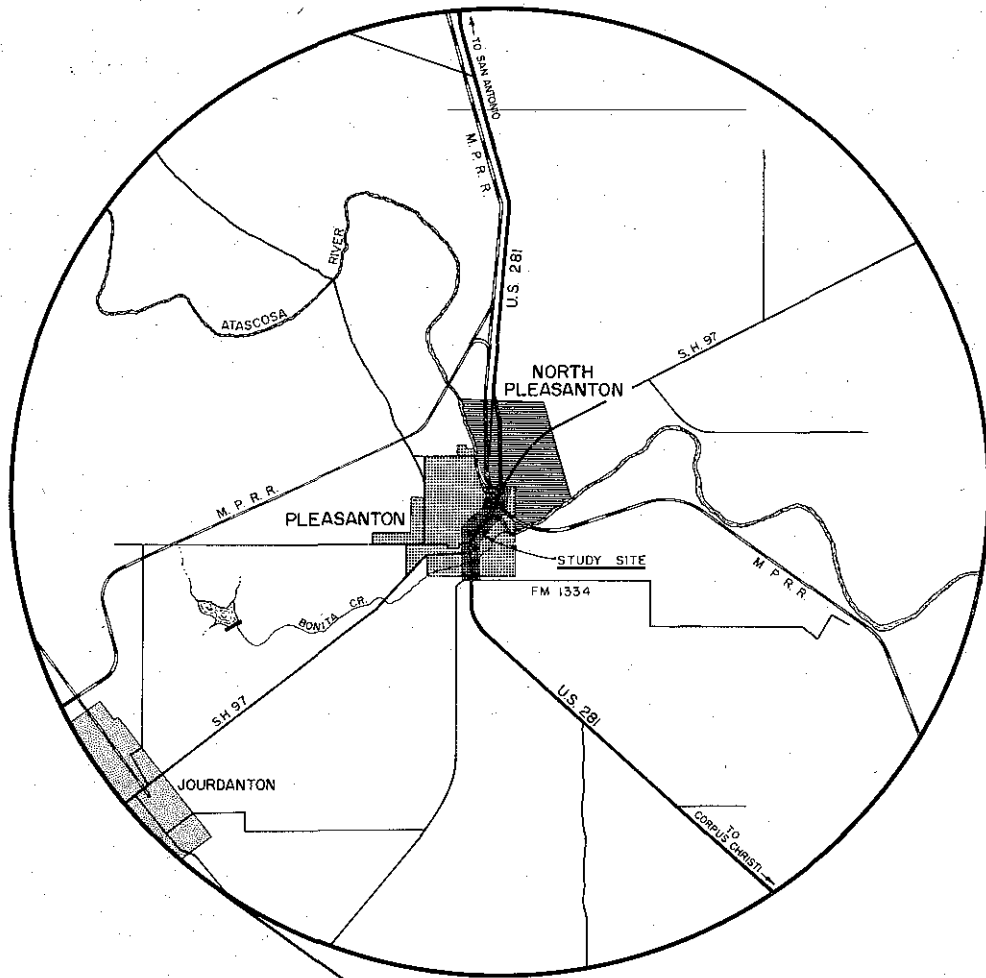
STUDY SITE
PLEASANTON , TEXAS

Figure 1.

A MEDIAN STUDY IN PLEASANTON, TEXAS

Introduction

The Texas Highway Department and the various cities and towns of Texas have long been concerned with the necessity for and problems involved in improving highway routes along city streets. These routes are usually major traffic arteries in the larger cities and often serve as the Main Street in the smaller towns. As such they are usually heavily developed with commercial businesses throughout their length.

These combination highway routes and city streets are charged with fulfilling two diametrically opposed functions. In the smaller towns they must move the transient traffic through the town as quickly, safely and efficiently as possible and still serve as service streets to the businesses located on the adjacent land. In the larger cities they must perform these same functions and in addition carry the traffic moving between major sections of the city or between the suburban and central downtown areas. The difficulty in performing these functions concurrently has long been recognized.

Several procedures have been tried in an attempt to increase the efficiency with which this dual-purpose facility can be made to perform its functions. Among the more successful have been: speed zoning and signalization to regulate traffic flow; street widening or the creation of additional traffic lanes to increase the physical size of the facility; the creation of bypasses or alternate routes to remove through traffic; and finally the addition of a median barrier to increase traffic speed and decrease the number of accident exposure points. Median barriers are, of course, usually operated in conjunction with some type of traffic signalization and control.

With the advent of the median barrier, however, have come additional problems. Businesses which had been accessible to the total traffic flow from each direction were now directly accessible from only one direction. Motorists wishing to patronize bussinesses on the left side of the street were forced to go to the next median opening, turn around and return to the merchant. Merchants were naturally skeptical about the proportion of their customers who would go to the additional trouble of crossing the median to trade at their firms.

As a consequence, both the Texas Highway Department and the local city governments were frequently petitioned for the alteration or abolition of existing median improvements, and planned street improvement programs which included medians in their design were frequently resisted with vigor.

Since the Texas Highway Department was jointly concerned with the city each time a median was built, it was anxious to develop a solid foundation of facts from which the question of median installation and operation could be evaluated. It is not surprising, then, that in September, 1958, a joint City-Highway Department committee was formed to investigate and make recommendations on city-state median practices.

As the Committee reviewed the history of median operations, it found that medians have long been justified in the minds of their builders on the basis of their effectiveness in providing more efficient traffic move-

ment and improving safety conditions. They have been opposed primarily on economic grounds. Local merchants feel that medians reduce their exposure to passing traffic and reduce their total sales volumes.

The committee felt, then, that its primary job was to determine through scientifically controlled research procedures just how the medians measured up to what was generally expected of them. That is, how much, if any, they increased traffic flow, eliminated delays, and increased safety, and how much, if any, they affected the retail sales volumes of adjacent businesses.

To do this, it was decided to select for study areas which were operating under nonmedian conditions but upon which medians were scheduled to be constructed in the immediate future. Each of these areas would then be subjected to a detailed analysis concerning both its record of traffic operation and the economic condition of its attendant businesses. The field work for this type of analysis would need to be initiated in time for a complete record of traffic and economic conditions to be developed prior to the beginning of construction. Additional analyses, covering the same type of data, would then be made at periodic intervals after the new median had been built.

This research procedure is commonly known as the "Before and After" approach. Quite simply, its aim is to develop a complete picture of an area under its original set of operating conditions, let the operating conditions be changed, and then develop another picture. The research techniques carried on under this program are merely the mechanical workings of the researcher's analogous camera.

After the research approach was decided upon and the problems of financing solved, the first step was to select the appropriate areas for study. Funds and personnel were available to handle three separate study sites. These were selected on the basis of the size of city, the scheduling of median construction, the density of traffic, the type of commercial and residential development and the availability of the needed traffic and economic information.

Pleasanton is a small city located in Atascosa County about 30 miles south of San Antonio. It is the largest town in the county, having a population of 3,467 in 1960. It is served by two major highways. Highway 97 serves the east-west traffic and Highway 281, extending from San Antonio to Corpus Christi, passes through the city and forms its main business street (see Figure 1). Over 50 businesses are located along this highway route. These businesses constitute the major portion of the town's 78 businesses rated by the U. S. Bureau of Census.

The economy of the town is influenced greatly by agricultural production in the area. This area is noted for its peanut and watermelon crops and also has a considerable production of truck crops for market. However, a large part of the county is devoted to cattle and sheep ranching. There is also a considerable amount of gas and oil activity in this area.

Concluding Observations — Pleasanton, Texas

ECONOMIC PHASE

Some of the general observations of the effect of the construction of a median on the sales of adjacent businesses within the study area may be briefly stated as follows:

1. Sales volumes of businesses fronting the facility were definitely decreased in the "construction" and "after" periods.

2. The loss in sales began about the fourth month of the construction period and continued throughout the remainder of the study.

3. Of the six firms which went out of business sometime during the three-year study period, four were considered economic casualties. The other two firms moved to other locations within the city and continued their operations. Only one of the four firms considered as an economic casualty had sales of a magnitude to have significant effect on the economy of the study area.

4. In this study, the traffic serving businesses, such as service stations, restaurants and motels generally fared better than other retail firms classified in this report as nontraffic serving businesses.

5. The construction of the facility through Pleasanton has improved the city's appearance and created attractive sites for commercial development. A nice restaurant, two drive-in grocery stores, and a liquor store were built along the route during the latter part of the study period, but were not opened until after the study was completed. It is estimated that the sales of these businesses will boost the area's economy by about $300,000 per year, or about 12 percent.

6. Businesses in this study did not show the gain in sales following the completion of the median that was experienced by businesses in the Baytown study.

7. Again, it was found that there was no significant relationship to indicate that firms located at median openings fared any better than those firms located away from an opening.

8. The small gain in right-turn customer traffic was not sufficient to offset losses due to restriction of left turns which indicates an absolute reduction in the frequency of shopping trips within the study area.

9. This study, like the Baytown study, found that in general there was a positive relationship between changes in customer traffic and sales volumes. However, other factors such as management, competition and economic conditions of the area appear to be of considerable importance in determining success of an individual business.

TRAFFIC PHASE

The results of the "before" and "after" traffic studies in Pleasanton, Texas, can be summarized as follows:

Traffic Volumes

Traffic volumes on U.S. 281 and the intersecting streets were approximately the same during the "before" and "after" study periods.

Accident Studies

The analysis of accident data for one and one-half years before and two and one-half years after reconstruction of the facility indicated increases in certain types of accidents and decreases in other types. Rear-end collisions involving vehicles waiting or slowing to make left turns were significantly increased. This increase is attributable to: (1) separate left-turn lanes were not provided in the second containing a four-foot median, and (2) travel speeds on the facility increased due to the general improvements afforded by reconstruction of the facility. There was also a large immediate increase in accidents involving vehicles turning from the wrong lane. This increase was due to the local drivers not being educated to the proper use of high-type multilane facilities. There was, however, a decrease in this type of accident during the second "after" study indicating a learning effect in use of the facility. Head-on collisions were completely eliminated.

Irregular Movements

The motion picture study indicated that numerous irregular movements which were detrimental to safe, efficient traffic flow were occurring before the installation of the median. These maneuvers were eliminated by the reconstruction of the facility and installation of the median. It was observed, however, that a large number of U-turn movements were created as a result of the median installation.

With the narrow, four-foot median and only two 12-foot traffic lanes and an eight-foot parking lane in each direction, most vehicles were unable to complete the U-turn maneuver beginning from the inside traffic lane. In such cases, it was necessary that the vehicle encroach upon the outside lane in order to clear the curb in completing the maneuver.

Travel Speeds

The travel time studies did not indicate a great deal of congestion or delay on U.S. 281 during the "before" period. There was some delay due to turning vehicles but most delays were due to signals in the study section. In the "after" studies the only delays observed were due to traffic signals in the system. These studies did indicate a substantial increase in travel speeds throughout the entire length of the facility. This increase in speeds was attributable mainly to the general improvement of the facility.

RECOMMENDATIONS

On the basis of the "before" and "after" studies of traffic operation on U.S. 281 in Pleasanton, the following recommendation is made regarding high-type urban highway facilities.

1. The medians on high-type facilities are successful in regulating traffic into an orderly, efficient flow pattern; however, the studies indicated that a very high U-turn movement was created in sections with considerable business activity. It should be realized that this movement will develop and perhaps some consideration should be given to this movement through design and control measures.

On facilities which warrant only the minimum design, two lanes in each direction, it is recommended that very careful consideration be given to a traversable-type median which would permit mid-block turns and thus eliminate the need for U-turns. It appears that this type of operation would not be objectionable because of the low traffic volume conditions which are evidenced by the minimum-type design.

Economic Analysis

This phase of the study is concerned with the economic influence of the median on businesses located along U. S. Highway 281 in Pleasanton. Only those firms fronting the facility were considered as being in the influence zone of the median. To assure an accurate picture of the business activity in this area, the following procedures were followed.

1. Selection of Study Area Businesses

These steps were primarily the same as those followed in each of the three segments of the over-all study. First, an inventory was made of all businesses located on the facility south of the intersection of State Highway 97 in North Pleasanton. Each of the businesses was plotted on a scale map of the study area as shown in Figure 2. Then the manager of each firm was written a letter informing him of the study and asking for his cooperation. At the same time the study was being publicized through the local newspaper and radio station and by city officials.

2. Selection of Control Businesses

In order to minimize the influence of external factors, such as an area wide boom or recession that would affect all businesses in the area, a group of control firms was selected to compare with the study firms. Each control firm was selected on the basis of its similarity to the firm in the study area that it was to control in order to assure that the controls were truly representative of the study area. Control service stations, for example, were picked according to their annual sales and brand of gasoline.

When possible the control bussiness was selected from those businesses in Pleasanton located off U.S. Highway 281. Only eight suitable firms were found in Pleasanton. Since it was impossible to find sufficient businesses in Pleasanton, additional control firms were selected in the nearby cities of Floresville and Hondo. Both cities are about the same size as Pleasanton and are located on major highways leading out of San Antonio. They further qualify as control areas in that they were not affected by any construction during the three-year study period. In Floresville, 23 businesses were selected as suitable controls for the various firms in Pleasanton. Comparable controls for the 10 remaining study area businesses were selected in Hondo.

After the controls were selected, they were subjected to the same treatment as the study businesses. Each business manager was contacted personally seeking his cooperation in the study. When a firm would not participate in the study, a preselected alternate business was chosen.

3. Business Interviews

The next step was the gathering of information from each of the study and control businesses regarding history of operation, management and conditions of the physical plant by personal interview. The main objective, however, was to obtain an accurate record of each firm's retail sales for 12 months preceding the beginning of construction. Additional interviews were then made after the construction was completed to get a record of sales during the construction period, and a third interview conducted after the new facility had been in operation for a year, yielded a record of sales for the 12 months after construction had been completed. Only two of the retail businesses located on U.S. 281 between the intersection of State Highway 97 to the south city limits of Pleasanton refused to cooperate in this economic study.

The businesses were grouped into eight major classifications using the standard industrial classifica-
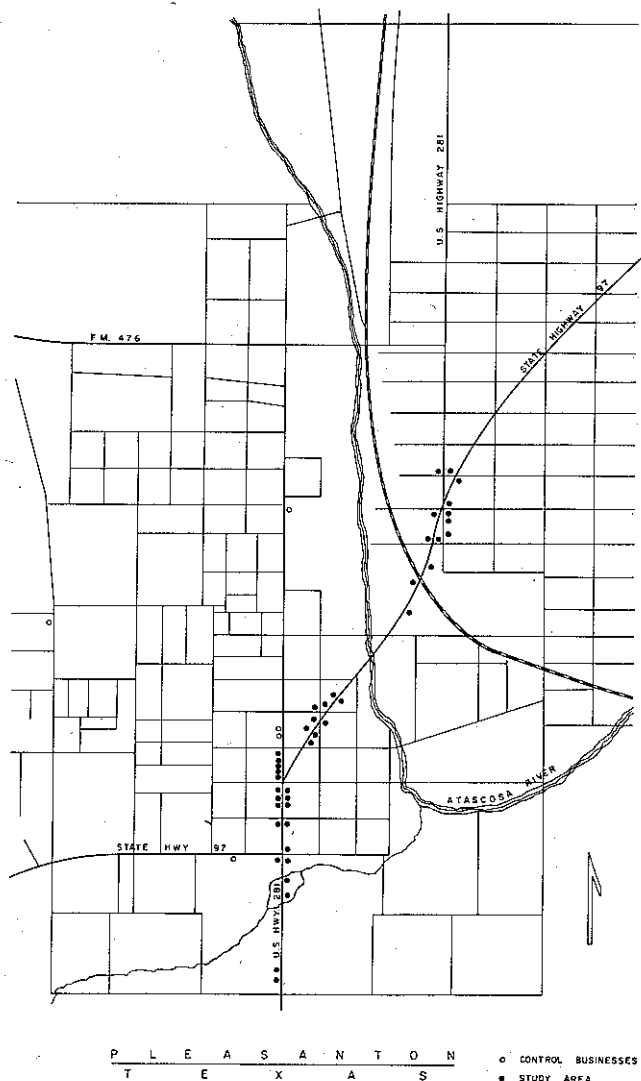
Figure 2.
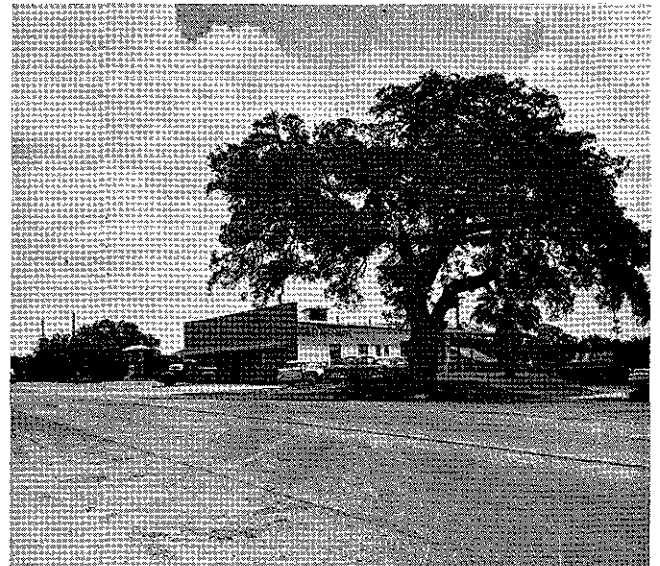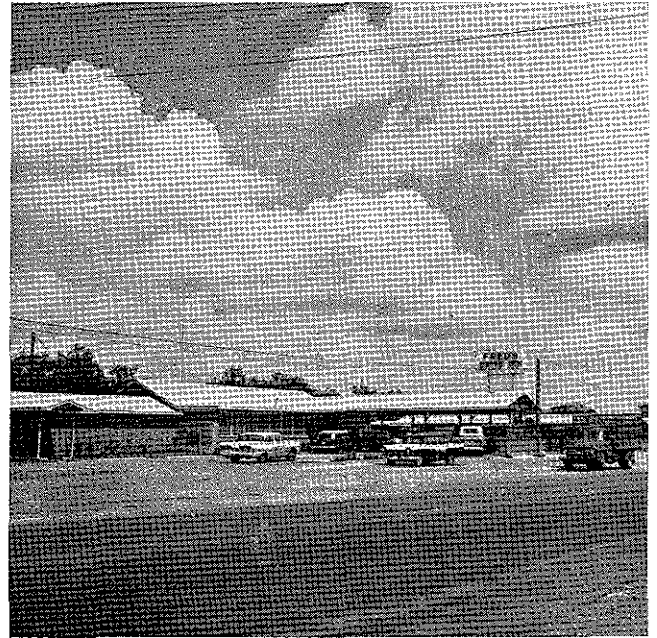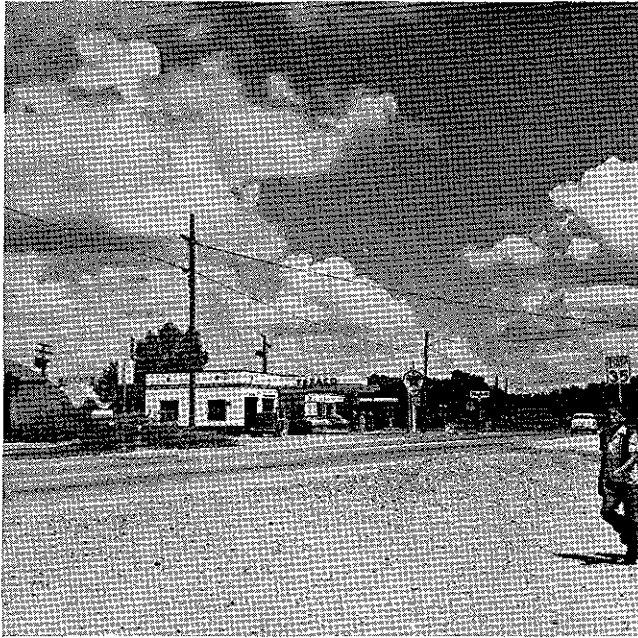
Prior to the construction of the new facility there was very little control of turning movement along the Highway route through Pleasanton.

tion index of retail firms as the basis for the groupings. This classification was made in order to allow better comparisons of business activity by type of retail business.

TESTING OF CONTROL AND STUDY FIRMS

In order to determine whether the control firms were legitimate or comparable to the study firms, the sales of these firms were subjected to the "t" test. This statistical test is used to determine whether the selected control firms were representative of, or taken from, the same parent population as the study group. The two-tailed "t" test was found to be the appropriate test, since it includes deviations both above and below the means for each group of firms.

In interpreting the results of the "t" test it should be remembered that significant "t" values indicate that there is a significant difference between the two groups of data being tested. Nonsignificant "t" values on the other hand indicate no statistically significant differences at the level of probability chosen. In this case the tests were made at the "t" .05 level, or the 95% level of probability. A significant "t" value then would mean that in less than 5% of the cases could a value of "t" larger than the theoretical "t" value (found in published "t" tables) be due to chance alone. A smaller computed value of "t" would indicate that such a difference could not be shown.

An example of the test is shown in Table 1. Here the test was applied to the group of service stations,

consisting of eleven firms from the study area and the eleven stations serving as their controls. The data under colums X_1 and X_2 represent the sales of the study and control area firms respectively.

The value of "t" in this test was 1.972, which was within the limits of normal deviation about the mean. Therefore, it can be stated that at the 95% level of probability there was no significant difference between the means of the study group and their controls. For the means of this group study and control firms to have been significantly different the "t" value would have to have been larger than the 2.228 listed in the "t" table.

The small number of firms included in the sample makes it necessary to have rather large variations before they can be proved to be statistically significant.

Rather than show the detailed calculations of the "t" test on each of the other groups of retail firms, which for the most part would be repetitious, only the results of each test are shown in the text.

Listed below are the six retail groupings with the number of firms in each group and the value of "t" for each one of the groups.

Types of Businesses	Number of Firms	Value of "t"	Maximum Limits of "t" Value*
Grocery Stores	5	-1.225	2.571
Restaurants	5	2.087	2.571
Auto & Farm Machinery	4	.125	2.776
Hardware & Furn.	4	.843	2.776
Personal Services	3	- .079	3.182
Mis. Retail	6	1.646	2.447

*When interpreting the results of each "t" test, any "t" value over the maximum limits of "t" value would indicate that there was a significant difference between the means.

According to the results of the "t" test on the above six groupings of retail firms, we can say with a high degree of confidence that there was no significant difference between the study and control firms.

Business Analysis

When the study was initiated, there were 42 retail businesses located in the selected study area. Monthly sales data were obtained from 39 of these firms. Two firms refused to cooperate in the study and one business, a service station, was closed during the "before" period. Table 2 presents a listing of the firms in the study area and the period in which each participated.

When the construction of the median began, two business firms moved off the highway but continued to operate at their new location. The management of these two firms reported that their moving from the route was not entirely due to the construction of the median.

At the beginning of construction one service station went out of business and did not reopen; while the service station that had been closed, reopened and remained open throughout the remainder of the study. One other unusual change occurred in the "construction" or "during" period. This was the closing of one of two

Table 1
TEST OF HYPOTHESIS OF NO DIFFERENCE BE-
TWEEN SERVICE STATIONS IN STUDY AREA AND
THEIR CONTROLS

Sales of Study Firms X_1	X_1^2	Sales of Control Firms X_2	X_2^2
000		000	
$150	22,500	$ 60	3,600
117	13,689	104	10,816
97	9,409	51	2,601
64	4,096	50	2,500
70	4,900	48	2,304
129	16,641	60	3,600
63	3,969	48	2,304
75	5,625	28	784
58	3,364	35	1,225
27	729	51	2,601
12	144	17	289
ΣX 862		552	
ΣX^2	85,066		32,624

$$\Sigma x_1^2 = \Sigma X_1^2 - \frac{(\Sigma X_1)^2}{N} = 85,066 - \frac{743,044}{11} = 17,516.5$$

$$\Sigma x_2^2 = \Sigma X_2^2 - \frac{(\Sigma X_2)^2}{N} = 32,624 - \frac{304,704}{11} = 4,923.6$$

$$S_1^2 = \frac{\Sigma x_1^2}{N_1 - 1} = \frac{17,516.5}{10} = 1,751.65$$

$$S_2^2 = \frac{\Sigma x_2^2}{N_2 - 1} = \frac{4,923.6}{10} = 492.36$$

$$s\bar{d} = \sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}} = \sqrt{\frac{1,751.65}{11} + \frac{492.36}{11}}$$

$$= \sqrt{204.00} = 14.29$$

$$\bar{d} = \bar{X_1} - \bar{X_2} = 78.36 - 50.18 = 28.18$$

$$t = \frac{\bar{d}}{s_{\bar{d}}} = \frac{28.18}{14.29} = 1.972 \text{ NS} - 10dF$$

restaurants which were operated under the same management. The manager did not keep separate records on the two businesses; therefore, the sales represented two restaurants in the "before" period and only one in the later periods. Since we were unable to segregate the sales of the two businesses, it was carried as one business throughout the study.

During the three-year study period, three other businesses were closed for short periods of time due to changes in management. The records of these businesses are shown in the analysis.

There were also four new firms established along the route during the later part of the three-year study. However, none of these firms were open for business prior to November 1961, which is the time that the study was terminated.

Because of the changes in the number of firms operating in the study area during the three years of observation, it was very difficult to show an accurate picture of the influence of the median on their sales volumes through use of a single method of sales comparisons. The effect on individual firms or groups of firms

could be quite different from that reflected by the area as a whole, and losses or gains in the number of businesses could have an effect on the over-all volume of business by the entire group. For this reason the analysis was conducted and the comparisons are presented in two different ways.

The first method of comparison is shown in Table 3. This is a comparison of only those firms which were operating in the area at both the beginning and the end of the study. The data presented here show the sales of 35 study area firms and their controls divided into eight industry groups. During the three-year period, there were wide fluctuations in sales within certain types of businesses. In some cases, these fluctuations in sales can be attributed to the management of one or more firms within the group.

During the three years of observation, the total sales of the study area firms decreased in both the "construction" period and "after" period while the control area firms showed an increase in both periods. The study area businesses experienced less than a six percent decline in sales during the "construction" period and an eight percent decline in the "after" period. At the same time, the control businesses showed a small gain of 0.1 percent in the "construction" period and 5.8 percent gain in the "after" period over their base period sales.

A large portion of the 8.3 percent loss in sales for the study area firms can be attributed to the loss which occurred in two industries. These industries are in the auto and farm machinery group, having three firms, and the restaurant group, consisting of four firms. The general opinion of the operators of the firms in the auto

Table 2

BUSINESSES BY TYPE AND RECORD OF PARTICIPATION IN THE PLEASANTON STUDY

Business Number	Business Class	Type of Business	Period of Participation		
			Before	During	After
1	Furniture &	Furniture	x	x	x
2	Hardware	Hardware	x	x	x
3		Hardware	x	x	x
4		Upholstery Shop	x		
5	Auto and	Farm Equipment	x	x	x
6	Farm Equipment	Auto Parts	x	x	x
7		Auto & Farm Equipment	x	x	x
8		Farm Equipment	x		
9	Grocery	Fruit Stand	x	x	
10		Grocery	x	x	x
11		Grocery	x	x	x
12		Grocery	x	x	x
13		Grocery	x	x	x
14	Personal	Beauty Shop	x	x	x
15	Service	Barber Shop	x	x	x
16		Shoe Repair	x	x	x
17		Barber Shop	x	x	x
18	Motel	Motel	x	x	x
19		Motel	x	x	x
		Motel			
20	Restaurant	Restaurant	x	x	x
21		Restaurant	x	x	x
22		Restaurant	x	x	x
23		Restaurant	x	x	x
		Restaurant			
24	Service	Service Station	x	x	x
25	Station	Service Station	x	x	x
26		Service Station	x	x	x
27		Service Station	x		
28		Service Station	x	x	x
29		Service Station	x	x	x
30		Service Station	x	x	x
31		Service Station	x	x	x
32		Service Station	x	x	x
33		Service Station	x	x	x
34		Service Station		x	x
35		Service Station	x	x	x
36	Miscellaneous	Drugs	x	x	x
37	Retail	Variety	x	x	x
38		Liquor	x	x	x
39		Jewelry	x	x	x
40		Apparel	x	x	x

[1]Moved from area in the "during" period.
[2]Moved from area at end of "before" period.
[3]Closed at end of "during" period—did not reopen.
[4]Would not cooperate.
[5]Changed management in the "during" and "after" periods.
[6]Operated two restaurants in "before" period; closed one in the "during" period and did not reopen.
[7]Changed management in "after" period.
[8]Closed during the "before" period—did not reopen.
[9]Was closed in "before" period—did reopen.
[10]Closed at the end of the "after" period.

Table 3

TOTAL SALES OF ALL FIRMS THAT WERE IN OPERATION AT BOTH THE BEGINNING AND ENDING OF STUDY PERIOD[1]

Type of Business	Before Period Base Sales	During Period			After Period		
		Sales	Change from Base Period	Percent Change	Sales	Change from Base Period	Percent Change
	(Dollars)	(Dollars)	(Dollars)	(Percent)	(Dollars)	(Dollars)	(Percent)
			STUDY AREA				
Auto and Farm Machinery	497,387	396,343	−101,044	−20.3	344,198	−153,189	−30.8
Service Stations	849,801	829,062	− 20,739	− 2.4	837,715	− 12,086	− 1.4
Restaurants[2]	348,966	288,815	− 60,151	−17.2	284,085	− 64,881	−18.6
Grocery	345,002	353,273	+ 8,271	+ 2.4	320,467	− 24,535	− 7.1
Furniture and Hardware	246,308	252,775	+ 6,467	+ 2.6	244,677	− 1,631	− .7
Miscellaneous Retail	394,711	400,696	+ 5,985	+ 1.5	420,720	+ 26,009	+ 6.6
Motel	22,690	26,036	+ 3,346	+14.8	25,673	+ 2,983	+13.2
Personal Services	15,159	15,328	+ 169	+ 1.1	15,513	+ 354	+ 2.3
Totals	2,720,024	2,562,328	−157,696	− 5.8	2,493,048	−226,976	− 8.3
			CONTROL AREA				
Auto and Farm Machinery	459,569	457,587	− 1,982	− .4	512,028	+ 52,459	+11.4
Service Stations	570,781	514,461	− 2,238	− .4	511,443	− 5,256	− 1.0
Restaurants	118,862	123,498	+ 4,636	+ 3.9	130,580	+ 11,718	+ 9.9
Grocery	1,016,751	1,060,437	+ 43,686	+ 4.3	1,157,888	+141,137	+13.9
Furniture and Hardware	139,498	94,855	− 44,643	−32.0	62,904	− 76,594	−54.9
Miscellaneous Retail	270,755	290,723	+ 19,968	+ 7.4	291,644	+ 20,889	+ 7.7
Motels	10,517	9,094	− 1,423	−13.5	10,980	+ 463	+ 4.4
Personal Services	16,468	16,025	− 443	− 2.7	19,950	+ 3,482	+21.1
Totals	2,549,119	2,566,680	+ 17,561	+ .1	2,697,417	+148,298	+ 5.8

[1]Does not include either firms that went out of business or new firms that located in the area after construction was completed.
[2]One operator had two restaurants in "before" period, and closed one at end of "before" period. (Had no separate records.)

and farm machinery group was that the drop in their sales was caused primarily by reasons other than the median. The businessmen felt that the farmers had not fully recovered from the drought in the middle 1950's and were continuing to use their old machinery. Their crops in the later 1950's and early 1960's had not been too profitable either. Therefore, the sales of the farm equipment dealers had been depressed.

Because the sales of the extra firm (restaurant) were included in the "before" period of Table 3, the decrease in sales shown for the restaurant industry does not present the true picture of the sales for the four firms that

Table 4

TOTAL SALES OF ALL FIRMS THAT WERE IN OPERATION DURING ANY ONE OF THE THREE STUDY PERIODS

Type of Business	Before Period Base Sales	During Period			After Period		
		Sales	Change from Base Period	Percent Change	Sales	Change from Base Period	Percent Change
	(Dollars)	(Dollars)	(Dollars)	(Percent)	(Dollars)	(Dollars)	(Percent)
			STUDY AREA				
Auto and Farm Machinery	611,894	396,343	−215,551	−35.2	344,198	−267,696	−43.8
Service Stations	861,897	861,465	− 432	− .1	871,532	+ 9,635	+ 1.1
Restaurants	348,966	288,815	− 60,151	−17.2	284,085	− 64,881	−18.6
Grocery	348,717	355,917	+ 7,200	+ 2.1	320,467	− 28,250	− 8.1
Furniture and Hardware	259,609	256,375	− 3,234	− 1.2	244,677	− 14,932	− 5.8
Miscellaneous Retail	394,711	400,696	+ 5,985	+ 1.5	420,720	+ 26,009+	+ 6.6
Motels	22,690	26,036	+ 3,346	+14.8	25,673	+ 2,983	+13.2
Personal Services	15,159	15,328	− 169	− .0	15,513	+ 354	+ 2.3
Totals	2,863,595	2,600,975	−262,620	− 9.2	2,526,865	−336,730	−11.8
			CONTROL AREA				
Auto and Farm Farm Machinery	590,675	579,307	− 11,368	− 1.9	637,028	+ 46,353	+ 7.9
Service Stations	569,342	570,781	+ 1,439	+ .1	562,862	− 6,480	− 1.1
Restaurants	118,862	123,498	+ 4,636	+ 3.9	130,580	+ 11,718	+ 9.9
Grocery	1,074,627	1,085,119	+ 10,492	+ 1.0	1,171,755	+ 97,128	+ 9.0
Furniture and Hardware	157,534	106,855	− 50,679	−32.2	80,728	− 76,806	−48.8
Miscellaneous Retail	270,755	290,723	− 19,968	− 7.4	291,644	+ 20,889	+ 7.7
Motels	10,517	9,094	− 1,423	−13.5	10,980	+ 463	+ 4.4
Personal Services	16,468	16,025	− 443	− 2.7	19,950	+ 3,482	+21.1
Totals	2,808,780	2,781,402	− 27,378	− 0.9	2,905,527	+ 96,747	+ 3.4

MONTHLY SALES OF STUDY AREA FIRMS AND THEIR CONTROLS THAT WERE IN BUSINESS AT BOTH THE BEGINNING AND ENDING OF THE STUDY PERIOD
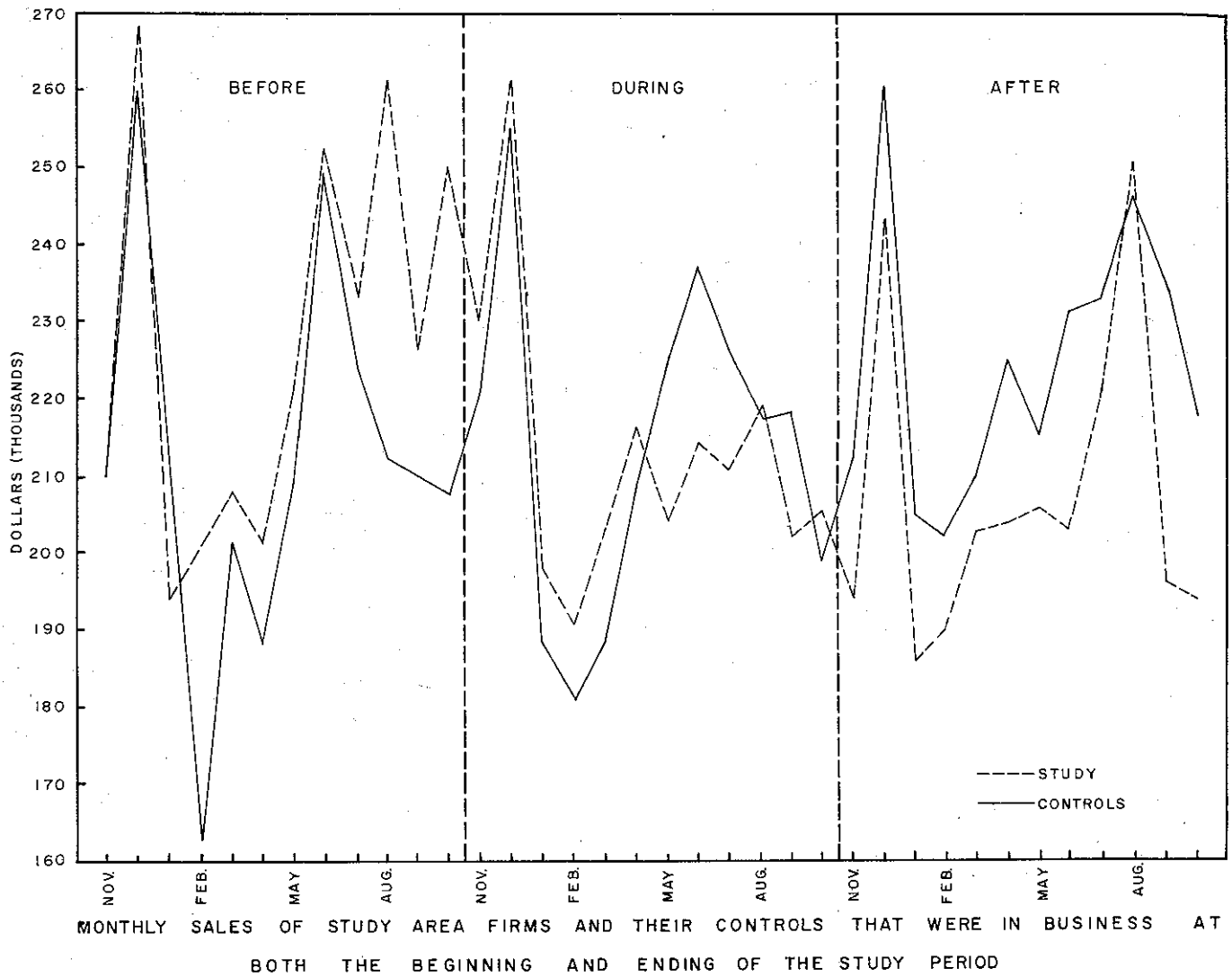
Figure 3.

were still in business at the end of the study. If the sales of the extra restaurant could have been separated from the totals in the "before" period, the percent change between periods would have been considerably smaller.

The second method of comparison is shown in Table 4. It shows the sales of all firms which were in operation within each time period. This is probably the most logical comparison that can be made for the area as a whole. It is concerned with the annual retail sales of all the firms rather than those of either the "original" or "surviving" firms as specific groups. These are the figures that reflect gross income for tax bases for the area as a whole. As such, they should be most useful to governmental taxing and planning agencies.

Table 4 shows that sales were down sharply during the "construction" period. This is influenced, to some extent, by the loss of two businesses moving off the facility and one firm going out of business. At the same time one firm that was closed in the "before" period reopened and continued to operate for the duration of the study. Consequently, the sales figures of the "during" period represent 38 firms compared to the 40 firms in operation in the "before" period.

The 9.2 percent loss in sales is indicative of the effect of the actual construction process on general business conditions. With the highway torn up for a considerable period of time, it is perhaps only natural for the businesses along its route to be adversely affected. Some businesses were completely isolated for short periods of time, but the majority of the firms were well pleased with the manner in which the contractor handled the construction. There were nine firms on the north end of the facility that were completely bypassed by the transit traffic for a period of four or five months while a bridge was being constructed over the Atascosa River. Their aggregate loss in sales during this period, however, was not extremely large, since six of the firms were of the nontraffic serving nature. The other three businesses were made up of two service stations and a drive-in restaurant, all of which showed a marked drop in sales.

During the "construction" period, the sales of the control area businesses decreased less than one percent from the "before" period volume as shown in Table 4. This means that the sales of the study area businesses dropped over eight percent more during the "construction" period than did their control businesses. Or, to put
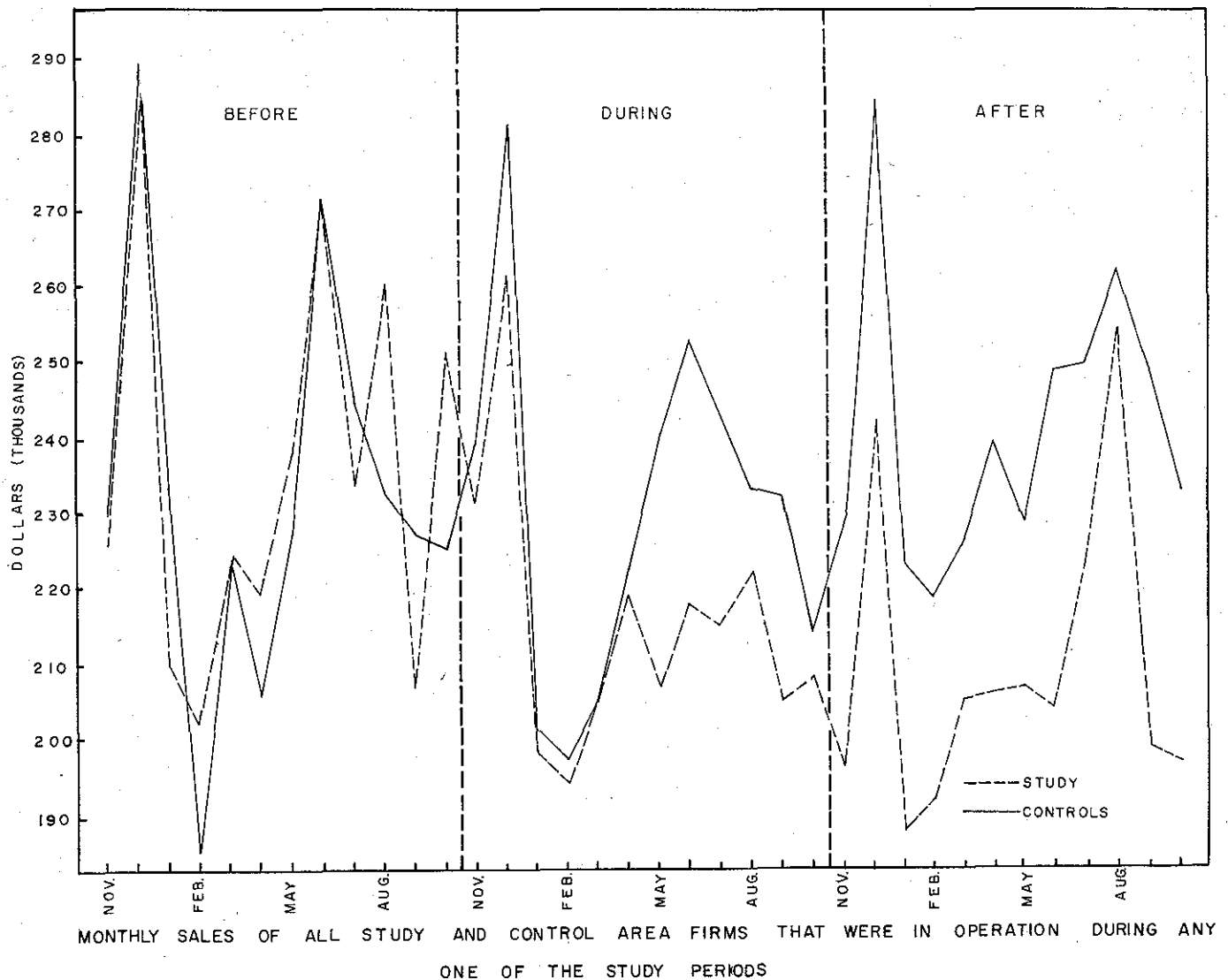
BEFORE   DURING   AFTER

MONTHLY SALES OF ALL STUDY AND CONTROL AREA FIRMS THAT WERE IN OPERATION DURING ANY

ONE OF THE STUDY PERIODS

Figure 4.

it another way, according to the evidence at hand, it appears that the construction process had a net adverse effect in excess of eight percent on the retail sales along the route.

After the construction was completed, sales did not recover in the Pleasanton study area as they had done in Baytown. During this period the sales continued to decrease in the study area, while the control sales showed a gain of 3.4 percent over the base period. On a net basis, then, at the end of the first year's operation under median conditions, the adjacent businesses reported a total sales volume some 15.2 percent lower than would have been anticipated had no change occurred.

It is interesting to note, however, that the first four groups of businesses in the study and control areas, listed in Table 4, do not perform alike with respect to changes in dollar volume. In each of these four groups the firms in the study area exhibited the opposite reaction to its control group of firms in the control areas. For example, the auto and farm machinery group of the study area shows a 43 percent decrease in sales while the control firms had a 7.9 percent increase. A large portion of

this decrease is a result of one large firm moving out of the area just before the construction began on the facility. In fact, the loss of this firm and its resultant effect on the industry total, accounts for over 50 percent of the decrease in the total "after" period sales.

Some of the loss in sales may have been due to factors other than the changes brought about by the construction of the median. For example, some of the 8.1 percent loss in the grocery industry may have been caused by the remodeling of one grocery store in another part of Pleasanton. After its renovation this firm became much more competitive and undoubtedly drew sales from the study area grocery firms. With the remaining industries, however, there does not appear to be any observable reasons for the changes in their sales, except that of the general economic conditions of the area or the effect of the median on their sales.

Figures 3 and 4 give a graphic presentation of the effect of the median on their sales.

Figures 3 and 4 give a graphic presentation of the effect that the construction of the median had on busi-

nesses during the three periods. These figures show on a monthly basis the same information for all businesses that is presented by years for the different classes of business in Tables 3 and 4.

Figure 3 (corresponding to Table 3 businesses) show that the monthly sales of both study and control firms fluctuated a great deal during each period. In the "before" period, the sales of both study and control firms performed similarly with respect to their seasonal movements. During each of the periods, sales hit a peak during the month of December. From this point, sales showed a considerable drop during January and February, followed by a gradual recovery for the remaining months. However, in the "construction" or "during" period the recovery of the study firms was much slower and did not extend nearly so high as they had in the "before" period. Sales usually pick up through the summer months due to both the seasonal farming activity

and to the tourist traffic passing through. However, during the period of construction, sales of study firms did not show the increase in the summer months that was characteristic of the control firms. By the time construction was completed, the monthly sales of study and control firms were both at about the same general level.

In the "after" period, study and control firms reacted according to the monthly cycle sales, but the study firms continued to operate below the general level of control firms for the duration of the study.

When all firms (Table 4 businesses) were included in the analysis, as in Figure 4, the picture generally remained the same for control firms in each period. However, from March or April of the "construction" period through the duration of the study, sales of study firms

Table 5
INDEX OF SALES SHOWING THE EFFECT OF THE CONSTRUCTION OF A MEDIAN ON EACH TRAFFIC SERVING BUSINESS
(Year November 1958 - October 1959 = 100)

	Before Base Period*	During Number	After Number
STUDY AREA FIRMS			
Service	100	115.8	135.2
Stations	100	117.2	133.6
	100	118.0	112.4
	100	105.4	104.2
	100	85.1	98.7
	100	71.4	88.8
	100	87.2	86.0
	100	94.4	78.6
	100	77.2	76.8
	100	86.9	67.7
Sub Total	100	99.9	101.1
Motels and	100	137.1	125.6
Restaurants	100	112.9	112.1
	100	87.6	109.8
	100	96.7	95.2
	100	71.5	56.1
	100	43.8	52.1
Sub Total	100	90.5	83.0
TOTAL	100	95.4	95.8
CONTROL AREA FIRMS			
Service	100	130.4	124.8
Stations	100	113.3	120.7
	100	101.1	118.3
	100	120.4	110.2
	100	103.4	101.9
	100	94.4	98.1
	100	107.7	98.1
	100	94.7	94.5
	100	84.4	93.3
	100	88.5	91.2
	100	79.8	72.2
	100	79.5	59.9
Sub Total	100	100.3	98.9
Motels and	100	117.2	151.4
Restaurants	100	103.9	135.5
	100	107.4	105.6
	100	86.4	104.4
	100	99.4	96.3
	100	96.9	90.3
Sub Total	100	102.5	109.4
TOTAL	100	100.7	100.8

*Base period equal 100.

Table 6
INDEX OF SALES SHOWING THE EFFECT OF THE CONSTRUCTION OF A MEDIAN ON NONTRAFFIC SERVING BUSINESSES
(Year Nov. '58 - Oct. '59 = 100)

Type of Business	Before	During	After
STUDY AREA FIRMS			
Miscellaneous Retail	100	83.1	147.9
Personal Services	100	107.3	137.1
Miscellaneous Retail	100	98.3	130.9
Personal Services	100	104.3	123.3
Hardware	100	112.7	120.8
Miscellaneous Retail	100	109.1	113.8
Miscellaneous Retail	100	116.8	107.9
Grocery	100	111.6	102.8
Personal Services	100	107.4	102.3
Hardware	100	107.0	97.1
Hardware	100	90.5	95.1
Auto and Farm Machinery	100	94.6	94.0
Grocery	100	97.0	91.8
Grocery	100	97.5	91.8
Miscellaneous Retail	100	101.7	91.5
Grocery	100	105.1	89.8
Personal Services	100	95.6	87.0
Auto and Farm Machinery	100	79.1	64.3
Auto and Farm Machinery	100	64.3	49.8
Grocery	100	71.2	
	100	87.3	82.4
CONTROL AREA FIRMS			
Miscellaneous Retail	100	135.9	183.0
Auto and Farm Machinery	100	110.6	121.7
Grocery	100	111.9	120.3
Personal Services	100	113.9	117.2
Auto and Farm Machinery	100	97.0	115.2
Grocery	100	101.0	114.4
Miscellaneous Retail	100	113.6	114.0
Miscellaneous Retail	100	116.5	110.9
Miscellaneous Retail	100	104.3	105.8
Personal Services	100	91.4	102.4
Grocery	100	107.9	100.0
Hardware	100	66.5	98.8
Auto and Farm Machinery	100	92.8	95.3
Grocery	100	103.8	93.3
Miscellaneous Retail	100	93.3	92.9
Miscellaneous Retail	100	109.2	92.4
Miscellaneous Retail	100	91.6	86.6
Hardware	100	77.6	77.2
Personal Services	100	96.2	72.5
Hardware	100	77.7	68.0
Auto and Farm Machinery	100	65.6	65.5
Grocery	100	42.6	24.0
Hardware	100	57.9	17.0
	100	98.5	104.3

remained well below those in the controls. Generally, this appears to substantiate the conclusion that sales of firms along the route were adversely affected by the construction of the median in Pleasanton.

Index of Sales

Another method used in analyzing the effect of the construction of a median on business activity is shown in Tables 5 and 6. Each of the tables represents the sales of individual firms. To facilitate comparison, they are grouped into traffic and nontraffic serving businesses. Firms are arrayed in these tables according to the magnitude of the changes in their sales as revealed by the index numbers in the "after" period. The "before" period sales represent the base where all index numbers are equal to 100. Individual firm names have been omitted in order to protect the identity of cooperating firms. Again, the index sales in each table shows that both the traffic and nontraffic serving firms in the study area were operating below the level of the base period and below the level of the control firms. The Index of Sales for traffic serving businesses in the study area, Table 5, dropped over four percent in the "after" period while the index for control firms showed a one percent gain over the base period. However, the index for the service station industry sales in the study area showed a small gain in the "after" period while control firms declined. Within the service station industry, sales of individual firms in the "after" period varied from an increase of 35 percent for one study firm to a 40 percent loss for one control service station. However, when comparing the total sales of both study and control stations, there was actually very little change in sales volume over the three-year period. It would appear then that in this instance at least, the median had very little influence on the service station industry.

The sales of the motel and restaurant industries were grouped in order to protect the identity of the individual firms. In this combined group, the study firms showed a 17 percent decrease in sales whereas the

control firms showed a 9.4 percent gain. Sales of study firms showed a drop in sales for the "during" and "after" periods, while the sales of control firms increased in each of the periods. Therefore, it appears that the construction of the median did have an influence on sales of these firms.

The firms were not analyzed by type of business in Table 6, since information was presented on the total sales of individual industry groups in Tables 3 and 4. This comparison is concerned only with the relationship between the total sales of nontraffic serving businesses along the median route and like businesses in the control group. Table 6 shows that the sales of nontraffic serving businesses along the median route were 18 percent below their base levels after a full year's operation with a median. The control firms managed to show a 4.3 percent gain in sales during the same time period. There is very little difference in the proportion of study and control firms that gained or lost business during the three-year study period. The degree of loss or gain in sales of individual firms did show up in the totals and evidently, the median did depress sales of the study firms.

Pleasanton, which is the largest city in the county, actually accounted for over 35 percent of the county's retail sales in 1958.[1] No information was available on the 1959 retail sales for Pleasanton, so the 1958 sales data are being used to show the city's relative position in the county's economy at that time. Retail sales for Atascosa County, as shown in Table 7, represent a picture of an almost stable economy during the three periods. These data will serve as a good indicator of Pleasanton's economy during the three-year study period.

A part of the decline in sales of study firms can be explained by the general drop in retail sales for the county. This drop in the county's economy, however,

[1]Texas Almanac—1958 retail sales according to U.S. Bureau of Census. Pleasanton accounts for 37 percent of county's retail sales, 24 percent of firms, 40 percent of employment, and 41 percent of county's payroll.

Table 7

A COMPARISON OF RETAIL SALES FOR BUSINESS FIRMS OF ATASCOSA COUNTY IN WHICH PLEASANTON IS LOCATED

	1959[2]	1960			1961		
	Sales 000	Sales 000	Change from Base Period		Sales 000	Change from Base Period	
			Sales 000	Percent		Sales 000	Percent
Retail Sales	$13,413	$13,263	− $150	−1.1%	$13,184	− $229	− 1.7%
Food	3,679	3,746	+ 67	+1.8	3,885	+ 206	+ 5.6
Eating and Drinking Establishments	609	609	0		625	+ 16	+ 2.6
General Merchandise	499	496	− 3	−0.6	520	+ 21	+ 4.2
Apparel	222	219	− 3	−1.4	219	− 3	− 1.4
Furniture and Household Appliances	146	137	− 9	−6.2	136	− 10	− 6.8
Auto	3,294	3,210	− 84	−2.6	3,026	− 268	− 8.1
Gas Stations	1,417	1,443	+ 26	+1.8	1,481	+ 64	+ 4.5
Lumber, Building and Hardware	1,895	1,813	− 82	−4.3	1,746	− 149	− 7.9
Drugs	460	471	+ 11	+2.4	485	+ 25	− 5.4
Others Not Specifically Listed	1,192	1,119	− 73	−6.0	1,061	− 131	−11.0

[1]Sales Management Magazine—an annual survey conducted on a county and city basis when estimates of retail sales are made by type of business. Key cities and counties within a state are surveyed to collect actual retail sales from businesses. Then these figures are made with the most current report of retail sales from the Department of Economics Survey and Current Business and Census of Business to arrive at estimates for individual cities and counties.
[2]Base year.
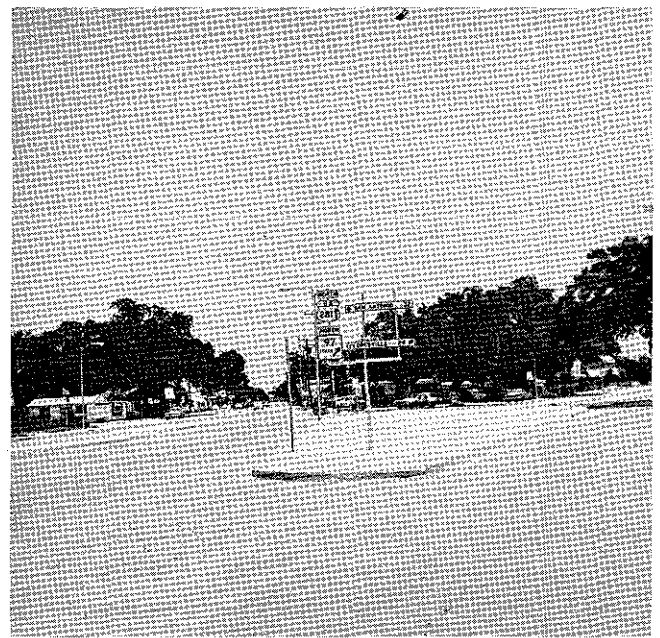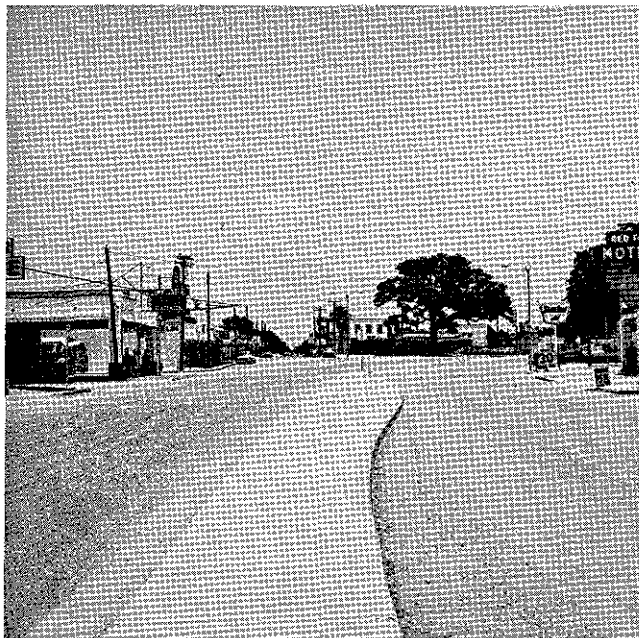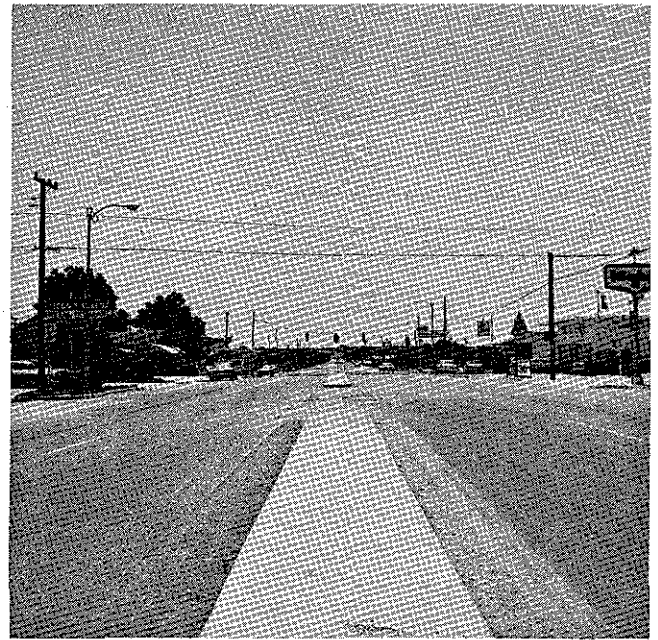
Views of the median barrier showing the various types of construction to facilitate traffic on the new route.

represents less than a two percent decline from the 1959 level. Since the sales of the study firms were included in the county's total, their losses, as reflected in Tables 3 and 4, had the effect of reducing the total sales of the county. Actually, the sales of the study area firms account for about 20 percent of the county's total retail sales. It is interesting to note that the drop of $157,696 in sales in the "during" period and $226,976 in the "after" period (Table 3) for study firms is almost the exact amount of the total drop in retail sales occurring throughout the county. It may be assumed then, that the decreases in the county's retail sales during 1960 and 1961 were a direct result of the drop in sales of those firms within the study area.

The loss in sales of study firms as shown in Table 4 does not reflect a complete picture of Pleasanton's or the county's economy, as some of these firms, included in the "before" period, moved off the highway route to new locations in Pleasanton and continued to do business, but in new locations. The "during" and "after" period sales of these firms are accounted for in the county's totals and their loss or gain in sales during the last two years of the study would be reflected in the county's total sales.

RELATIONSHIP TO MEDIAN OPENINGS

When a new facility is to be constructed which calls for a median with limited openings, businessmen in the area are reluctant to accept its design unless there is a

The median restricts left turns into and out of businesses located in mid block.

median opening in front of each adjacent business. Generally, it is their contention that a business near an opening in the median is benefitted greatly since this provides its customers convenient access to and from both streams of traffic.

As part of this study, it was decided to test the validity of the above contention, in as far as the data would permit. Each firm was classified as being located either at or away from a median opening. All firms which could be approached by a *legal* left turn were considered as being located at a median opening. Those that could not be entered by a legal left turn were placed in the nonopening group.

An analysis by the various types of businesses was not possible in this phase of the study, since the additional breakdown of firms would expose the identity of several cooperating businesses. However, the businesses were divided into two groups, traffic serving businesses and nontraffic serving businesses. The comparison of sales with respect to the firms' location to a median opening is shown in Tables 8A and 8B.

Of the 35 firms which were in operation during the entire study period, 16 were located at a median opening and 19 were located away from the median opening. Of the two groups, those firms located at median openings fared the poorest in this study. Their sales were 11 per-

cent below their base period levels after a full year's operation with the median. The other group, while also showing a loss, was operating only six percent below their base period.

In each of the groups above, firms fared better in the "during" or "construction" period than in the period after construction was completed. Firms at median openings showed an eight percent drop in sales in the "during" period from their base level, while the other group had only a two percent drop.

As expected, most of the firms located at median openings were of the traffic serving nature, while the nontraffic serving businesses made up the majority of the firms located away from a median opening.

Of the 16 firms located at median openings, 12 were classed in the traffic serving category. Sales of these 12 firms showed a three percent drop in the "during" period and were operating only one percent under the base level at the end of the study. The traffic serving group shown in Table 8A consisted of two restaurants and ten service stations. Of the ten service stations, six showed a drop in sales in the "during" and "after" periods while the other four reported that their businesses had increased in each period.

From the data presented in Table 8A, it would appear that the four nontraffic serving businesses were definitely hindered by being located near an opening in the median. However, it is believed that there are other factors, other than location, affecting the sales of these firms. The management of two firms, showing the largest drop in sales, felt that their losses were not caused by the median, but by a cyclical decline in demand for their products.

Of the 19 firms shown in Table 8B, 15 were of the nontraffic serving nature and four were considered to be traffic serving. It appears that the nontraffic serving businesses fared much better than those businesses classified as traffic serving.

The traffic serving group consisted of two motels and two restaurants. The 44 percent decrease in sales is not indicative of the group's economy, since a large portion of the loss resulted from the closing of one restaurant just as construction was begun on the median. As stated earlier, the sales of this restaurant were combined with the sales of another restaurant in the "before" period, as they were under the same management and individual records on each business were not available. Therefore, this loss had a noticeable influence on the percent change of the total index for the four traffic serving businesses that were located away from a median opening. If the sales of the firm going out of business were estimated, the Index Sales would be increased by approximately 20 percent in the "during" and "after" periods. However, even with such a change, the four traffic serving businesses would not have fared as well as the 15 nontraffic businesses.

The nontraffic serving businesses listed in Table 8B generally held their own with respect to sales volume during the three-year study period. As a group, there was very little variation in their sales during this time period. This group of firms was represented by ten different types or classes of retail businesses. There was also very little difference in the proportion of firms that gained or lost business during the three year period.

From an anlysis of data in both Tables 8A and 8B, it would appear there was no advantage to a firm in being located near a median opening. The variation in sales of firms both with and without median openings strongly supports the contention that within the competitive framework existing in a city of size and character of Pleasanton, individual management or manage-

Table 8A
INDEX OF THE EFFECT OF FIRM LOCATION WITH RESPECT TO MEDIAN OPENINGS ON SALES VOLUMES
Year Nov. 1958 - Oct. 1959 = 100
GROUP I—FIRMS LOCATED AT MEDIAN OPENINGS

Firm No.	Before Number	During Number	After Number
	Traffic Serving		
21	100	88	110
22	100	97	95
24	100	105	104
25	100	117	134
26	100	87	68
28	100	85	99
29	100	71	89
30	100	87	86
31	100	118	112
32	100	116	135
33	100	77	77
35	100	94	79
Subtotal	100	97	99
	Nontraffic Serving		
5	100	79	64
7	100	64	50
12	100	98	92
16	100	96	87
Subtotal	100	80	68
TOTALS	100	92	89

Table 8B
GROUP II—FIRMS NOT LOCATED AT MEDIAN OPENINGS

Firm No.	Before Number	During Number	After Number
	Traffic Serving		
18	100	113	112
19	100	137	126
20	100	44	52
23	100	71	56
Subtotal	100	72	56
	Nontraffic Serving		
1	100	113	121
2	100	90	95
3	100	107	97
6	100	95	94
10	100	97	92
11	100	105	90
13	100	112	103
14	100	104	123
15	100	107	102
17	100	107	137
36	100	102	91
37	100	109	114
38	100	83	52
39	100	83	108
40	100	98	131
Subtotal	100	102	100
TOTALS	100	98	94
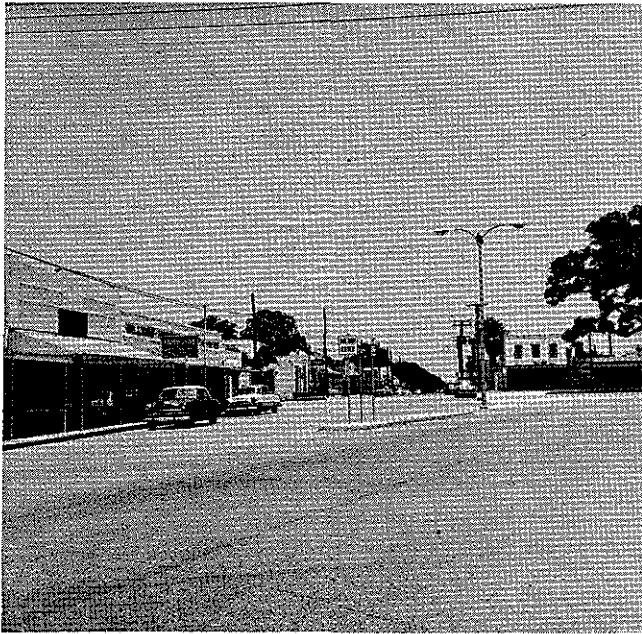
Main street now has one way traffic.
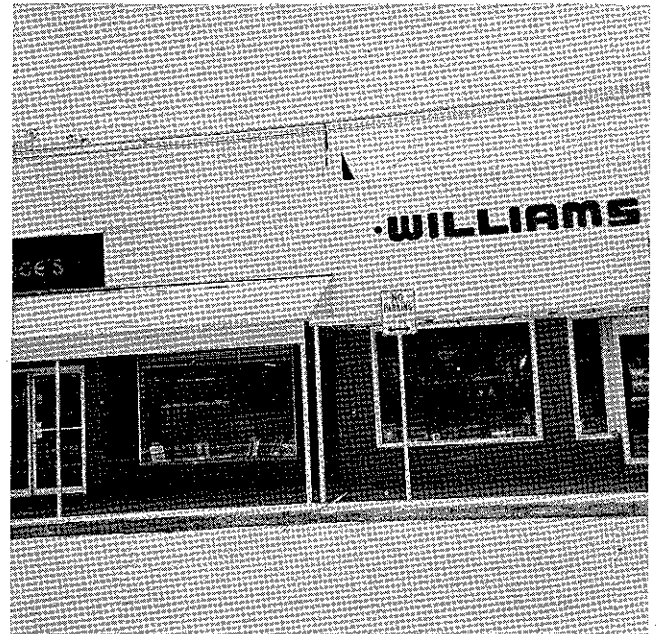
No parking zone.

The improved facility required certain restrictions on traffic in the downtown area.

ment's reaction to changing conditions exerts a much stronger influence on sales than does location.

MEDIAN INFLUENCE ON CUSTOMER TRAFFIC

The influence of the median on customer traffic is studied by a combined analysis of the economic and traffic data collected. Generally, in a city of this size with separated buildings, each business provides its own parking facilities. This allows the identification of each customer into a particular business. The introduction of a median restricted the left turns into businesses, and it is this restriction that provides the basis for this analysis.

Most businesses along the route feel that the loss of left turns into their businesses has had an adverse effect on their operations. In this study, an attempt is made to answer two questions about customer traffic: first, the extent to which a median would restrict it; and second, the influence that the change would have on the sales of businesses concerned.

The directional movement of traffic into and out of each business was recorded for a 12-hour period before and after the construction of the median. The "after" count was made approximately a year after the median was completed. The hourly count began at 7:00 a.m. and continued to 7:00 p.m.

The traffic section of the report discusses the influence of the median on the total traffic of the facility. It is only necessary at this point to summarize several ob-

Table 9

A COMPARISON OF AVERAGE DAILY TRAFFIC TO SHOPPING TURNS INTO BUSINESSES ALONG HIGHWAY 281 IN PLEASANTON, TEXAS

| | Before | | After | | Percent Change | |
	Customer Turn Ins	Total Traffic	Customer Turn Ins	Total Traffic	Turn Ins	Traffic
		Number	Number	Number	Number	Number
Hours						
7 - 8	223	281	142	288	−36%	+ 3%
8 - 9	223	372	210	394	− 6	+ 6
9 - 10	231	386	224	427	− 3	+11
10 - 11	254	396	228	483	−10	+22
11 - 12	270	407	250	504	− 7	+24
12 - 1	274	363	261	507	− 5	+40
1 - 2	210	352	182	459	−13	+30
2 - 3	207	358	225	495	+ 9	+38
3 - 4	247	364	255	523	+ 3	+44
4 - 5	228	411	277	602	+22	+47
5 - 6	294	469	251	637	−15	+36
6 - 7	185	419	223	501	+21	+20
Totals	2846	4578	2728	5820	− 4%	+27%
Average	237	382	227	485		
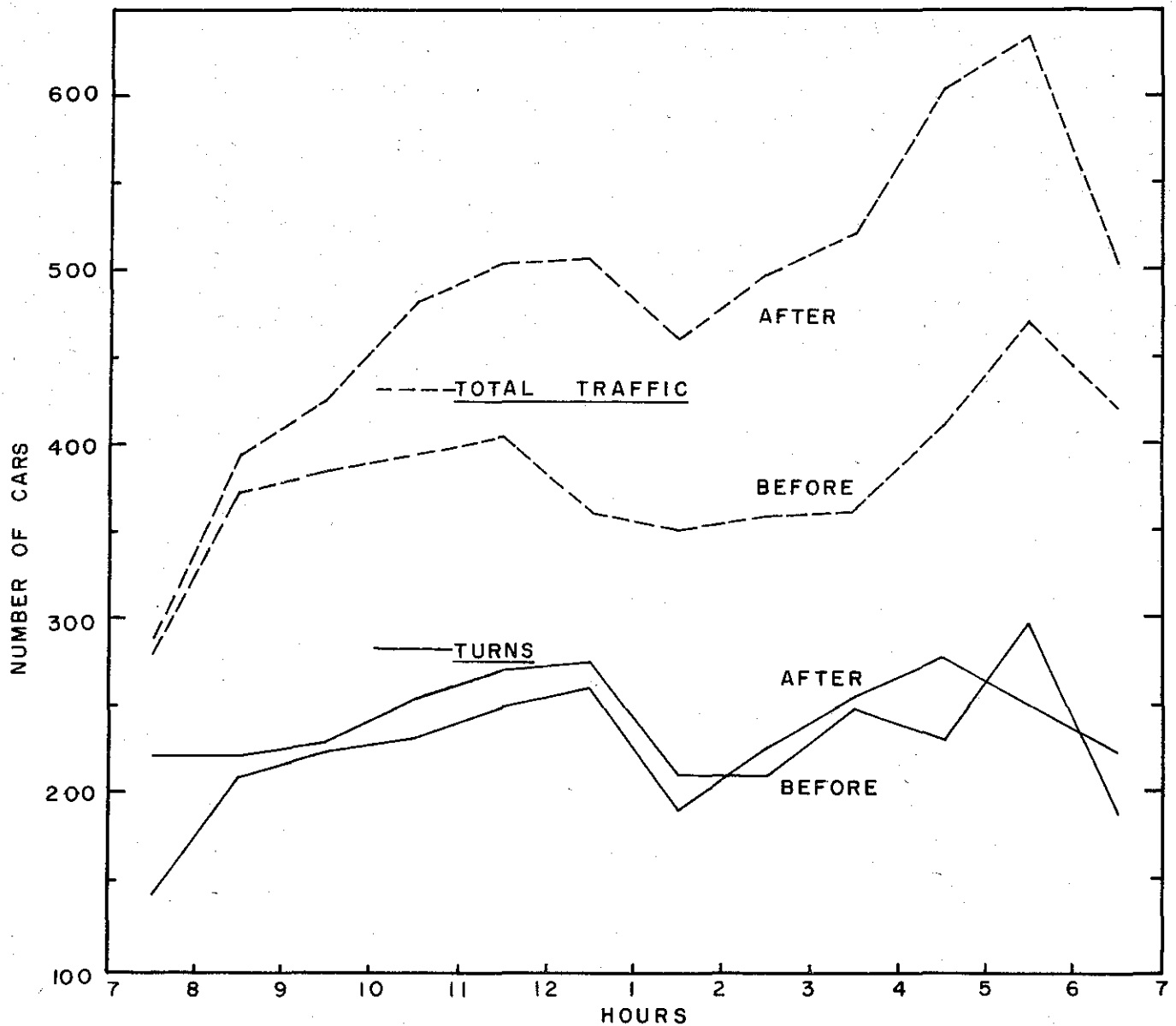
TOTAL TURNS INTO BUSINESSES IN RELATION TO TOTAL TRAFFIC
BY HOURS ALONG HIGHWAY 281, PLEASANTON, TEXAS

Figure 5.

servations. The average daily traffic for the 12-hour period increased approximately 27 percent from the "before" to the "after" count, while the shopping turns decreased four percent as shown in Table 9. Hourly traffic increased during each of the hours, with the largest gain of 47 percent occurring between 4:00 and 5:00 p.m.

The count showed that average hourly traffic during the 12-hour period increased from 382 vehicles before the median to 485 after, or an increase of 103 vehicles per hour.

Turns into businesses did not follow the trend of the ADT as shopping turns decreased during eight of the 12 hours. In the "after" period, customer turns showed gains during four of the afternoon hourly time periods.

The hourly distribution of total traffic and customer traffic is shown graphically in Figure 5. The two total

traffic curves clearly show that the "after" period had more pronounced peaks and lows but generally followed the same pattern as the "before" count except at a higher level. This graph also shows that hourly shopping turns in the "after" period followed the same general pattern as in the original period throughout the 12 hours studied. However, there was less variation in the hourly shopping turns than in the total hourly traffic.

To obtain a measure of the dispersions of total traffic during the two periods, standard deviations were computed. For comparison, the standard deviation of each was divided by the arithmetic mean in order to measure the relative variation. This measure, the coefficient of variation, showed a nine percent variation in the "before" and an 18 percent variation in the "after" period. Turns into businesses followed a similar pattern

PERCENTAGE TURN-INS OF TOTAL TRAFFIC

BEFORE

AFTER

TURNS INTO BUSINESSES AS A PERCENTAGE OF TOTAL HOURLY TRAFFIC
ALONG HIGHWAY 281, PLEASANTON, TEXAS

HOURS

Figure 6.

LEFT TURNS BEFORE
U TURNS & LEFT TURNS AFTER
LEFT TURNS AFTER
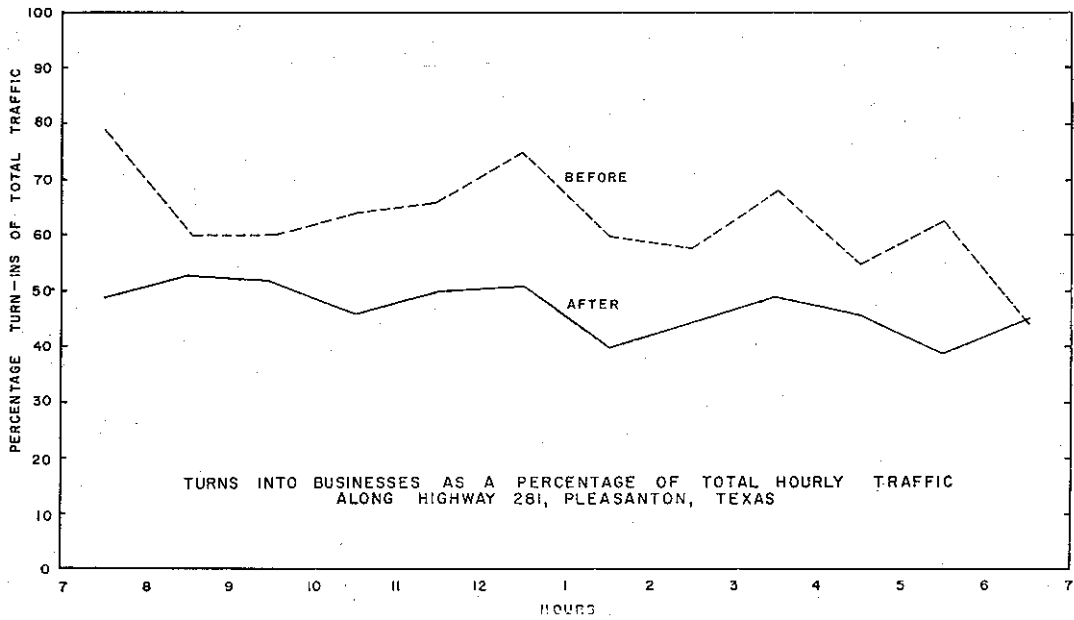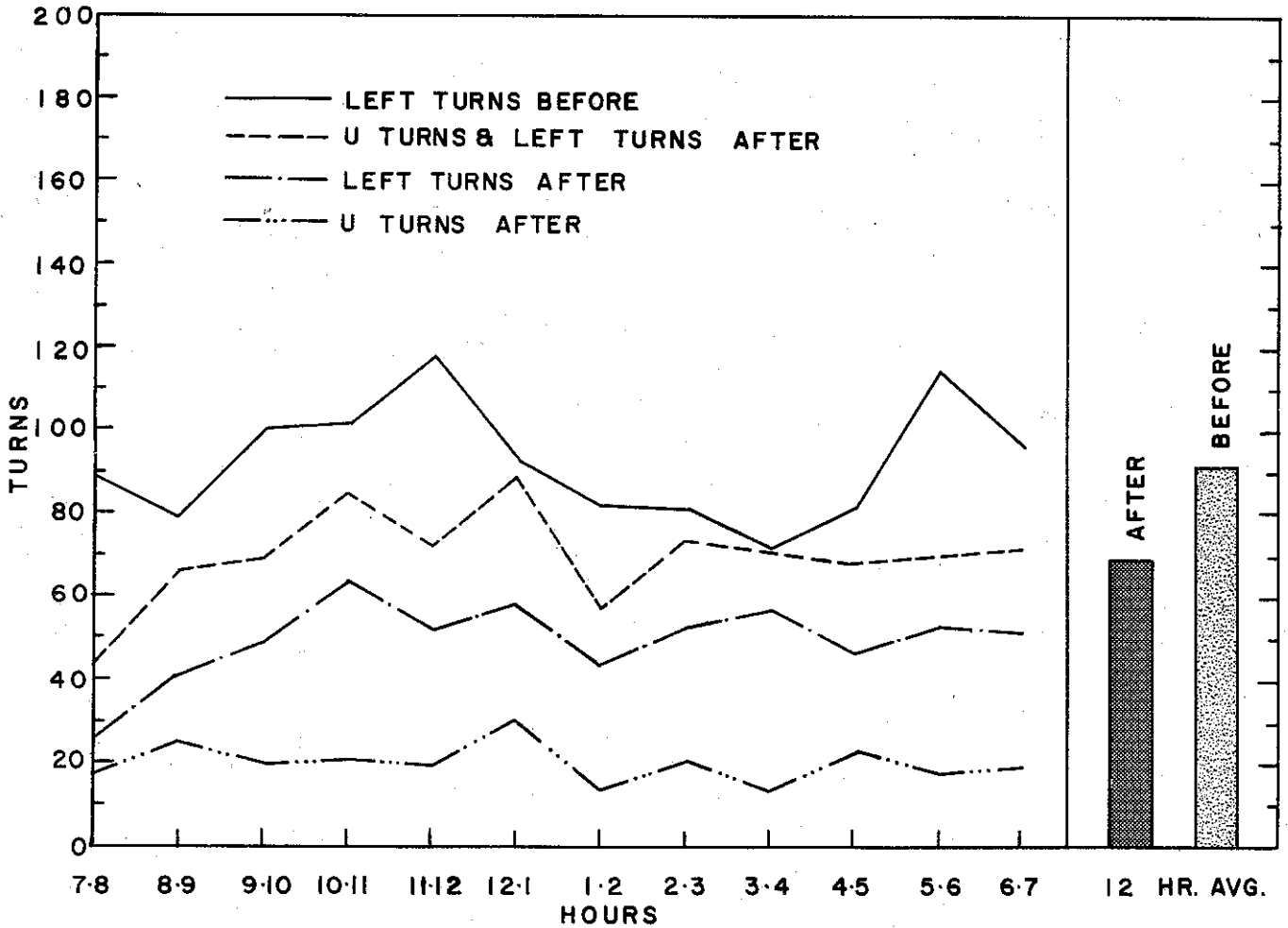U TURNS AFTER

TURNS

HOURS

AFTER   BEFORE

INFLUENCE OF A MEDIAN ON LEFT TURNS INTO THE BUSINESS FIRMS ALONG HIGHWAY 281,
PLEASANTON, TEX.

Figure 7.

Table 10
THE INFLUENCE OF A MEDIAN ON TURNS INTO BUSINESS FIRMS ALONG HIGHWAY 287, PLEASANTON, TEXAS

	Total Turn Ins	Right Turns		Left Turns		U Turns	
		Number	Percent of Totals	Number	Percent of Totals	Number	Percent of Totals
TRAFFIC SERVING BUSINESSES							
Before	1,891	1,051	56%	840	44%		
After	1,627	1,071	66	428	26	128	8%
NONTRAFFIC SERVING BUSINESSES							
Before	955	714	75	241	25		
After	1,101	819	74	166	15	116	11
TOTALS							
Before	2,846	1,765	62	1,081	38		
After	2,728	1,890	69	594	22	244	9

Table 11
INFLUENCE OF A MEDIAN ON TURNS INTO TRAFFIC SERVING AND NON-TRAFFIC SERVING BUSINESSES ALONG HIGHWAY 287, PLEASANTON, TEXAS

	Traffic Serving			Nontraffic Serving			Totals		
	Before	After	Percent Change	Before	After	Percent Change	Before	After	Percent Change
	Number	Number	Percent	Number	Number	Percent	Number	Number	Percent
Right Turns	1051	1071 / L-428	+ 2%	714	819 / L-166	+15%	1765	1890 / L-594	+ 7%
Left and U Turns[1]	840	U-128	−34	241	U-116	+17	1081	U-244	−23
Totals	1891	1627	−14	955	1101	+15	2846	2728	− 4

[1] No U turns in "Before" period.

Table 12
INFLUENCE OF A MEDIAN ON TURNS INTO SELECTED BUSINESSES BY LOCATION TO MEDIAN OPENINGS ALONG HIGHWAY 287, PLEASANTON, TEXAS

	Median Openings			No Median Openings		
	Before	After	% Change	Before	After	% Change
	Number	Number	Percent	Number	Number	Percent
Traffic Serving Businesses						
Number of Firms		12			4	
Right Turns	791	754	− 5%	164	113 / L-10	−31%
Left and U-Turns	602	319	−47	150	U-17	−82
Totals	1,393	1,073	−23	314	140	−55
Non-traffic Serving Business						
Number of Firms		4			15	
Right Turns	169	144	−15	399	477 / L- 8	+20 / −54
Left and U-Turns	30	53	+77	131	U-52	−54
Totals	199	197	− 1	530	537	+ 1
Totals						
Number of Firms		16			19	
Right Turns	960	898	− 7	563	590 / L-18	+ 5
Left and U-Turns	632	372	−41	281	U-69	−69
Totals	1,592	1,270	−20	844	677	−20
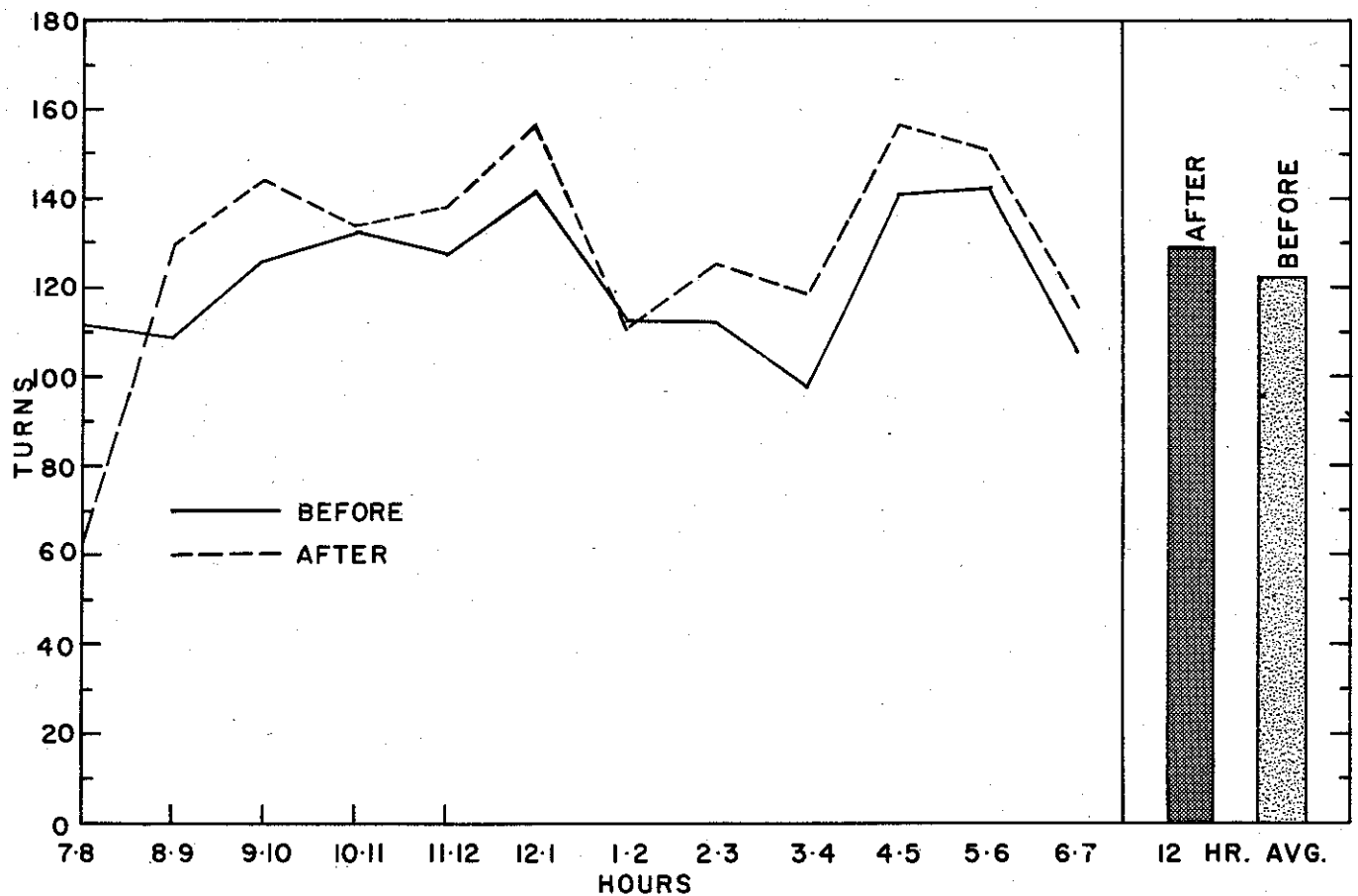
INFLUENCE OF A MEDIAN ON RIGHT TURNS OUT OF BUSINESS FIRMS ALONG HIGHWAY 281,
PLEASANTON, TEX.

Figure 8.

as shown in Figure 6. The "before" coefficient of variation was eight percent and the "after" was 16 percent.

There may be several explanations of the greater variations in the "after" period. The most logical explanation suggested by the data collected is that the 27 percent increase in total traffic was due mainly to through highway traffic which apparently had little influence on the economy of the immediate area. This is pointed out in Figure 6 which shows that shopping turns as a percent of total traffic in the "after" period were at a considerably lower level than before the construction of the median. In fact, shopping turns in the "before" period represented about 62 percent of the total 12-hour traffic while in the "after" period they only represented 47 percent.

Since the increase in total traffic is assumed to be an increase primarily in the out of town and through traffic, we may conclude that the greater variation in traffic in the "after" study can be at least partially explained by this 27 percent increase.

Table 10 shows the influence of the median on shopping turns into study area firms by direction of turns. This also compares the turning movements of traffic serving and nontraffic serving businesses. All firms doing business at the time of the "after" count are included

in these data. The most significant point here is the sharp reduction in both the absolute number and the relative proportion of left turns in the shopping traffic stream. Before the median was built, left turns represented 38 percent of the shopping turns. After construction they represented only 22 percent of customer turns into businesses.

Another way of comparing shopping turns into businesses is shown in Table 11. The seven percent increase in right turns in the "after" period was not sufficient to offset the 23 percent loss in left and U-turns. Consequently, businesses in the area had four percent fewer shopping turns in the "after" period. Another significant point shown in this table is the 14 percent reduction of shopping turns into traffic serving businesses while nontraffic serving businesses showed a 15 percent increase over the traffic count made during the "before" period. This decrease of shopping turns into traffic serving businesses was not expected since most of these businesses are located at median openings which allows convenient access to the firms by both left and right turns.

In the "after" period, the nontraffic serving businesses showed significant gains in both right and left turns, while the traffic serving businesses experienced a small gain in right turns and a considerable loss in
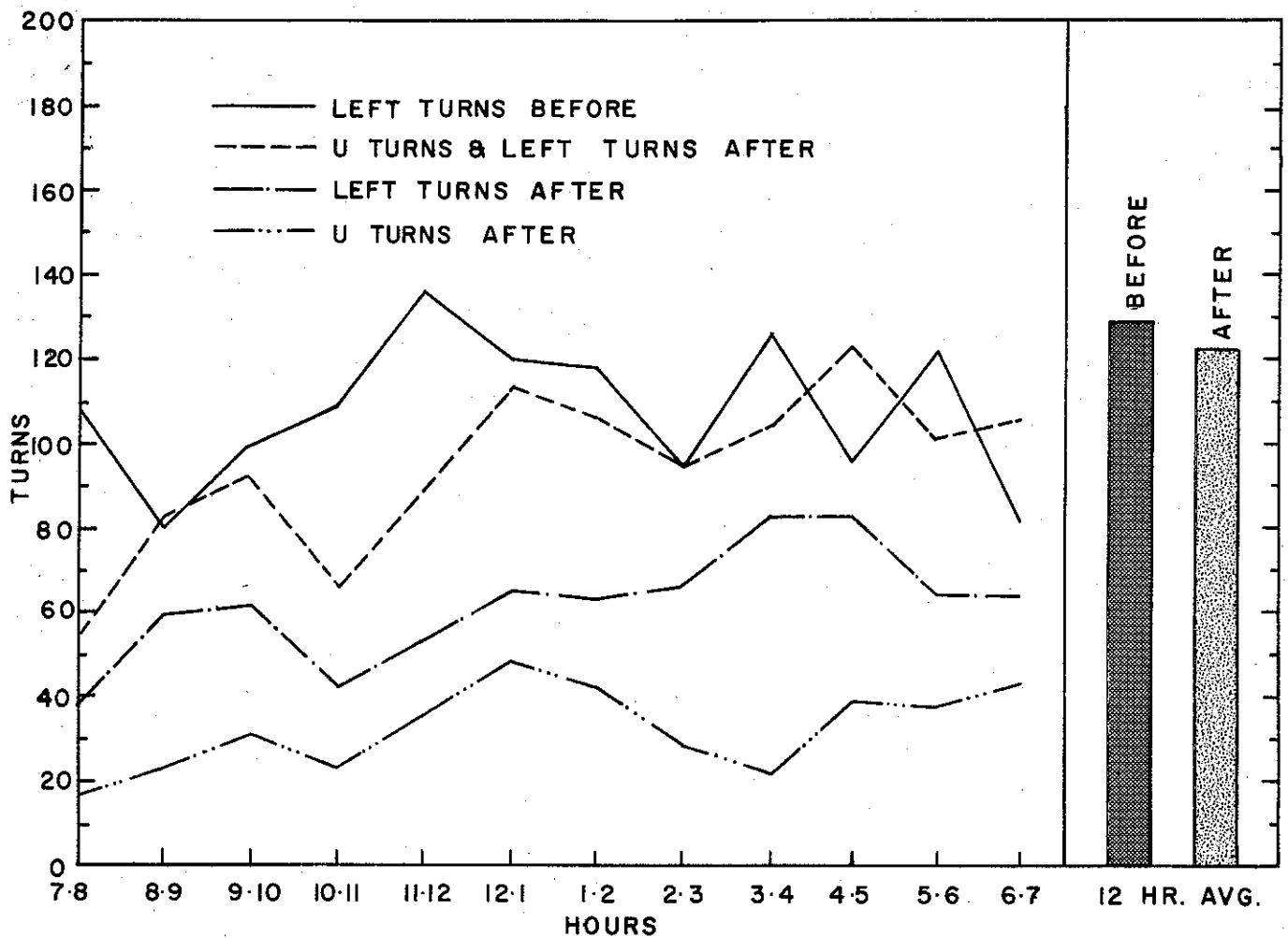
INFLUENCE OF A MEDIAN ON LEFT TURNS OUT OF BUSINESS FIRMS ALONG HIGHWAY 281,
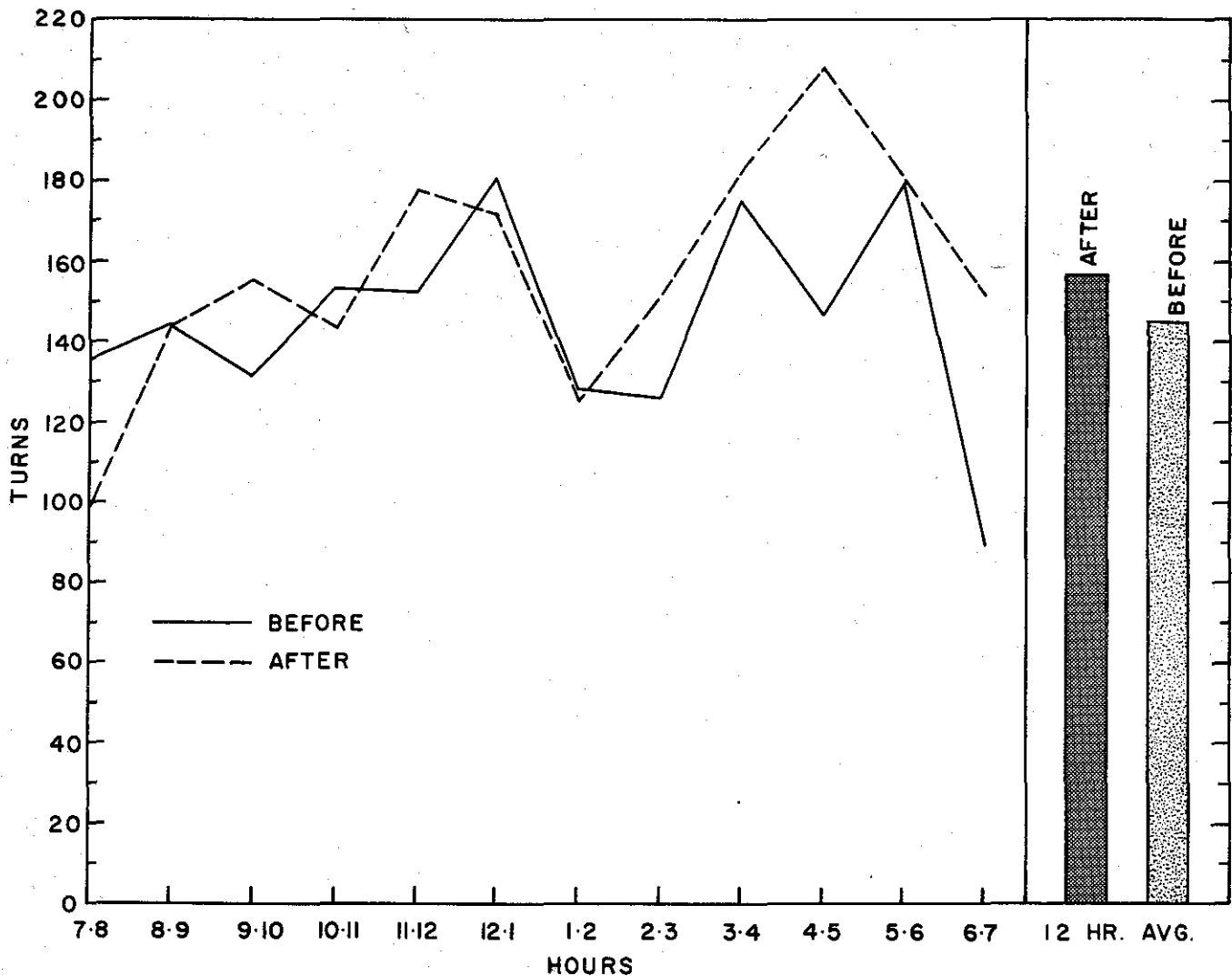PLEASANTON, TEX.

Figure 9.

cross traffic movements. Thus, Table 11 clearly illustrates the relative effects of the median on the different types of businesses in this study area.

Table 12 is a grouping of the same 35 firms that were in business during the entire study period as shown in Tables 8A and 8B. It shows in more detail the influence of the median on shopping turns and location of businesses relative to an opening in the median. The firms are again divided into traffic and nontraffic serving groups to show the effects of location on shopping turns.

It can be seen that most of the traffic serving businesses are located at median openings while most of the nontraffic serving firms are located away from median openings. Only four of the 16 traffic serving businesses were located away from an opening while four of the 19 nontraffic firms were located at median openings. This distribution makes it difficult to draw conclusions about the over-all effect by business type. However, the table shows that as a group there was no significant change in the number of turns into the nontraffic serving busi-

nesses while significant decreases in turns were recorded for the traffic serving firms.

The increase in right turns offsets the decrease in left turns for the nontraffic serving businesses located in mid-block or away from a median opening. In contrast, those traffic serving businesses not located near a median opening showed decreases in both right and left turns. Another important point brought out in this table is the decrease in total left and U-turns into both groups of firms. The 69 percent loss in cross traffic into firms not located at an opening was considerably larger than the 41 percent loss by firms located at a median opening. However, when the left and U-turns were combined with the rights for the total shopping movements for each of the groups of businesses, a 20 percent drop in shopping turns was recorded in each case from the "before" period. This loss in total shopping traffic is somewhat larger than the 11 percent loss in sales occurring for the same group of 16 firms located at median openings and the six percent loss in sales for the other group of 19 firms as shown in Tables 8A and 8B.

INFLUENCE OF A MEDIAN ON RIGHT TURNS INTO BUSINESS FIRMS ALONG HIGHWAY 281, PLEASANTON, TEXAS
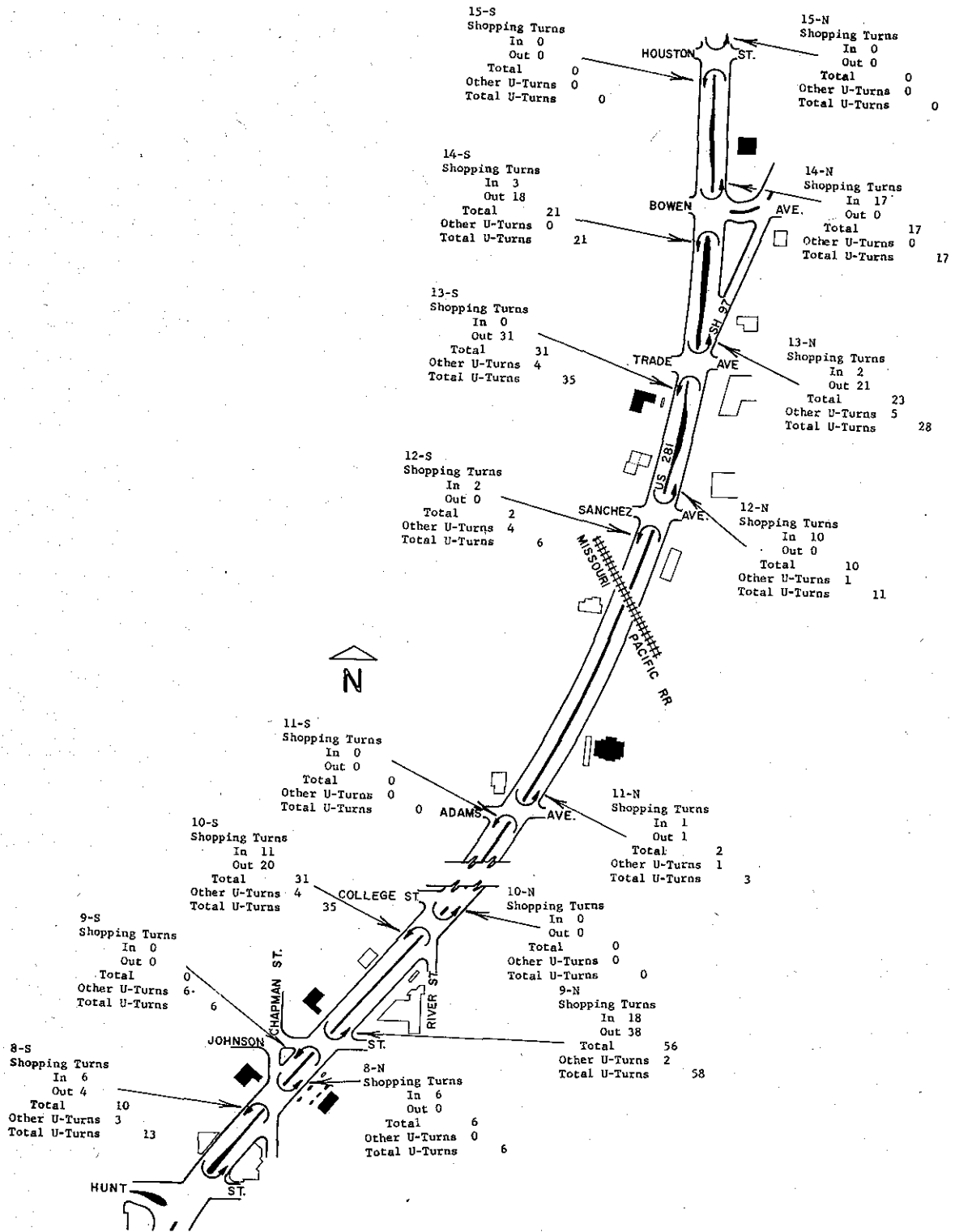
Figure 10.

It seems reasonable to assume that the firms showing the largest loss in left-turn traffic would also show the largest loss in sales. However, in this case there doesn't appear to be a close relationship between these factors when comparing the sales data in Tables 8A and 8B with the traffic volumes in Table 12. When considering total shopping turns, there does appear to be a close relationship between the percent change in sales and the percent change in shopping turns into those businesses located away from a median opening. We do not know if this holds true with firms located at median openings since shopping turns originating from side streets or leaving via side streets were not recorded in this study.

The 18 left turns recorded for businesses located away from a median opening were made by automobiles which were forced to oppose on-coming traffic for some distance between the median opening and the curb opening to the business. Such turns are illegal and are considered to be quite hazardous.

The hourly changes in customer turns into and out of study area firms are shown in Figures 7, 8, 9, and 10. Here again is shown the sharp reduction in left turns with a correspondingly small increase in right turns. These figures also show the reduced level of combined left and U-turns in the "after" period in comparison with the original level of left turns. In addition, there is a small bar chart on each figure showing a 12-hour average for the particular type turns presented in that figure.

Since U-turns are created by the median, some additional attention was paid to determining their distribution within the area and their occurrence throughout the day. Figures 11 and 11A show a rough outline of the study area with the businesses located in their proper relation to median openings. The businesses shown in black are considered traffic serving businesses while all others are nontraffic serving. Also shown is the number of U-turns made at each opening (by direction), the number of those turns that were for shopping purposes

15-S
Shopping Turns
In 0
Out 0
Total 0
Other U-Turns 0
Total U-Turns 0

HOUSTON ST.

15-N
Shopping Turns
In 0
Out 0
Total 0
Other U-Turns 0
Total U-Turns 0

14-S
Shopping Turns
In 3
Out 18
Total 21
Other U-Turns 0
Total U-Turns 21

BOWEN AVE.

14-N
Shopping Turns
In 17
Out 0
Total 17
Other U-Turns 0
Total U-Turns 17

13-S
Shopping Turns
In 0
Out 31
Total 31
Other U-Turns 4
Total U-Turns 35

TRADE AVE

SH 97

13-N
Shopping Turns
In 2
Out 21
Total 23
Other U-Turns 5
Total U-Turns 28

12-S
Shopping Turns
In 2
Out 0
Total 2
Other U-Turns 4
Total U-Turns 6

SANCHEZ AVE.

US 281

12-N
Shopping Turns
In 10
Out 0
Total 10
Other U-Turns 1
Total U-Turns 11

MISSOURI PACIFIC RR.

N

11-S
Shopping Turns
In 0
Out 0
Total 0
Other U-Turns 0
Total U-Turns 0

ADAMS AVE.

11-N
Shopping Turns
In 1
Out 1
Total 2
Other U-Turns 1
Total U-Turns 3

10-S
Shopping Turns
In 11
Out 20
Total 31
Other U-Turns 4
Total U-Turns 35

COLLEGE ST

10-N
Shopping Turns
In 0
Out 0
Total 0
Other U-Turns 0
Total U-Turns 0

9-S
Shopping Turns
In 0
Out 0
Total 0
Other U-Turns 6
Total U-Turns 6

CHAPMAN ST.

RIVER ST.

9-N
Shopping Turns
In 18
Out 38
Total 56
Other U-Turns 2
Total U-Turns 58

JOHNSON ST.

8-S
Shopping Turns
In 6
Out 4
Total 10
Other U-Turns 3
Total U-Turns 13

8-N
Shopping Turns
In 6
Out 0
Total 6
Other U-Turns 0
Total U-Turns 6

HUNT ST.

DISTRIBUTION OF U-TURNS BY PURPOSE, U. S. HIGHWAY 281, PLEASANTON, TEXAS

Figure 11.

within the immediate area, and the distribution of these turns between turns into and turns out of study area firms.

By studying the character of the turns at each opening, the generation of the U-turn traffic by businesses can be appreciated. Openings No. 1 and No. 3 had the heaviest concentration of U-turn movements. Both are located south of the main business area, and turns at
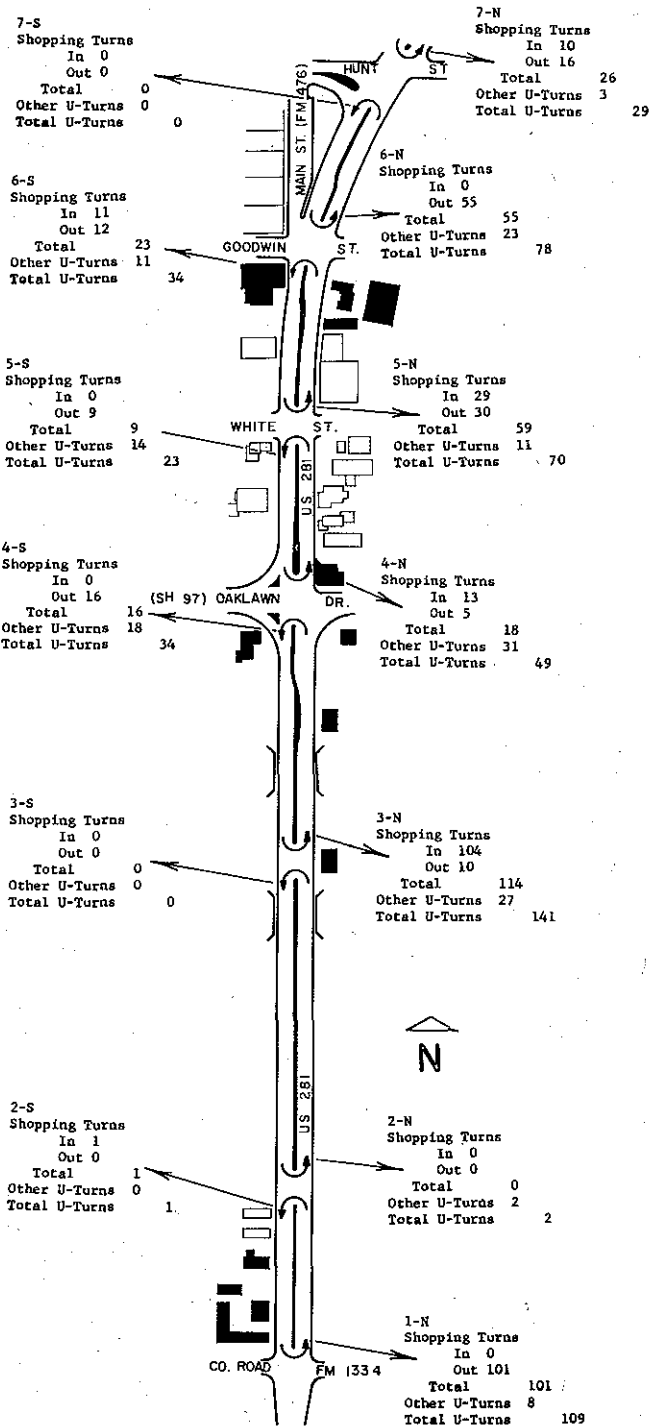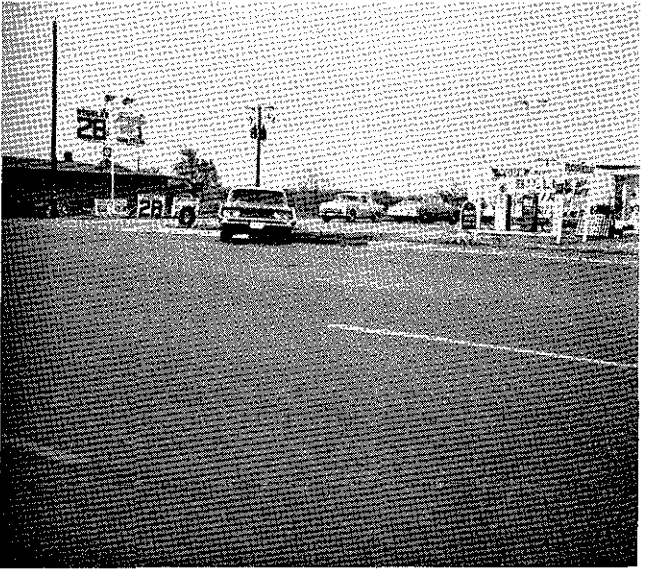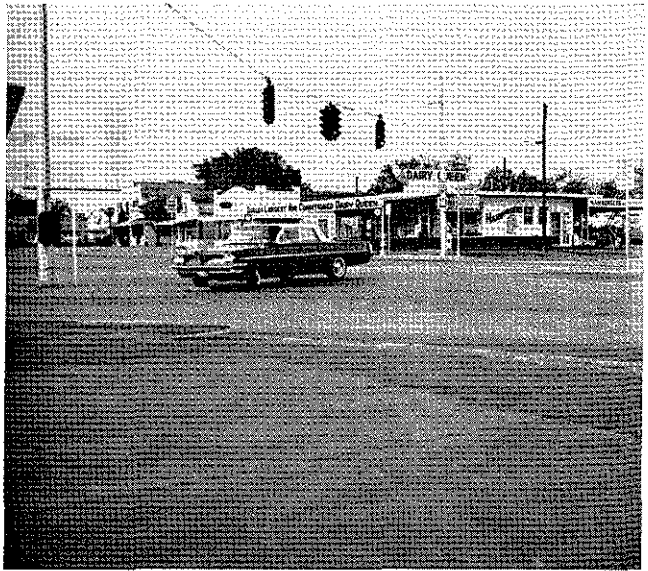
Figure 11a.

Breaks in the median created a large number of U-turns.

Table 13

A COMPARISON OF THE AVERAGE HOURLY SHOPPING TURNS INTO AND OUT OF BUSINESSES ALONG HIGHWAY 281—PLEASANTON, TEXAS

	BEFORE		AFTER	
	Turn Ins	Turn Outs	Turn Ins	Turn Outs
	Number	Number	Number	Number
Left and U-Turns[1]	92	108	70	95
Right Turns	145	122	157	129

[1]There were no U-turns in the before period, but in the after period, left and U-turns were combined for this table.

each of these openings were generated by two restaurants located nearby. Most of the turns at opening No. 1 were made by customers leaving the business while U-turns at opening No. 3 were made by cars entering the business. These are explained by the location of each business in relation to the main part of town which is their main source of trade.

The relationships between business location and U-turns points up the importance of giving full consideration to both the present and potential business development in designing a median-type facility. In fact, the business that generated most of the U-turns at opening No. 3 was constructed after the completion of the median.

During the gathering of shopping turn data, it was noticed that vehicles had difficulty in making U-turns at opening No. 3 due to the narrow right-of-way. Most standard size vehicles were unable to complete the turn without having to stop and back up. This created a serious hazard to oncoming traffic.
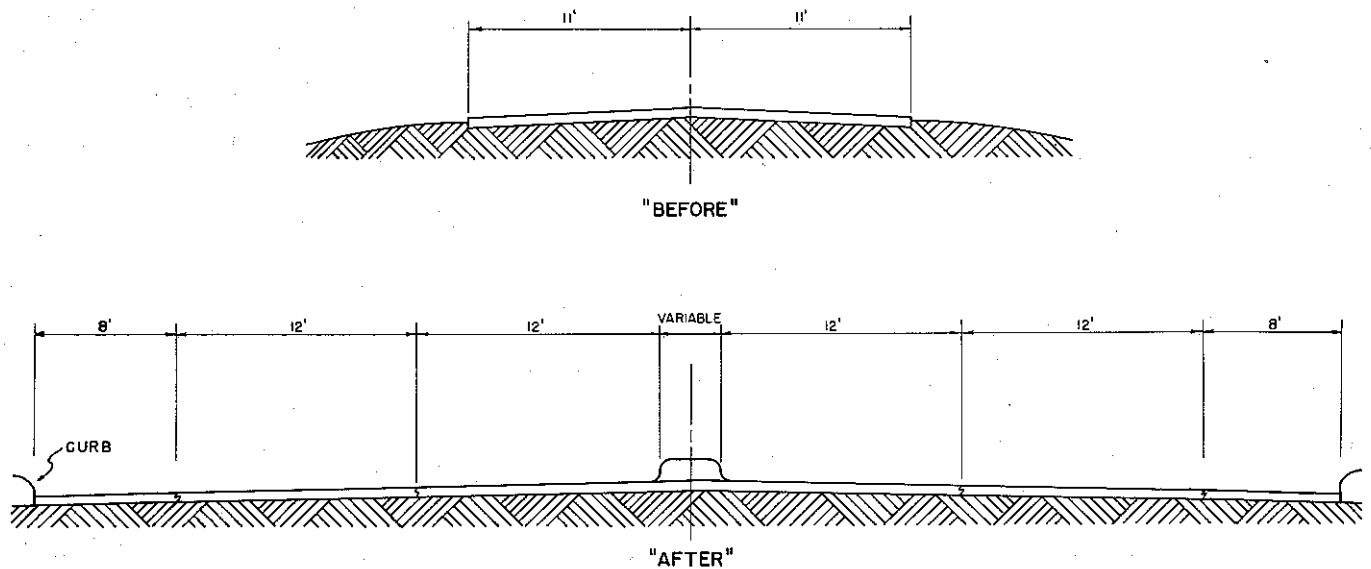
In reviewing the data in Table 13, it should be kept in mind that these data represent average hourly shopping turns. The most significant point brought out here is that more left turns were made by customers leaving businesses than by customers entering. Conversely, more right turns were made in entering businesses than leaving. Therefore, it is reasonable to believe that under these median conditions, drivers prefer to make left turns out of a business rather than left turns into a firm. The driver probably feels that it is safer to make a cross traffic turn out of a firm since he can wait for an opportunity to cross the traffic stream and not have the fear of a vehicle plowing into his rear. The median in Pleasanton does not provide much protection for vehicles waiting to make left or U-turns since it is only four feet in width. In areas with wide medians with protected left turn slots, left turns from the traffic stream are much less hazardous.

Traffic Analysis

Traffic studies were conducted in Pleasanton to investigate the character of traffic operation and to evaluate the level of service that existed on the study section in Pleasanton during the "before" and "after" study periods.

The site selected for the traffic studies, as shown in Figure 1, was a section of U. S. 281 approximately two miles in length extending from just south of the north Pleasanton city limit to the intersection of F.M. 1334 and U. S. 281 at the south city limit of Pleasanton. During the "before" period, U. S. 281 in the study section consisted of a two-lane pavement, 22 feet in width with unsurfaced shoulders. Figure 12 illustrates a typical cross section during the "before" period. In 1960, U. S.

TYPICAL CROSS-SECTIONS - PLEASANTON STUDY

Figure 12.

ADAMS — ST.

4212 / 4050

ST.

3710 / 4044

COLLEGE ST.

2131 / 2054

HUNT 1252 / 1009

CHAPMAN ST.

85 / 191

GOODWIN 697 / 518

OAKLAWN DR. 2539 / 2468 S.H. 97

BONITA CREEK

2443 / 2323 F.M. 1334

2440 / 2461
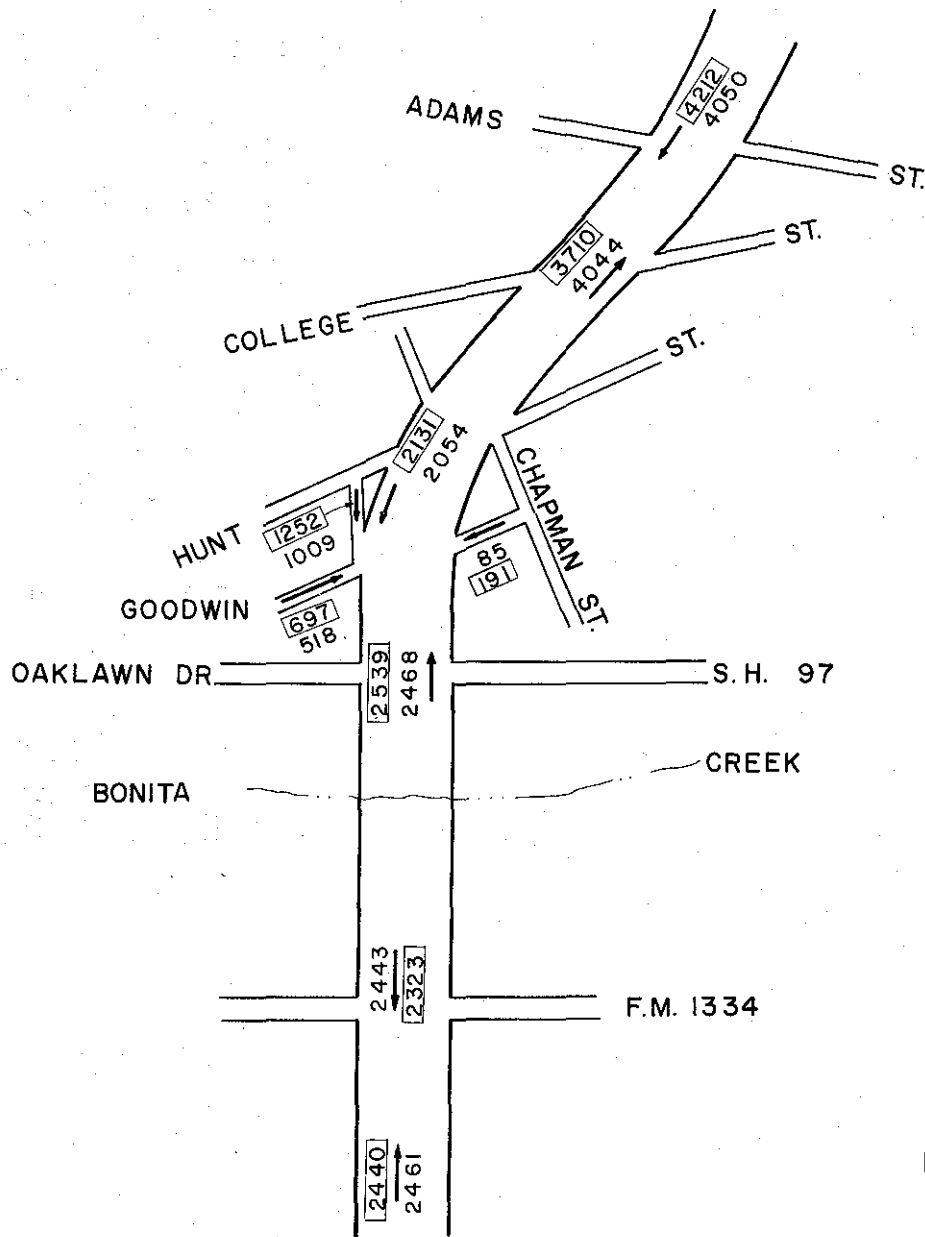
☐ — INDICATES "AFTER" VOLUMES

TRAFFIC VOLUMES
"BEFORE" AND "AFTER"
PLEASANTON STUDY

Figure 13.

281 in the study section was widened to provide two traffic lanes in each direction and a median of variable width. At minor intersections, the median was four feet wide and left turns were made from the inside through lane. At the major intersections, the median was widened to 16 feet in order to provide separate left-turn lanes. A typical cross section of the facility during the "after" period is also shown in Figure 12.

Four separate types of traffic studies were conducted to evaluate "before" and "after" traffic conditions. These were:

1. Traffic volume studies.

2. Accident studies.

3. Operational studies.

4. Travel time studies.

Although these studies were aimed at evaluating the effect of the median on traffic operation, it was generally difficult to relate changes in traffic operation to specific roadway elements. This was due to the fact that the facility under study was greatly improved through reconstruction and it was to be expected that other new elements of the facility would also produce an effect on traffic operation. Therefore, in general, the findings of the traffic studies reflect the effect of changing the entire highway facility; however, there were cases where the effects of the median could be specifically evaluated.

TRAFFIC VOLUME STUDIES

Traffic volume studies consisted of manual and machine counts conducted to establish 12- and 24-hour traffic volumes representative of the "before" and "after" study periods. Manual traffic counts were conducted from 6:00 a.m. to 6:00 p.m. at the intersection of U. S. 281 with Goodwin and Main Streets. This intersection represents the central area of the business district. Also 24-hour machine counts were made on U. S. 281 at the Atascosa River Bridge and at the Bonita Creek Bridge. The counts for the "before" period were made in 1959 and the counts for the "after" period were made in 1961.

Figure 13 provides a comparison of traffic volume data for the "before" and "after" study periods. This comparison shows that there was virtually no change in traffic volume conditions during the "before" and "after" periods.

TRAFFIC ACCIDENT STUDIES

The section of roadway selected for the accident studies was the same as that shown in Figure 1. Data on accidents occurring within the study section were obtained from the Statistical Division of the Department of Public Safety. These data resulted primarily from the reports of individual drivers rather than officer reports. The City of Pleasanton did not make accident investigation records available for this research, and therefore, it was necessary to rely upon the driver reports. It is significant to note that less than half of the accidents were reported to the Department of Public Safety by investigating officers.

The "before" study period was January 1, 1958 to June 30, 1959. The first "after" study period was November 1, 1960 to October 15, 1961, an 11½ month period which immediately followed reconstruction of facility. The second "after" study period was January 1, 1962 to June 30, 1963. This period was selected to provide data on accidents after a sufficient time had elapsed for local drivers to become accustomed to driving on the new facility.

Only those accidents occurring within the confines of the right-of-way limits of U. S. 281 were considered in the study.

For each of the study periods the accidents were classified according to the type or cause of collision. A comparison of the accidents by type and by total number for each of the study periods is provided in Tables 14 and 15. Also included in this tabulation are the estimated property damages and the number of personal injury accidents and fatalities for each of the study periods.

Accident Analysis

It is difficult to draw firm conclusions from a comparison of the "before" and "after" accident data in this type of study. In making such an analysis, it must be

Table 14
PLEASANTON ACCIDENT STUDY

	Before 1/1/58 to 6/30/59	1st After 11/1/60 to 10/15/61	2nd After 1/1/62 to 6/30/63
Right-angle collision where one vehicle fails to yield right-of-way.	4	6	4
Right-angle collision where left turn vehicle collides with opposing traffic.	4	4	6
Head-on collision where vehicle crosses center stripe or median.	1	0	0
Rear-end collision involving traffic stopped for signal or congestion.	2	2	2
Rear-end collision involving a vehicle slowing or waiting to turn right.	2	0	2
Rear-end collision involving a vehicle slowing or waiting to turn left.	0	2	4
Collision involving left turn into a passing vehicle.	3	0	0
Collision involving vehicle turning from wrong lane.	0	11	4
Side-swipe collision involving an improper lane change.	2	1	2
Fixed object collision involving median.	0	1	1
Out-of-Control vehicle due to driver error or vehicle failure (sleeping driver, faulty brakes, etc.)	8	3	6
Collision involving a parked vehicle.	2	1	3
Collision involving a pedestrian.	0	1	2
Miscellaneous.	1	1	0
TOTALS	29	33	36

taken into consideration that reconstruction of the facility changed the entire character of traffic operation on the facility. Due to this difference in character one might expect some types of accidents to be virtually eliminated while other types would become more frequent in number. For this reason, it was felt that the best means of analyzing the accident data was to examine the types and causes of accidents and to relate these to elements of the facility.

Right-Angle Collisions—There were eight right-angle collisions during the "before" period as compared to ten during each of the two "after" periods. Since the first "after" period was approximately one year while the "before" and second "after' periods were 18 months, the increase in the rate of this type of accident was considered significant. Since the second "after" period shows a decline in the rate of this type of accident, it is believed that the initial increase was due to drivers not being properly educated to use a high-type multi-lane facility.

Head-On Collisions—Although there was only one head-on collision actually reported during the "before" study there were two other collisions classified as "out-of-control" which were actually precipitated from a situation where a head-on collision would have occurred if evasive action had not been taken. In both of the "after" studies this type of accident was eliminated and this reduction was attributable to the installation of a median.

Rear-End Collisions—In the major category of rear-end type collisions, the data were further classified according to the type of operation or maneuver at the time of the collision. In the subclassification of rear-end collisions involving traffic slowing or stopping for signals or other slow moving traffic there was no significant change in the number of accidents reported during any of the study periods. This was essentially true in the subclassification involving vehicles slowing or waiting to turn right from the facility. However, in the subclassification of rear-end collisions involving a vehicle slowing or waiting to turn left there was a significant increase from zero to two accidents during the shorter first "after" study and four in the second "after" study.

Table 15
ACCIDENT SUMMARY
PLEASANTON STUDY

	Before 1/1/58 to 6/30/59	After 1 11/1/60 to 10/15/61[1]	After 2 1/1/62 to 6/30/63
Total Accidents	29	33	36
Personal Injury Accidents	3	5	7
Fatalities	1	0	1
Total Estimated Cost	$9,087	$7,011[2]	$19,710[3]
Average Estimated Cost per Accident	$ 311	$ 234	$ 347[4]

[1]Note that first after study only covers 11½ months compared to 18 months in the "before" and second "after" studies.
[2]Total estimate is exclusive of 3 accidents in which damage data was not available.
[3]Total estimate is exclusive of 6 accidents in which damage data was not available. Total estimate includes $10,000 estimate on a truck-trailer.
[4]Average estimated cost is based on all available data except $10,000 damage to a truck-trailer.

Although these are rather small numbers in comparison it is believed that this increase is significant and is attributable to the fact that the left turns were being made from the inside traffic lane which is generally the high speed lane for through traffic. It is possible that these accidents are at least partially attributable to the increased travel speeds on the facility. However, it is also reasonable to assume that, for the most part, these accidents would have been eliminated if separate left turn lanes had been provided at all intersections within the study area.

Improper Maneuvers—Accidents involving improper maneuvers were further classified into three different types. The first of these classifications consisted of collisions involving vehicles making a legal left turn into a passing vehicle. There were three accidents of this type during the "before" study, and none in the "after" studies because this particular type is applicable only to two lane operation. In the second classification where an improper lane change resulted in a side-swipe there was no significant change in the number of accidents in any of the study periods. In the third classification involving vehicles turning from the wrong lane there was a very pronounced increase between the "before" and the first "after" study, from zero accidents to eleven; however, there were only four during the second "after" study. This comparison is a very strong indication that the local drivers did not know how to drive on the facility when it was first opened to traffic. The decline in the number of accidents of this type during the second "after" study is indicative of the learning effect. However, there is some indication that, even after three years, there are still some problems in proper use of the facility.

Fixed Object Collisions—Accidents classified under this type consisted of collisions involving the median only. All other fixed object collisions which could possibly have been classified under this type involved vehicles unquestionably out-of-control and are classified in that category. In collisions involving the median there was one in each of the two "after" studies.

Other Types—As shown in Table 14 there were other types of accidents on the facility but none of them appear to have any direct bearing on the evaluation of the effect of the median. There was a rather large number of accidents involving vehicles out-of-control but these were primarily attributable to either driver errors or vehicle failures.

OPERATIONAL STUDIES

A motion picture study of selected areas on U. S. 281 was conducted to investigate the extent to which improper maneuvers were occurring during the "before" period. The section of U. S. 281 with the most business activity, extending from Chapman street to White street was selected for this study. This area is shown in Figure 14.

Approximately two hours of traffic operation were filmed at selected intervals between 9:00 a.m. and 5:30 p.m. An analysis of these films showed 194 vehicles making irregular maneuvers during the time of filming operations. These maneuvers were highly variable in nature and difficult to classify; however, they consisted mainly of long sweeping turns into and out of intersect-

JOHNSON ST.

HUNT ST.

GOODWIN ST.

WHITE ST.
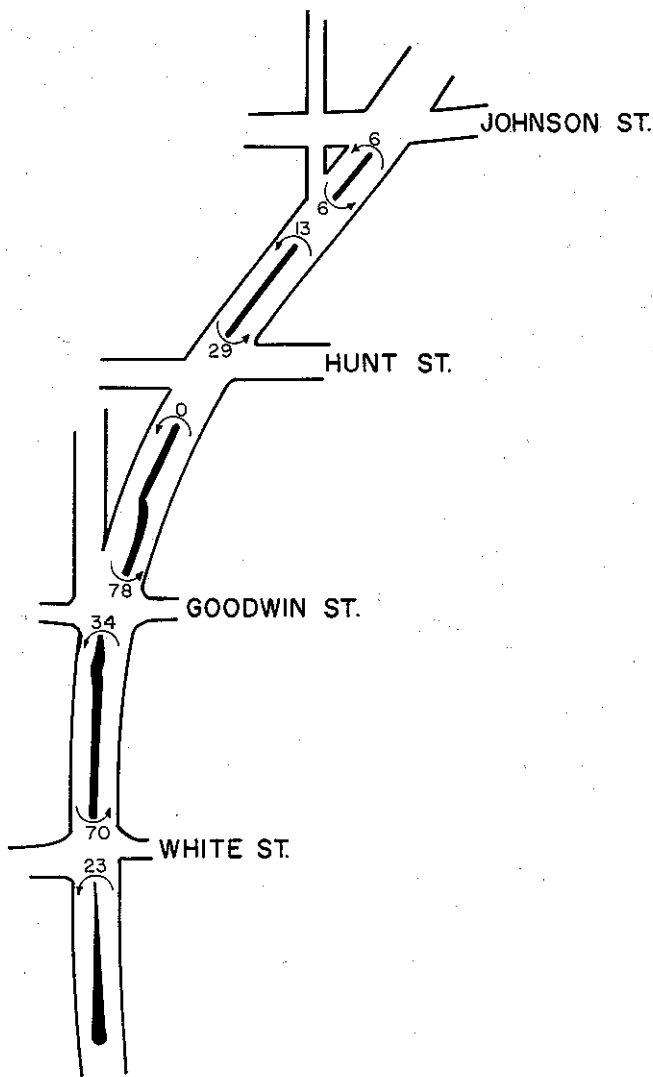
U — TURNS

"AFTER" STUDY

Figure 14.

ing streets and various business establishments in the study area. A summary of these maneuvers is shown in Figure 15.

Observation of the study area after the median was installed indicated that the type of irregular movement observed during the "before" period was virtually eliminated; however, there was observed a substantial number of U-turns at the median openings. These were generated by the installation of the median. For comparative purposes, the U-turn movements for the study area were taken from an 11-hour count conducted in connection with the economic studies. During the 11-hour count which coincided in general with normal business hours, 230 U-turns were observed in the area previously studied by motion pictures. Proportionately, the number of U-turns observed was much smaller than the

number of irregular maneuvers observed during the "before" study. The U-turns observed in the operational study section are shown in Figure 14.

The U-turn maneuver is not necessarily a hazardous maneuver, particularly during traffic volume conditions which existed in the study section; however, on this particular facility which was comprised of two 12-foot traffic lanes and one eight-foot parking lane in each direction separated by a four-foot median, it was difficult for most automobiles to make a U-turn maneuver beginning from the inside through lane. It was generally necessary to encroach upon the outside traffic lane in order to clear the curb in completing the maneuver. In such a case, the U-turn is considered hazardous to some extent.
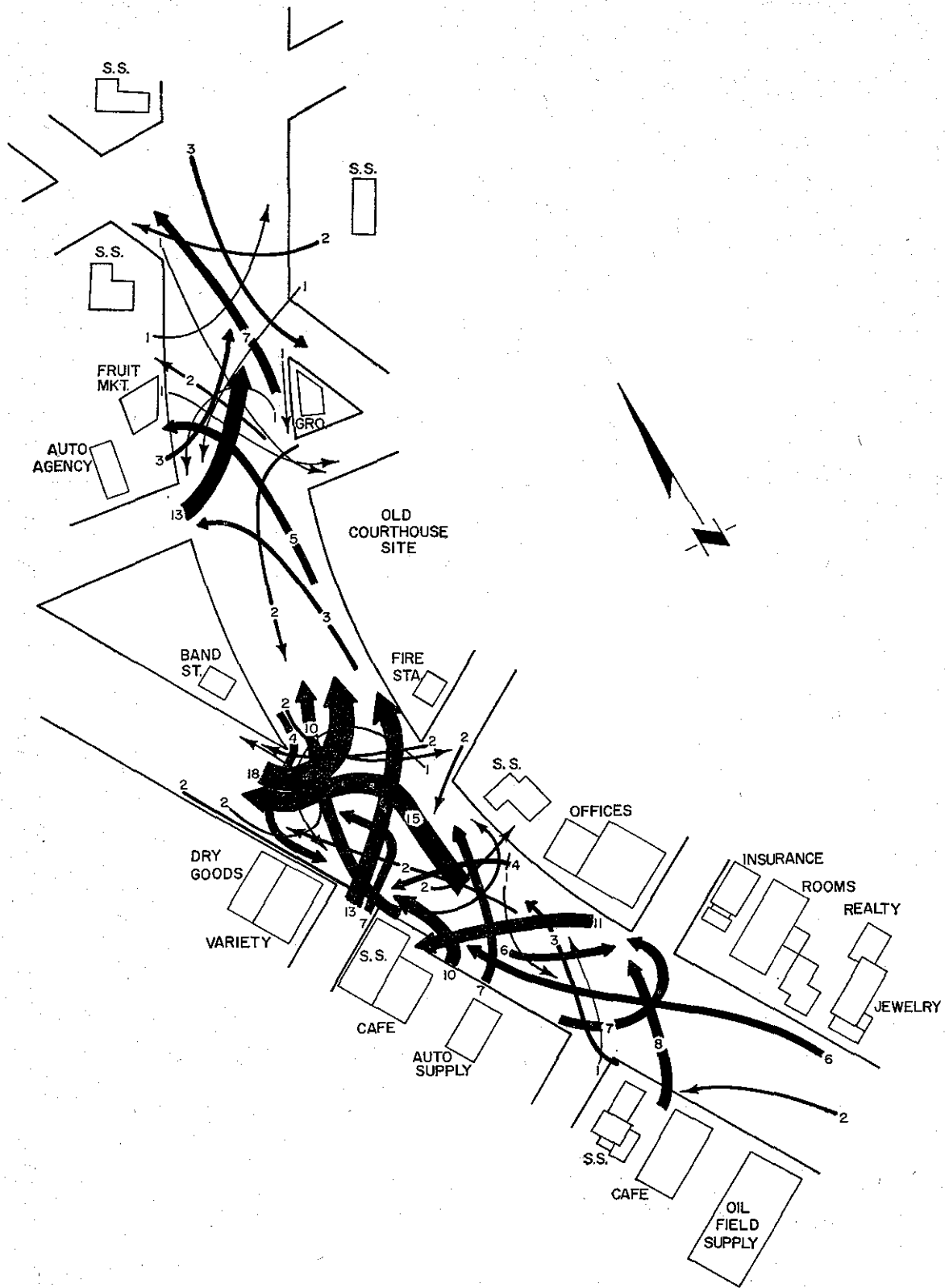
TRAVEL TIME STUDIES

Travel time studies were conducted in order to obtain a measure of the level of service provided by the facility, both during the "before" and "after" periods. Travel time data were obtained by the "average car method" in which a vehicle was driven through the study section at the average speed of traffic. Data were obtained on speeds through various sections of the facility and the delays were recorded. Travel time runs for both the "before" and "after" studies were conducted throughout the day from 8:00 a.m. to 6:00 p.m. to adequately sample peak and off-peak traffic conditions.

Figure 16 shows a plot of the "before" and "after" travel speeds for both directions of travel. During the "before" study, the slowest speeds and the greatest amount of delay were observed in sections 7-8 and 8-9. These two sections included the area of major business activity, and there was a traffic signal located in each of the two sections which accounted for most of the delay. As in the other control sections, there was an occasional delay to the test car due to a vehicle slowing or waiting to make a turn from the facility. No real congestion was observed at any time during the travel time studies.

During the "after" study, travel speeds were consistently 5 to 10 mph higher. In some control sections, the difference in speed was as high as 20 mph. There was very little delay observed during the "after" studies and that which did occur was due to the traffic signals. No delay was caused by vehicles waiting to make a left turn from the facility.

Although the increased travel speeds would suggest a much higher level of service than existed during the "before" period, it must be taken into consideration that travel time studies conducted under low volume conditions are greatly influenced by the character of the driver making the runs. On frequent occasions, there were relatively few other vehicles on the roadway and the driver selected the average speed on the basis of his appraisal of the roadway rather than floating with other traffic. For this reason some of the increase in travel speed must be attributed to the difference in drivers, as well as to improvement of the facility and elimination of the delays due to turning vehicles.

IRREGULAR MANEUVERS
"BEFORE" STUDY

Figure 15.

BEFORE   AFTER

NORTH PLEASANTON   CITY LIMIT

CONTROL POINT NO. 1
6 + 52.00

42.2 MPH   40.4 MPH   49.7 MPH   45.4 MPH

CONTROL POINT NO. 2   UVALDE   ST.
25+ 13.60   WACO   ST.
                                             DALLAS   ST.
33.5 MPH   33.9 MPH   AUSTIN   ST.   39.4 MPH   37.6 MPH
                                             SAN ANTONIO   ST.

CONTROL POINT NO. 3   COMMERCE ST.   (SPUR 242)
38+ 71.29
                                             MARKET   ST.
32.0 MPH   34.5 MPH   43.2 MPH   39.9 MPH
                                             CROCKETT   ST.   S.H. 97
                                             HOUSTON   ST.
CONTROL POINT NO. 4   NORTH   PLEASANTON   CITY LIMIT
51 + 43.79   PLEASANTON
29.9 MPH   31.9 MPH   TRADE   ST.   38.7 MPH   37.3 MPH

CONTROL POINT NO. 5
62+ 99.82
27.9 MPH   28.6 MPH   M.P. R.R.   38.5 MPH   41.9 MPH
                                             ADAMS   ST.
                                   ATASCOSA
CONTROL POINT NO. 6   ST.
75+ 73.42   COLLEGE   RIVER
33.9 MPH   33.8 MPH   ST.   40.2 MPH   37.2 MPH

CONTROL POINT NO. 7
86+ 59.00   HUNT   ST.
21.2 MPH   25.9 MPH   GOODWIN   34.6 MPH   35.9 MPH

CONTROL POINT NO. 8   OAKLAWN   DR. (S.H. 97)
97+ 69.00
32.0   21.7   45.2   35.4
CONTROL POINT NO. 9   BONITA   CREEK
103+ 11.66
44.7 MPH   42.7 MPH   47.4 MPH   44.6 MPH

CONTROL POINT NO. 10   F.M. 1334
113+48.10

TRAVEL   SPEEDS
"BEFORE" AND "AFTER"
PLEASANTON   STUDY

Figure 16.