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LAND USE IMPACT OF IMPROVING SECTION THREE
OF WESTHEIMER ROAD IN A DEVELOPING AREA
IN HOUSTON, TEXAS

by

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Research Report 225-16
Research Study Number 2-8-77-225
Economics of Highway Design Alternatives

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PREFACE

The authors wish to acknowledge the assistance that others have given in conducting this study. Special thanks are due Mr. James W. Barr and Mr. James R. Farrar of the Texas State Department of Highways and Public Transportation. Also, Mr. Robert Todd, Mr. Merwyn Hirsh, and Mr. Chris Olavson of the Houston-Galveston Regional Transportation Study were helpful in providing materials and data sources.

Officials of the City of Houston supplied valuable land use and traffic information and were very cooperative in providing background data for the study. Mr. Joe C. Chow and Mr. David Waller of the City Planning Department were very patient and provided invaluable assistance in the collection and evaluation of the available data. Several business people and residents of Houston provided additional information.

Members of the Texas Transportation Institute staff have rendered valuable assistance. Mr. Eric Schulte very skillfully prepared the maps and other graphics. Special assistance was given by Mrs. Betty Benson and Ms. Susan Freedman in typing and reviewing this manuscript.

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented within. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

ABSTRACT

The majority of previous land use impact studies have been devoted to investigating the effects that new highway construction has on land use change and development. In view of the new emphasis placed upon upgrading and redesigning existing facilities rather than building new ones, highway planners need information relative to the influence that existing facility improvement has on area land uses. This report relates the findings of such an improvement which occurred in Houston, Texas when Section Three of Westheimer Road, between Fondren Road and West Belt Drive, was upgraded from a two-lane rural type road to a six-lane divided thoroughfare. Prior to the improvement, the study area was described as a developing area in which the predominant land use was unimproved. Abutting and nonabutting properties were analyzed to determine the impact that the Westheimer Road improvement had on land development relative to location of property within the Study Area. Land use inventory data were collected for four study period years: 1964, the first "before" year; 1970, the last "before" year and year of final planning; 1973, the first "after" year; and 1978, the last "after" year. The 14-year study period includes six "before" years, three "construction" years, and five "after" years. Comparisons of the type and rate of land use change were made between each of the three analysis periods to determine the impact of the improvement on area development. The results are reported in narrative, graphic and tabular form.

Other factors affecting land development were also investigated and are included in this report. Highway planners should be able to implement this and subsequent reports of this study to make more accurate predictions of land use change relative to specific highway improvement projects.

SUMMARY OF FINDINGS

Land use data were collected for the Westheimer Road, Section Three, Study Area in the southwestern part of Houston, Texas to determine the probable land use impact of upgrading Westheimer Road (F.M. 1093) between Fondren Road and West Belt Drive. Westheimer Road was changed from a two-lane undivided road with open drainage to a six-lane divided road with raised median and curbs and gutters. The effects on the type, amount, and rate of land use change for abutting and nonabutting land in a developing area have been studied. Land use data were collected to measure land use changes on a "before" period, "construction" period, and "after" period basis, covering a 14-year period (1964-1978). Data were collected for 1964, 1970, 1973, and 1978, marking the beginning and/or end of the above three periods.

The Study Area is located in an area of Houston that has had a much greater potential for development than many other areas in Houston. Between 1960-1978, the area's population has increased over 464%, while Houston's population increased only 86%. Total employment in the area increased 230%, while employment in Houston increased only 42%. People living in the area held higher paying jobs, lived in more expensive homes, and were more highly educated than those living in other parts of Houston.

Traffic volumes on Westheimer Road (at Gessner Road) have increased 463% between 1963 and 1979, and much of that increase occurred before the study facility was improved to carry more traffic. Therefore, the facility had become quite congested with vehicles, especially during the morning and afternoon peak periods.

The findings on land use changes experienced by the Study Area are summarized below:

1. Over one-half (55.9%) of the Study Area's land changed use during the study period (1964-1978).
 - a. The Study Area changed from a developing area to a developed area during the study period. The area was 52.2% improved in 1964 and 83.8% improved in 1978.
 - b. The predominant land use of the Study Area changed from unimproved to single-family residential during the "after" period.
 - c. All land use categories, except industrial, experienced a net increase in acreage during the study period, with commercial and multi-family residential, in that order, experiencing the greater increases. More land changed use during the "after" period than any other period.
2. Over two-thirds (71.3%) of the abutting land in the Study Area changed use during the study period.
 - a. The predominant abutting land use changed from unimproved to commercial use during the study period. Abutting land was 53.6% improved in 1964 and 89.3% improved in 1978.
 - b. More abutting land changed to commercial use than any other use, and multi-family residential was next. Single-family residential is the only improved

- use that experienced a net decrease in acreage during the study period.
- c. More abutting land changed use during the "after" period than in any other period.
3. Less than one-half (48.3%) of non-abutting land changed use during the study period.
 - a. The predominant nonabutting land use changed from unimproved to single-family residential during the "after" period. Nonabutting land was 50.6% improved in 1964 and 89.1% improved in 1978.
 - b. More nonabutting land changed to multi-family residential than to any other use, and commercial was a close second. No improved use category experienced a net reduction in acreage during the study period.
 - c. More nonabutting land changed use during the "after" period than in any other period.
 4. The average annual rate of land use change during the 14-year study period was 5.10% for abutting land and 3.45% for nonabutting land.
 - a. Abutting land experienced an average annual rate of change of 4.08% in the "before" period and 7.84% in the "after" period.
 - b. Nonabutting land experienced an average annual rate of change of 1.23% in the "before" period and 6.38% in the "after" period.

- c. The average annual rate of change was greater for abutting land than for nonabutting land during every time period.
 - d. The average annual rate of change was greater for unimproved land than for improved land on abutting and nonabutting land.
5. The improvement of Westheimer Road was viewed by people knowledgeable about the area as having had a positive influence on land development.
 6. Land use in the study area at the end of the study period (1978) was not greatly different from that projected for the area.
 7. Generally, the improvement of Westheimer Road, Section Three, has encouraged continued development and redevelopment of properties in the Study Area.

METRIC CONVERSION FACTORS
RELEVANT TO THIS REPORT

Approximate Conversions to Metric Measures

<u>U.S. Customary Units Used in Report</u>		<u>Factor (multiply by)</u>		<u>Metric Equivalents</u>
acres	x	0.4	=	hectares
miles	x	1.6	=	kilometers
feet	x	0.3	=	meters

IMPLEMENTATION STATEMENT

This report relates the findings of a case study on land use changes that have occurred after an existing street was improved. The findings can be implemented immediately by highway agencies in predicting what might happen as a result of a similar street improvement in a comparable area elsewhere.

This case study is one of several being done in Texas cities. The predictive capabilities will be increased after analysis and comparison of data from all areas is accomplished. Those findings will be described in other reports.

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INTRODUCTION

Purpose and Objectives of Study

The near completion of the Interstate Highway System, the completion of many urban freeways, and the increasing shortage of funds for future highway construction have caused state highway agencies to turn to upgrading and expanding the vehicular capacity of existing streets and highways as a means of improving the transportation network. Much of the land use impact research conducted in the past investigated the effect of new location highway construction, while very little research was devoted to studying the impact of upgrading an existing facility in an urban area. In order to optimize public benefits, highway agencies need information concerning the effect of existing facility improvements to assist in making decisions on highway funding alternatives. The overall purpose of this study is to provide data to state highway agencies concerning the impact of improving the existing highways.

One important factor in determining the impact of any highway construction is the changes that occur in adjacent land use. The specific task of this analysis is to investigate land use changes in areas where an existing street or highway has been upgraded. Land use changes in the specified areas are compared to general land use plans and/or zoning maps to determine their importance to the evolution of area development. Traffic volume changes are also reviewed to ascertain the effects of various types of existing facility improvements. Many other economic and social factors are included in the study to assist in measuring the impact of existing street or highway improvement on urban land use.

Specifically, this report relates the findings of an investigation of land use change and development conducted in an area of Houston, Texas, where a

portion of Westheimer Road (FM 1093) was widened and repaved through a developing section of the city. The Westheimer Road, Section Three Study Area, as shown in Figure 1, is one of three contiguous areas along Westheimer Road chosen for land use analysis relative to thoroughfare improvement. The area is also one of eighteen sites which have been or are now under investigation which are located in different Texas cities with various types of existing highway designs, various stages of land development, and various predominant land uses prior to the facility's design change and improvement. Reports of findings in those areas are available or will be forthcoming.

Objectives of this study are as follows:

- (1) To determine the initial and long-range land use impacts of different highway design changes on existing highways with a minimum of data collection.
- (2) To determine traffic volume changes resulting from various types of improvements.

Method of Study

A "before and after" study approach was employed in this analysis to identify land use changes in Westheimer Road, Section Three Study Area. Since land use changes may have been affected by the public's anticipation of a better roadway, data were collected for a time before formal planning for the specific project began as well as for subsequent years through 1978 (the applicable time periods are described in the Definitions section).

The amount of land (acres) in various uses was determined for the selected "before and after" years, and then average annual rates of land use change were calculated for each of the time periods. In addition, changes in improved and unimproved properties' land use were established separately for each period.

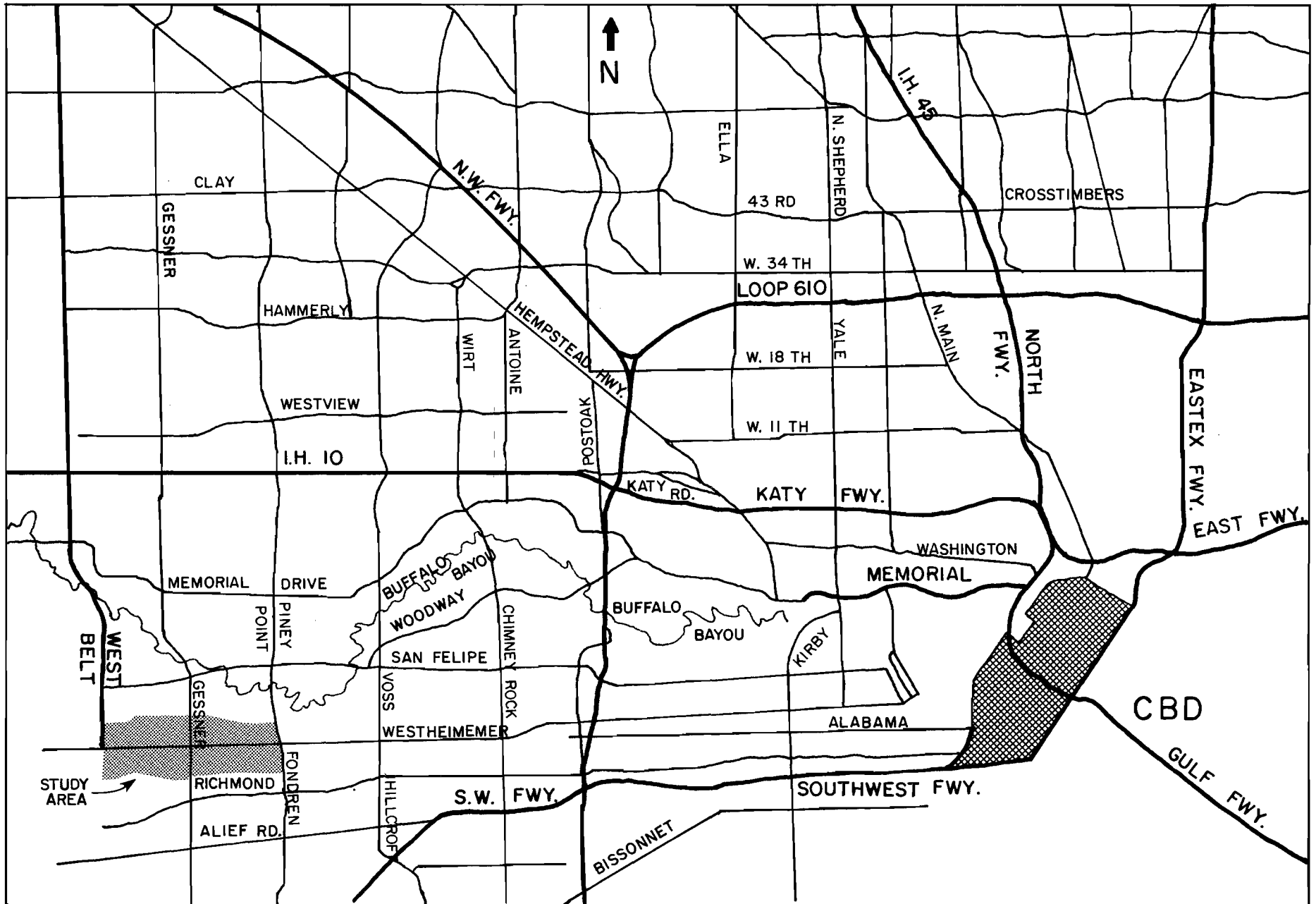


Figure I. Map of the Northwest Houston Area Showing the Location of Westheimer Road Study Area, Section Three

Finally, the differences in the annual rates of change between periods were analyzed to indicate the effect of the improvement on land use change and development.

The land in the Study Area was divided into abutting and nonabutting properties to permit further analysis. Abutting improved properties were identified as being on land having frontage along Westheimer Road not divided by a street and part of one development. Undeveloped properties with frontage were identified to be land extending 300 feet back from the facility. The remaining properties in the Study Area were defined as nonabutting properties (see Definition Section). These two categories of properties were studied separately to determine the differences in land uses and rates of development brought about by the improvement project.

In order to obtain background information about land use changes and development, several knowledgeable people were interviewed concerning the impact of the Westheimer Road project. Real estate people and area residents who were familiar with the area provided information on land sales and developments and about past and present land use. These individuals also provided insight into considerations given to the street improvement in making land development decisions in the Study Area.

Various factors which might have influenced land use changes were also investigated to provide additional background data about the social, economic, and environmental make-up of the area studied. The factors are: traffic volume, population characteristics, area land use plans, and area growth statistics.

Location of Street Improvements

The improved portions of Westheimer Road being studied are now located within the incorporated city limits of Houston. Houston, the nation's fifth largest city and largest city in the South and Southwest, is the business and population center of a dynamic metropolitan area situated on the upper Gulf Coast of Texas, located approximately 50 miles from the Gulf of Mexico. The growth of Houston, Harris County, and the Houston SMSA has been phenomenal in recent decades, as is illustrated in Table 1. The 1978 Houston population has been estimated at 1,623,000 by the Houston Chamber of Commerce, and when compared to the 1970 census figure of 1,232,000 represents an increase of 31.7%.

Several industries have contributed to the extraordinary growth of the Houston-Gulf Coast region, but the chemical and petrochemical industries have played an extremely important part in the city's growth. The discovery of oil and gas in Southeast Texas and the opening of the Houston Ship Channel in the early 1900's stimulated development of the petroleum refining in the area to the extent that today over 50% of the nation's major petrochemical manufacturing capacity is located in the region. The Houston SMSA has long been the nation's leading producer of refined petroleum and petrochemicals, and, as a result, various allied industries have also located in the metroplex.

The Houston-Gulf Coast region possesses an excellent transportation network to both international and national business markets. The Port of Houston is the third largest seaport in the United States in total tonnage and ranks second in total dollars of foreign trade. The major import products are steel, petroleum, and passenger cars, while the port's leading export commodities are agricultural products, petroleum equipment, and chemicals. Also serving the international

Table 1. Population and Percent Changes of Area Population for the Houston SMSA, Harris County, City of Houston and Census Tracts 439 and 423, 1950-1978

Area	1950	% Change Overall & Average Annual 1950-1960	1960	% Change Overall & Average Annual 1960-1970	1970	% Change Overall & Average Annual 1970-1975	Dec. 31, 1975 ^a	% Change Overall & Average Annual 1975-1978	1978 ^a
Houston SMSA	947,500	+51.0% +5.1%	1,430,394	+39.8% +4.0%	1,999,316	+25.8% +5.2%	2,516,000	+5.8% +1.9%	2,661,000
Harris County	806,701	+54.1% +5.4%	1,243,158	+40.1% +4.0%	1,741,912	+24.3% 4.9%	2,165,301	+6.4% +2.1%	2,304,000
City of Houston	596,163	+57.4% +5.7%	938,219	+31.4% +3.1%	1,232,793	+19.8% +4.0%	1,477,022	+9.9% +3.3%	1,623,000
Census Tract 439 (Includes Northern Portion of Study Area)	NA ^c		272 ^b	+1321.3% +132.1%	3,866	+158.7% +31.7%	10,003	+23.0% +7.7%	12,305
Census Tract 423 (Southern portion of Study Area)	NA ^c		7,875 ^d	+124.0% +12.4%	17,616	+42.9% +8.6%	25,173	+33.6% +11.2%	33,633

^a Houston Chamber of Commerce Population Estimates.

^b Census Tract 90-C in 1960 is identical to Census Tract 439 in 1970.

^c Census Tract Information in 1950 was not applicable for comparative analysis.

^d Census Tract 91-F in 1960 is similar to Census Tract 423 in 1970.

market, air passenger and freight service is provided through two large airport terminals in the Houston area. The national business market is served well through a variety of transport modes. Low-cost barge transportation is available via the Intracoastal Waterway which connects Houston to the midcontinent regions of the Mississippi River and its tributary systems. Rail and motor freight operations are provided by six major railroad companies and a large number of common-carrier, specialty-carrier, and local delivery trucking firms. Houston is also a major center of oil and gas transmission for pipeline companies which operate 13 crude oil and products pipelines and 21 gas pipelines which serve almost every section of the nation.

The favorable industrial, transportation, and energy environment of the Houston-Gulf Coast area has led to an increasingly diversified economic structure during the past 20 years. During the 1960's, Houston's growth as a corporate center expanded tremendously. Since 1970, over 200 major companies have moved their headquarters, divisions, or subsidiaries to Houston making the city an important center of international economic activity.

The substantial business activity and population growth and subsequent growth of Houston as a marketing center has generated increasing amounts of traffic and has made greater demands on the street and highway system to provide adequate access to developed and developing urban areas. The improvement of Westheimer Road was accomplished to meet the traffic needs of an area (Census Tract 423 and 439) which has experienced population increases that are greater percentagewise than that experienced by the Houston SMSA, Harris County, and City of Houston during the study period shown in Table 1.

The Study Area, as shown in Figure 1, is located approximately eight miles west of Houston's central business district and is situated between IH 10 (to the north) and the Southwest Freeway (to the south), two of the city's major

traffic carriers. The location of Westheimer Road relative to the city's free-ways has placed great pressure on this facility to provide access to and from the large amount of developing acreage in western Houston.

Reviewing general land use maps, the Study Area can be described as one that is developing into "medium density residential," i.e., a mixture of single-family and multi-family developments. Most of the single-family residences are about 15 years old and are of brick or brick-veneer construction while the multi-family apartment complexes range from 2 to 10 years old. The housing is described as being in good condition.

Key Characteristics of Street Improvement

Westheimer Road, Section Three Study Area is one of six Houston study sites chosen for analysis of land use changes relative to street improvements. The study areas were chosen according to the following characteristics:

- (1) The stage of area development (see "Definitions" section.)
- (2) Type of highway or street,
- (3) The predominant land use, and
- (4) The type of setting (suburban or urban).

These factors were determined during the period of time prior to the beginning of the street improvement project. Using these characteristics, different types of study sites have been selected that will permit analyses of various design changes and the resulting impact on land use changes.

The characteristics of the Westheimer Road, Section Three Area, during the "before" period were determined to be as follows:

- (1) The stage of area development--developing;
- (2) Type of highway--two-lane, undivided road with open ditches;
- (3) Predominant land use--unimproved; and

(4) Type of setting--urban-fringe (suburban).

Due to the abundance of unimproved land and the general growth of Houston toward the west, large amounts of land use change and development were expected to occur during the study period. These changes in land use were expected to be accelerated by the Westheimer Road improvement, but the trend and type of land developments were not expected to be affected by the design change.

Sources of Data

The major source of planning information concerning the Westheimer Road improvement was obtained from the Houston City Planning Department, while construction and street design data were collected from the Houston Public Works Department, Paving Division.

Land use data were available through several sources, but the most applicable information was provided by the City Planning Department (CPD). Other sources of valuable land use data were the District Office of the State Department of Highways and Public Transportation (SDHPT), Harris County Agricultural Stabilization and Conservation Service Office, and Houston-Galveston Regional Transportation Study (H-GRTS). Most of the land use data were collected from colored (Lambert) maps, aerial photographs, and on-site inspections of the area.

Background land use information was collected from city directories of Houston, from Sanborn (fire insurance) maps, from subdivision platting records maintained by Harris County, and from personal interviews with real estate developers and brokers, city planners and officials, and property owners and area residents. Information about city-wide and regional land use plans was obtained from CPD and H-GRTS publications.

Traffic volume data were provided by the Houston Traffic and Transportation Department for city streets and relevant state and federal highways. H-GRTS was also a source of traffic volume information. The Houston Chamber of Commerce provided historical U.S. census and population projections along with housing information for Houston and its metropolitan area. Socio-economic data were collected from U.S. Bureau of the Census publications found in the City of Houston's Public Library.

Definitions

The following land use categories and time periods are used to identify properties within the arbitrarily defined study area:

Abutting Properties - improved tracts with frontage along Westheimer Road, not separated by streets, and a part of the same development. Unimproved tracts, with Westheimer Road frontage extending 300 feet back from the facility.

Nonabutting Properties - all tracts within the Study Area not defined as abutting Westheimer Road.

Single-Family Residential - tract improved with occupiable house for one family.

Multiple-Family Residential - tract improved with duplex or apartment complexes designed to house two or more families.

Commercial - tract improved with a commercial business.

Public-Governmental - tract improved with a governmental office, park, public owned utility, public schools, etc.

Semi-Public-Nonprofit - tract with improvements such as churches, non-profit clubs, or other non-profit organizations.

Industrial - tract improved for manufacturing, product storage, etc.

Streets and Roads - land improved with a street or road; includes land dedicated as right-of-way.

Unimproved - land which has not been developed for any particular use; also includes previously developed land that is presently vacant or unused and land used for agricultural purposes.

Before Period - the time period which ends the year prior to the initiation of formal planning and construction. For Westheimer Road, the "before" period includes the years 1964 to 1970.

Construction Period - the years in which final planning, funding and construction processes occur. In this report, the construction period includes one year before construction started. The years 1970 through 1973 constitute the "construction" period.

After Period - the period which includes those years after the construction" period to the present, or specifically, 1973 to 1978.

Stage of Area Development - one of three stages of land development determined by the percentage of total land area already improved with buildings, parks, roads, and streets as follows: *undeveloped* - 0 to 10% improved, *developing* - 10% to 80% improved, and *developed* - 80% to 100% improved.

CHARACTERISTICS OF AREA STREETS
BEFORE AND AFTER THE IMPROVEMENT
OF WESTHEIMER ROAD

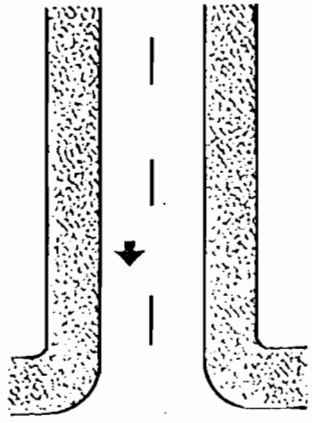
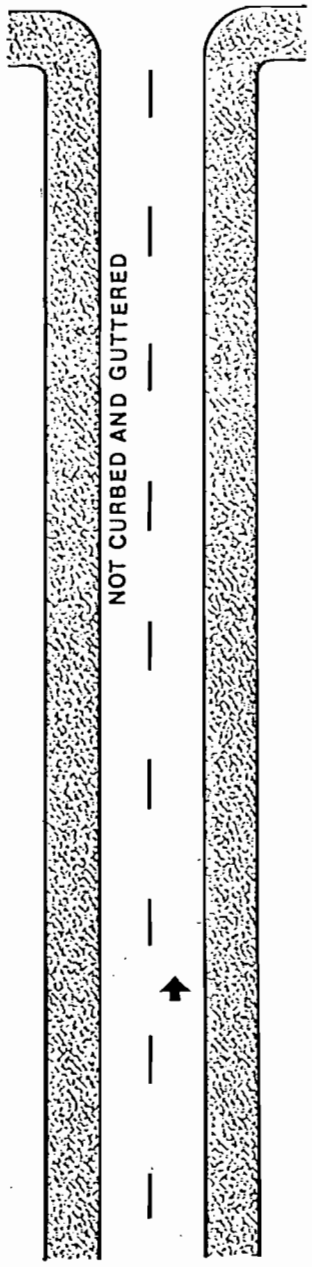
Westheimer Road

Westheimer Road is a major east-west thoroughfare which extends west from the central business district (CBD) of Houston approximately 20 miles to the Harris-Fort Bend county line. Westheimer Road, or FM 1093 (a state maintained facility), extends beyond the county line an additional 43 miles west to Eagle Lake, Texas. This report focuses on a section of Westheimer Road (Figure 1) located between Fondren Road and West Belt Drive that was improved during 1971-72. FM 1093 carries the highest traffic volume of any farm-to-market road in Texas.

The 2.20 mile portion of Westheimer under investigation in this report is the last of three sections of Westheimer Road which were improved by the State of Texas. The funds for the planned design change were provided through the 1967-68 Consolidated Program. Work began on this section in February 1971 and construction was completed and accepted in March 1972. The "before" design of the analysis section was a 24-foot wide, two-lane, undivided asphalt roadway with six-foot wide shoulders and open drainage (Figure 2) which was upgraded to a six lane divided thoroughfare with two 36-foot road surfaces, raised median, and curbs and gutters. The "before" and "after" right-of-way was 120 feet; no additional right-of-way was acquired for the improvement.

The other two portions of Westheimer Road east of the study section were also improved between 1966 and 1972. The adjacent section, from Fondren Road to Hillcroft-Voss Road, was upgraded to the same "after" design as the study section during 1970-71. The next section, from Hillcroft-Voss east to South Post Oak, was upgraded to the same "after" design as the study section during

Before Period Design



After Period Design

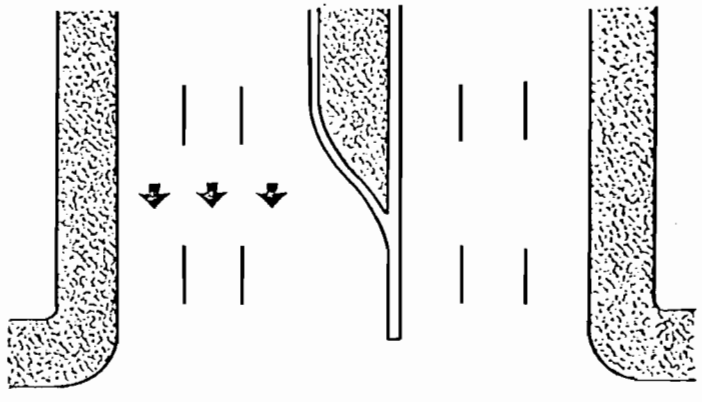
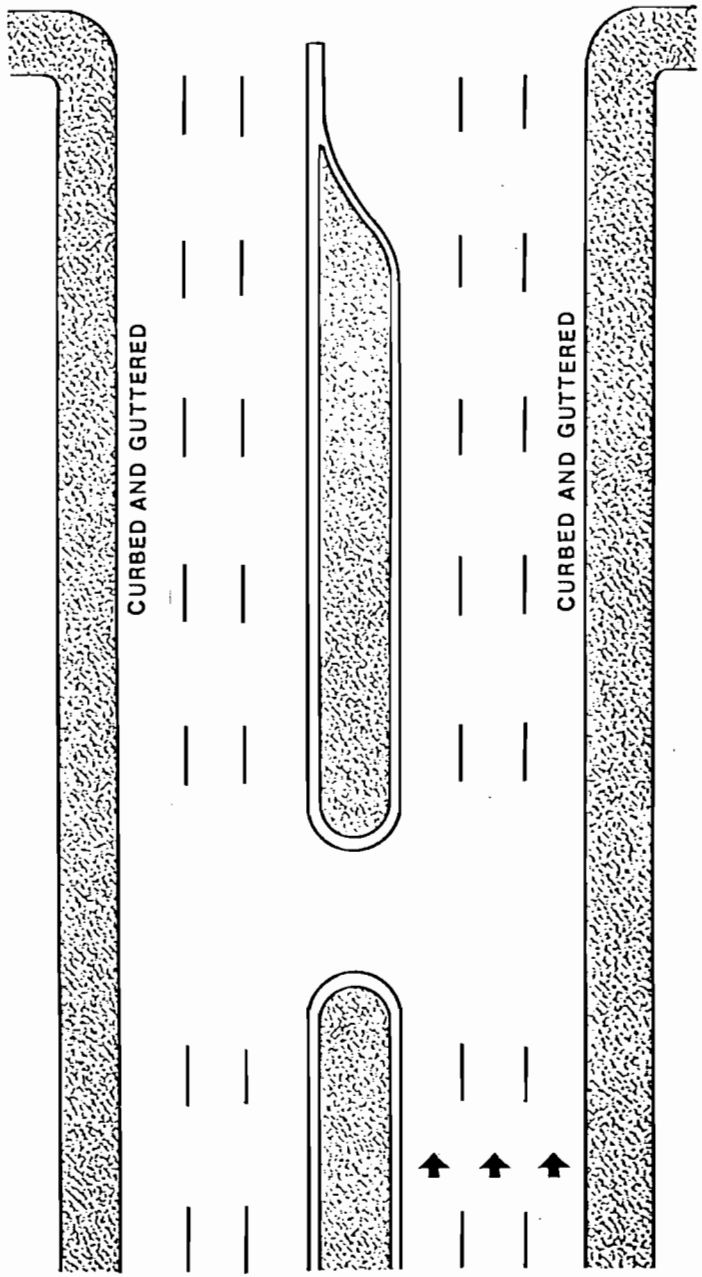


Figure 2. Street Design

1966-67.

As shown in Table 2, Traffic count data collected by the City of Houston and the SDHPT indicate a dramatic increase in vehicular traffic on Westheimer Road during the overall study period; i.e., Westheimer at Gessner Road increased 463% (33.1% average per year). Reviewing the traffic data by periods more or less corresponding to the three study periods reveals that traffic volumes on Westheimer at Gessner increased 98.9% (14.1% per year) during the "before" period, 1963-69; 116.9% (29.2% per year) during the "construction" period, 1969-73; and 26.2% (6.6% per year) during the "after" period, 1973-79. Traffic data shown for Westheimer at West Belt are too limited to calculate comparable traffic volume changes.

Intersecting Streets

The three major thoroughfares intersecting Westheimer Road within the Study Area are Fondren Road, which forms the eastern border; Gessner Road, which intersects Westheimer near the middle of the study area; and West Belt Drive, which makes up the western boundary (Figure 1). Fondren intersects Southwest Freeway to the south, while Gessner Road intersects Katy Freeway to the north and Southwest Freeway to the South. West Belt Drive intersects Katy Freeway to the north and Southwest Freeway by way of other streets to the south. Fondren Road is a four-lane, divided, curbed and gutter thoroughfare with raised median that was improved to its present design during 1965-66. West Belt Drive, north, is a six-lane, divided curbed and gutter thoroughfare with a raised median that was improved during 1971-73. Gessner Road is a four-lane, divided curbed and gutter thoroughfare with a raised median that was improved during 1976.

Traffic volume on Fondren has increased during the study period, as illustrated by the 178% (13.6% per year) increase in traffic count recorded at

Table 2. Twentyfour Hour Traffic Counts by Street Location and Year^a

Location	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
<u>Westheimer Road</u>															
at Gessner Road	8,088		11,251		13,489		16,078			26,277	34,482	34,870	35,832		43,522
at West Belt Dr.										20,939	30,403	31,901	33,999	41,699	
INTERSECTING STREETS															
<u>Fondren Road</u>															
at Westheimer	7,518		10,040	11,948	10,081		11,585		19,752		26,220	21,367	20,626	20,892	
at Buffalo Bayou		7,502		11,554	9,299	10,730	18,633		21,955	9,909	22,834	9,545	10,641		11,851
at Bellaire Blvd.												24,520	25,414	26,179	27,237
<u>Gessner Road</u>															
at Westheimer											12,889		18,232	22,659	28,312
at Buffalo Bayou										7,849		16,099	21,709		28,483
at Richmond Ave.												16,385	20,354	24,278	
West Belt Dr.															
at Westheimer												11,204	12,334	13,577	
PARALLEL STREETS															
<u>Memorial Drive</u>															
at Benigus	4,467		8,143		10,007		9,910		9,973		11,815	17,099	16,780	17,817	
at West Belt Dr.							12,979		13,683		13,699	19,583	18,285		21,494
<u>Richmond Drive</u>															
at Fondren											13,727	16,763	19,830		29,542
at S. Gessner											3,138	9,213	12,405		12,172

^a Average annual 24-hour traffic counts determined by SDHPT.

its intersection with Westheimer Road between 1963 and 1969 (Table 2). On an approximate time period basis, the "before" period traffic volume increased by 54% (9.0% per year); "construction" period traffic volume increased 126% (25.3% per year); and "after" period traffic volume decreased -20% (-6.8% per year). Traffic counts collected along Fondren locations north and south of Westheimer also indicate that 24-hour traffic volume has increased over the study period (Table 2). Not enough traffic data are available on the other intersecting routes for comparison purposes.

Parallel Streets

The major thoroughfares immediately adjacent and parallel to Westheimer Road are Memorial Drive and Richmond Avenue (Figure 1). Memorial Drive is located one mile north of Westheimer Road and outside of the Study Area. This facility meanders along Buffalo Bayou west to Addicks-Howell Road for about five miles beyond the Study Area and east to downtown Houston. San Felipe Road which ends at Memorial Drive serves as a more direct route to downtown Houston. Richmond Avenue is located about one-half mile south of Westheimer Road and extends from near downtown Houston to West Belt Drive, the west boundary of the Study Area.

At the intersection of Memorial Drive and Benignus Road, midway of the Study Area, traffic volumes (Table 2) have increased 299% (23% per year) during the study period (1963-76). During the "before" period (1963-69), traffic volumes increased 122% (20.3% per year). During the "construction" period (1969-73), traffic volumes increased 19% (4.8% per year). During the "after" period (1973-76), traffic volumes increased 51% (16.9% per year). The overall study period growth in traffic volume, on Memorial Drive, at Benignus Road, has not been as great as that experienced on Westheimer Road at Gessner Road.

Only "after" period traffic volume data could be obtained for Richmond Drive at Fondren Road, and at Gessner Road. During that period (1973-77), traffic volume increased 115% (28.8% per year) and 288% (72% per year), respectively, for these two locations. Thus, the "after" period growth in traffic volume on Westheimer Road at Gessner Road has not been as great as that on Richmond Road at these locations. Since Richmond Road comes to an end at West Belt Drive, it more accurately reflects the actual growth in traffic generated in an area which encompasses parts of the Study Area.

CHARACTERISTICS OF THE STUDY AREA BEFORE AND AFTER THE IMPROVEMENT OF WESTHEIMER ROAD, SECTION THREE

Size and Boundaries of Study Area

The dimensions of the Westheimer Road, Section Three Study Area are approximately 3,400 feet wide and 12,400 feet long. The 921-acre Study Area is delineated to include an equivalent of three blocks of developed land on either side of the improved facility. The eastern boundary is formed by Fondren Road, while the western border of the Study Area is formed by West Belt Drive. With Westheimer Road bisecting the identified area, the northern section extends about 1,440-2,040 feet from the improved facility and its boundary is formed by Ella Lee Lane (in the eastern portion) and Meadow Lane (in the western portion). The southern section ranges from 1,400-2,000 feet in width and the southern border of the Study Area is formed by Meadowglen Drive and a set of property lines which are in alignment with Meadowglen. The Study Area is located in a section of the Houston metropolitan area which has experienced rapid growth and development during the 1960's and 1970's.

Land Use Characteristics

A review of the land use characteristics of the Westheimer Road, Section Three Study Area indicates that a large amount of land use change and development has occurred during the analysis period. The predominant land use of the Study Area has changed during the study period, and the percentage of the total area acreage remaining unimproved has decreased considerably. A detailed account of area land uses was collected for four selected years of the study period: 1964, 1970, 1973 and 1978. Each of these years corresponds to important dates for the planning, funding, construction, and completion of the

Westheimer Road improvement project. Figures 3 and 4 illustrate the land uses identified for 1964 and 1970, the first and last year of the "before" period, respectively. Figures 5 and 6 illustrate the land uses identified for 1973 and 1978, the year after "construction" period and the last year of the "after" period, respectively. Total acreage devoted to each of the identified land use categories in each of the four selected years is listed in Table 3. Also found in Table 3 are the absolute acreage and percentage change in each use category recorded during each of the three time periods (i.e. before, construction, and after) and the overall 14-year period.

In 1964 (the first year of the analysis period), the Study Area could be described as a developing area with the predominant land use being unimproved (some of which was agricultural land). Of the 921 total area acres, over 47.8% or 440.0 acres was unimproved while 52.2% or 480.64 acres was improved. The percentage breakdown by land use category existing then is as follows: single-family residential, 30.9%; multi-family residential, 0.8%; commercial, 3.8%; industrial, 6.4%; streets and roads, 10.2%; and unimproved, 47.8%.

The land use configuration during the last year of the study period, 1978, as shown in Figure 6, was quite different from the 1964 configuration. The predominant land use had changed from unimproved to single-family residential. The percentage of unimproved land had dropped to only 16.2% while the improved properties made up 83.8% of the total Study Area. Figure 6 illustrates that multi-family residential, commercial, and single-family residential developments occurred where unimproved land was before. The percentage breakdown by land use category as of 1978 is as follows: single-family residential, 30.3%; multi-family residential, 12.4%; commercial, 18.1%; industrial, 6.4%; public and semi-public, 3.6%; streets and roads, 13.3%; and unimproved, 16.2%.

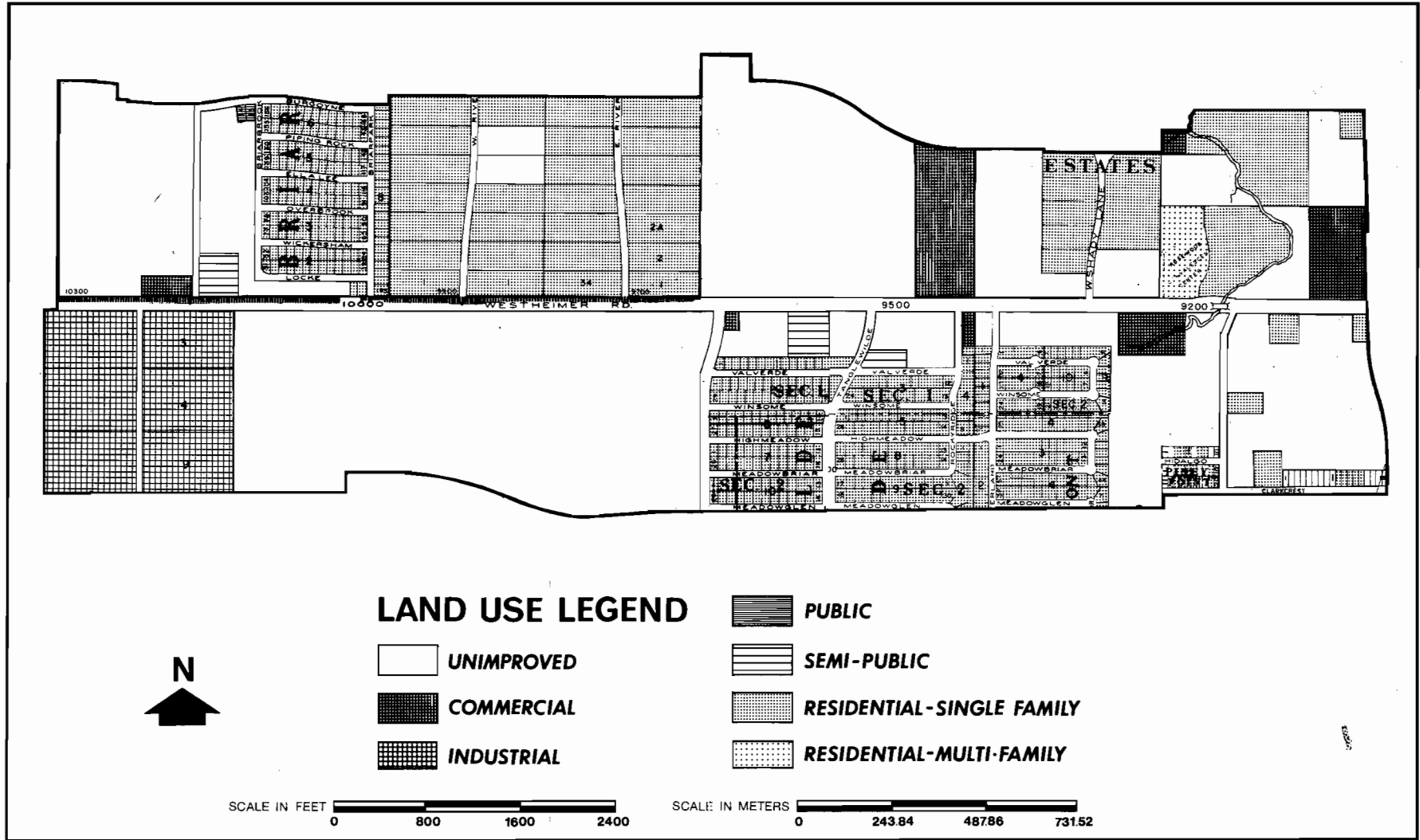


Figure 3. Map of Land Use in the Westheimer Road Study Area in 1964

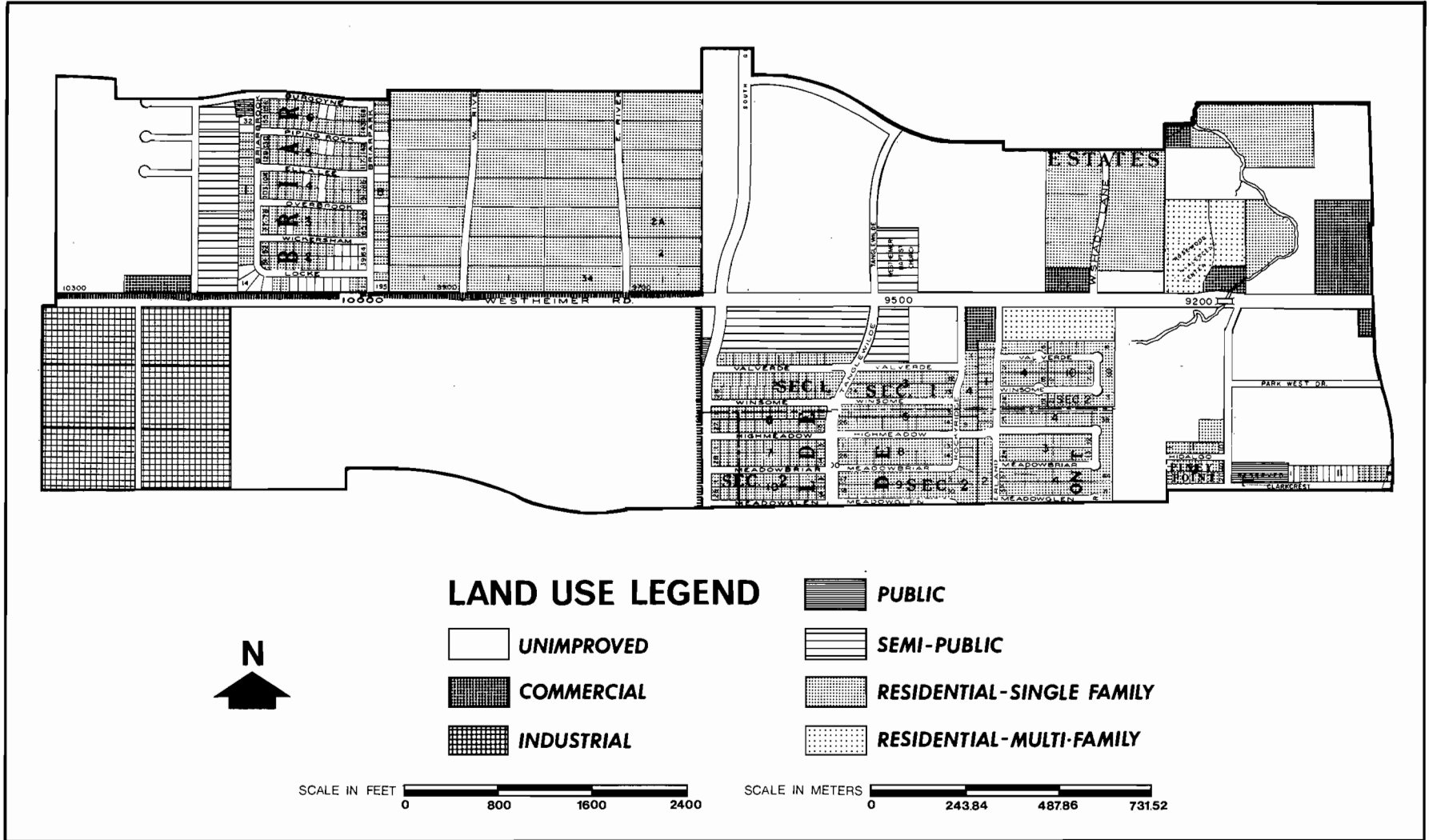


Figure 4. Map of Land Use in the Westheimer Road Study Area in 1970

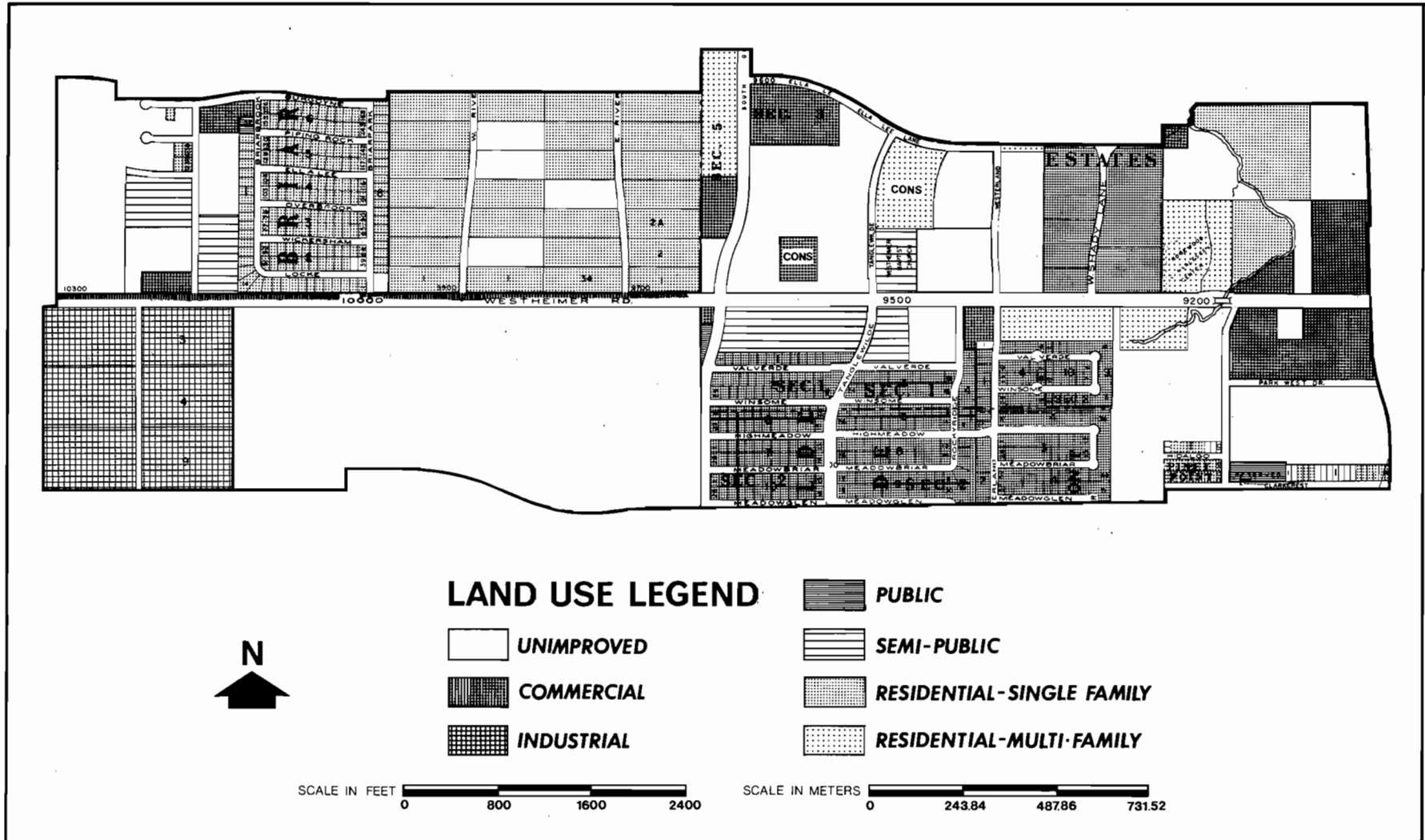


Figure 5. Map of Land Use in the Westheimer Road Study Area in 1973

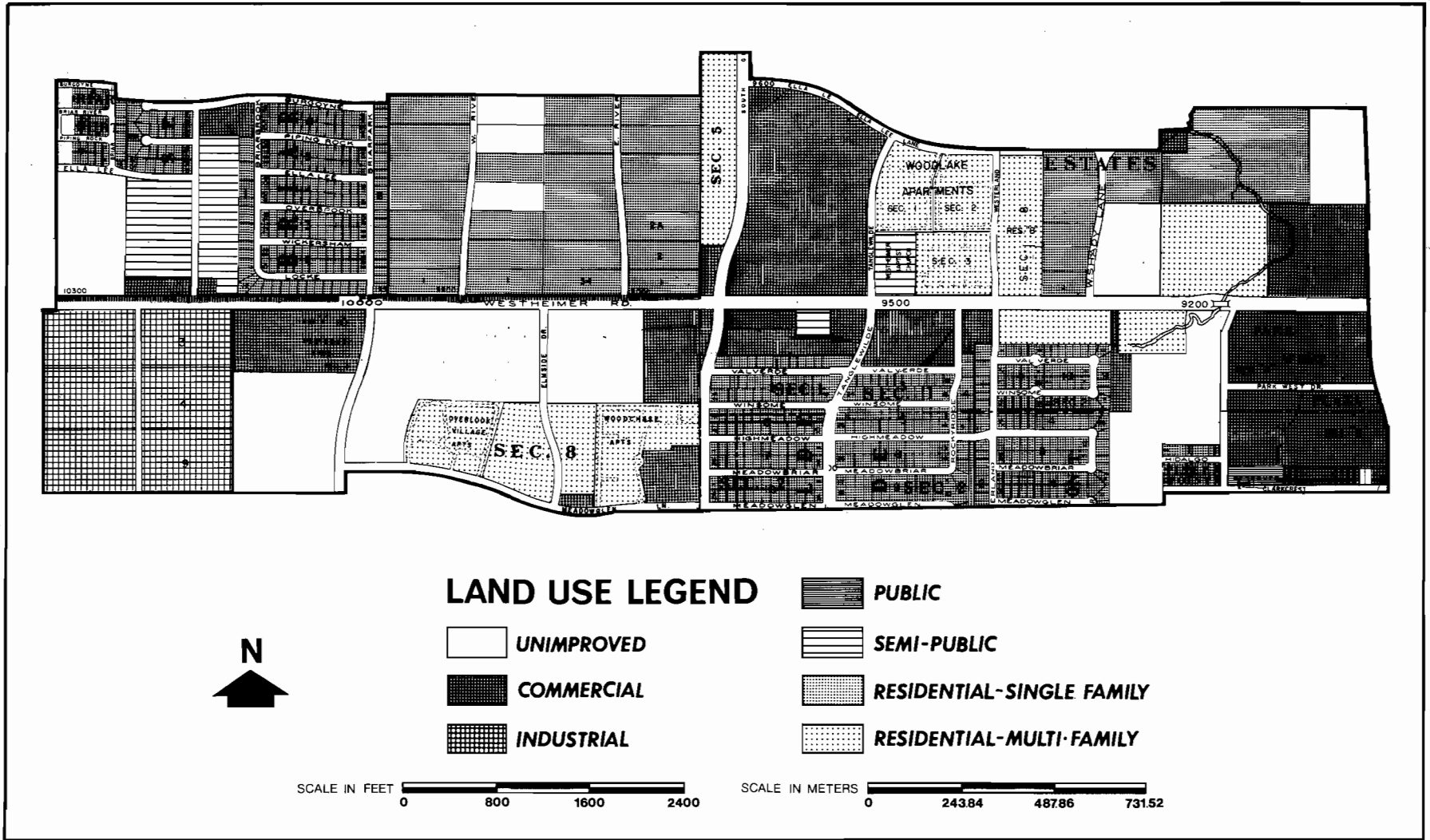


Figure 6. Map of Land Use in the Westheimer Road Study Area in 1978

Table 3. Total Study Area Land Use Inventory by Time Period and Land Use Category

Land Use Category	Before Period		Construction		After Period		Overall Period	
	1964		1970		1973		1978	1964-1978
<u>Single-Family Residential</u> Total Acres Absolute Change Percent Change	276.37	-5.51 -1.99%	270.86	+3.30 +1.22%	274.16	+3.44 +1.25%	277.60	+ 1.23 + 0.45%
<u>Multi-Family Residential</u> Total Acres Absolute Change Percent Change	7.35	+10.79 +146.80%	18.14	+21.24 +117.09%	39.38	+74.37 +188.85%	113.75	+106.40 +1447.62%
<u>Commercial</u> Total Acres Absolute Change Percent Change	35.12	-15.94 -45.39%	19.18	+30.83 +160.74%	50.01	+116.53 +233.01%	166.54	+131.42 +374.20%
<u>Industrial</u> Total Acres Absolute Change Percent Change	58.76	0 0	58.76	0 0	58.76	0 0	58.76	0 0
<u>Public</u> Total Acres Absolute Change Percent Change	0.60	+1.95 325.00%	2.55	+0.15 5.88%	2.70	-0.98 -36.30%	1.72	+1.22 +186.67%
<u>Semi-Public</u> Total Acres Absolute Change Percent Change	8.57	+24.42 +284.95%	32.99	-1.06 -3.21%	31.93	-0.87 -2.72%	31.06	+22.49 +262.43%
<u>Streets & Roads</u> Total Acres Absolute Change Percent Change	93.87	+11.94 +12.72%	105.81	+3.31 +3.13%	109.12	+13.59 +12.45%	122.71	+28.84 +30.72%
<u>Unimproved</u> Total Acres Absolute Change Percent Change	440.40	-27.65 -6.28%	412.75	-57.77 -14.00%	354.98	-206.08 -58.05%	148.90	-291.50 -66.19%
<u>Total Study Area Acreage</u>	921.04		921.04		921.04		921.04	

Land Use Changes

The land use configuration of the Westheimer Road Study Area has changed somewhat during the 14-year study period. The land use changes that occurred in the Study Area are analyzed first on an overall area basis and second, in terms of the proximity of property to Westheimer Road.

Overall Study Area

The predominant land use changed from unimproved to single-family residential during the study period, and unimproved acreage has decreased considerably from 52.2% in 1964 to 16.2% in 1978 of the total area acreage. The multi-family residential and commercial use categories have experienced large acreage increases primarily at the expense of unimproved property. Table 3 indicates the amount of acres devoted to each use category in each of the four years in which data were collected and the acreage and percentage change by category between the selected years.

Reviewing specific land use changes for the overall period, commercial development recorded the greatest absolute increase (131.42 acres) and multi-family residential development recorded the greatest percentage increase (1447.62%) between 1964 and 1978. Notable growth was also realized in the semi-public category (22.49 acres or 262.43%). The unimproved land use category had the greatest absolute (291.50 acres) and percentage (66.2%) decrease in acreage. As the above description suggests, the majority of the land use changes have been the result of the development of previously unimproved land (see Table 3).

Analyzing land use changes by the three time periods reveals which land uses experienced the greatest change within each period (Table 3). During the "before"

period (1964-1970), semi-public development had the greatest increase in acreage (24.42 acres). Decreases in acreage were also recorded for public (1.95 acres) and for streets and roads (19.35 acres). Decreases were recorded for single-family residential (5.51 acres), commercial (15.94 acres), and unimproved (27.65 acres). During the construction period (1970-73), land use changes began to accelerate, with commercial development experiencing the greatest increase in acreage (30.83 acres). Decreases were also recorded for single-family residential (3.30 acres), multi-family residential (21.24 acres), public (0.15 acres), streets and roads (3.31 acres). Decreases were recorded only for semi-public (1.06 acres) and unimproved (57.77 acres). During the "after" period (1973-78), commercial land use again experienced the greatest increase in acreage (166.53 acres). Other land uses experiencing increases in acreage were: single-family residential (3.44 acres), multi-family residential (74.37 acres), and streets and roads (13.59 acres). Land uses experiencing decreases in acreage were: public (0.98 acres); semi-public (0.89 acres), and unimproved (206.08 acres).

Total Study Area acreage devoted to each land use category by selected year is illustrated in Figure 7.

Proximity to Westheimer Road

The Study Area properties were segregated into two separate categories according to their location relative to Westheimer Road in order to facilitate a comparative analysis. Dividing the properties into either the abutting or nonabutting land category allows a study approach to be implemented to determine the influence of the street improvement on the location of land use changes. Abutting properties normally are expected to undergo relatively more land use changes than nonabutting properties as a result of the street improvement; however, several factors may exist that could alter the anticipated

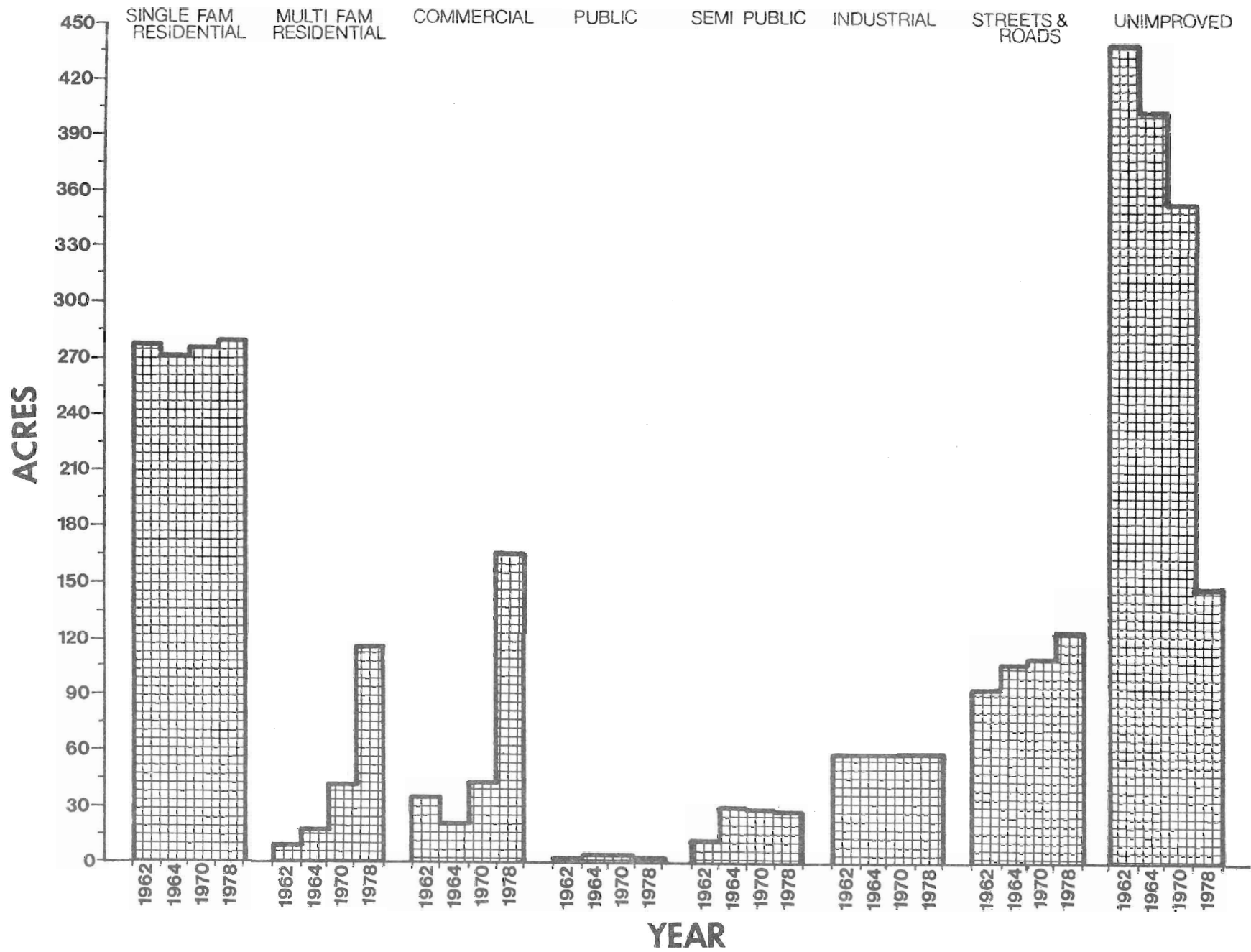


Figure 7. Changes in Total Land Use in the Westheimer Road Study Area by Category and Selected Years

results (i.e., availability of developable land, predominant land use, etc.). Therefore, an analysis of the land use changes occurring in each location category is reviewed to confirm or reject the above hypothesis.

Abutting Properties. Abutting properties are defined as those tracts with frontage along the subject facility, which is Westheimer Road. For developed properties, if an abutting tract was improved as a single development, all of the land development was included to avoid arbitrary division of the tract. For unimproved tracts with frontage on the subject facility, a section of land 300 feet (91.44 meters) deep from the right-of-way was defined as abutting properties. Abutting property in the Study Area was defined according to land use configuration in 1978, the last year of the analysis period, and remained consistent for the preceding 14 years.

In the first year of analysis, 1962, unimproved land is shown to be the predominant abutting land use, with 141.91 acres (Table 4). The acreage breakdown for the abutting improved uses, ranked by number of acres, is as follows: industrial, 56.92 acres; streets and roads, 38.72 acres; single-family residential, 35.24 acres; commercial 24.10 acres; multi-family residential, 9.35 acres; semi-public, 5.29 acres; and public, 0.0 acres.

By 1970, the last year before final planning and improving this section of Westheimer Road began, unimproved land is still shown to be the predominant abutting land use, with 40% or 122.32 acres (Table 4). However, abutting unimproved acreage is shown to have declined by 13.8% or 19.59 acres. Of the improved uses, single-family residential and commercial show a decline in acreage for this period. The remaining improved uses show an increase in acreage, especially the semi-public use which experienced an increase of 15.2 acres or 287.0%.

Table 4. Abutting Property Land Use Inventory by Time Period and Land Use Category

Land Use Category	Before Period		Construction		After Period		Overall Period	
	1964		1970		1973		1978	1964-1978
<u>Single Family Residential</u> Total Acres Absolute Change Percent Change	35.24	-6.16 -17.48%	29.08	+9.69 +33.32%	38.77	-17.16 -44.26%	21.61	-13.63 -38.68%
<u>Multi-Family Residential</u> Total Acres Absolute Change Percent Change	7.35	+10.79 +146.80%	18.14	+4.59 +25.30%	22.73	+26.29 +115.66%	49.02	+41.67 +566.94%
<u>Commercial</u> Total Acres Absolute Change Percent Change	24.10	-5.84 -24.23%	18.26	+17.70 +96.93%	35.96	+57.09 +158.76%	93.05	+68.95 +286.10%
<u>Industrial</u> Total Acres Absolute Change Percent Change	56.92	0 0	56.92	0 0	56.92	0 0	56.92	0 0
<u>Public</u> Total Acres Absolute Change Percent Change	0	+0.23 + -	0.23	+0.23 +100%	0.46	-0.46 -100%	0	0 0
<u>Semi-Public</u> Total Acres Absolute Change Percent Change	5.29	+15.22 +287.11%	20.51	0 0	20.51	-11.89 -57.97%	8.62	+3.33 +62.95%
<u>Streets and Roads</u> Total Acres Absolute Change Percent Change	38.72	+1.67 +4.31%	40.39	+0.76 +1.83%	41.15	+0.82 +1.99%	41.97	+3.25 +8.39%
<u>Unimproved</u> Total Acres Absolute Change Percent Change	141.91	-19.59 6.41%	122.32	-32.97 -27.37%	87.51	-54.69 -62.50%	32.82	-103.57 -75.94%
<u>Total Study Area Acreage</u>	305.85		305.85		305.85		305.85	

By 1973, the year after this section of Westheimer Road was improved, unimproved land is still shown to be the predominant abutting land use, with 28.6% or 87.51 acres (Table 4). Abutting unimproved acreage is shown to have decreased by 33.0 acres or 27.4% during this period, and all the unimproved land uses show an increase. Commercial land use shows the greatest increase, with 17.70 acres.

By the last year of the "after" period, 1978, unimproved land use is shown to be no longer the predominant abutting land use, with only 32.82 acres (Table 4). Also, single-family residential and semi-public uses show a significant loss in acreage, losing 17.16 and 11.89 acres, respectively. Commercial and multi-family residential show to be the big gainers in acreage during this period, gaining 57.09 and 26.29 acres, respectively. Finally, the acreage breakdown for the abutting improved uses, ranked by number of acres, is as follows: commercial, 93.05 acres; industrial, 56.92 acres; multi-family residential, 49.02 acres; streets and roads, 41.97 acres; single-family residential, 21.61 acres; and semi-public, 8.62 acres.

Between 1964 and 1978, abutting unimproved acreage shows the greatest loss, 103.57 acres or 75.9% (Table 4). Of all uses, commercial acreage shows the greatest gain, 68.95 acres or 286.1%. Also, commercial is shown to have replaced unimproved as the predominant land use. Multi-family residential is shown to be another big gainer in acreage. Single-family residential is shown to be the other loser in acreage.

Figure 8 shows, graphically, the changes in abutting land uses in the Study Area, as reflected by selected years of study.

Nonabutting Properties. Nonabutting property in the Study Area is defined simply as those tracts not classified as abutting the improved facility (see

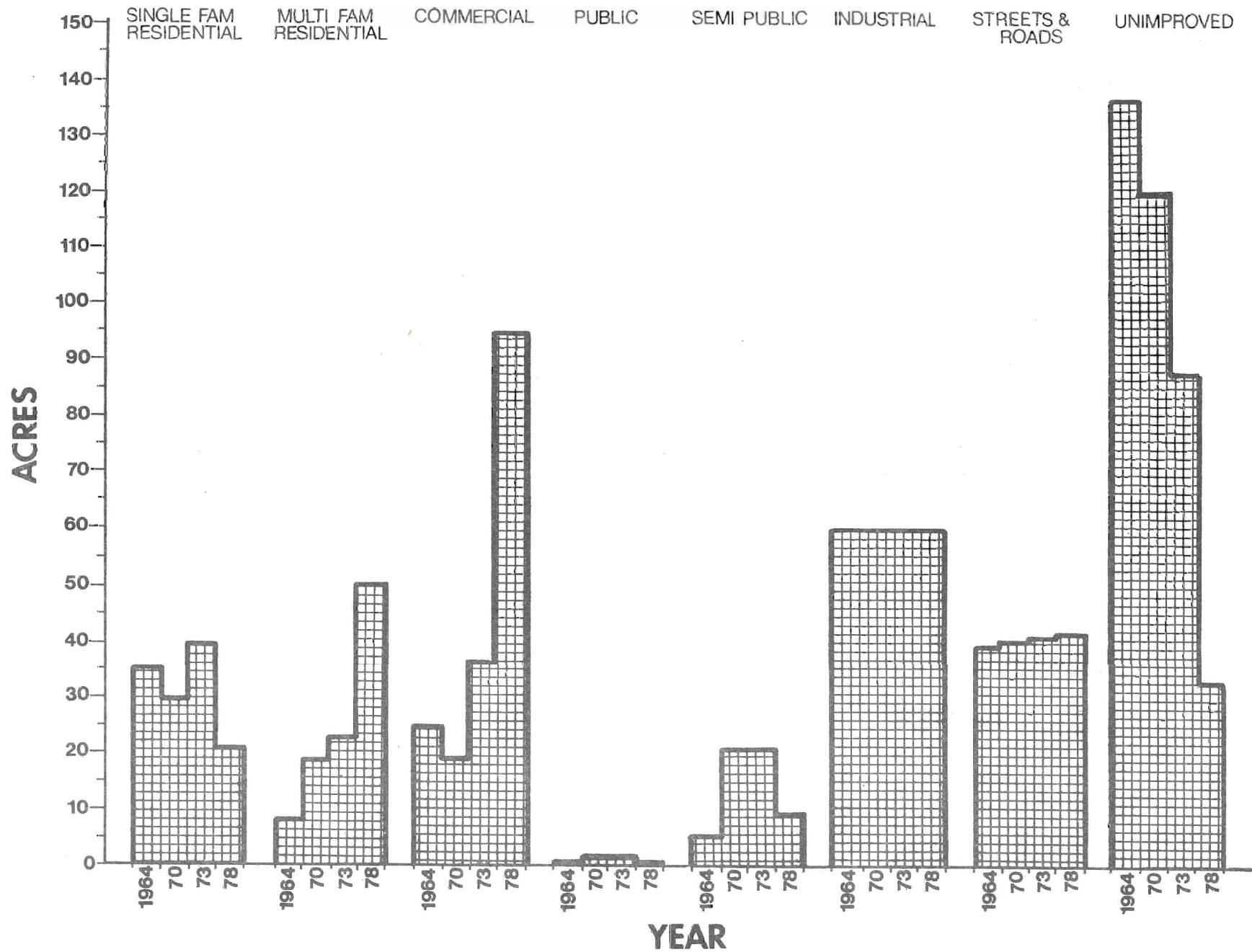


Figure 8. Changes in Abutting Land Uses in the Westheimer Road Study Area by Category and Selected Years

Definitions). Using this criteria, 615.15 acres are defined as nonabutting property. Table 5 indicates the acreage and amounts of change for each land use category and selected time period.

As in the case of abutting property, the predominant nonabutting land use in 1964 is shown to be unimproved acreage, with 304.01 acres or 49.9% of the total nonabutting acreage. The 1964 ranking of the improved land use categories, by number of acres, is as follows: single-family residential, 241.13 acres; streets and roads, 55.15 acres; commercial, 11.02 acres; semi-public, 3.28 acres; public, 0.60 acres; multi-family residential and industrial, 0.00 acres, respectively.

At the end of the "before" period, 1970, unimproved acreage is shown to be still the predominant land use, but showing a loss of 11.74 acres to other uses during the period. Commercial use also shows a loss. The other improved uses show small gains in acreage, except industrial.

At the end of the "construction" period, 1973, unimproved acreage is seen to be still the predominant nonabutting use, but showing a loss of 24.80 acres during the period. Single-family residential, public, and semi-public acreages are shown to be reduced by small amounts. Multi-family residential commercial, and streets and roads show modest gains in acreage.

At the end of the "after" period, 1978, unimproved acreage is replaced by single-family residential as the predominant land use, showing a loss of 151.39 acres or 56.6% during the period. The 1978 rankings of the land use categories, by number of acres, is as follows: single family residential, 255.99 acres; unimproved, 166.08 acres; streets and roads, 80.74 acres; commercial, 73.49 acres; multi-family, 64.73 acres; semi-public, 22.44 acres; public, 1.72 acres; and industrial, 0.00 acres. Multi-family and single-family

Table 5. Nonabutting Property Land Use Inventory by Time Period and Land Use Category

Land Use Category	Before Period		Construction		After Period		Overall Period	
	1964		1970		1973		1978	1964-1978
<u>Single-Family Residential</u> Total Acres Absolute Change Percent Change	241.13	+0.65 +0.27%	241.78	-6.39 -2.64%	235.39	+22.60 +8.75%	255.99	+14.86 +6.16%
<u>Multi-Family Residential</u> Total Acres Absolute Change Percent Change	0	0 0	0	+16.65 + -	16.65	+48.08 +288.77%	64.73	+64.73 + -%
<u>Commercial</u> Total Acres Absolute Change Percent Change	11.02	-10.10 -91.65%	0.92	+13.13 1427.17%	14.05	+59.44 +423.06%	73.49	+62.47 +566.88%
<u>Industrial</u> Total Acres Absolute Change Percent Change	0		0		0		0	
<u>Public</u> Total Acres Absolute Change Percent Change	0.60	+1.72 +286.67%	2.32	-0.08 -3.45%	2.24	-0.52 -23.21%	1.72	+1.12 +186.67%
<u>Semi-Public</u> Total Acres Absolute Change Percent Change	3.28	+9.20 +280.49%	12.48	-1.06 -8.49%	11.42	+11.02 +96.50%	22.44	+19.16 +584.15%
<u>Streets and Roads</u> Total Acres Absolute Change Percent Change	55.15	+10.27 +18.62%	65.42	+2.55 +3.90%	67.97	+12.77 +18.79%	80.74	+25.59 +46.40%
<u>Unimproved</u> Total Acres Absolute Change Percent Change	304.01	-11.77 -3.86%	292.27	-24.80 -8.49%	267.47	-151.39 -56.60%	116.08	-187.93 -61.82%
<u>Total Nonabutting Acreage</u>	615.19		615.19		615.19		615.19	

residential uses are ranked higher in 1978 than in 1964, and unimproved, semi-public, and public are ranked lower. Although the commercial category's ranking is not changed, it shows a considerable increase in acreage.

Figure 9 shows, graphically, the changes in nonabutting land uses in the Study Area, as reflected by the years of study.

Land Use Impediments

Many factors can alter the rate and type of land use development in an area besides the improvement of a single thoroughfare. Zoning laws, subdivision (deed) restrictions, and comprehensive land use plans could have dictated how development and change occurred in the impacted area. Other factors also investigated to determine their influence on area land use are regional land developments, area accessibility, and property ownership.

Land Use Plans and Controls

The City of Houston does not have zoning laws and, therefore, has no legal means of enforcing or controlling land use. The process through which the city may influence land use development is by approving or rejecting plats submitted by land developers. When approving plats, the city has the authority to impose certain restrictions, e.g. location and number of access points to major thoroughfares, type and width of local streets, and set-back distance of buildings from street; but the city cannot dictate the type of land development. Deed restrictions are the only legal method of controlling land use in Houston, but area property owners, not the city government, must instigate the action to prevent a nonconforming land use.

Although land use planners in Houston have no power to enforce land use

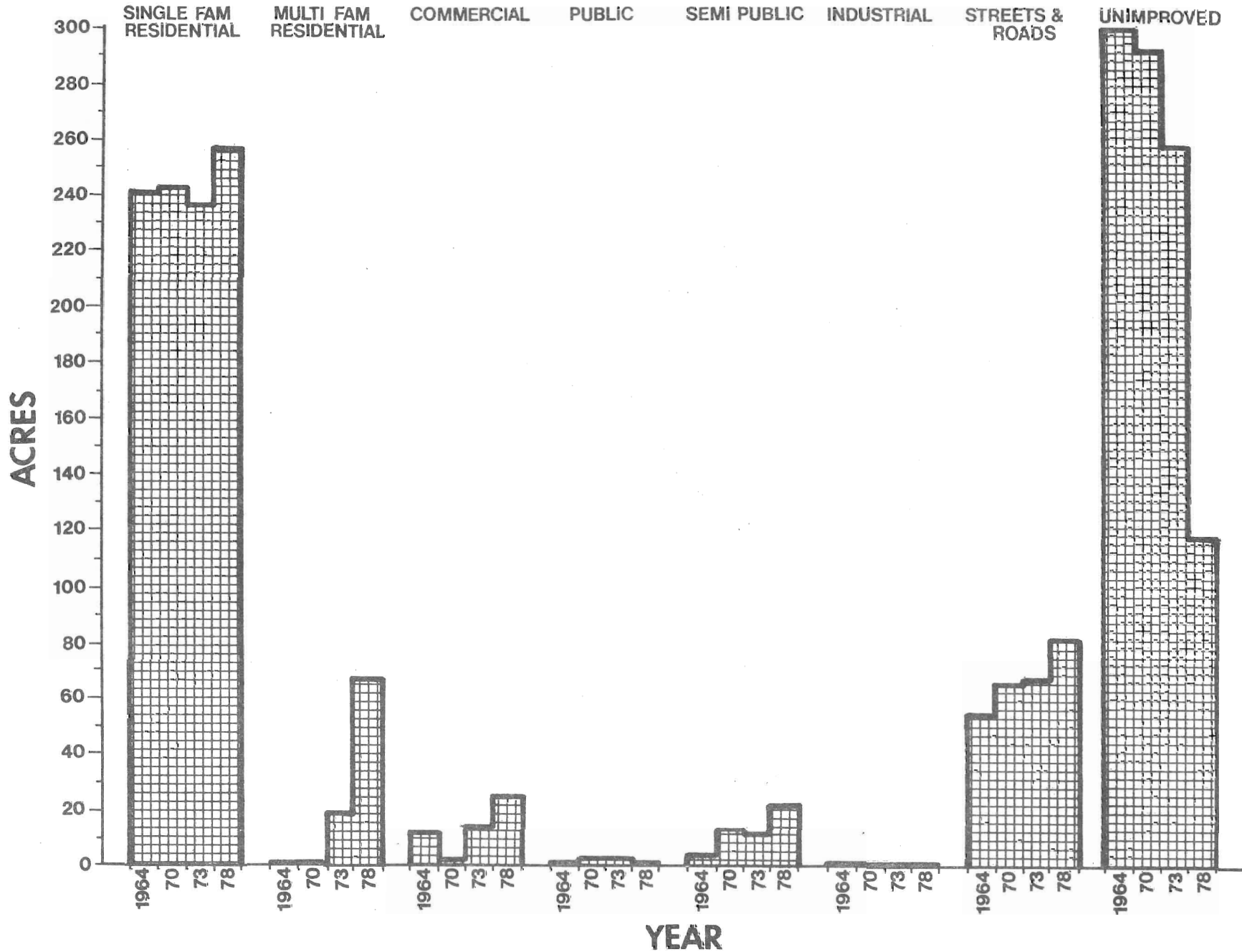


Figure 9. Changes in Nonabutting Land Uses in the Westheimer Road Study Area by Category and Selected Years

controls, comprehensive land use plans have been developed to reflect general trends in land development. In 1960, the Houston Metropolitan Area Transportation Study published a 1980 land use plan for Harris County which indicates that the Westheimer Road Section Three Study Area would evolve into a predominantly single-family residential area with strip commercial establishments concentrating along Westheimer Road. The 1980 general plan did not project any multi-family residential developments for the Study Area. In the 1990 general land use plan, published by the Houston City Planning Commission in 1972, the entire Study Area is described as low and medium density residential. The 1990 plan does not address, or account for strip commercial developments like the ones located in the Study Area; only regional and neighborhood shopping centers and large business establishments are identified in the general land use plan.

These land use plans were based on existing land use, age of existing improvements, amenities offered for the various types of developments, land use development plans, and area growth trends. The 1978 land use configuration found in the Westheimer Road, Section Three, Study Area is not entirely consistent with the Houston Metropolitan Area plan. The differences between the actual and forecasted land use are the large tracts of land which have remained unimproved as of 1978, the widespread multi-family residential development throughout the area, and the strip commercial establishments abutting Fondren Road. Although the 1980 plan correctly forecasted the regional land use trend of strip commercial and single-family residential development, the Study Area's land use development has not followed the regional single-family residential trend because of the importance of multi-family residences locating near Westheimer and the problem of property owners not selling or improving

several large tracts of land within the area.

Other Factors Influencing Land Use Change

Due to the availability of unimproved land and the lack of land use controls (i.e., zoning laws and deed restrictions), land development in the Study Area has not encountered many impediments. The only type of impediment encountered is the resistance of several owners of large tracts of property to develop or sell to developers. It is difficult to ascertain the impact of these large unimproved tracts on Study Area development. Certainly, if these tracts were made available, additional land development in the form of commercial, multi-family and single-family residential use would occur in the area. In all probability, the resistance of property owners has caused developments that would have been located in the Study Area to locate elsewhere.

Factors which might have encouraged commercial and multi-family residential development are: the growth trend of Houston toward the west, the fact that Westheimer Road is the only east-west traffic artery that directly serves the Study Area, availability of large tracts of unimproved land, and the completion and improvement of the area's thoroughfare network (i.e., San Felipe, Richmond, West Belt, and Fondren).

Socio-Economic Characteristics

The socio-economic characteristics of an area may have an important influence on the regional land use development. Factors such as population growth, median family income, educational level, and labor force characteristics were investigated to determine their possible significance to land use development trends in Section Three of the Westheimer Road area.

Table 6 enumerates the 1960 and 1970 Bureau of the Census population and labor force data for Census Tracts 90-C/439 and 91-F/423 and the City of Houston. These data are presented to show significant differences in the above characteristics between the City of Houston and the census tracts during the two years of interest. Since Census Tracts 90-C/439 and 91-F/423 encompass the Study Area, a comparative analysis between the two sets of data may be implemented. (Census Tracts 90-C and 91-F are the 1960 census identification codes for Census Tracts 422 and 423 in the 1970 census.)

Table 6 indicates that the population in Census Tracts 90-C/439 and 91-F/423 increased by 263.7% from 1960 to 1970, while the City of Houston increased 31.4% during the same time frame. Also, the percent of high school graduates in both the 1960 and 1970 censuses is shown to have been higher for the census tracts, than for Houston. Correspondingly, the median family income is shown to be higher in Census Tract 91-F/423 than in Houston. (Income data for 1960 is not available for Census Tract 90-C.) In addition, the median value of owner-occupied residences of the two census tracts is shown to be higher than the comparable Houston median value for both the 1960 and 1970 censuses. Median rent, paid by tenants is shown to be higher for Census Tract 90-C. Generally, the respective values of the above characteristics are shown to be not only higher for the census tracts than for Houston, but are shown to have increased more in absolute and percentage terms between 1960 and 1970.

Table 6 also shows occupational characteristics for the two Study Areas census tracts and for Houston, as reported in the 1960 and 1970 censuses. Total employment in the census tracts is shown to have increased 230% compared to 42% for Houston. In general, the percentages of professional,

Table 6. Comparison of 1960 and 1970 Socio-Economic Characteristics of Houston and Census Tracts 90-C/439 and 91-F/423

Socio-Economic Characteristics	1960			1970		
	Houston	Tract 90-C	Tract 91-F	Houston	Tract 439	Tract 423
<u>Population</u>	938,219	272	7,875	1,232,793	3,866	17,616
Median School Years Completed	11.3	NA	12.4	12.1	16.0	13.2
Percent High School Graduates	45.2	70.0	60.2	51.8	90.1	75.3
Median Family Income	\$5,902	NA	\$6,848	\$9,876	\$20,613	\$12,551
Median Income of Families and Unrelated Individuals	\$5,093	NA	\$6,606	\$8,055	\$19,612	\$10,221
Median Value of Owner Occupied Residences	\$10,900	\$25,000+	\$13,800	\$14,400	\$43,700	\$22,100
Median Rent Paid by Tenants	\$67	NA	\$93	\$96	\$195	\$158
Percent Families Below Poverty Level	NA ^a	NA ^a	NA ^a	10.7	2.0	6.3
<u>Occupation</u>						
Total Employed, 16 Years and Over	363,636 ^b	135 ^b	2,929 ^b	515,619	1,468	8,657
Percent Professional, Technical, and Kindred Workers	12.49	24.44	18.13	16.53	36.24	27.11
Percent Managers & Administrators, Except Farm	9.97 ^c	14.81 ^c	13.21 ^c	8.78	23.16	10.80
Percent Sales Workers	8.08	3.70	11.67	8.97	16.83	15.46
Percent Clerical and Kindred Workers	16.56	22.22	14.44	20.09	13.83	22.89
Percent Craftsmen, Foremen & Kindred Workers	12.72	2.96	6.79	13.10	4.16	6.88
Percent Operatives, Except Transport	13.79 ^d	NA ^d	9.15 ^d	9.29	2.22	4.13
Percent Transport Equipment Operatives	NA ^d	NA ^d	NA ^d	4.24	NA	1.13
Percent Laborers, Except Farm	5.74	6.67	9.53	5.19	1.49	3.26
Percent Farm Workers	NA ^c	NA ^c	NA ^c	0.24	NA	0.10
Percent Service Workers	9.44	9.44	4.92	11.14	1.43	6.58
Percent Private Household Workers	4.21	NA	6.76	2.09	0.41	1.64

^a Percent Families Below Poverty Level was not calculated by the Bureau of the Census in the 1960 Census.

^b In the 1960 Census, Total Employed included all employed persons 14 years old and over.

^c In the 1960 Census, the percent total for managers and administrators included farm workers; therefore, a separate percent total for Farm Workers was not available.

^d In the 1960 Census, the percent total for Operatives include transport equipment operatives; therefore, a separate percent total for Transport Equipment operatives was not available.

Note: NA stands for "Not Available".

technical, managerial, administrative and sales type workers are shown to be higher in the census tracts than in Houston for both census years. The reverse is generally true for the percentages of craftsmen, laborers and service workers. Also, the absolute and percentage changes in workers of the various occupations are shown to be greater in the census tracts than in Houston.

The socio-economic data found in Table 6 indicates that the Study Area and the surrounding region have experienced greater changes in population, education, income, and employment levels than Houston. The differences and changes in these socio-economic characteristics suggest that the Study Area has had an economic base more conducive to rapid land development than perhaps Houston in general.

IMPACT OF THE STREET IMPROVEMENT ON LAND USE IN THE STUDY AREA

Two approaches are used to indicate whether the Westheimer Road, Section Three improvement impacted land use in the Study Area. The first approach is based on "before" and "after" average annual percentage changes in land use or land development. The second approach is based on the opinions of knowledgeable people to ascertain the land use impact of the improvement.

Actual Land Use Changes

Tables 7 and 8 show the extent of land use change which occurred in the Study Area according to property location (abutting vs. nonabutting). Table 7 indicates the period by period absolute acreage changes in land use. Table 8 shows the period by period average annual percentage changes in land use, calculated to adjust for the difference in the number of years between time periods. Both tables also indicate the previous and new use categories for each change recorded. This approach permits a comparative analysis to be done between abutting and nonabutting property changes and, therefore, determines the possible levels and types of land use impact of the Westheimer Road improvement relative to property location.

For the whole 14 year study period, the annual average percentage change in land use is shown to have been 5.10% for abutting property and 3.45% for nonabutting property (Table 8). Basically, this result conforms to the hypothesis that abutting property is influenced more than nonabutting property by the improvement of the study facility.

Previously unimproved acreage is shown to have changed 3.22% for abutting property and 2.31% for nonabutting property during the overall period. Specifically, unimproved acreage changing to commercial use represents the

Table 7. Absolute Changes in Land Use of Abutting and Nonabutting Acreage by Time Period and Type of Land Use Change

Type of Land Use Change	Before Period		Construction Period		After Period		Overall Period	
	1964-1970		1970-1973		1973-1978		1964-1978	
	Abutting	Nonabutting	Abutting	Nonabutting	Abutting	Nonabutting	Abutting	Nonabutting
	Acres ^a							
Single-family to Unimproved	6.03	6.24	0	14.81	10.10	6.88	16.13	27.93
Single-family to Multi-family	4.13	0	0	0	5.45	0	9.58	0
Single-family to Commercial	1.84	0	0	0	1.61	13.38	3.45	13.38
Commercial to Multi-family	0	0	1.38	0	1.38	44.29	2.76	44.29
Commercial to Unimproved	20.43	10.10	.69	0	11.02	0	32.14	10.10
Commercial to Single-family	0	0	1.84	0	0	0	1.84	0
Single-family to Public	0	.91	0	0	0	0	0	.91
Public to Unimproved	0	0	0	.08	0	0	0	.08
Public to Commercial	0	0	0	0	.46	.52	.46	.52
Public to Single-family	0	0	0	0	0	0	0	0
Semi-Public to Unimproved	0	0	0	1.06	0	0	0	1.06
Semi-Public to Commercial	0	0	0	0	13.95	0	13.95	0
Unimproved to Public	.23	.81	.23	0	0	0	.46	.81
Unimproved to Commercial	12.75	0	21.61	13.13	53.47	89.83	87.83	102.96
Unimproved to Multi-family	6.66	0	3.21	16.65	19.47	3.79	29.33	20.44
Unimproved to Single-family	5.84	7.80	7.85	8.42	0	13.67	13.69	29.89
Unimproved to Semi-Public	15.22	9.20	0	0	2.06	11.02	3.33	19.16
Unimproved to Streets and Roads	1.67	10.27	.76	2.55	.82	12.77	3.25	25.59
Total Acreage Changing Use	74.80	45.33	37.57	56.70	119.79	196.15	218.20	297.12
Improved Acreage	32.43	17.25	3.91	15.95	43.97	65.07	80.31	98.27
Unimproved Acreage	42.37	28.08	33.66	40.75	75.82	131.08	137.89	198.85
Total Acreage Not Changing	231.05	567.86	268.28	559.49	186.06	419.04	87.65	318.07
Total Acreage	305.85	615.19	305.85	615.19	305.85	615.19	305.85	615.19

^aOne acre equals 0.4046856 hectares.

Table 8. Average Annual Percentage Changes in Abutting and Nonabutting Acreage by Time Period and Type of Land Use Change

Type of Land Use Change	Before Period		Construction Period		After Period		Overall Period	
	1964-1970		1970-1973		1973-1978		1964-1978	
	Abutting	Nonabutting	Abutting	Nonabutting	Abutting	Nonabutting	Abutting	Nonabutting
	----- Percent ^a -----							
Single-Family to Unimproved	0.33	0.17	0	0.80	0.66	0.22	0.38	0.32
Single-Family to Multi-Family	0.23	0	0	0	0.36	0	0.22	0
Single-Family to Commercial	0.10	0	0	0	0.11	0.43	0.08	0.16
Commercial to Multi-Family	0	0	0.15	0	0.09	1.44	0.06	0.51
Commercial to Unimproved	1.11	0.27	0.08	0	0.72	0	0.75	0.12
Commercial to Single-Family	0	0	0.20	0	0	0	0.04	0
Single-Family to Public	0	0.02	0	0	0	0	0	0.01
Public to Unimproved	0	0	0	0.01	0	0	0	0.01
Public to Commercial	0	0	0	0	0.03	0.02	0.01	0.01
Public to Single Family	0	0	0	0	0	0	0	0
Semi-Public to Unimproved	0	0	0	0.06	0	0	0	0.01
Semi-Public to Commercial	0	0	0	0	0.91	0	0.33	0
Unimproved to Public	0.01	0.02	0.03	0	0	0	0.01	0.01
Unimproved to Commercial	0.69	0	2.36	0.71	3.50	2.92	2.05	1.20
Unimproved to Multi-Family	0.36	0	0.35	0.09	1.27	0.12	0.68	0.24
Unimproved to Single-Family	0.32	0.21	0.86	0.46	0	0.44	0.32	0.35
Unimproved to Semi-Public	0.83	0.25	0	0	0.13	0.36	0.08	0.22
Unimproved to Streets and Roads	0.64	0.27	0.08	0.14	0.05	0.42	0.08	0.30
Total Acreage Changing Use	4.08	1.23	4.10	3.07	7.84	6.38	5.10	3.45
Improved Acreage	1.77	0.47	0.43	0.86	2.88	2.12	1.88	1.14
Unimproved Acreage	2.31	0.76	3.67	2.21	4.96	4.26	3.22	2.31

^a Derived from the absolute acreages in Table 7. For example, the individual acreages changing use during the "before" period are divided by the total abutting on nonabutting acreage at bottom of Table 7 to obtain the corresponding percentages for that period. Then each percentage figure is divided by the number of years represented by the "before" period. This procedure is repeated for each period.

land use type having had the greatest average annual percentage. However, the rate of change experienced by abutting property is higher than that experienced by nonabutting property.

Previously improved acreage is shown to have experienced an average annual percentage change of 1.88% for abutting property compared to 1.14% for nonabutting property (Table 8). Again, the rate of change for abutting property is shown to have been higher than that for nonabutting property. For improved abutting property, changing from commercial to unimproved use represents the type of change having had the highest annual rate of change. For unimproved nonabutting property, changing from commercial to multi-family residential represents the use change having had the highest annual rate of change.

Reviewing the percentage changes by time period in Table 8 indicates that the highest rate of change in improved and unimproved acreage occurred during the "after" period. The rate of change during that period is shown to have been greater for abutting property than for nonabutting property and greater for unimproved acreage than improved acreage. Of the unimproved uses, the highest rate of change in use for the "after" period is shown to have been a change to commercial for abutting and nonabutting properties. Of the improved uses, the highest rate of change in use for the "after" period is shown to have been a change from semi-public to commercial for abutting property and a change from commercial to multi-family for nonabutting.

The overall annual rate of change is shown to have been lowest during the "before" period for abutting and nonabutting properties, with the latter showing the lowest rate of change.

The data illustrated in Tables 7 and 8 seems to suggest that the improvement of Westheimer Road has facilitated the development of previously unimproved property in the Study Area. The abutting land use analysis, especially, indicates that new commercial development was influenced by the improvement project. The nonabutting land use analysis points out that trends in use may have been altered from single-family to commercial and multi-family uses. The fact that several large tracts of unimproved land were held off the market may have inhibited some additional development during the study period. Generally, the improvement of Westheimer Road has encouraged the continued development of unimproved property and has influenced the redevelopment of certain properties in the Study Area.

Opinions of Knowledgeable People

Interviews were conducted with local real estate personnel, area property owners, and city government officials in an effort to obtain relevant background information that would provide additional insight as to the land use impact of the Westheimer Road, Section Three, improvement. These persons felt that in general the widening and paving of Westheimer Road had facilitated and accelerated land development in the Study Area but did not alter the land use trends that existed prior to the improvement.

Real estate personnel pointed out that Westheimer Road was the only major east-west traffic arterial, prior to the extension of Richmond Road, which provided access to large amounts of acreage being developed between the Southwest Freeway (U.S. 59) and Katy Freeway (IH 10) during the 1960's and 1970's (Figure 1). As a result, Westheimer Road has become one of the most traveled thoroughfares in Houston and the abutting and adjacent pro-

perties have become some of the most attractive commercial and multi-family residential land in Harris County. The improvement of Westheimer Road, as a six-lane, raised median facility has improved access to the developing area and, coupled with the growth trend of Houston toward the west and north, has accelerated the existing land use development trends. Real estate developers indicated that strip-commercial developments along Westheimer were probably influenced most by the widening and paving project, while multi-family residential developments along and near Westheimer were influenced by the completion of the area's whole thoroughfare network and the increasing population. The consensus among real estate people was that the Study Area's property was prime strip-commercial and multi-family residential land.

City government officials were in agreement with real estate people in that the improvement of Westheimer Road has encouraged land development in the area. In fact, one official felt that pressures placed on Westheimer as a traffic artery by increased population and new land developments in the area resulted in the improvement of the facility. Officials also said that the combination of Westheimer Road being one of Houston's most traveled streets and Houston's phenomenal growth has influenced the types of land uses that have been developed in the Study Area. Government officials felt that the Westheimer Road improvement project accelerated the land use development trends which existed in the area.

The opinions of real estate developers and brokers, property owners, and government officials agree that the improvement of Westheimer Road, Section Three, accelerated and facilitated land use change and development. Basically, these opinions coincide with the findings of the land use analysis of the Study Area.

CONCLUSIONS

Land use data collected during the 14-year study period indicate that the Westheimer Road, Section Three, Study Area has experienced a considerable amount of land use change and development. The Westheimer Road improvement has influenced the development of area unimproved properties into primarily commercial and multi-family residential uses. During the study period, most of the Study Area's property underwent a change in land use. The predominant land use category changed from unimproved to single-family residential.

More than two-thirds of the abutting land has experienced a change in use; and correspondingly, the predominant land use has changed from unimproved to commercial. The majority of the land use change involved commercial and multi-family residential developments. Some redevelopment of abutting tracts occurred during each of the time periods, with the redevelopment of rural single-family residences being the most important type. Each of the time periods experienced a decrease in unimproved acreage. The largest amount of acreage changed use during the "after" period. Also, this is the period that experienced the highest average annual percentage change for unimproved and improved land.

Nonabutting land also experienced significant land use changes during the study period, but less than one-half of nonabutting land changed use. The predominant nonabutting land use changed from unimproved to single-family residential. Most of the unimproved land changed to commercial, multi-family residential or single-family residential use. Redevelopment of improved land also occurred during the study period, involving mostly single-family or commercial tracts changing to other uses. As in the case of abutting land,

the largest amount of nonabutting land, unimproved or improved, changed use during the "after" period. Also, this is the period that experienced the highest average annual percentage change in land use, with abutting land having a higher annual percentage change in use than nonabutting land.

All of the above changes in land use could have been encouraged by the Westheimer Road improvement. It is significant that the "after" period experienced a higher annual percentage change in land use than the "before" period. It is also significant that abutting property experienced a higher average annual percentage change in land use than nonabutting property.

The extensive land use changes and developments experienced along Westheimer Road and in the Study Area are attributed to the phenomenal population growth of the region and the characteristics of Westheimer Road. Westheimer Road (F.M. 1093), being one of the most heavily traveled thoroughfares in Harris County and coupled with the westerly growth of Houston, has made property fronting on and near to the study facility some of the most attractive for commercial and multi-family residential development in the Gulf Coast region. The type of land developments occurring during the study period has generally conformed with the projected land uses published by area governments in comprehensive use plans. However, it is also reasonable to conclude that the improvement of Westheimer Road and other roads in the area has facilitated and perhaps accelerated the development of previously unimproved property to other uses, especially to commercial and multi-family residential uses.