TEXAS
TRANSPORTATION
INSTITUTE

TEXAS
HIGHWAY
DEPARTMENT

COOPERATIVE
RESEARCH

THE EFFECT OF ACCESS ON HIGHWAY RIGHT OF WAY COSTS AND THE DETERMINATION OF SPECIAL BENEFITS

in cooperation with the
Department of Transportation
Federal Highway Administration
Bureau of Public Roads

RESEARCH REPORT 82-1F
STUDY 2-15-65-82
THE EFFECT OF ACCESS ON THE COST OF
RIGHT OF WAY FOR THE INTERSTATE SYSTEM

The Effect of Access on Right of Way Costs and the Determination of Special Benefits

by

William D. Franklin
Assistant Research Economist

Lynn A. Evans
Research Assistant

Research Report Number 82-1F

The Effect of Access on the Cost of Right of Way for the Interstate System

Research Study 2-15-65-82

**Sponsored by
the Texas Highway Department
in Cooperation With the
U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads**

October, 1968

TEXAS TRANSPORTATION INSTITUTE
Texas A&M University
College Station, Texas

TABLE OF CONTENTS

PREFACE

The authors wish to express their appreciation to all those who helped in both formulating and conducting this study. Special thanks are due to the two sponsoring agencies—the Texas Highway Department and the U. S. Department of Transportation. Federal Highway Administration, Bureau of Public Roads—for their continued support and guidance. Mr. Walton O. Threadgill, of the Texas Highway Department, and Mr. J. T. Murphree, of the Bureau of Public Roads, have been most helpful in guiding this project through their efforts as Advisory Committee members. Former members of this Committee have made valuable contributions in the past to the study.

Appreciation is expressed also to the many people in Montgomery, Walker, Dallas, Taylor, Navarro, Hill, Harris, Smith, and Colorado Counties whose assistance was critical to the completion of the study. Various real estate dealers, the County Clerk's Office, the County Tax Office, the City Planning Office, and numerous title and abstract companies in the individual counties were especially helpful. To all these people, as well as to the many others too numerous to mention, deepest thanks are expressed.

Other members of the Department of Highway Economy, Division of Transportation Economics, of the Texas Transportation Institute have made valuable contributions to the completion of this study. Dr. C. V. Wootan, Head of the Division, reviewed a preliminary draft of the material. Mr. J. L. Buffington assisted in the development of the appraisal segment of the report. Dr. W. G. Adkins, Head of the Department reviewed the final report. Finally, Mr. J. G. Darroch, of the Institute of Statistics, made valuable analytical suggestions in the design and analysis of the research material.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

Summary and Conclusions

Acquisition of right of way for a major highway system presents a number of unique problems in property evaluation. For the Interstate Highway System alone, some three-quarters of a million parcels of land will be required. The magnitude of the costs involved in acquiring this right of way poses a compelling need for developing procedures to assure that expenditures for this purpose are spent effectively. Systematic and precise valuation of highway investment decisions ensures a more adequate allocation of resources within the public sector.

When an appraiser begins his appraisal of land that is to be used for highway right of way purposes, he follows a specified step by step procedure. This method is based upon various laws and court decisions and has its beginnings in the state's inherent power of eminent domain. It is agreed that if all the land owned by an individual is to be taken for right of way he should be paid the market price for that particular property. Special problems arise in partial takings.

A partial taking occurs whenever an individual has land remaining after the necessary amount is taken for right of way purposes. This remainder may incur damages because of the taking and it might also incur benefits due to the facility. Damages occur when the following elements are established: (1) The whole property forms an inseparable optimum economic unit. (2) A physical part of the whole property is being taken. (3) The remaining property as an economic unit is worth less than prior to the taking of part of the property. (4) The reduction in value of the remainder is a direct result of the taking of part of the property. Benefits are measured by the enhancements in value the remainder incurs because of its relationship to the facility.

Measurement of Benefits

Because special benefits may be used to offset the amount paid for damages in connection with land acquisition for highway right of way purposes in Texas, the distinction between general and special benefits assumes a position of some importance. If special benefits can be acceptably quantified, the amount paid by the state in property damages associated with right of way acquisition may be reduced in many instances.

General benefits have been defined as those benefits shared by the community as a whole as a result of constructing a highway facility. These benefits reflect the economic impact of a public improvement upon an area. One measure of this economic effect is the altered structure of property values after the construction of the facility. Because general benefits are of economic value and are reflected in rises in property values in general, they can be estimated through statistical analysis of real estate sales data. This simply means that general benefits can be measured in terms of general increases in property values as a result of construction of the highway. If average property value in the area is higher than before (excluding any increase attributable to general economic factors), then it may be said that general benefits have resulted from the highway.

The methodology for establishing the value of general benefits also may be used for estimating the value of special benefits accruing to individual properties affected by highway location. If general benefits are reflected by the average change in value of all properties in an area affected by a highway, then the change in value of individual parcels of remainder property may be compared to the average change for all properties of the same type and use to ascertain special benefits or damages.

Access As a Special Benefit

Access rights include the right of ingress to and egress from property that abuts upon a public facility such as a major highway. With the exception of a new facility, constructed where no previous right of access existed, the right of access cannot be denied nor unreasonably restricted, nor can an owner be deprived of such right, except by due process of law and upon payment of compensation.

The value of an access right is influenced by various conditions. With the advent of right of way purchase for the Federal Interstate System, this factor has assumed a magnitude of significance previously unrealized. The taking of access can be considered a damage to remaining property. On the other hand, the granting of access can be considered an enhancement, or special benefit, offsetting any calculated damages. The variety and complexity of access problems are numerous. In some instances the creation of an outer highway or frontage road can completely offset severance damages.

Measurement of Access

The measurement of access within the framework of special benefits is an elaboration of the procedure previously emphasized. If the increase in value of an individual parcel of remainder property over the average for all properties of the same type and use can be considered as a special benefit, then the relationship of the remainder and access to the highway is a part of that special benefit.

Specifically, measurement of access requires that a comparison be made between property abutting the facility that has access as opposed to property abutting the facility that does not have access. All other things equal, the percentage differential between the market price of the two properties will be the amount attributed to access. Figure 1.

To summarize, the method for calculation of the net access special benefit to an abutting remainder is the net differential in appraised value of the remainder abutting on the facility, with access, adjusted by a non-abutting comparable; minus the net differential in

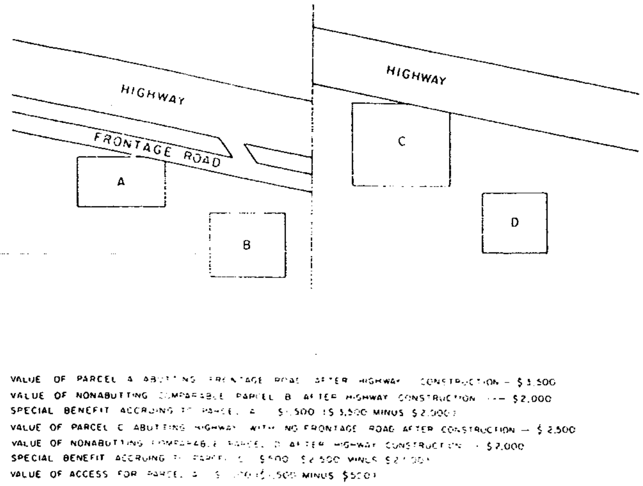


Figure 1. An example of the determination of special benefits due to access.

appraised value of a comparable remainder abutting on the facility without access, adjusted by a nonabutting comparable; plus or minus an adjustment for differences in location along the facility with respect to interchanges and ramps.

This amount can be utilized by the appraiser in two ways: (1) as a possible enhancement to offset any calculated damages to those properties granted access; (2) as an indirect measure of possible damage to individual properties as a result of denial of access.

Empirical Analysis

Benefits or damages to abutting remaining property as a result of highway construction may vary with the quality of access to the new facility. Frontage roads, ramps, and interchanges influence the value of abutting property but factual data relating to the extent of this influence previously had not been developed fully in light of right of way costs.

In 1964 the Texas Highway Department, in cooperation with the U. S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, commissioned the Texas Transportation Institute to conduct a three-year study of the effects of access on highway right of way costs.

The research procedures followed in the study varied with the specific objectives pursued. Basically, the analysis followed two related branchings. First, IBM print-out information obtained from the Texas Highway Department was utilized in an analysis of right of way costs. In this manner it was possible to examine the internal interplay of land costs and damages as they made up the total cost of each parcel. Access, as a special benefit, would logically be expected to reduce damages to the individual properties. This was found to be the case.

Secondly, an examination of real estate sale records maintained by public officials in various study areas were utilized in an analysis of remainder land values. It was felt that an analysis of actual remainder real estate sales and their relation to the physical aspects of the facility would reveal the quantitative or qualitative benefit individual buyers in the market placed on the value of access.

Analysis of the amount paid for damages in relation to whether access was granted to the remainder was developed from a random sample of 342 acquisitions, as recorded by the Right of Way Section of the Texas Highway Department. The sample covered ten individual highway projects covering 11 counties. Frontage roads were constructed along 211 of these parcels and 131 had no frontage roads. The land value analysis was developed from a sample of 715 remainder property sales. These sales were obtained from deed records maintained in each individual study area. The sample covered 15 individual highway projects covering nine counties. Each parcel was personally inspected by a member of the research team to ascertain the particular property characteristics under consideration. Frontage roads were constructed along 511 of these parcels and 204 had no frontage roads. The data were coded and transferred to IBM punch cards for analysis.

Access and Damages in Right of Way Acquisition

An analysis of 342 acquisitions consisting of over 3,600 acres of property taken for highway purposes by the Texas Highway Department indicated that access played a significant role in the determination of damages to property remainders. Damages paid for properties not granted access were approximately $162, on a per acre basis, whereas damages paid for properties granted access amounted to approximately $76 per acre. The study indicated that damages paid in connection with properties granted access were approximately 53 percent less than damages paid in connection with properties not granted access. In other words, the granting of access to property remainders cut the amount paid for damages approximately in half.

Land Value Changes

The next step in the analysis involved the use of actual market sales. It was felt that a study of actual remainder real estate sales and their relation to the physical aspects of the facility would provide an indication as to the actual benefit individual buyers in the market placed on the value of access.

Analysis of market value behavior in the past or near past should provide an adequate basis for predicting market behavior in the future, either under the assumption of a natural or real market or under hypothetical conditions. The record of past transactions is, broadly speaking, the major reliance as a basis for prediction. By various kinds of inferential analysis, behavior is forecasted under the assumption that individuals in the future will act like individuals have acted in the past under the same circumstances.

An analysis of 715 remainder sales consisting of approximately 43,680 acres of property was studied by means of a "before" and "after" technique. Due to minor differences in property characteristics, and to enable the results to be tabulated on a computer, it was thought advisable to reduce the results of the comparative analysis to a percentage loss or gain. The influence of the highway in relation to frontage roads or access was expressed as the difference between percentage changes in prices between those properties with and without access abutting the facility, adjusted by nonabutting control properties to eliminate the increase due to general benefits. This method assumed that prices for both study and control properties would have changed by the same percentage amounts in the absence of the highway.

Unimproved Property

This category included property that was classified as either unimproved or held for future use. In general, this type of property experienced a great increase in value after the highway was completed. This is a logical occurrence since this type includes the bulk of what is normally considered speculative property.

The average gross percentage increase in price per acre between the before and after periods for properties abutting the highway where frontage roads had been constructed was 291.19 percent. When this figure was adjusted for the increase in nonabutting control property, the average net percentage increase amounted to 187.83 percent.

The difference between the net percentage increase in price per acre for property abutting the facility with frontage roads as opposed to property without frontage roads was 152.64 percent. This amount can logically be attributed to the influence of access on the value of unimproved property.

Agricultural Property

The average net percentage increase in price per acre, after adjustment by nonabutting controls, of agricultural land between the before-after periods for properties abutting the highway where frontage roads had been constructed as a means of access was 75.82 percent.

The average net percentage increase in price per acre, after adjustment by nonabutting controls, for abutting properties where no frontage roads had been constructed was 63.97 percent.

The difference between the net percentage increase in price per acre for agricultural property abutting the facility with frontage roads as opposed to property without frontage roads was 11.85 percent. This amount can be attributed to the influence of access on the value of the property.

Residential Property

The average gross percentage increase in price per square foot of urban residential properties between the before-after periods for those abutting the highway where frontage roads had been constructed as a means of access was 21.02 percent. When this figure was adjusted for the increase in nonabutting control property, the average net percentage increase amounted to a negative 54.60 percent.

The average gross percentage increase in the square foot price between periods for properties abutting the facility where no frontage roads had been constructed was 110.97 percent. When this figure was adjusted for the increase in nonabutting control property the average net percentage increase amounted to 35.35 percent.

The difference between the net percentage increase in square foot price of property abutting the facility with frontage roads as opposed to property without frontage roads was a negative 89.95 percent. Both abutting residential properties, with and without frontage roads, and nonabutting properties increased in value, but the larger increase in the latter resulted in an overall negative influence.

This follows logically since direct access to a frontage road would probably not be as important to overall residential development as would general accessibility to the facility. The negative value does not necessarily mean that nonfrontage areas are better for residential development than frontage areas. Several alternative explanations could exist. First, the nonfrontage areas could have had a greater potential initially than did frontage areas for this type development; second, the most likely explanation for the larger increase in price of the nonabutting over the abutting properties lies in the fact that they probably ripened earlier into a higher land use thereby commanding the early high residential development values; and third, properties that sold were possibly not representative of all existing sample properties in control and study areas.

Commercial Property

The average net percentage increase in price per square foot, after adjustment by nonabutting controls, of commercial property abutting frontage roads was 97.00 percent.

It was not possible to compare the difference between the net percentage increase in price per square foot for property abutting the facility with frontage roads as opposed to property without frontage roads as there were no commercial observations in the post-construction period for the nonfrontage category. This does not imply that there were no sales throughout the state of commercial properties abutting the facility with no frontage roads, it only indicates that none appeared in this particular sample. Nevertheless, commercial properties seemingly are highly related to the presence of frontage roads. The fact seems to be that frontage road location is a prime determinate for property to move into this type use.

Industrial Property

The 21 nonabutting industrial property sales investigated indicated that the average percentage increase on a square foot basis between periods was 4.51 percent. No industrial properties sold abutting the facility for the periods investigated, for either the frontage or nonfrontage areas. All industrial sales occurred in the nonabutting category. Again, this does not necessarily mean that there were no industrial properties sold abutting the facility throughout the state, it only indicates that none appeared in the present sample. This further emphasized the importance of general accessibility as opposed to specific access for particular property categories.

The Interchange Complex

Certain characteristics are associated with higher-than-average land values. A major factor related to significant increases in property value is relationship to what this study has called the "interchange complex." This complex is defined to be that area of the highway system that includes an intersection of the highway with some other road, involving a transfer of traffic between the two, and encompassed by the ingress-egress ramps and the intersection of the frontage roads with the intersecting road, Figure 2.

An examination of abutting properties and their relation to the interchange revealed that proximity to the interchange held definite advantages. An analysis of interchange observations indicated that their mean value increase per acre fell between a high of 273 percent for property directly on the interchange, to a low of about 17 percent for that located approximately a half mile from the interchange, Figure 3. It was further observed that the price per acre had a pronounced "peak" at the ramp locations. All properties located at a zero distance from an egress ramp had an approximate 205 percent increase in value between the before and after periods.

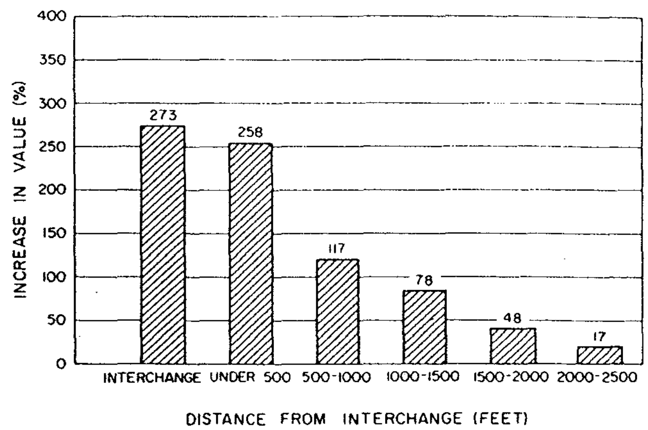


Figure 3. Relationship between property value and distance from highway interchange (before-after study).

Property Values After Completion of Highway Construction

As an alternative technique of analysis the average abutting property values were calculated for each individual land use category, utilizing only those property sales that occurred after completion of highway construction, *the implicit assumption being that the properties that sold adequately reflected any necessary adjustments for nonabutting comparables.* These post-construction abutting property values confirmed the land value increases observed in the before-after study in relation to the highway facility. Without exception, property abutting the highway where frontage roads had been constructed sold for a higher price than that abutting areas where no frontage roads had been constructed.

Abutting undeveloped per acre land values after completion of highway construction indicated that unimproved property and property held for future use sold for an average of $10,621 per acre where frontage roads had been constructed and $6,188 where no frontage roads had been constructed, Figure 4. Buyers in the land market were willing to pay 42 percent more for abutting property with frontage roads in this category.

Although agricultural property sold for a smaller price than unimproved and held for future use properties, the large 69 percent difference between the average price per acre of abutting property with frontage roads as opposed to that with no frontage indicated that possible future changes into a higher land use were probably being incorporated into agricultural land values. The abutting agricultural properties with frontage roads sold for an average of $3,264 per acre whereas those without frontage roads sold for a more modest $1,026 per acre, Figure 4.

Abutting developed square foot values after completion of highway construction indicated that residential property sold for an average of .18649 per square foot where it abutted a facility constructed with frontage roads and .08844 where no frontage roads had been constructed, Figure 5. In other words, residential property abutting on frontage roads was 53 percent higher than property with no frontage roads constructed.

Commercial property sold for an average of $1.87455 per square foot where it abutted a facility

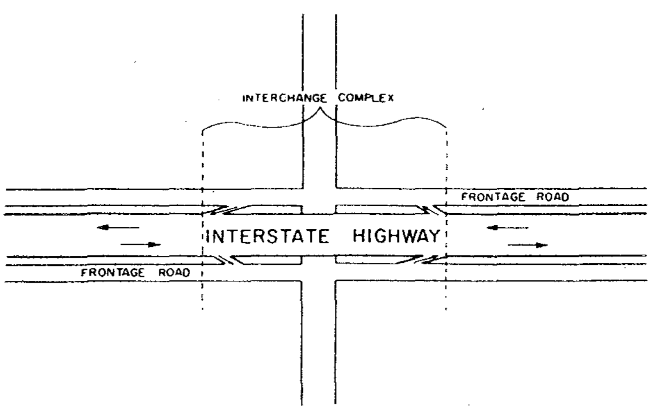


Figure 2. The interchange complex.

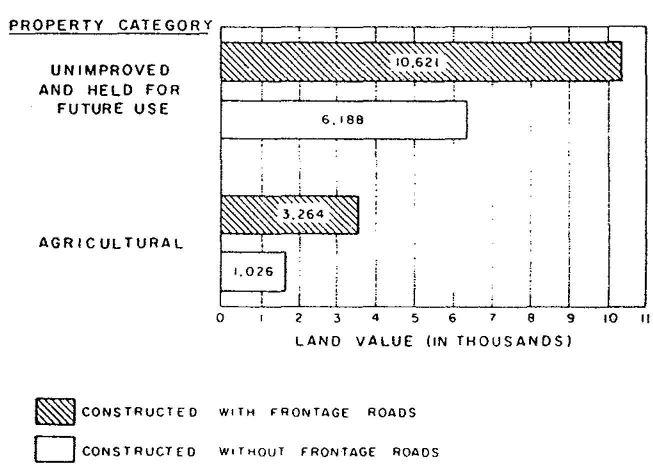


Figure 4. Abutting undeveloped per acre land values after completion of highway constructed with and without frontage roads.

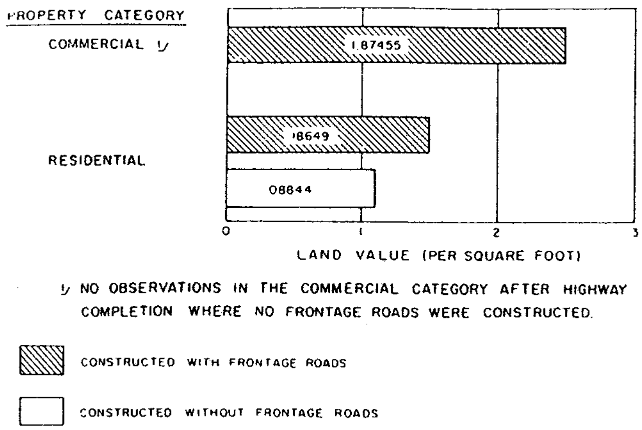


Figure 5. Abutting developed square foot land values after completion of highway constructed with and without frontage roads.

constructed with frontage roads, Figure 5. Since no observations were observed in this category for the sample in the post-construction period it was not possible to compare the frontage values with the nonfrontage values. As previously stated, commercial properties are logically highly related to the presence of frontage roads and location on acceptable frontage is a prime determinate for property to move into this type use.

The abutting per acre land values in the "interchange complex" reinforced the finding that distance from the interchange and land value were highly related. The average post-construction per acre value of property located directly on the interchange was $17,642 and progressively declined as distance away from the interchange increased, Figure 6. Average per acre value was about $4.43, or .04 percent, lower for each foot of distance away from the interchange within the area of the "interchange complex."

General Conclusions

Based on the foregoing analysis, it is evident that the granting of access has the effect of reducing the amount paid for damages connected with property acquisition for highway right of way purposes. In summary, several points may be enumerated:

1. An examination of approximately 3,600 acres of acquisitions for highway right of way indicated that overall the amount paid for damages to those properties granted access was approximately 53 percent less than damages paid to those properties not granted access.

2. An analysis of remainder real estate transactions indicated a net percentage differential increase of approximately 153 percent for unimproved property with access as opposed to such property without access.

3. Agricultural property with access had about a 12 percent differential increase.

4. Residential properties with access had a negative 89 percent differential.

5. Commercial properties with access had a 97 percent increase.

6. Those properties located directly abutting an interchange had an approximate 273 percent increase in value, whereas, those properties located at a greater distance experienced somewhat smaller increases in value.

7. Price per acre had a pronounced "peak" at ramp locations. Properties located at a zero distance from an egress ramp had an approximate 205 percent increase in value.

8. An analysis of *only* the abutting properties that sold in the "after" or post-construction period indicated that those properties abutting a facility constructed with frontage roads sold for a higher price than did those abutting a facility constructed without frontage roads.

(a) Unimproved and property held for future use sold 42 percent higher.

(b) Agricultural property sold 69 percent higher.

(c) Residential property sold 53 percent higher.

(d) Average per acre value declined roughly $4.43, or .04 percent, per foot of distance away from the interchange within the area of the "interchange complex."

There is no doubt that the granting of access in conjunction with property acquisition does reduce the amount paid for damages in connection with highway right of way. An evaluation of remainder property sales in relation to the highway facility further indicates that buyers in the land market place a considerable value on access to individual properties. This value is reflected both in overall increase in property values between the before and after periods of highway construction and their relationship to frontage road access to the facility and in the obviously higher selling price of properties with access in the post-construction period.

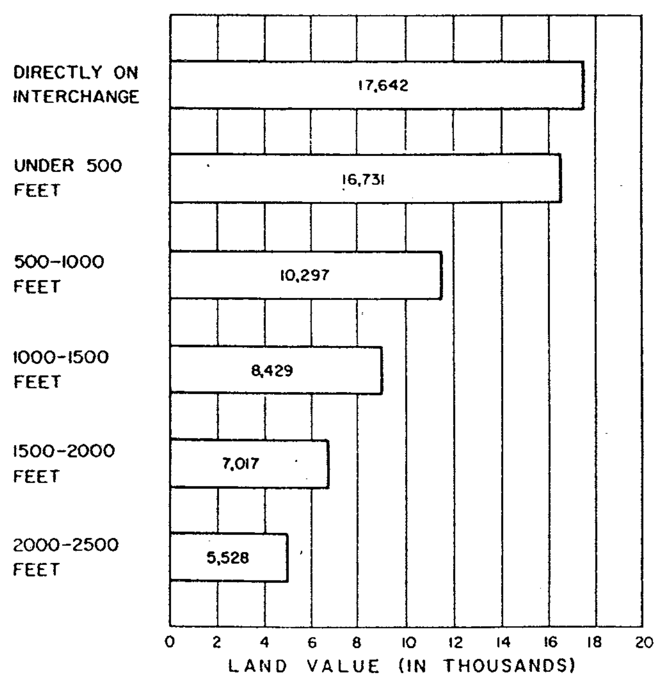


Figure 6. Abutting per acre land values after completion of highway in relation to distance from interchange.

CHAPTER II

Introduction

Statement of the Problem

Acquiring the lands needed for highway right of way on an equitable and timely basis constitutes one of the major tasks facing highway builders today. Over two million property owners and vast sums of public money are involved. For the Interstate System alone, a system comprising only about one percent of America's three-and-a-half-million-mile road system. some three-quarters of a million parcels of land will be required over a 15-year period. During this same period, approximately twice this amount of property is estimated to be needed for the ABC program—primary, secondary, and urban highways other than the Interstate System.[1]

The magnitude of the costs involved in acquiring right of way for federal-aid highways poses a compelling need for developing procedures to assure that public money used for this purpose is spent carefully. Furthermore, the magnitude of the right of way costs involved —over $6 billion for the Interstate System alone—suggests the size of the savings which may be possible. It has been pointed out. for example. that a mile of 300-foot-wide right of way for the Interstate System contains over 1.5 million square feet, so that a savings of over $15,000 per mile could be realized if right of way costs could be reduced by only one cent per square foot. a relatively small reduction considering the fact that right of way often costs over $1 per square foot.[2]

Acquisition of right of way for a major highway system presents unique problems in property evaluation. Benefits or damages to abutting remaining property as a result of highway construction may vary with the quality of access to the new facility. Frontage roads. ramps. and interchanges influence the value of abutting property. but factual data relating to the extent of this influence have not been developed fully in light of right of way costs. There exists a need to determine the relationship relating to general and special benefits accruing to remaining properties due to access and to relate this to the appraisal process in evaluating future right of way.

Objectives of the Study

The specific objectives of the research study are:

1. To study and compare sections of the highway system constructed with frontage roads to sections constructed without frontage roads in order to determine:

a. The relative costs of right of way for sections transversing similar areas.

b. The zone of influence of special benefits as opposed to general benefits on remaining property resulting from highway construction.

c. The effect of interchanges and ramps on the value of comparable property abutting the highway.

2. To develop a consistent approach for appraising the value of access of remainder parcels from right of way acquisition.

Method of the Study

The research procedures followed in this study varied with the specific objectives pursued. Basically, IBM print-out information obtained from the Texas Highway Department was utilized in the analysis of right of way costs. An examination of real estate sale records maintained by public officials in the various study areas was utilized in the analysis of land values.

Comparative, case study and statistical techniques were used to analyze the data. Based upon a survey of previous work in this area indicating that "regression analysis is the best available technique for isolating and quantifying the influence of the access variable,"[3] several models were developed to extract this particular factor from the "bundle" of factors the appraiser must examine in the determination of land value.

The "cost of right of way" model was developed from a random sample of 342 acquisitions. as recorded by the Right of Way Section of the Texas Highway Department. Frontage roads were constructed along 211 of these parcels and 131 had no frontage roads. The "land sale" model was developed from a sample of 715 remainder sales. These sales were obtained from deed records maintained in each individual study area. Each parcel was personally inspected by a member of the research team to ascertain particular property characteristics. Frontage roads were constructed along 511 of these parcels and 204 had no frontage roads. The data were coded and transferred to IBM punch cards for analysis.

The specific characteristics of the samples. the statistical discussion of each model and the individual case studies are covered in later sections of the report.

CHAPTER III

Theoretical Considerations

The Interstate Highway System

In 1944 Congress passed the Federal Aid Highway Act creating the system of interstate highways. This act stated that the objectives of the system would be to "connect by routes, as direct as practicable. the principal metropolitan areas. cities. and industrial centers. to serve the national defense. and to connect at suitable border points with routes of continental importance."[4] Subsequently, in 1956, the Federal Aid Highway Act of that year named the facility the National System of Interstate and Defense Highways and appropriated additional funds in order to complete the system by 1970.[5] This law also stated that the design standards were to be capable of handling the types and volumes of traffic forecasted for 1975. However, the actual standards that were jointly formulated by the American Association of State Highway Officials and the Bureau of Public Roads were designed to handle the volume of traffic which will exist in the design year that "hereafter is to be twenty years beyond that in which the plans, specifications and estimates for actual construction of the section are approved."[6] Some of the more important general standards used are:

1. Access to the main lanes is controlled by either acquiring access rights outright prior to construction or by the construction of frontage roads.

2. Intersections at grade are permitted only under very specific circumstances and then only when no appreciable hazard is created.

3. All railroad grade crossings are to be eliminated.

4. The design speed ranges from 70 miles per hour on flat, open terrain to 50 miles per hour in urban areas.

One of the major steps in the construction of the highway facility is the acquisition of the right of way. This is composed of both the needed land and any easements required.

Before the beginning of the right of way program, several steps are necessary: the work must receive program approval by the State Highway Commission, the schematic drawings prepared by the district offices must be approved by both the Design Division of the Texas Highway Department and the Bureau of Public Roads, public hearings must be held, and all federal requirements must be met. When these steps have been completed a letter of release is sent to the district office authorizing the purchase of the right of way.[7]

The purchase process begins with the preparation of detailed maps. These right of way maps show the relation between the highway facility and the abutting properties. The exact portion of the property to be taken is specified along with whether or not direct access to the facility is to be granted. Once these maps have been prepared the appraising of the land to be taken may begin.

The Texas Constitution authorizes the taking of private property for public use, but stipulates that just compensation must be made to the owner.[8] Just compensation has been judicially interpreted to mean market value.[9] This is estimated by an appraisal of the property to be taken.

Foundations of Value Theory

The primary purpose of any appraisal is to estimate value. The evolution of the theory of value can be traced to the ancient world of Greece and Rome. From the modern point of view, the Greek legacy is meaningful and deserving of attention. The philosopher, Aristotle, can be ranked among the founders of the core of the subject matter of economics. He put forth the fundamental proposition that every commodity may be viewed from two angles: whether it serves to satisfy a want directly, as in use; or whether it serves to satisfy a want indirectly, as in exchange.

Aristotle took a decisive step forward by reasoning that value in exchange is derived from value in use. Their common denominator is human wants. Commodities differ not only in their ability to satisfy these wants (utility), but also in the ease with which they can be readied for human consumption (cost of production). Hence, according to Aristotle, value is not a quality inherent in a commodity, but something dependent upon two factors: utility and cost of production.[10]

In the main, no novel ideas were produced in the field until the period from the sixteenth to the eighteenth centuries.[11] Prior to this time, discussions of value arose only as a sidelight to other subjects under consideration. The Mercantilists, a group of businessmen and traders in England, were concerned with the concept of value in the exchange of goods. They advocated a strong balance of trade position along with the hoarding of gold and silver. They were also in favor of centralizing the political power of England into one government rather than dispensing it among the many townships and manors.

It was not until the middle of the 18th century that economics came into being as a separate body of thought, distinct from religion, politics, and jurisprudence. This separation never was completed, even in recent times, but the tendency to investigate economic matters as a primary rather than a secondary or derivative problem begins with the Physiocrats.

The Physiocrats may be considered the first "school" of economists: they referred to themselves as *Les Economists.* They emphasized the individual and his rights in contrast to the Mercantilists who subordinated the individual to the state. The Physiocrats justified private property and believed that the individual should have a large measure of freedom in disposing of his property. In fact, they were the first to use the now familiar maxim *laissez faire,* and stressed the doctrine that the chief function of government was to protect life, liberty, and property. They believed that if the individual followed his own interests, he would act in a manner which coincided with the best interests of the state. They regarded agriculture and the extractive industries as the only productive types of economic activity. In addition, they also recognized the difference between value in use and value in exchange. One of their main concerns was the increasing power of the central governments. Their work laid the foundations for the defense of individual economic activity by Adam Smith.[12]

Smith, in his classic, *Wealth of Nations*, emphasized that if each individual acted in his own self interest, and had little interference from the government, then he would behave in a manner beneficial to the entire economic society. Smith believed the basis of value was the cost of production. However, he defined cost of production in different ways. Sometimes he stressed labor as the predominant cost, while at other times the emphasis was placed upon the "natural" price of a commodity. The natural price was determined when it covered the "natural costs" of labor, wages, rents, and profits. It was also the price that the market price would move toward under competitive conditions.[13]

David Ricardo followed Smith and further contributed to the evolution of the concept of value with a theory of economic rent. According to Ricardo, value was determined by scarcity and the quantity of labor required to produce commodities. In his analysis, capital costs entered as production costs. But since capital to Ricardo was merely stored-up labor, all such costs were reduced in the final analysis to labor costs.

Rent, according to Ricardo's concept, is a differential payment made possible by the difference in the productivity of the land. As long as man can get all the land he needs for nothing, no rent will be paid. As population increases and as the prices of farm products advance, the better grades of land become scarce and some farmers are forced to take up poorer lands. Since farm products are higher priced, these poorer lands will now pay the cost of operation but not rent. As this pressure of population increases and the prices of farm products advance, the less productive lands will come under cultivation, and more and more rent can be charged for the better grades of land. Thus, rent is a sort of differential paid for the better grades of land.

Rent does not enter into the cost of production, Ricardo's concept maintains. Costs are determined on the marginal land. The poorest land that must be cultivated to get the product needed to cover exactly the labor and capital costs but not rent, establishes the costs. This reduces value to "labor cost," or the wages of labor, and the price paid for capital which Ricardo considers stored-up labor. Ricardo's principal contribution was his definition of rent which he said was "that portion of the produce of the earth which is paid to the landlord for the use of the original and indestructible powers of the soil."

The next major contributor to the theory of value was Karl Marx. His position was that labor was the only determinant of value. Characteristics such as soil fertility, which had no labor values, were classed as having a "use value." Using his assumptions, value could be explained by measuring the amount of labor that was expended.[14]

The relationship between price and value was developed by the Austrian or "Marginal Utility" school. They held that the cost of production affected value only because it affected supply. Therefore, the effective use value of any product diminished as its supply was increased. This resulted because as supply increases the marginal utility of the last unit diminishes. If each unit is interchangeable, then it is the marginal utility of the last unit that determines the utility of the entire supply.[15]

During the last decades of the nineteenth century and the early years of the twentieth, the neoclassical or Cambridge school re-examined classical theory in the light of the attacks by the Austrians and the socialists. The principal representative of the neoclassical school was Alfred Marshall. In fact, this group is often referred to as the "Marshallian" school.

Marshall was a mathematician by training and often used mathematical formulae to assist in presenting his propositions relating to the theory of general equilibrium. Marshall did not try to find points of general equilibrium for the entire economic system but rather of the particular equilibrium or tendency toward equilibrium of the prices, and values, of specific commodities. By considering one commodity only and holding other things constant, the value of that commodity could be defined as the point of balance between demand and supply forces.

Marshallian economics produced methods for analyzing economic problems of the type which concern appraisers and other businessmen. The division of the value problem in accordance with different periods of time, for example, is of basic importance to the appraiser. Similarly, the concept of economic forces tending toward equilibrium at the margin is used by the appraiser each time he makes a value estimate for any other purpose than determining current market price.

Since value is the very heart of economic theory, it is not strange to find close relationships between philosophy and economics. In fact, up to the time of Adam Smith, economic thought was little more than a special branch of philosophy. Close relationships between these fields of thought continue to exist even at the present time.

It was not until comparatively recent times that economists have concerned themselves with the specific types of problems which confront the appraiser. The primary interest in the history of value theory for the appraiser is for the assistance it may give him in solving the practical valuation problems with which he deals every day.

Benefit Criteria

A benefit is generally considered a gain or advantage obtained either voluntarily or involuntarily, and, as concerns real property, can be one of many.[16] There are three types of benefits that accrue to property as a result of public improvement. The first is what is known as general benefits and are those benefits arising from public improvements which affect the entire community and perhaps raise the value of land in an entire city, county or town. The second type, neighborhood benefits, accrue to a certain definite district by reason of its nearness to a public facility. The third type, known as special benefits, affect a particular parcel of property by reason of its direct relationship to the public improvement.

The evaluation of whether or not a change or relationship between a particular parcel of property and a new facility amounts to a special benefit becomes rather involved in some instances. Several criteria have been utilized in making the determination as to special benefits. The quality of a special benefit is derived from a comparison between the property benefited and other property in the immediate area or is derived from an analysis of the physical relation between the facility and the property that is benefited. The first method is generally utilized in calculation of benefits, but has been considered less than satisfactory by most practitioners. The second method has been utilized less extensively due to the general lack of information concerning the physical relationship between a facility and the abutting property.

The complex nature of special benefits makes their measurement rather difficult. Separation of the various elements, as severance damage, access, etc., involves problems not readily resolved through prevailing valuation techniques. The method of calculating benefits to individual parcels used in remainder studies conducted by the highway departments of individual states is generally the comparison of a "before" remainder parcel to an "after" remainder parcel.

In states which both general and special benefits can be applied against the cost of acquiring right of way property, a control area removed from the highway influence is utilized. However, in over half the states where only special benefits are to be considered in determining adjustments to be made with affected property owners, control areas are used that are located in the same immediate neighborhood as the study parcel.[17]

Control parcels or control areas are used as a standard or base of reference to which partial taking data are usually related to show highway effects. It is considered fundamental that controls should resemble the study parcel or area as much as possible, so that differences which develop between the study and control areas can reasonably be ascribed to the highway.[18]

If only special benefits are to be detected and measured, the procedure is generally followed of selecting control properties near the subject or study property. Selecting control properties in the "immediate area" or "as near to the project as possible" provide controls which, like the study parcel, are supposedly subject to any general influence of the highway.[19] Given comparable characteristics between study and control parcels, the relationship generally used to explain the absence or presence of a special benefit is:

$$SB = VP_sA - VP_cA$$

Where:

SB = Special benefit.

VP_sA = Value of study parcel in after period.

VP_cA = Value of control parcel in after period.

Differences in the experience of such control parcels and the study parcel are then considered to be due only to special benefits (or damages). Any general benefits (or disadvantages) would be realized by the control property as well as the study parcel, and any general benefits accruing to the study parcel would not be isolated or identified. Use of a control parcel or control area which experiences any general benefits resulting from highway improvement are used to isolate any benefits which are peculiar to that particular parcel of land —special benefits.[20]

This evaluation procedure suffers from a number of defects, chief of which is that it assumes a *ceteris paribus* condition. The subtraction procedure attempts to isolate the benefits holding everything else constant. The procedure of holding various factors constant while attempting to isolate one element can be accomplished mathematically by the use of least squares analysis. The value of a partial regression coefficient in a regression analysis is found while holding all other independent variables in the equation constant.

Access As a Special Benefit

Access rights include the right of ingress to and egress from property that abuts upon a public facility such as a major highway. With the exception of a new facility, constructed where no previous right of access existed, the right of access cannot be denied nor unreasonably restricted, nor can an owner be deprived of such right, except by due process of law and upon the payment of compensation.[21]

The value of an access right is influenced by various conditions. With the advent of right of way purchase for the Federal Interstate System, this factor assumed a magnitude of significance previously unrealized. In the State of Texas the taking of access could be considered a damage to remaining property. On the other hand, the granting of access could be considered a special benefit, or enhancement, to offset any calculated damages. The variety and complexity of access problems are legion. In some instances the creation of an outer highway, or frontage road, can completely offset severance damages.

The problem of access to privately owned property has been accentuated with the development of the massive Interstate System. Limitations of access pose unique property valuation problems. The degree of this limitation of access generates a multitude of perplexing and controversial issues regarding the payment of just compensation. An appraisal of the value of access should logically be based upon facts found in the market place, rather than upon opinion.[22]

The present study goes to the market place and attempts to isolate the influence that access exerts on property values. The presence or absence of frontage roads is used as a measure of access as it relates to the Interstate System. A least squares formula is used to calculate special benefits in an effort to separate the value of access from the "bundle" of factors that an appraiser must take into consideration in any appraisal of land value.

The Concept of an Abstract Model

The methodology utilized in the present analysis consists of both comparative techniques and the development of several models. The rationale of alternative decision-making is an empirical application of economic resource allocation. The method is to construct theoretical "models" as an abstract of the conditions of the real world. The theory is not intended to be a complete replica of the real world with all its complexities, but a simplified model representing only certain features of the real world which are believed to be important for the problem under consideration. It can be compared to a map of an extensive territory. No map can be complete; if it included everything, it would be useless, for it would be a full-scale replica of the area covered. The investigator's map is drawn in an attempt to pick out the features which are significant for a particular type of problem and to leave out all the features which are considered to be of little significance for the purpose in view.

A model can be defined as a representation of reality that attempts to explain the behavior of some aspects of it. Since a model is an explicit representation of reality it is always less complex than the reality itself, but is sufficiently complete to approximate those aspects of reality being investigated.

As the correspondence between the physical reality and the model becomes more abstract it is referred to as an analog. Statistical sampling is an example of such a model. The less than 100 percent observation of every member of a universe for certain criteria is generalized by statistical laws to describe the complete composition of the universe in question. A frequency distribution is an example of a two-dimensional analog. When a model has no physical form it is called a symbolic or mathematical model.

As previously emphasized, a model is a simplified representation of actual reality. Therefore, its explanation of that reality will of necessity be simplified. But even the highly simplified explicit model provides a more clearly understood starting point than a hazily formulated, unarticulated model which the decision-maker might carry about in his head. An explicit model pinpoints the relationships which appear to be significant and requires that they be considered systematically and in context.

The abstract model can be compared in some respects to the process of thought. The thinking process is abstractive in a number of ways: first, thoughts are an abstraction from reality; and second, thoughts deal with only a few aspects of the complex of reality. Qualitative correlation goes on in our minds all of the time. The individual relates one factor with another by the building of an abstract mental model in his own mind. This is the type of correlation utilized by the appraiser in arriving at his final estimate of value.

The models developed for this study are the least squares regression type, or what is known as a quantitative model. Quantitative correlation is a statistical means of determining the extent to which a change in one factor is accompanied by a change in another factor. Sometimes, the changes are linearly related—that is, equal changes in one of the controlled variables results in a nearly constant increase or decrease every time.

There are many weaknesses in both qualitative and quantitative correlation. Nevertheless, within the limitations of bounded rationality, the mind does seem to be able to correlate variables which, when correlated quantitatively, result in very complex equations. Perhaps it is not that the mind just correlates on the basis of frequency patterns, but rather it is able to discern causality in a logical sense.

Models are more widely used in decision-making than is generally realized. Unless an individual makes decisions entirely by instinct or guess-work, he must have in his mind some explanation of the relationship between the alternatives he faces and the expected outcomes of the various alternatives. However sketchy or incomplete they might be, the rational decision-maker utilizes models.

Development of the Models

A logical relationship exists between the cost of right of way and certain characteristics of property utilized for right of way purposes. This relationship is based upon appraisal data and related estimation procedures and is of a functional nature. A least squares regression analysis was chosen for the development of several models in the study because of this functional relationship and the fact that a determination of the relative magnitudes of any factors under consideration was deemed important.

In the development of the models, two major problems were encountered. The first of these was the existence of two major types of independent variables: discrete and continuous. In a general solution of a multiple regression equation, discrete variables are handled by assigning weights to the levels of each one. They are then treated as continuous variables and the equation is developed accordingly. This procedure is acceptable as long as it can be implicitly assumed that the levels of a discrete variable can be ranked in some logical manner and that the weights assigned are correct. The second major difficulty was unbalanced data, in that there were unequal frequencies of occurrence of the various independent variables used.

To solve both the problem of data imbalance and the mixture between discrete and continuous variables, a linear covariate model was developed. The first step in construction of a model of this type is the development of an incidence matrix of the discrete variables. This matrix is then combined with the covariate's partial sums matrix, the uncorrected sum of squares and sum of products of the covariate matrix, and the response variable vector consisting of the partial sums of the response variable along with its uncorrected sum of products between the response variable and the covarite. This forms what is known as the normal equations matrix. This type matrix, as it exists, has no unique solution because of the data imbalance. To overcome this it must be reduced prior to solution. This is done by making a qualifying assumption that the summation of a set of discrete variable coefficients being zero.

Thus, the developed equation is in the form of:

$$Y = \alpha + B_1X_1 + B_2X_2 + \dots B_XX_X + D_{1Q} + D_{2Q} + \dots D_{iQ} + \dots D_{iZ} + D_{jK}D_{lM}$$

Where:

Y = The estimated value of the dependent variable.

α = The Y intercept.

$B_1 \dots B_X$ = The partial regression coefficients for the continuous independent variables.

$D_{iQ} \dots D_{iZ}$ = The coefficients for the discrete independent variables Q . . . Z and the number of levels the variables may have, represented by the subscript i. As an example, if there were six different land uses being investigated then the coefficient for land use (D) would have five separate values.

$D_{jK}D_{lM}$ = The interaction coefficient of the Kth and Mth discrete variables. The coefficients are represented by a j × l matrix. The summation of each row and each column of this matrix equals zero. The value of this coefficient represents the effect of being in the jth level of the Kth variable while at the same time being the lth level of the Mth variable. Since the number of columns in this instance will always be two when the empirical model is being presented, only the first column of each interaction variable will be presented. The second column may be found by changing the signs of the corresponding elements of the first column. It is not to be inferred that the value of these interaction coefficients are in any way arrived at by multiplying any two discrete variables together.

CHAPTER IV

Cost of Right of Way

The general objective of the study analyzed in this section is the comparison of sections of the Interstate Highway System constructed with frontage roads with those sections not having frontage roads in order to determine the relative costs of right of way for sections transversing similar areas.

A constraint embodied in the analysis is the requirement that the results be applicable to a later development of appraisal theory as it relates to the valuation of access as an internal factor in the overall process.

The isolation of the effect of access, or frontage roads, upon property value is obviously difficult because of the qualitative and essentially nonmeasurable aspects of some of the variables, as well as the mutual interdependence of the variables. To accomplish this calculation requires the identification, so far as possible, of all other variables influencing this value so that the residual influence of access can be identified and measured.

Characteristics of the Sample

The sample data were generated by taking a random sample of highway projects as enumerated in the Texas Status of Improvements to the Interstate System, Texas Highway Department, Planning Survey Division, revised edition. The presence or absence of frontage roads was chosen as a criterion of inclusion since a prime factor under consideration was that of access. The data were broken into area blocks and each block consisted of a continuous section of highway that had both frontage roads and sections with no frontage roads present. With the aid of a table of random numbers, ten area blocks were selected for inclusion in the study. From these ten blocks 342 individual land acquisitions were recorded along with selected characteristics. The locations of individual blocks by number, interstate highway, county, project number, and the physical limits of the projects are given in the Appendix. The prices of property were deflated to common dollars by using the Consumer Price Index. (See explanation and schedule in the Appendix.)

After the sample was completed, a careful inventory of the amount of interstate highway completed or under construction was accomplished. Slightly over 39 percent of the total number of miles of interstate highway constructed in Texas without frontage roads was included in the study.

TABLE 1. ACREAGE DISTRIBUTION OF PROPERTY CATEGORIES IN RANDOM COST MODEL IN RELATION TO FRONTAGE ROADS

Category	Frontage	Non-frontage	Total Acres	Percent of Total
Acreage-Vacant	1373.76	602.40	1976.16	54.05
Residential	420.63	359.67	780.30	21.34
Commercial:				
Residential	217.39	132.22	349.61	9.56
Business	285.53	190.03	475.56	13.01
Industrial	50.38	24.10	74.48	2.04
Total	2347.69	1308.42	3656.11	100.00

TABLE 2. FREQUENCY DISTRIBUTION OF PROPERTY BY CATEGORY IN RELATION TO ACCESS

Category	Access	No Access	Number of Observations	Percent of Total
Acreage-Vacant	128	77	205	59.94
Residential	36	34	70	20.47
Commercial				
Residential	15	8	23	6.73
Business	19	8	27	7.89
Industrial	13	4	17	4.97
Total	211	131	342	100.00

There were approximately 3,656 acres of taking included in the study. As anticipated, over half that amount was considered in the acreage-vacant category. The percentage of the various land category classifications were distributed in a satisfactory manner throughout the sample in that there were no empty land classification cells to be included in the analysis. There were approximately 2,348 acres of frontage and approximately 1,308 acres of nonfrontage property examined.

In addition, a frequency distribution of the properties, by category, in relation to access indicates that of the 342 observations included in the sample, 211 were granted access and 131 were not granted access. Again, the larger number of observations were in the acreage-vacant category. Though not by design, this type of internal distribution within land classifications considerably facilitates the analysis.

As would be expected, property taken for purposes of interstate highway construction falls within a fairly small class interval, in acres, by size of taking. Since the highway right of way is 300 feet wide in most instances, the increase in acreage taken is usually associated with length. Slightly over 64 percent, or 220 individual takings, were ten acres or less, Table 3. Over 83 percent of the takings examined were 20 acres or less.

TABLE 3. FREQUENCY DISTRIBUTION OF PROPERTY BY SIZE OF TAKING

Class Interval (Acres)	Frequency	Percent of Total	Cumulative Percentage
0 - 10	220	64.33	64.33
11 - 20	65	19.01	83.34
21 - 30	31	9.06	92.40
31 - 40	9	2.63	95.03
41 - 50	10	2.92	97.95
51 - 60	2	.59	98.54
61 - Over	5	1.46	100.00
Total	342	100.00	

TABLE 4. FREQUENCY DISTRIBUTION OF PROPERTY BY SIZE OF REMAINDER

Class Interval (Acres)	Frequency	Percent of Total	Cumulative Percentage
0 - 100	246	71.93	71.93
101 - 200	50	14.62	86.55
201 - 300	19	5.56	92.11
301 - 400	9	2.63	94.74
401 - 500	5	1.46	96.20
501 - 600	2	.59	96.79
601 - Over	11	3.22	100.00
Total	342	100.00	

TABLE 5. SUMMARY OF DATA INCLUDED IN RANDOM COST MODEL

Item	Frontage	Nonfrontage
Number of Observations	211	131
Acres Purchased	2,347.69	1,308.42
Total Price Paid	$900,224.61	$471,093.99
Number Unimproved Acres	1,373.76	602.40
Average Price Per Unimproved Acre	$ 153.28	$ 270.53
Number Improved Acres	973.93	706.02
Average Price Per Improved Acre	$ 708.15	$ 436.42

Source: Right of Way Division, Texas Highway Department, Austin, Texas.

Another interesting feature was the small size of the remainders. Almost 72 percent were a hundred acres or less. Over 92 percent of the total number of remainders were less than 300 acres.

A feature not unusual in situations of taking for highway purposes is the presence of a remainder in conjunction with the parcel taken. The presence of a remainder is a necessity in order to evaluate damages and to calculate the effects of severance to a property. For severance damage to exist there must be a remainder or property remaining to the owner.

Table 5 indicates that the average price paid per acre of unimproved property where frontage roads were constructed was $153, whereas it was $270 per acre where no frontage roads were constructed. This indirectly demonstrates that, on the average, the lack of frontage roads in connection with unimproved properties probably results in increased damages in connection with right of way. The improved properties seemingly indicate that the reverse is true, but logically one would expect frontage roads to be constructed on a parcel by parcel basis in areas of high economic activity and high improved prices and not be constructed in areas of low activity and low prices. This activity, as a factor in land price, is demonstrated by examination of Table 6. As the use intensity, as measured by property category, increases, so does the average price paid, both on a total and per acre basis.

The means of the right of way cost variables were calculated from the information obtained from the Right of Way Division of the Texas Highway Department in Austin, Texas. The total cost column in Table 7 is the summation of the land cost column and the damages column. Means such as these have a natural tendency to mask the fluctuations associated with any aggregative calculations. It also has the effect of either overemphasizing or underemphasizing varying factors. Additionally, it does not permit any evaluation of the interaction between internal variables. The case studies contained in the Appendix demonstrate that the least squares estimation models are more effective predictive measures than are means for right of way calculations.

Variables in the Analysis

The characteristics of land taken for right of way purposes used in the cost model were as follows:

Dependent Variables:

Y_1 = Total cost of land parcel.

Y_2 = Cost of land taken.

Y_3 = Damages to the remainder.

Where: $Y_1 = Y_2 + Y_3$.

Independent Variables:

Continuous:

X_1 = Size of taking (acres).

X_2 = Size of remainder (acres).

Discrete:

D_{i1} = The area block in which the property was found. (Where i = 1 through 10.)

D_{i2} = Whether or not the property had been granted direct access to the facility. (Yes: i = 1; No: i = 2.)

D_{i3} = The type of property involved. (i = 1 through 5.)

D_{i4} = The manner in which the property was acquired. (Negotiation: i = 1 or Condemnation: i = 2.)

TABLE 6. AVERAGE PRICE PAID FOR PROPERTY BY CATEGORY IN RANDOM COST MODEL

Category	Average Land Cost		Average Damages		Average Total Price	
	Total	Per Acre	Total	Per Acre	Total	Per Acre
Acreage-Vacant	$ 1,425.22	$ 284.56	$ 396.91	$ 68.23	$ 1,822.13	$ 352.80
Residential	2,297.79	409.18	1,134.74	178.64	3,432.53	587.83
Commercial:						
Residential	5,612.05	386.30	1,935.28	102.82	7,547.34	489.12
Business	15,252.79	5,354.05	3,103.30	147.14	18,356.09	5,501.18
Industrial	4,381.31	1,108.37	812.93	265.94	5,194.24	1,374.31

Source: Calculated from IBM print-out information obtained from the Right of Way Division, Texas Highway Department, Austin, Texas.

TABLE 7. MEANS OF RIGHT OF WAY COST VARIABLES

Independent Variables	Means of Variables: Total Cost (In Dollars)	Land Cost (In Dollars)	Damages (In Dollars)
Mean (All Properties)	$ 4,009.70	$ 3,123.98	$ 885.72
How Property Was Acquired:			
Negotiation	2,889.88	2,141.81	748.07
Condemnation	8,968.94	7,473.59	1,495.35
Type of Property:			
Unimproved	1,822.13	1,425.22	396.91
Residence	3,432.53	2,297.79	1,134.74
Commercial Residence	7,547.34	5,612.04	1,935.28
Commercial Business	18,356.09	15,252.79	3,103.30
Industrial	5,194.24	4,381.31	812.93
Access Granted:			
Yes	4,266.47	3,485.05	781.42
No	3,596.14	2,542.41	1,053.73
Property Severance:			
Divided	6,124.44	4,358.01	1,766.43
Not Divided	2,434.44	2,204.75	229.69
Area Where Property Was Located:			
1	12,809.60	9,132.48	3,677.12
2	3,907.19	3,170.96	736.23
3	956.70	684.02	272.68
4	1,574.03	1,246.57	327.46
5	2,967.82	2,091.63	876.19
6	17,474.82	15,795.96	1,678.86
7	7,184.46	4,905.44	2,279.01
8	1,474.04	908.97	565.07
9	2,431.29	1,539.68	891.61
10	1,398.45	1,072.57	325.88

Source: Calculated from IBM print-out information obtained from the Right of Way Division, Texas Highway Department, Austin, Texas.

D_{i5} = Severance, which occurs when the facility divides the remainder into two or more parcels on different sides of the highway. (Severed: i = 1 or Not Severed: i = 2.)

Several of the factors listed require special explanation. Due to the large number of observations, the factors analyzed were either obtained from maps or from data generated by the Texas Highway Department. Physical inspection of the individual land takings was not considered practicable. The basic information for the following variables was taken from right of way maps and final plans maintained by the Texas Highway Department:

1. Size of remainder.
2. Area or block.
3. Access.
4. Severance.

The remaining variables were taken from computer listings of land parcels and related characteristics obtained from the Right of Way Division, Texas Highway Department. There were five property-type classifications used in the analysis. These were the same as those currently being utilized by the Highway Department. The value of improvements was removed from all land use classifications in order that final cost figures would reflect only bare land cost within each use category.

1. Acreage—Vacant Lot.
2. Residence—one family dwelling.
3. Commercial Residence — any building where more than one family resides.
4. Commercial Business.
5. Industrial.

Empirical Analysis

The model, as developed, consists of three dependent variables, each with a corresponding equation of independent variables as diagrammatically illustrated in Figure 7. The response variables used were:

Y_1 = Total cost of each parcel.

Y_2 = Total land cost of each parcel.

Y_3 = Total damages to the remainder.

The dependent variables above are interrelated in the sense that the first is a summation of the last two. This results in the coefficients themselves being additive. The independent variables that were used were the same for all three equations and were those factors listed previously.

The Statistical "Damage" Model

The first step in the overall analysis of the data was the development of the statistical models. As previously indicated three models were initially developed. The Y_1 or "total cost" model and the Y_2 or "land cost" model were developed only to test the hypothesis that access was not significant as a factor in their internal composition. This was found to be true. These two models are contained in the Appendix. Since the discrete variables consisted of more than one level it was not possible to interpret the model as a single equation, therefore, the solutions are presented in Table 8 with all calculated values given. The alpha term in the equation is the Y intercept. This is the value that would be given if all independent variables were equal to zero.

TABLE 8. VALUE OF COEFFICIENTS FOR RIGHT OF WAY COST MODELS

Independent Variables For All Models	Value of Variables		
	Total Cost Model (In Dollars)	Land Cost Model (In Dollars)	Damage Model (In Dollars)
Intercept:			
α	$4,002.94	$3,268.67	$ 734.28
Discrete Variables:			
How Property Was Acquired:			
Negotiation	−1,300.69	−1,184.86	− 115.83
Condemnation	1,300.69	1,184.86	115.83
Type of Property:			
Unimproved	−2,175.99	−1,350.61	− 825.37
Residence	−1,851.42	−1,605.33	− 246.09
Commercial Residence	− 620.31	− 290.29	− 330.02
Commercial Business	6,222.73	4,784.06	1,438.68
Industrial	−1,575.02	−1,537.83	− 37.20
Access Granted:			
Yes	− 64.71	160.54	− 225.26
No	64.71	− 160.54	225.26
Property Severance:			
Divided	15.43	− 296.60	312.03
Not Divided	− 15.43	296.60	− 312.03
Area Where Property Was Located:			
1	4,059.99	2,899.69	1,160.30
2	− 464.34	− 584.39	120.06
3	−2,523.38	−2,417.19	− 106.19
4	−1,760.82	−1,432.31	− 328.51
5	−3,005.29	−3,293.46	288.16
6	9,669.53	10,490.86	− 821.34
Discrete Variables:			
Area Where Property Was Located:			
7	$3,288.27	$2,138.75	$1,149.52
8	−3,090.02	−2,786.20	− 303.82
9	−3,337.22	−2,835.22	− 502.00
10	−2,836.72	−2,180.53	− 656.19
Area x How Acquired:			
Negotiation[1]			
1	879.42	491.67	387.75
2	1,968.28	1,608.83	359.46
3	950.69	970.08	− 19.39
4	1,102.21	630.57	471.65
5	− 676.84	1,246.64	−1,923.48
6	−5,868.26	−6,383.89	515.63
7	−2,548.26	−1,799.41	− 748.85
8	1,464.40	1,232.14	232.26
9	1,103.63	869.46	234.17
10	1,624.73	1,133.91	490.80
Access x Severance:			
Access-Divided or No Access-Divided	− 758.03	− 609.26	− 148.77
Access-Not Divided or No Access-Divided	758.03	609.26	148.77
Area x Severance:			
Divided[2]			
1	4,504.30	3,228.22	1,276.09
2	1,347.41	1,449.35	− 101.94
3	− 363.10	− 46.00	− 317.09
4	− 483.84	− 168.70	− 315.14
5	−1,343.59	− 135.11	−1,208.47
6	−4,621.30	−5,441.13	819.84
Discrete Variables:			
Area x Severance:			
Divided[2]			
7	$2,335.87	$1,552.36	$ 783.51
8	− 43.85	274.73	− 318.58
9	−1,153.08	− 826.26	− 326.82
10	− 178.82	112.54	− 291.40
Continuous Variables (Value Per Acre):			
Size of Taking	184.71	129.90	54.81
Size of Remainder	4.12	2.25	1.87

[1]The values associated with "condemnation x area" are the opposite or "shadow" of those associated with "negotiation x area." If the value of the variable for "negotiation" is a positive amount, the value for "condemnation" is the same value with a negative sign.

[2]To derive the values associated with "not divided x area" utilize the same procedure as in Footnote 1. If the sign is positive for "divided" it will be the same amount with a negative sign for "not divided."

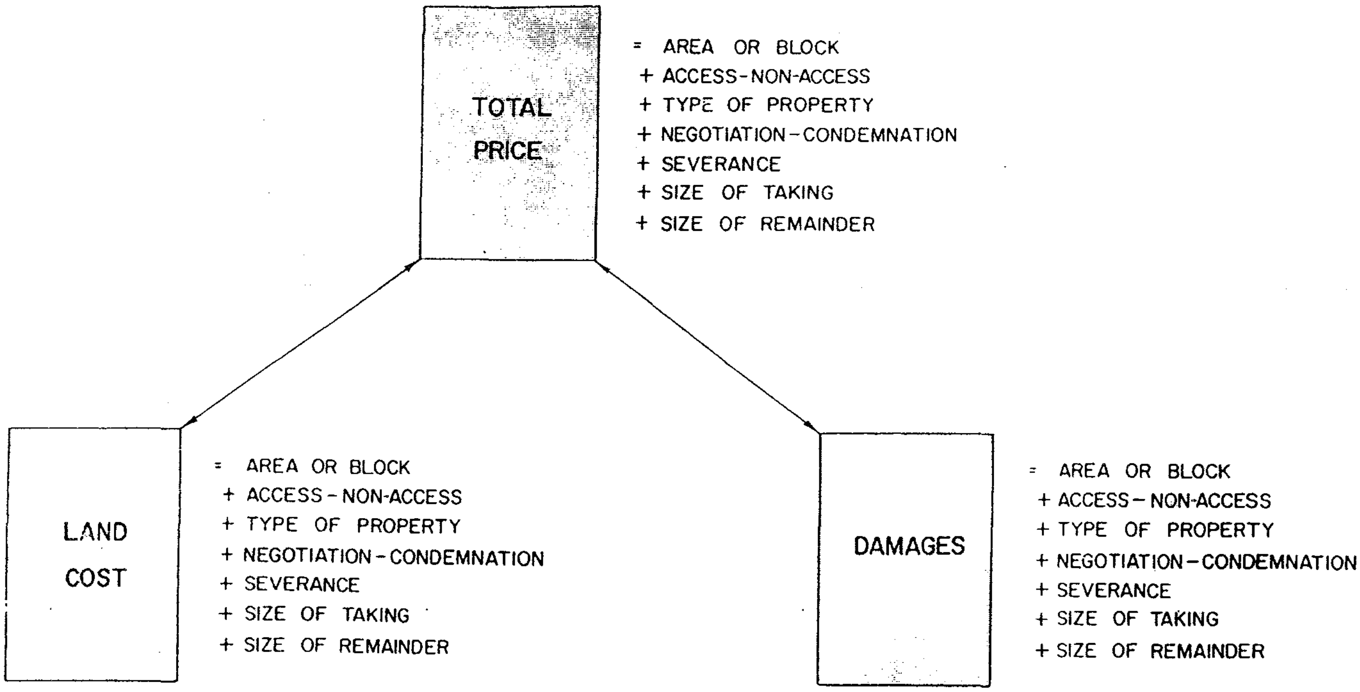


Figure 7. Diagrammatic illustration of the statistical cost models.

The "damage" model regression statement says, in effect, that within this range of observations, if the land parcel was acquired by negotiation then $115.83 would be subtracted from the estimated damages Y_3. If the parcel was not granted access then $225.26 would be added to Y_3. The amount contributed by the various characteristics under consideration is indicated in the "damage" column in the table. The influence of the interaction terms are calculated similarly except that now the levels of the two variables must be considered in order to determine the correct coefficient. As an example, if the land parcel were located in area six and was not divided ("severance × area") then the contribution from this set of circumstances would be minus $819.84. If the property had been divided and from area six then it would have been plus $819.84. The two continuous coefficients ("size of taking" and "size of remainder") are on a per acre basis.

To derive the estimated damages associated with a given land parcel, utilizing a model of this type, involves selecting the applicable characteristics, or independent variables, of the parcel as calculated in the "damages" column of Table 8, summing the values, in dollars, of these variables and their interactions to arrive at the given individual estimate.

In standard multiple regression notation the correlation coefficient R^2 for the entire equation is computed by dividing the sum of squares due to regression by the corrected sum of squares. In this manner the multiple correlation coefficient R^2 indicates the percentage of variation in the dependent variable that is explained by the regression analysis. The standard method of calculation of the regression sum of squares is to multiply the vector of coefficients by the vector of right hand sides (in matrix notation: $(\hat{\underline{B}})\ (X'y)$). However, the computation of the regression equations used in this study is not the standard solution technique. Thus, if the regression sum of squares is computed using the above formula it will include the sum of squares due to the mean. Dividing by the corrected sum of squares would overstate the R^2 value. To remedy this situation two sets of figures are presented for each model. The first is obtained by dividing the sums of squares due to regression by the total sum of squares which yields .60465 for the damage model. The second is found by dividing the sums of squares due to the coefficients by the corrected sum of squares which yields .54983 for the model. The sum of squares due to the coefficients is computed by subtracting the correction for the mean $(\Sigma Y)^2/N$ from the regression sum of squares. The statistical significance of the regression is shown in the analysis of variance, Table 9.

The reduction in sum of squares attributable to coefficients is tested for significance by utilizing the "F" test. In the case of the damages analysis, the model is statistically significant at the .99 level of probability.

Table 10 demonstrates the significance of the individual coefficients relating to the damages model. The "F" tests of significance are calculated for three levels of confidence. An examination of the changing pattern of

TABLE 9. RIGHT OF WAY COST DAMAGE MODEL OVERALL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	1,935,196,800		
Due to Coefficients	37	1,064,040,300	28,757,846	10.04**
Error	304	871,156,500	2,865,646	

**Significant at .99 level of confidence.

TABLE 10. DAMAGE MODEL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	1,935,196,800		
How Acquired	1	1,423,790	1,423,190	.50
Type of Property	4	64,883,996	16,220,999	5.66**
Access	1	12,990,506	12,990,506	4.53*
Severance	1	14,455,617	14,455,617	5.04*
Area	9	50,819,144	5,646,572	1.97
How Acquired x Area	9	91,142,737	10,126,971	3.53[1]
Access x Severance	1	5,897,347	5,897,347	2.06
Severance x Area	9	82,808,085	9,200,898	3.21[1]
Size of Taking	1	83,315,750	83,315,750	20.97**
Size of Remainder	1	40,543,280	40,543,280	14.15**
Error	304	871,156,500	2,865,646	

*Significant at .95 level of confidence.
**Significant at .99 level of confidence.
[1]Significant at .90 level of confidence.

significance associated with the independent variables reveals the internal logic of the statistical model. The variables related to "access," "severance," and "size of remainder" are statistically significant in this model. The pattern of significant variables is logically consistent when analyzed within the framework of conventional appraisal theory; they would enter into the calculations at this stage of the appraisal during the assessment of applicable damages.

The coefficient of access in the "damage" model was 44.25 percent of the mean, holding all other variables constant. The lack of access coefficient was 23.48 percent. Property severance was 29.82 percent of the mean and no severance was 73.90 percent. In this model the coefficients in question, expressed as a percentage of their means, were quite large in magnitude and statistically significant.

The right of way cost data generation and analysis flow chart illustrates the sequence involved in the development of the various models under consideration, Figure 8. The statistics calculated from these models are given in Table 11. Since all three models were constructed utilizing the same internal variables it is possible to gain an insight into the relative influence each variable exerts in the models by ranking them on the basis of their "F" ratios, Figure 9.

An examination of Figure 9 indicates that the area effect which ranked second in the "total cost" and "land cost" equations fell to next to last, or ninth place, in the "damages" equation and lost statistical significance. The conclusion is that the amount paid for damages, holding all other variables constant, did not vary significantly from one area to another.

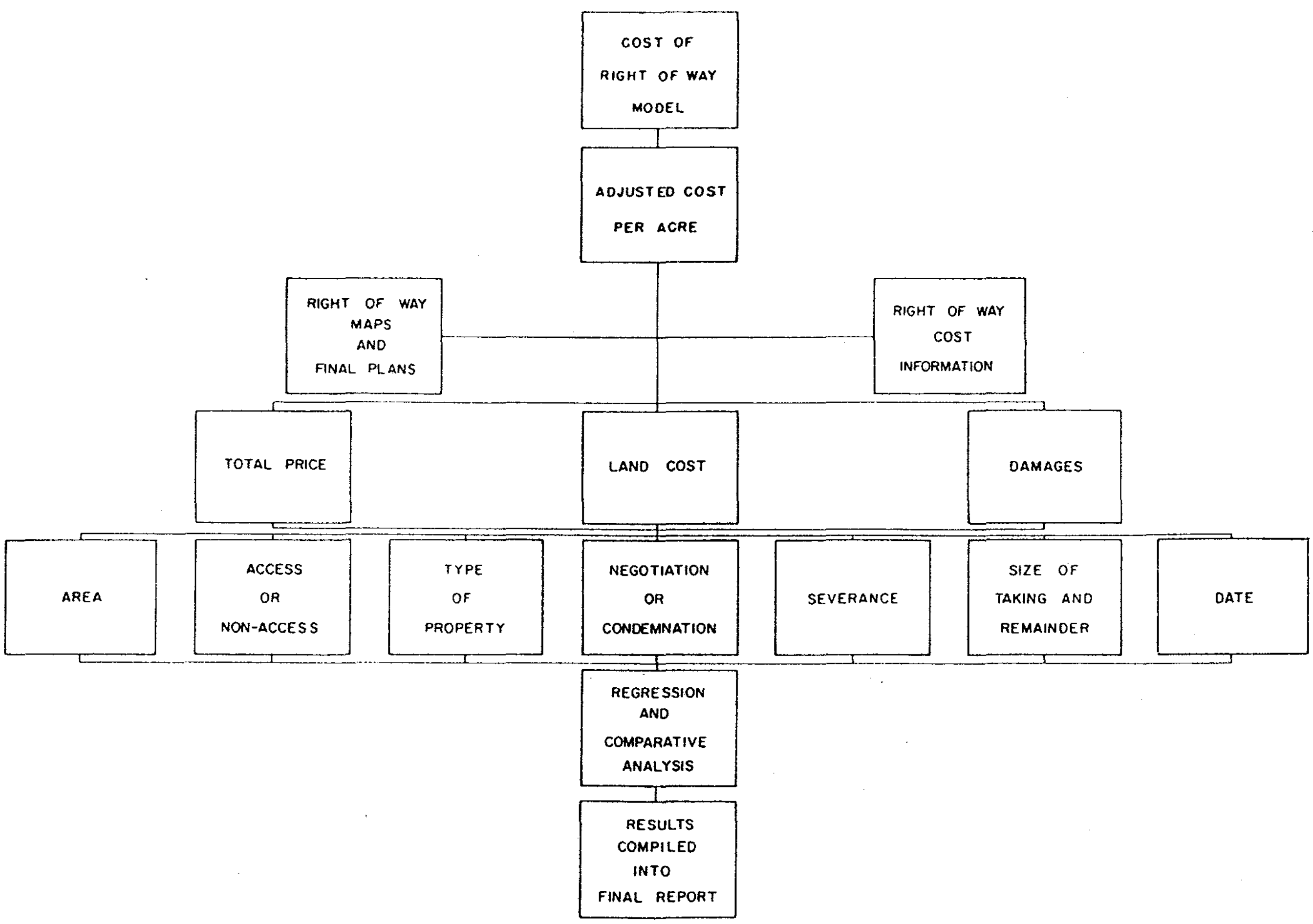


Figure 8. Right of way cost data generation and analysis flow chart.

Total Cost	Land Cost	Damages
Size of Taking	Size of Taking	Size of Taking
Area Where Property Was Located	Area Where Property Was Located	Size of Remainder
Type of Property	How Property Was Acquired	Type of Property
Size of Remainder	How Acquired x Area	Property Severance
How Property Was Acquired	Type of Property	Frontage Roads
Frontage Roads x Severance	Frontage Roads x Severance	How Acquired x Area
How Acquired x Area	Severance x Area	Severance x Area
Severance x Area	Size of Remainder	Frontage Roads x Severance
Property Severance	Property Severance	Area Where Property Was Located
Frontage Roads	Frontage Roads	How Property Was Acquired

Figure 9. Ranking of variables based on mean squares.

The presence or absence of access or frontage roads, the size of the remainder, and severance behaved in a logical manner within the models, having little significance in either the "total cost" or "land cost" models. However, the size of the remainder became the second most significant factor in the "damages" equation and severance became the fourth most important factor. Frontage roads also became significant in the "damages" equation implying that access does affect the cost of right of way by the reduction of the amount paid for damages.

Frontage roads are more likely to be constructed in areas of intensive land use and concentrated economic activity, therefore, land prices will generally be higher in these areas even before acquisition proceedings begin. These factors will contribute to the probability of the higher priced land being granted access. The values of the coefficients reflect this situation.

The coefficients relating to severance indicated that if the property was divided damages increased by approximately $312.03. If the property was not divided, the damages were reduced by about $312.03. Exogenous factors undoubtedly contribute to this behavior. A large, agricultural tract is much more likely to be divided than a small, commercial business and, conversely, the value of the agricultural property would be lower. As would be expected, commercial businesses in the sample were damaged the most, while unimproved properties were damaged the least.

TABLE 11. STATISTICS CALCULATED FROM A LEAST SQUARES ANALYSIS BETWEEN PRICE PAID FOR RIGHT OF WAY PROPERTY AND SELECTED INDEPENDENT VARIABLES[1]

Item	Total Cost Model	Land Cost Model	Damages Model
Regression Sum of Squares Divided by Total Sum of Squares[2]	.62056	.54745	.60465
Sum of Squares Due to Coefficients Divided by Corrected Sum of Squares[3]	.55205	.48484	.54983
Number of Observations Utilized in Development of Each Model	342	342	342

[1]Independent variables consisted of size of taking, size of remainder, the area block in which the property was found, whether or not the property had been granted direct access to the facility, the type of property involved, the manner in which the property was acquired, whether or not the property had been severed.

[2]The regression sum of squares divided by the total sum of squares represents the percentage variation explained by the models when the effects due to the mean are included in the calculations.

[3]The sum of squares due to the coefficients divided by the corrected sum of squares represents the percentage variation explained by the models when the effects due to the mean are eliminated.

In summary, a simple arithmetic average of only the unimproved property acquired for highway right of way indicated that the average price per acre paid where no frontage roads were constructed was $270, whereas, it was $153 per acre where frontage roads were constructed, or a decrease of 43.34 percent.

Utilizing least squares regression analysis to analyze damages in relation to access indicated that damages for properties not granted access were approximately $162 per acre, whereas, damages were $76 per acre for those properties granted access. The decrease in the amount paid for damages was approximately 53 percent.

Additionally, a number of observations were selected for the purpose of a price-profile case study from those included in the random cost model. The amount paid for damages was 42.19 percent lower for those properties granted access.

Overall, the average algebraic decrease in damages due to the granting of access was 46.32 percent. A summary of the percentage decreases is illustrated in Figure 10. The conclusion was drawn that access does affect

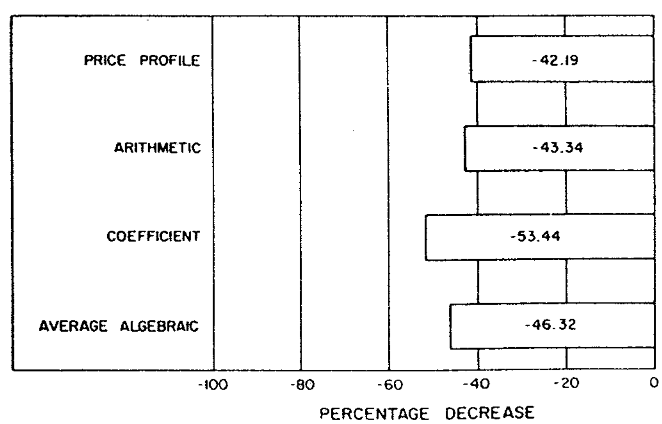


Figure 10. Percentage decrease in property damage paid as a result of granting access.

the cost of right of way by the reduction of the amount paid for damages.

Influence of Exogenous Economic Factors

It should be recognized from the preceding discussion that within the context of practical problems, certain kinds of exogenous factors apparently connected with changes within the chain of economic causation, are not infrequently involved. There is a penumbra of economic interactions that are somewhat difficult to include as variables in an analysis; nevertheless, for purely practical reasons, it is often necessary to take them into account.

In the preceding analysis, the variable used in the equation to denote the "area where the property was located" was utilized as a level of association between the sample area and objective exogenous economic forces. This variable indicates the relative influence that being located in a particular study area has on an individual land taking.

Economic models of the type utilized in a least squares model involve stochastic relationships. A stochastic relationship is one in which variations in the dependent variable are not completely and exactly explained by variations in the specified independent variables; rather, some variations are attributed to factors which have not been specified but which, in combination, may affect the relationship in some manner. In a model of this type, observed variations in the independent variables are not expected to explain all the observed variations in the dependent variable. These relationships are not expected to be exact for a number of reasons, the chief one being the assumption of *ceteris paribus*.

All models are abstractions, which, by necessity, deal only with the relevant factors involved with the problem at hand. All other factors that might in some way influence the variables under examination are assumed under the *ceteris paribus* assumption to be constant. Nevertheless, in the real world, these ignored factors may account for some variation in the model. The use of the area variable in the present analysis somewhat reflects these economic movements in each local economy and permits their inclusion, in an indirect way, into the models.

CHAPTER V
Land Value Analysis

The general objectives of the overall study embodied in this section are the determination of the zone of influence of special benefits, as opposed to general benefits, to remaining property resulting from highway construction and the determination of the effect of interchanges and ramps on the value of comparable property abutting the highway.

The objective measurement of access, or frontage roads, as a quantitative factor in property value involves the isolation of this particular variable from other applicable variables that must be examined in order to arrive at any specific estimation of land value. The complexity is compounded by the fact that relatively none of the variables are completely independent. Access alone is not the price determinant of property value in relation to a highway facility, but access in conjunction with other factors. The mutual interdependence of the variables affecting value requires a method of analysis that can take this interrelationship into consideration. The methodology used, in part, is that of least squares analysis. In this manner the interaction among and between variables can be examined. Various comparative techniques are additionally utilized.

Characteristics of the Sample

The sample data were generated by taking a nine-area sample of highway segments as enumerated in Texas Status of Improvements to the Interstate System, Texas Highway Department, Planning Survey Division, revised edition. The presence or absence of frontage roads was chosen as a criterion of inclusion since access, or frontage road, effects was the major item under examination. From these nine areas, 715 individual land sales were recorded along with selected characteristics. Each property was personally inspected to ascertain the various factors under consideration. The locations of individual study areas by number, interstate highway number, county, project number, and the physical limits of the projects are given in the Appendix. The prices of property were deflated to constant dollars by using the Consumer Price Index. (See explanation and schedule in the Appendix.) All data were transferred to IBM punch cards for analysis with the aid of electronic computers.

After the sample was completed, an inventory of the miles of interstate highway constructed with frontage roads and that constructed without frontage roads was accomplished. Almost 45 percent of the total number of miles constructed in Texas without frontage roads was included in the study. With the exception of that located within corporate city limits, all highway east of Abilene was considered part of the universe.

The distance on either side of the facility that should constitute the study area presented a problem at the beginning of the survey. The use of an arbitrary distance on either side of the facility might imply that the economic influence went so far and no farther. Since distance from the facility was only one of the variables under consideration, it was decided not to permit this one factor to exert paramount analytical control. Since there was no accepted generalization relating distance and the several other factors under consideration, it was decided to move outwards on either side of the facility to what could be considered to be a natural boundary. On the basis of preliminary investigation, the decision was made to gather data for a distance band of approxi-

TABLE 12. ACREAGE DISTRIBUTION OF PROPERTY CATEGORIES IN LAND VALUE ANALYSIS

Category	Total Number of Acres	Percent of Total	Cumulative Percentage
Unimproved	14,310.43	32.76	32.76
Agricultural	12,076.35	27.65	60.41
Rural Residence	6,874.63	15.74	76.15
Urban Residence	2,188.68	5.01	81.16
Commercial Business	8,136.78	18.63	99.79
Industrial	92.50	.21	100.00
Total	43,679.37	100.00	

mately 4,300 feet wide, including the facility. This distance was approximate because property lines were followed, rather than an exact numerical distance. These property lines were not followed when inclusion of a very small portion of a very large property would distort the results. This meant that the outer boundary of the area was not equidistant from the facility.

There were approximately 43,680 acres of property included in the study. Over half the acreage was considered in the unimproved and agricultural category. There were no empty land classification cells to be included in the analysis. The high percentage of vacant property in the study somewhat facilitated the isolation of the frontage road effect. There are two methods of approach in utilizing the record of land sales. The first requires the use of all property sales and appraising the improvements included in the sale so that they can be subtracted from the entire sale price. The final result is the change in value attributable to the land only. The second method utilizes only the sales of unimproved properties, and thereby eliminates any question as to the amount of change in value to be assigned to the land. This method is obviously preferable. Nevertheless, if an appraisal of improvements is financially prohibitive, some value can be derived in the analysis of improved properties by a land classification category system. In this manner the relative magnitudes between property types and property values may be observed.

Additionally, a frequency distribution of the properties, by use category, indicated that of the 715 obser-

TABLE 13. FREQUENCY DISTRIBUTION OF PROPERTY CATEGORIES IN LAND VALUE ANALYSIS

Category	Abutting	Non-abutting	Total	Percent
Unimproved[1]	80	180	260	36.41
Agricultural	27	18	45	6.30
Rural Residence[2]	10	16	26	3.64
Urban Residence	18	281	299	41.88
Commercial	20	44	64	8.83
Industrial	0	21	21	2.94
Total	155	560	715	100.00

[1]Includes property not under cultivation or used for any other purpose and also property classified as being held for future use.

[2]Tracts used primarily as a dwelling place, with an occupiable house, located outside city limits and not connected with agricultural enterprise.

TABLE 14. DISTRIBUTION OF ABUTTING AND NONABUTTING OBSERVATIONS BY TIME OF SALE (LAND VALUE ANALYSIS)

	Abutting	Percent	Non-abutting	Percent
Before	65	41.93	315	56.25
After	90	58.07	245	43.75
Total	155	100.00	560	100.00

vations included in the sample, 260 were classified as unimproved or held for future use by a personal inspection of each property. If the agricultural properties are included with the unimproved, this yields approximately 43 percent of the observations without improvements that can be utilized in the analysis of land value. As emphasized earlier, this will facilitate the examination of the frontage road effect on property value—in isolation—without regard to improvements.

The general approach to the analysis utilizes the so-called before and after technique. This is a comparative technique used to measure changes in land values over time. One time period is designated as the "before" period and another as the "after" period. For purposes of analysis, the "after" period is measured as the month the highway was completed. Each sale of property is recorded on a numerical scale with the completion date of the highway as zero. In this manner all sales in the period before completion are recorded as a negative month and all sales after completion are recorded as a positive month.

Empirical Analysis

The first step in the analysis consists in the determination of the zone of special benefits as a result of highway construction. A benefit can be thought of as the result of an occurrence that is favorable to some members of a society.[23] A benefit arising out of construction of a highway can be subdivided into what is generally known as vehicular, or user benefits, and nonvehicular, or nonuser benefits. The division of highway effects into user and nonuser benefits is a somewhat misleading dichotomy. The difficulty is that user benefits are, by nature, transferable or shiftable to nonuser beneficiaries.[24] For purposes of this analysis, a benefit is the change in land value arising from the completion of a portion of the Interstate Highway System. It is favorable to some members of a community or town (affected in a positive manner) because of its proximity.

The benefits in question can be further subdivided into three categories: general, neighborhood, and special. General benefits are those that influence the entire community. This can be seen in the resultant change that all land values make in a community because of the effects of the Interstate Highway System. This change is in no way related to the position of the properties in relation to the interstate but affects all land in a community equally, regardless of its distance from the interstate. Neighborhood benefits are those that occur due only to the distance that a definite district is from the highway. These benefits are a special form of general benefits that increase as the distance to the interstate decreases.

Special benefits are those benefits remaining after the general and neighborhood benefits have been considered. They occur because of the direct relationship the property has with the interstate. And they result due to a property's position on the interstate and not because of its location. In the context of this definition only abutting property can have special benefits because it is only these that have a direct relationship with the interstate. However, the fact that a land parcel abuts the facility is not in itself a special benefit.

The existence of special benefits is not universally present among abutting property but must be determined on an individual basis relying on the position of the individual parcel on the highway system. Given the condition of the previous logical constructs, Figure 11 illustrates the behavior of the three classes of benefits.

Special Benefits

The isolation of special benefits has assumed a position of some importance in the appraisal procedures utilized in Texas for the condemnation of property. These benefits may legally be used to offset any damages that accrue in connection with a particular property acquisition for highway purposes. One previously described isolation technique has been to compare differences between subject and control parcels near the facility. Assuming that both the subject and control properties are adequate comparables, difficulties nevertheless still arise. The abutting property logically would be subjected to a more intensive influence from the facility than would a comparable nonabutting parcel. This would be due both to its position on the facility which gives rise to special benefits and to its location abutting the facility which gives rise to neighborhood benefits. However, neighborhood benefits decrease as the distance from the highway increases. Subtracting a nonabutting control property value from the abutting study parcel value and calling the total residual a special benefit would have a tendency to overstate the contribution of this class of benefits. Part of this difference would be due to the neighborhood benefits.

As an alternative to looking at what is being done by the mechanics of this method, look at why it is being done. The subtraction of prices of comparable pieces of

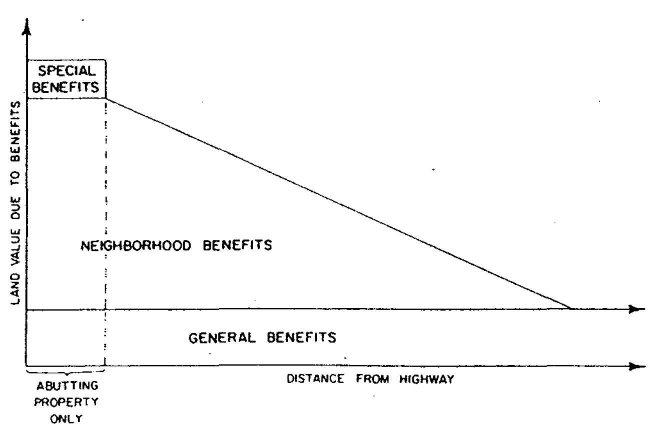


Figure 11. Hypothetical relation of benefits to highway facility.

property, one control and one study, is the attempt at isolating the value of any special benefits holding everything else constant. However, the method will, in some instances, somewhat overstate special benefits by the inclusion of some neighborhood benefits as well. The procedure of holding various factors constant while attempting to isolate one element can be accomplished mathematically by least squares analysis. The value of a partial regression coefficient in a regression analysis is found while holding all other independent variables in the equation constant.

The Texas Supreme Court, in the decision *State v. Meyer*, ruled that "when the taking of land for highway purposes results in new or increased access to the remaining and abutting property, this benefit may be considered by the jury as offsetting any damages . . . ."[25] To ascertain the influence of this particular special benefit, a regression equation examining the behavior of land sales abutting the facility was developed using the characteristics of access defined by the court as one of the independent variables. To fulfill the second objective of determining the effect of interchanges and ramps on the value of abutting property, a variable was included in the equation to measure this influence. Figure 12 illustrates the general flow model utilized in the land value analysis.

Variables in the Analysis

Due to either structural deficiencies, intercorrelation, etcetera, several of the land characteristics studied were not suitable for inclusion in the final regression model. The inclusion of material relating to their calculation is intended only for informational purposes to indicate to future researchers the methods that were tried during the duration of the study. The variables that were eventually analyzed include those given in Table 15 and Table 17. The characteristics of land sales that were considered at one time or another for use in this model were as follows:

Dependent Variables:

Y_1 = Adjusted price per acre.
Y_2 = Total adjusted price.

Independent Variables:

Continuous Variables Applying to All Sales:

X_1 = Month-year sold.
X_2 = Distance to the central business district.
X_3 = Difference between distance to CBD of each sale and mean distance to CBD for that particular study area.
X_4 = Depth factor.
X_5 = Width factor.
X_6 = Front feet.
X_7 = Size measured in square feet.
X_8 = Shape factor.
X_9 = Property trend variable.

Continuous Variables Applying to Nonabutting Sales:

X_{10} = Road distance to interstate.
X_{11} = Road distance to nearest state highway
X_{12} = Exit distance from interstate.
X_{13} = Access distance from interstate.

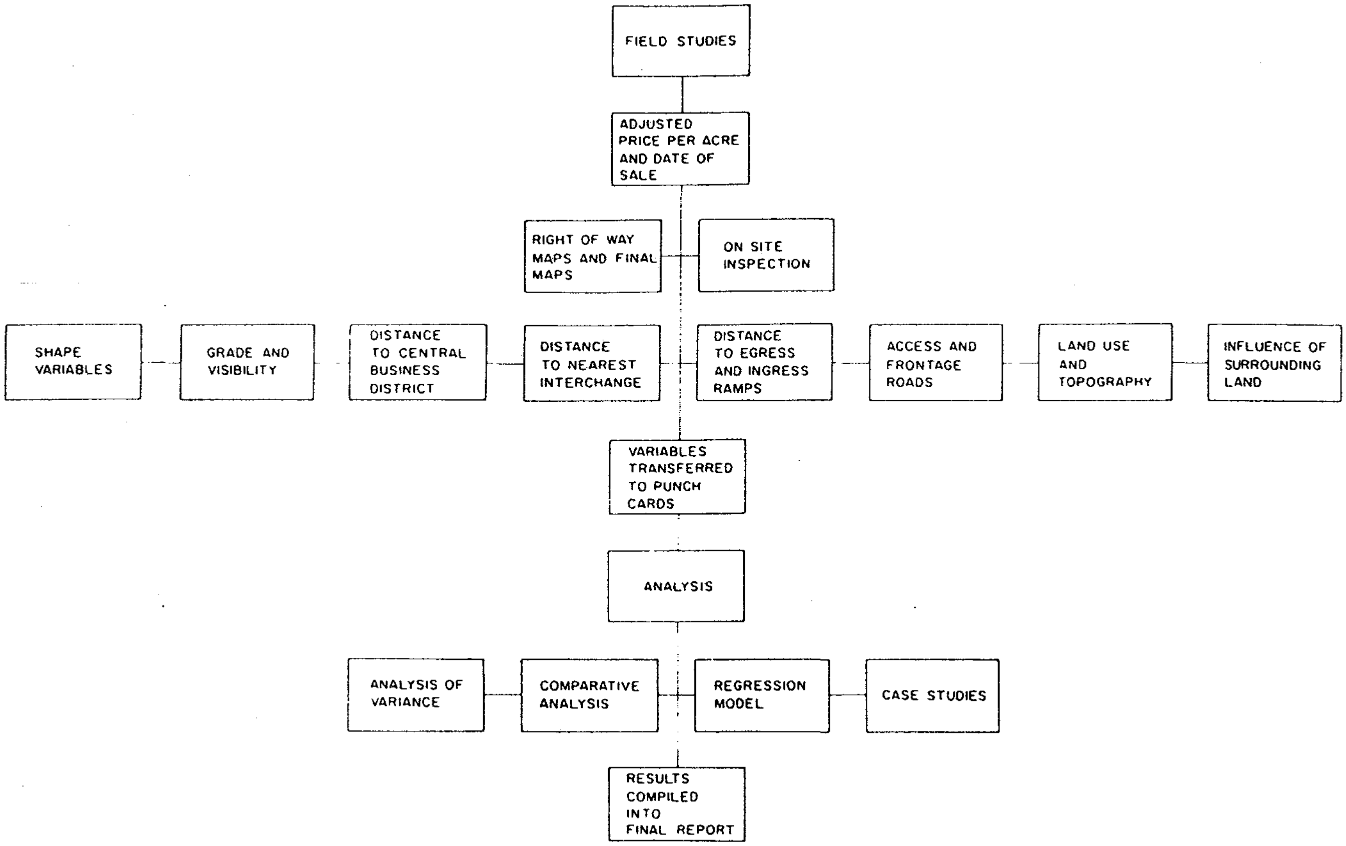


Figure 12. Land value data generation and analysis flow chart.

Continuous Variables Applying to Abutting Sales:

X_{14} = Road distance to nearest interchange.
X_{15} = Distance to egress ramp.
X_{16} = Distance to ingress ramp.
X_{17} = Visibility.
X_{18} = Grade.
X_{19} = Shortest distance to nearest interchange.

Discrete Variables Applying to All Sales:

D_{11} = The study area in which the property was found.
D_{12} = Land use at sale.
D_{13} = Influence of surrounding land.
D_{14} = Topography of land.
D_{15} = Access and frontage roads.
D_{16} = Time of sale.
D_{17} = Type of sale.

The techniques utilized in calculating and recording several of the variables under consideration require further elaboration. The month of completion of the interstate within the particular study area was used as the beginning point (given a value of zero) in recording the month-year that the property sold. All dates of sales were then measured in months from this point (either positive if sale was after completion date or negative if it was before). This emphasizes the influence the interstate exerts based upon a standard time scale. Thus, all sales are measured from the same relative point in time regardless of when a particular interstate was completed in a particular area.

The difference between the distance to the central business district of each sale and the mean distance to the CBD for that particular study area was introduced as a variable. The distance to the central business district for a sale in one area might be 8,000 feet, while in another study area it might be over 60,000 feet. Subtraction of the mean was accomplished as a distance difference adjustment between areas.

Since the depth of a land parcel will, in a great many instances, vary from one side to another, it was decided to measure it at set intervals and average the results. A further refinement was made in that the length of the intervals was increased as the maximum depth (depth at deepest point) increased. This value was utilized as a depth factor relating to each individual parcel. This method was tried because it was felt that the smaller properties were more sensitive to changes in depth than the large ones. A copy of the table used to calculate these factors is contained in the Appendix. The width factor was measured in the same manner as the depth factor.

A shape factor was calculated for each property by use of the formula:

$$S_f = \left(\frac{MVW}{MVD}\right)\left(\frac{1}{SP}\right)$$

where

S_f = Shape factor.
MVW = Maximum value of width.
MVD = Maximum value of depth.
SP = Size of property.

The rationale used in development of the shape factor utilizes similar assumptions as those followed in several appraisal techniques such as the 40-30-20-10 rule and others. The front part is considered the most valuable part of the property. This is taken into consideration by using the width as the numerator and the depth as the denominator of the fraction. As the maximum depth increases, the shape factor value decreases and as the maximum width increases, the shape factor value increases (holding area constant in all cases). As the area of property approaches an infinite size, the consideration given to shape decreases. Because the reciprocal of the area is used, this characteristic is taken into account. The implicit assumption contained in this rationale is that of diminishing marginal utility as size-shape increases.

In order that the general trend of property values as expressed by land sales might be explained, another time-measurement variable was considered. This property trend variable was measured from the beginning of the study period (January, 1956) to its conclusion (December, 1965). January, 1956 would be the starting point having a value of 1. All other months of sale would have values depending upon their consecutive ranking. In addition, another variable relating to visibility was calculated. This variable was measured utilizing the plan profiles obtained from the Texas Highway Department. As a crude approximation of how easily an abutting parcel could be seen, the distance both up and down the highway was measured until an elevation was reached that was higher than the abutting parcel's elevation. Also, the existence or absence of curves in the facility were taken into consideration in the measurement.

The grade variable was a three number moving average of the difference between the grade of the interstate and the grade of the property at 25 feet intervals. A moving average was used rather than an arithmetic mean in order to minimize any extreme difference in grade. The influence of surrounding land was classified as either positive, negative, or no effect. The topography was classified as either wooded or cleared and rolling or flat.

The study area in which the property was found was coded: i = one through seven. Time of sale was coded: before, i = 2 and after, i = 1. The type of sale was: abutting sale, i = 1 and nonabutting sale, i = 2.

Access and frontage roads contained several different considerations. The abutting land classes included: access and frontage roads, access and no frontage roads, frontage roads and no access, and no access and no frontage roads. The nonabutting land classes included: access to frontage roads, and no direct access to frontage roads.

The Interchange Complex

In order to approximate the influence of interchanges and ramps on the value of abutting property a variable was designed to evaluate what was termed the "interchange complex" in the regression equation. This complex is defined to be that area of the highway system that includes an intersection of the highway with some other road, involving a transfer of traffic between the two, and encompassed by the ingress-egress ramps and the intersection of the frontage roads with the intersecting road.

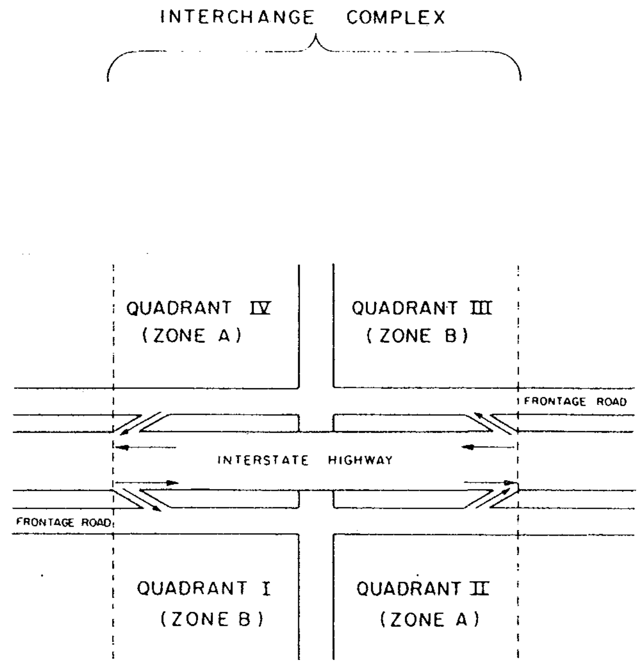


Figure 13. The interchange complex quadrant zones.

The area contained within what is known as the "interchange complex" consists of four zones, two on each side of the facility. The first and third quadrants contain similar zones, called zone "B's," while the second and fourth quadrants also contain similar zones, called zone "A's." In this case "similar zones" is in reference to the direction of the flow of traffic traveling on the highway, Figure 13.

Traffic first enters zone "B" of quadrant I in the interchange complex. It remains in this zone until it reaches a point halfway between the limits of the complex, or the intersecting road. At this time it enters zone "A" or quadrant II of the interchange. The process repeats itself for quadrants III and IV of the complex. From an economic viewpoint it seems that the zone "B's" would be better suited for traffic-serving commercial development purposes than would the zone "A's" since the "B's" are the "lead-in" quadrants of the complex in terms of traffic flow.

The Land Value Regression Model

The development of the model used in this stage of the analysis followed the same procedures previously employed; a covariate regression equation with related analysis of variance. Since the discrete variables consisted of more than one level it was not possible to interpret the model as a single equation, solutions are presented as Table 15, with all calculated values given. For purposes of analysis, study areas five, six and nine were combined into study area five and areas two and seven were deleted due to the absence of several criteria needed for inclusion. The alpha term in the equation is the Y intercept—the value that would be given to land if all independent variables were equal to zero.

TABLE 15. VALUE OF COEFFICIENTS FOR ABUTTING UNIMPROVED LAND VALUE MODEL

Independent Variables	Value of Variable (In Dollars)
Intercept:	
α	$ 9,028.86
Discrete Variables:	
Area Where Property Was Located:	
1	7,528.53
2	7,754.49
3	7,480.19
4	- 2,780.90
5	4,925.24
Access Granted:	
Yes	878.76
No	- 878.76
Before Sale	6,067.98
After Sale	- 6,067.98
Size of Sale:	
0-5 Acres	- 1,140.96
5-Over	1,140.96
Zone:	
A	1,718.25
B	- 1,718.25
Area x Access:	
1	117.98
2	15,790.65
3	- 14,094.18
4	462.61
5	- 2,277.06
Area x Zone:	
1	6,719.62
2	- 17,097.90
3	5,264.85
4	821.99
5	4,291.44
Access x Before-After Sale:	
Access and After Sale or No Access and Before Sale	4,382.36
No Access and After Sale or Access and Before Sale	- 4,382.36
Discrete Variables	
Access x Size:	
Access and Size = 0-5 Acres or No Access and Size = 5-Over Acres	$ 3,065.03
No Access and Size = 0-5 Acres or Access and Size = 5-Over Acres	- 3,065.03
Access x Zone:	
Access and Zone A or No Access and Zone B	- 4,977.57
No Access and Zone A or Access and Zone B	4,977.57
Continuous Variable:	
Month-Year Sold	77.90

The reduction in sum of squares attributable to the coefficients can be tested for significance by use of the "F" test. In this case the model is statistically significant at the .99 level of probability. The sum of squares due to regression divided by the total sum of squares is equal to .81018 and the sum of squares due to coefficients divided by the corrected sums of squares equals .74697 for the model. This implies that approximately 75 to 80 percent of the variation in value of unimproved abutting property is explained by the model.

Table 17 illustrates the significance of the individual coefficients relating to the land value. The "F" test is calculated for three levels of statistical significance.

The "F" test in the analysis of variance indicates that access becomes significant when examined in conjunction with other variables in interaction terms. Logically it would seemingly make little difference on a per acre basis if access were given to a 500-acre parcel. However, to an owner of a half acre of land next to an interchange the existence or non-existence of access could be crucial. The interaction term of "access and zone" had the largest "F" ratio of all variables tested. The absolute magnitude of the coefficients for this term exceeds both the "access" and "zone" coefficients added together. Thus, in this model the effect of either having access or not and being in a particular zone of an interchange at the same time affect the per acre price more than these two characteristics when considered separately. The same is true with respect to access and size. The interaction between size and access changes the price per acre more than does either size or access when considered by themselves. From the above results it can be implied that the possession of access, when considered in conjunction with other variables, does significantly influence the value of land abutting the facility.

TABLE 16. LAND VALUE MODEL UNIMPROVED ABUTTING SALES OVERALL ANALYSIS OF VARIANCE

Source	d.f.	Sums of Squares	Mean Squares	F
Total	68	6,136,046,700		
Due to Coefficients	20	4,583,426,800	229,171,340	70.85**
Error	48	1,552,619,900	3,234,625	

**Significant at .99 level of confidence.

The behavior of the "month-year sold" coefficient indicates that abutting land prices generally increased after construction of the facility. The value of the coefficient, about $78, means that for every month after construction, abutting land prices increased by that amount on a per acre basis, while they decreased by a like amount for each month before construction. The value of the "size" coefficient indicates that the smaller parcels seemingly have a lower per acre value. However, size is also considered as an interaction with access.

TABLE 17. LAND VALUE MODEL UNIMPROVED ABUTTING ANALYSIS OF VARIANCE

Source	d.f.	Sums of Squares	Mean Squares	F
Total	68	6,136,046,700		
Area	4	832,530,650	208,132,660	6.43**
Access	1	15,584,325	15,584,325	.48
Before-After	1	437,253,840	437,253,840	13.52**
Size	1	24,080,070	24,080,070	.74
Zone	1	70,671,595	70,671,595	2.18
Area x Access	4	1,110,277,900	277,569,480	8.58**
Area x Zone	4	1,600,369,100	400,092,300	12.37**
Access x Before-After	1	261,435,530	261,435,530	8.08**
Access x Size	1	174,783,750	174,783,750	5.40*
Access x Zone	1	520,177,580	520,177,580	16.08**
Month-Year Sold	1	118,519,630	118,519,630	3.66'
Error	48	1,552,620,900	32,346,269	

*Significant at .95 level of confidence.
**Significant at .99 level of confidence.
'Significant at .90 level of confidence.

In this instance the interaction term magnitude is greater than both discrete variables.

The general design of the "zone" variable as a measure of the "interchange complex" effect, or the influence of interchanges and ramps, indicated that land values in zone "B" were higher than those in zone "A" based on an examination of the coefficients in the equation.

Isolation of Access Influence

Up to this point in the analysis, the analytical method of least squares analysis has been utilized in an effort to determine the influence of access on property values associated with a major highway system. A logical alternative to this type analysis is a statistical comparative technique wherein differentials between various survey and control areas are analyzed.

Analysis of market value behavior in the past or near past should provide the best available basis for predicting market behavior in the future, either under the assumption of a natural or real market or under hypothetical conditions. The record of past transactions is, broadly speaking, the major reliance as a basis for prediction. By various kinds of inferential analysis, behavior is forecasted under the assumption that individuals in the future will act like individuals have acted in the past under the same circumstances.[26]

Due to differences in before and after property characteristics, and to enable the results to be tabulated on a computer, it appears that it may be advisable to finally reduce the results of any comparative analysis to a percentage loss or gain.[27] The influence of the highway in relation to frontage roads or access will be expressed in terms of two indexes for each type of measurement used. Index 1 is the absolute influence expressed as a percentage of the pre-construction or "before" price of each property category in the study area. This index assumes that, in the absence of the highway, values in the study and control areas would have changed by the same absolute amount. The absolute influence is equal to the algebraic difference between absolute changes in study and control areas. Index 2 is the algebraic difference between percentage changes in prices in study and control areas. The second index assumes that prices in both study and control would have changed by the same percentage amounts in the absence of the highway. The measures under each index may be considered as the upper and lower limits of the range of influence.

There were considerable differences in effects on land values among land classification categories and the presence or absence of frontage roads. Table 18 shows the changes in land value of properties abutting the highway, constructed with frontage roads, as compared with nonabutting control areas. With the exception of the urban residence category, abutting land values soared upward in market value from the pre-construction to post-construction period. The frontage road influence is reckoned between 40 and 87 percent by Index 1 and between 76 and 188 percent under Index 2. The urban residence category experienced a negative decline under both index calculations, with the implication that the presence or absence of frontage roads exerted minor influence on residential values as a result of proximity to the facility. Both abutting residential properties with frontage roads and nonabutting residential increased in value, but the larger increase in the latter resulted in an overall negative influence.

Changes in land value of abutting properties located on highway constructed without frontage roads reveals the magnitude of increase in frontage road properties even more dramatically, especially in the unimproved and held for future use category, Table 19. The percentage increase in frontage road areas in this category, after adjustment for increases in nonabutting control property, was approximately 188 percent, whereas the increase for areas where no frontage roads were constructed was a more modest 35 percent. The analysis of urban residential property in relation to lack of frontage roads reveals a 35 percent increase in price, after adjustment for nonabutting control increases. Additionally, there was a 97 percent increase in commercial business property in frontage road areas whereas there were no observations in this category occurring in the post-construction period in areas of no frontage roads.

An examination of Table 20 indicates that the unimproved and agricultural properties, without adjustment for control, increased by a greater amount in areas

TABLE 18. CHANGES IN LAND VALUE OF ABUTTING PROPERTIES CONSTRUCTED WITH FRONTAGE ROADS AND NONABUTTING CONTROL AREAS AND INDEXES OF HIGHWAY INFLUENCE ON LAND PRICES[1]

Category	Change (In Dollars)		Percentage Change		Frontage Road Influence on Land Value in Study Areas[2]		
	Frontage	Nonabutting	Frontage	Nonabutting	Absolute	Index 1	Index 2
Unimproved (Per Acre)	7,906	6,806	291.19	103.36	1,100	40.52	187.83
Agriculture (Per Acre)	1,071	−316	48.83	−26.99	1,387	63.25	75.82
Urban Residence (Sq. Ft.)	.03240	0.27051	21.02	75.62	−0.23811	−154.53	−54.60
Commercial Business (Sq. Ft.)	.84117	−0.06374	81.39	−15.61	.90491	87.57	97.00
Industrial (Sq. Ft.)	NA[3]	0.02073	NA	4.51	NA	NA	NA

[1]From real estate sales adjusted to common dollars. See supporting tables in the Appendix for all property types and price index reciprocals.

[2]Absolute influence is difference between the absolute increases in the properties constructed with frontage roads and the nonabutting control area. Index 1 is the absolute influence expressed as a percentage of the pre-construction prices in the study area. Index 2 is the difference between the percentage increases in frontage road areas and nonabutting control areas.

[3]No industrial observations occurred in the frontage road category so no comparisons were possible.

TABLE 19. CHANGES IN LAND VALUE OF ABUTTING PROPERTIES CONSTRUCTED WITHOUT FRONTAGE ROADS AND NONABUTTING CONTROL AREAS AND INDEXES OF HIGHWAY INFLUENCE ON LAND PRICES[1]

Category	Change (In Dollars)		Percentage Change		Highway Influence on Land Value in Study Areas[2]		
	Nonfrontage	Nonabutting	Nonfrontage	Nonabutting	Absolute	Index 1	Index 2
Unimproved (Per Acre)	3,594	6,806	138.55	103.36	3,212	123.82	35.19
Agricultural (Per Acre)	277	— 316	36.98	— 26.99	593	79.17	63.97
Urban Residence (Sq. Ft.)	.04652	0.27051	110.97	75.62	0.22399	534.33	35.35
Commercial Business (Sq. Ft.)	NA[3]	—0.06374	NA	15.61	NA	NA	NA
Industrial (Sq. Ft.)	NA[4]	0.02073	NA	4.51	NA	NA	NA

[1]From real estate sales adjusted to common dollars. See supporting tables in the Appendix for all property types and price index reciprocals.

[2]Absolute influence is difference between the absolute increases in properties constructed without frontage roads and the nonabutting control area. Index 1 is the absolute influence expressed as a percentage of the pre-construction prices in the study areas. Index 2 is the difference between the percentage increases in nonfrontage road areas and nonabutting control areas.

[3]No commercial business observations occurred in the "after" period for the nonfrontage category so no comparisons were possible.

[4]No industrial observations occurred in the nonfrontage category so no comparisons were possible.

where frontage roads were constructed. Commercial properties seemingly are highly related to the presence of frontage roads. The implication being that frontage roads or access is a prime determinate for property to move into this type use.

If special benefits, as a result of frontage roads, are defined as being the net percentage differential increase between property values abutting areas where highway is constructed with frontage roads as opposed to those abutting areas where highway is constructed without frontage roads, the relationship $SB = VP_f - VP_n$ would hold for each property type, adjusted by nonabutting controls, where:

- SB = Special benefit.
- VP_f = Increase in value of each property type abutting on a facility constructed with frontage roads minus nonabutting controls.
- VP_n = Increase in value of each property type abutting on a facility constructed without frontage roads minus nonabutting controls.

A comparison utilizing this relationship indicates a net percentage differential increase of 152.64 for unimproved property abutting a facility constructed with frontage roads, an 11.85 differential for agricultural property, a 97.00 for commercial property, and a negative 89.95 for urban residential. This negative value does not necessarily mean that nonfrontage areas are better for residential development than frontage areas. Several alternative explanations could exist. First, the nonfrontage areas could have had a greater potential initially than did frontage areas for this type development; and second, properties that sold were possibly not representative of all existing sample properties in control and study areas; and finally, it seems, on the basis of personal inspection as a result of field work on the study, that the presence or absence of frontage roads has had minor influence on residential development. Of particular significance is the fact that commercial sales in areas where frontage roads were constructed had a 97 percent increase in the post-construction as compared with the pre-construction period, while no observations in the commercial category were found in the

TABLE 20. CHANGES IN LAND VALUE FOR HIGHWAY CONSTRUCTED WITH AND WITHOUT FRONTAGE ROADS[1]

Category	Increase (In Dollars)		Percentage Increase		Frontage Road Influence on Land Value in Study Areas[2]	
	Frontage	Nonfrontage	Frontage	Nonfrontage	Absolute	Percentage Differential
Unimproved (Per Acre)[3]	7,906	3,594	291.19	138.55	4,312	152.64
Agricultural (Per Acre)	1,071	277	48.83	36.98	794	11.85
Commercial Business (Sq. Ft.)	.84117	NA[4]	81.39	NA	NA	NA
Urban Residential (Sq. Ft.)	.03240	.04652	21.02	110.97	—.01412	— 89.95

[1]From real estate sales adjusted to common dollars by use of the Consumer Price Index. See supporting tables in the Appendix for calculations for all property types and price index reciprocals.

[2]Absolute influence is equal to the algebraic difference between absolute changes in frontage and nonfrontage observations. Percentage differential is the algebraic difference between percentage changes in prices in frontage and nonfrontage observations.

[3]Includes all properties classified by field inspection as either unimproved or held for future use.

[4]No commercial observations occurred in the "after" period for the nonfrontage category so no comparisons were possible.

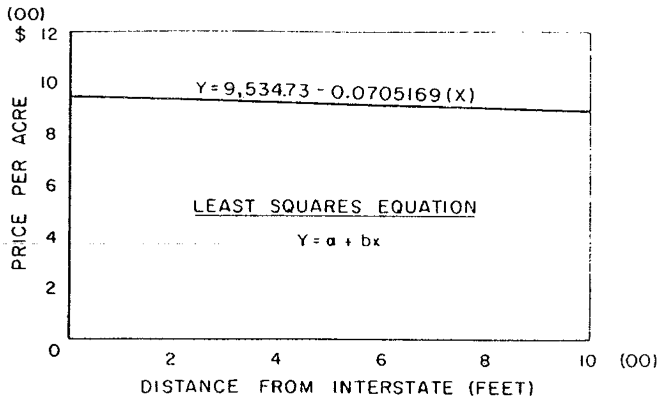


Figure 14. Simple correlation analysis between property price per acre and distance from highway.

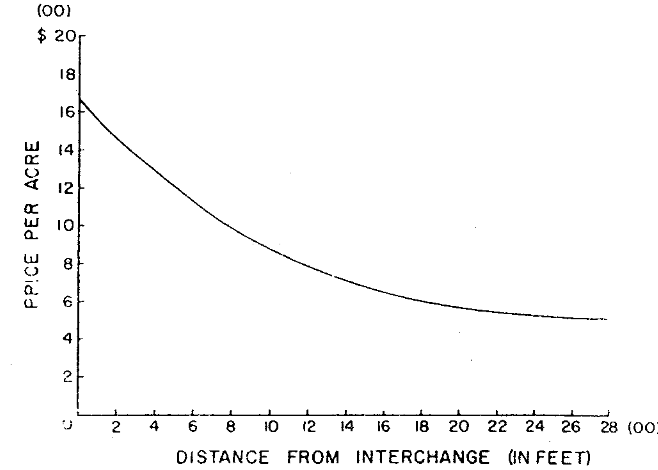


Figure 15. Relationship between property price per acre and distance from interchange.

post-construction period where no frontage roads were constructed.

The relationship between property price and distance from the interstate highway was examined by means of a simple correlation analysis. One hundred and eighty unimproved study and control observations were analyzed to ascertain if an inverse relationship between "bare land" prices and distance existed.

Figure 14 shows the values of the solved linear equation with price per acre on the vertical scale and distance from the interstate highway on the horizontal scale. The slope of the line indicates that price per acre decreases approximately seven cents per foot as distance from the facility increases.

The Influence of Interchanges and Ramps

Certain characteristics are associated with higher-than-average land values. A major factor related to significant increases in property value is relationship to what this study has called the "interchange complex." This complex includes the area encompassed by the interchange and related ingress and egress ramps.

The advantage of property being located in what was termed zone "B" of the complex was indicated by the earlier least squares analysis. The major disadvantage in this analysis was the assumption of linearity resulting in an equal spread of value over all properties located within the zone without regard to their particular location in relation to direction of traffic flow.

A closer examination of all abutting properties and their relation to the interchange revealed that proximity to the interchange held definite advantages. A half mile area, a distance often used to distinguish between interchange and noninterchange areas, was analyzed.[28]

Figure 15 illustrates the relationship between price per acre and distance from an interchange for 72 interchange observations. The vertical axis is price per acre in thousands of dollars and the horizontal axis is distance from the interchange expressed in feet. The points surrounding the curve are not individual observations but means calculated for various distances from the interchanges. The mean values fell between a high of $17,642 per acre for that directly on the interchange, to a low of $5,528 for that located approximately a half mile from the interchange. Figure 16 gives a visual interpretation of the percentage increase in property values within the influence of the "interchange complex."

An interesting relationship was found between distance from the interchange and the effect of being located at an egress ramp. The price per acre and distance from interchange curve has a pronounced "peak" at the ramp locations. All properties located at a zero distance from an egress ramp had a 204.79 percent increase in value between the before and after periods. These properties had a mean value of $14,432 in the post-construction period, Table 21.

A scatter diagram of interchange sales, relating price per acre and time, was examined. Value on a per acre basis and number of sales increase as completion of the facility approaches. Value declines after completion but number of sales increases. This is a logical relationship since more transactions are likely to occur after the facility is physically in place.

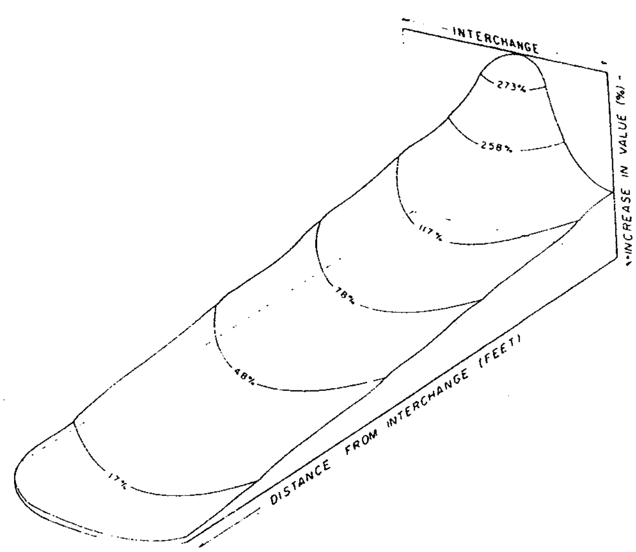


Figure 16. Percentage increase in property value within influence of the interchange complex.

The cluster of high values around the zero time period, or the highway completion date, probably has its basis in a physical reality associated with interchanges. There are a limited number of interchanges, and each interchange has only four quadrants. Additionally, these quadrants are of unlike quality, depending on unique design and probable or existing traffic flow. The high quality interchange parcels will be under vigorous competitive pressure as soon as construction begins and their design and location becomes relatively assured. For example, much of the competitive pressure for high quality interchange sites comes from the major oil companies for service station locations. These buyers are aware that there are a limited number of suitable interchange sites and if they wait until their competitor purchases a site it will, to all intents and purposes, be out of the market permanently since the competition is not likely to sell them the property. They may purchase alternate properties of somewhat lower or equal quality, but their competition may have purchased these also. Therefore, the intense competitive activity forces the price of the choice interchange properties upward.

Property Values After Completion of Highway Construction

As an alternative technique of analysis the average abutting property values were calculated for each individual land use category, utilizing only those property sales that occurred after completion of highway construction. The implicit assumption being that the properties that sold adequately reflected any necessary adjustments by nonabutting comparables. These post-construction abutting property values confirmed the land value increases observed in the before-after study in relation to the highway facility. Without exception, property abutting the highway where frontage roads had been constructed sold for a higher price than that abutting areas where no frontage roads had been constructed.

Abutting undeveloped per acre land values after completion of highway construction indicated that unimproved property and property held for future use sold for an average of $10.621 per acre where frontage roads had been constructed and $6.188 where no frontage roads had been constructed. Table 22. Buyers in the land market were willing to pay 42 percent more for abutting property with frontage roads in this category.

TABLE 21. RELATIONSHIP BETWEEN INCREASE IN PROPERTY VALUE BETWEEN PERIODS AND LOCATION WITHIN THE INTERCHANGE COMPLEX

Distance from Interchange	Price (Per Acre) Post-Construction Period	Increase Between Periods (Dollars)	Increase (Percent)
Interchange Property[1]	17,642	12,907	272.58
Property on Ramps[2]	14,432	9,697	204.79
Under 500 Feet[3]	16,731	11,996	258.34
500 - 1000 Feet	10,297	5,562	117.46
1000 - 1500 Feet	8,429	3,694	78.01
1500 - 2000 Feet	7,017	2,282	48.19
2000 - 2500 Feet	5,528	793	16.74

[1]Property located directly abutting the interchange-intersection complex.

[2]Property located at a zero distance from an egress ramp.

[3]Measured beginning with first tier of property behind that located directly on the interchange.

TABLE 22. ABUTTING LAND VALUES AFTER COMPLETION OF HIGHWAY CONSTRUCTED WITH AND WITHOUT FRONTAGE ROADS[1]

Property Category	Post-Construction Value		Difference	Percent
	Non-frontage	Frontage		
Unimproved[2] (Per Acre)	6,188	10,621	4,433	42
Agricultural (Per Acre)	1,026	3,264	2,238	69
Commercial[3] (Sq. Ft.)	NA	1.87455	NA	NA
Residential (Sq. Ft.)	.08844	.18649	.09805	53

[1]From real estate sales of all property types adjusted to common dollars by Consumer Price Index reciprocals.

[2]Includes all properties classified by field inspection as either unimproved or held for future use.

[3]No commercial observations occurred in the post-construction period for the nonfrontage category so no percentage differentials could be computed.

Although agricultural property sold for a smaller price than unimproved and held for future use properties, the large 69 percent difference between the average price per acre of abutting property with frontage roads as opposed to that with no frontage indicated that possible future changes into a higher land use were probably being incorporated into land values. The abutting agricultural properties with frontage roads sold for an average of $3.264 per acre whereas those without frontage roads sold for a more modest $1.026 per acre.

Abutting developed square foot values after completion of highway construction indicated that residential property sold for an average of .18649 per square foot where it abutted a facility constructed with frontage roads and .08844 where no frontage roads had been constructed. In other words, residential property abutting on frontage roads was 53 percent higher in value than property with no frontage roads constructed.

Commercial property sold for an average of $1.87455 per square foot where it abutted a facility constructed with frontage roads. Since no observations were observed in this category for the sample in the post-construction period it was not possible to compare the frontage values with the nonfrontage values. As previously stated, commercial properties are logically highly related to the presence of frontage roads as location on acceptable frontage is a prime determinate for property to move into this type use.

The abutting per acre land values in the "interchange complex" reinforced the finding that distance from the interchange and land value were highly related. The average post-construction per acre value of property located directly on the interchange was $17.642. Land values were progressively lower as distance away from the interchange increased. Average per acre value declined roughly $4.43, or .04 percent, per foot of distance away from the interchange within the area of the "interchange complex."

CHAPTER VI

Access In The Appraisal Process

While objective factors typically are of greater importance today in appraisal. subjective factors are given special weight as, for example, in connection with appraising for condemnation purposes. Price and value are considered to be synonymous terms only under conditions of theoretically perfect competition. Under actual conditions, of course, market prices may be far above or far below the prices which would have resulted under ideal market conditions. It is because the real estate market does not rank very high in effectiveness when compared with the markets of many other goods that appraisers are called upon to make value estimates. It takes a period of two, three, or more years for substantial additions to be made to the available supply of real estate. This time lag explains why there may be great variations between value and price of real property at a given time.

In arriving at his value estimates, an appraiser tends to assume conditions which will approximate a "perfect market," a "normal market," or some similar situation. For example, the appraiser usually assumes that both buyers and sellers are well informed, that they are free to act without compulsion, and that they will act rationally.

The concept of value that has evolved over a number of years, from the appraiser's standpoint, can be summarized as follows:

Value is not a characteristic inherent in an object (real property) itself, but depends upon the desires of man. It varies from man to man and from time to time as individual desires vary.

An object (real property) cannot have value unless it has utility. Utility is the ability to arouse desire for its possession.

Utility alone does not give an object (real property) value. It must also be relatively scarce. So utility plus scarcity are two of the elements creating value.

Utility and scarcity together do not confer value unless they arouse desire in the market of a purchaser who has the resources (purchasing power) to buy.[29]

In the appraisal process, the value that is generally of most interest is market value. This has been defined as "that price which a seller, willing but not compelled to sell, would accept from a buyer, willing but not compelled to buy." There have been other defintions offered, but they have been essentially the same as the above.[30]

Principles of Real Property Value

Real property values are based upon the economic principles of supply and demand, substitution, and marginal productivity. These values are also influenced by the principles of highest and best use, conformity, change, anticipation, contribution, competition, surplus productivity, and increasing and decreasing returns. The principle of highest and best use states that land is at its highest and best use when it is most likely to produce the greatest net return to land on investment. Conformity is used as a modifying factor for the principle of highest and best use because it alleges that land use should generally conform to the area around it. Change and antipication are closely linked because the former says that change is a way of life, while the latter is the expectations of these changes and the resulting benefits that will arise. According to the principle of contribution, the value of an item in production is measured by its contribution to the net return of the enterprise.[31]

Competition is one of the most familiar and readily recognized forces present at all levels of economic activity. It is a product of supply and demand. A study of the highest and best use of real property will take into consideration supply and demand factors to determine resulting probable use-density of various land use types.[32]

Surplus productivity is defined as the net income which remains after the costs of labor, capital, and entrepreneurship have been paid. This surplus can be credited to the land and tends to fix the land's value. Surplus productivity is dependent upon the principle of balance, the law of increasing and decreasing returns, and the proper proportioning of the four agents of production.[33] The principle of increasing and decreasing returns affirms that larger and larger amounts of the agents of production will produce greater and greater net income up to a certain point (the law of increasing returns). At this point, the maximum in value will have been developed (the point of decreasing returns). Any additional expenditures after this point will not produce a return commensurate with these additional investments (the law of decreasing returns).[34] Needless to say, the appraiser takes all of these principles into consideration when he estimates value.

The Appraisal Process

The methods an appraiser will apply in an estimation of value depend, to a great extent, upon the type of property being appraised. Property of the investment type, such as stores or office buildings, is valued on its ability to generate income. Property of a non-investment nature, such as a home, has its estimated value based upon actual sales of property of a like nature. Finally, estimated value for service property is based upon its replacement cost.[35]

The appraiser utilizes a standard procedure known as the appraisal process to estimate value. This is "an orderly program by which the problem is defined, the work necessary to solve the problem is planned, and the data involved are acquired, classified, analyzed, and interpreted into an estimate of value."[36]

The first step in any appraisal is the definition of the problem. The appraiser must define for his own information what property is to be appraised, the property rights involved, the purpose of the appraisal, and what value is to be estimated. He may then begin planning his appraisal and collecting the relevant data. The data are then classified and analyzed using three approaches to estimate value. The three approaches—cost, income, and market data—are based on three facets of value commonly thought of by appraisers:[37]

1. The current cost of reproducing a property less depreciation from all sources, that is, deterioration and functional and economic obsolescence.

2. The value which the property's net earning power will support, based upon a capitalization of net income.

3. The value indicated by recent sales of comparable properties in the market.

Appraisal for Right of Way Purposes

When an appraiser begins his appraisal of land that is to be used for highway right of way purposes, he follows a specified step by step procedure. This method is based upon various laws and court decisions and has its beginnings in the state's inherent power of eminent domain. The use of this power is limited by two United States constitutional amendments, the Fifth and the Fourteenth. The Fifth Amendment states ". . . nor shall private property be taken for public use without just compensation," while the Fourteenth states ". . . nor shall any state deprive any person of life, liberty, or property, without due process of law."[38] It is the "due process of law" clause which has given rise to the court procedures at the disposal of the landowner if he is dissatisfied with the state's offer.

It is generally agreed that if all the land owned by an individual is to be taken for right of way he should be paid the market price for that particular property. The problem arises in partial takings. A partial taking occurs whenever an individual has land remaining after the necessary amount is taken for right of way purposes. This remainder may incur damages because of the taking and it might also incur benefits due to the facility. Damages occur when the following elements are established: "(1) The whole property forms an inseparable optimum economic unit. (2) A physical part of the whole property is being taken. (3) The remaining property as an economic unit is worth less than prior to the taking of part of the property. (4) The reduction in value of the remainder is a *direct result* of the taking of part of the property."[39] Benefits are measured by the enhancements in value the remainder incurs because of its relationship to the facility.

There are three methods used by various states to determine the amount of compensation a landowner is to receive. The first of these is known as the "Before and After Rule." This consists in simply taking the value of what the landowner has after the taking and subtracting it from what he had before the taking. Twenty-six states use this method.[40] The second method is called the "Modified Before and After Rule." Twenty-three states use this method in the estimation of just compensation.[41] Just compensation in this case can be represented by the equation:

Value of the property to be taken as part of the whole.
\+ Difference between value of remainder as part of the whole before the taking and value of remainder after the taking.
— Any applicable benefits.

The final method, called the "Severed Land Concept," was established by a court case over 20 years ago in Texas.[42] This method of valuation is utilized only by Texas as a means of determining value. The amount that is to be paid the landowner is determined by:

Value of the land taken considered as *severed* land.
\+ Difference between the value of the remainder before the taking considered as severed land and the value of the remainder after the taking.
— Any allowable benefits.

The Appraisal of Access

Previous sections of this report present rather detailed theoretical and empirical data concerning the evaluation of access. Almost all the instances involving the denial of direct access were accomplished by the construction of a highway without frontage roads. On the other hand, owners with remainders along highways having frontage roads were paid significantly less in damages, due to offsetting benefits of access to their remainders.

The land value analysis confirmed the findings of the right of way cost analysis. In the case of the former, the sample of buyers and sellers in the market place considered that remainders located along sections of the Interstate System with frontage roads (having direct access) were worth more than those so located without frontage roads (not having direct access). This difference was not statistically significant. However, when access was considered directly with location (zone) or with time "before-after" opening of the facility, the differences in land value between the two groups of remainders were highly significant statistically.

The results of the above analyses indicate that the appraisers and purchasers of the remainders studied were in agreement that access granted by means of frontage roads adds to the total cost or value of such remainders. This fact is especially true of remainders within the interchange complex mentioned earlier.

As previously suggested, the market approach to value is the most accepted technique in establishing an estimate of the market value of real property involved in right of way acquisitions. This technique establishes at least the minimum value of a property as established by the "willing buyer and seller" concept. The technique generally fits more types of property than other approaches to value. Then too, this technique is perhaps the most sensitive and precise approach to use in valuing access and other property rights directly affecting the property involved.

Selection of Comparables

Inherent in the market approach used to value a particular property (either the whole property, the taking, the remainder "before," or the remainder "after") is the selection of comparable properties which have recently sold in the market place. A recent study of appraisal review problems indicates that comparable sales are considered by the majority of the Texas Highway Department review appraisers as being sufficient evidence of damages to remainders of right of way acquisitions.[43] Conversely, this also applies in the case of enhancements to remainders.

Two problems, brought out in the appraisal study, seem pertinent here. First, that of selecting comparables which are truly comparable to the subject, and second, that of making the proper adjustments on the selected comparables. To the Texas Highway Department review appraisers, the most common problem in right of way appraisal is documentation—which primarily means comparables selected and adjusted to the subject. The above problems are magnified in the appraisal of right of way to be acquired and remainders "before" and "after" acquisition. In these cases, odd shaped properties are created, making it rather difficult to locate adequate comparables. Right of way review appraisers indicate that partial takings result in the greatest differential between appraisal estimates on the same tract. The study further indicated that right of way fee appraisers are generally accurate in distinguishing between specific and general enhancements.[44]

Whole Property Comparables

The location and adjustment of appropriate comparables for the whole property is the first step in the "market value" approach. Ideally, the comparables should have the same type of access as the subject whole property. This ideal is seldom achieved in the real world. Under these circumstances a body of generalized knowledge can be a helpful guide. In one sense the aggregative empirical data analyzed in this report is a source of general knowledge or a so-called "rule of thumb" that may be applied in the evaluation of remainders.

For instance, the analysis revealed that unimproved remainder tracts granted access were worth more per tract than the same type of tracts with no access granted. For this to be acceptable as a "rule of thumb," the subject tract under consideration should be adjusted to the model as to average size, type use, location, etc., of those tracts which produced the above figure. To the extent which it does not, adjustments need to be made. A more accurate "rule of thumb" would be the value arrived at when access and location were considered together.

Remainder "Before" Comparables

There are few properties planned and offered for sale which fit the shape and size requirements of remainders created by right of way acquisitions. Thus, to evaluate the value of the remainder before, the original whole property comparables are sometimes utilized. As in the case of the "taking," the comparables (used to estimate land value) are adjusted to the remainder before features. Changes in highest and best use, *access*, location, size, shape, and etc., are taken into account. The accuracy of these adjustments depends on how much the remainder differs from the comparables and the experience of the individual appraiser. The land value of the remainder is established by adjusting unimproved comparables, and any improvements are evaluated by the cost approach.

Remainder "After" Comparables

The present study indicates that the value of the remainder "after" fluctuates to a considerable extent depending on the type of access coupled with its location along the new highway. The study evaluated access and location on the basis of whether remainders were abutting a facility with or without frontage roads. Texas Highway Department review appraisers were asked several questions about identical "farm" remainders, one abutting a frontage road facility and another abutting a nonfrontage road facility. This was the only difference assumed between the two remainders. Both of the original tracts were assumed to be of the same size, fronting on a farm to market road, and well removed from city influence. The overwhelming majority of the review appraisers concluded that the tract without frontage roads would likely involve the highest right of way cost, would constitute the most difficult appraisal, and would be considered by themselves and the general public to be the least desirable to own. Conversely, they considered that the tract having access to frontage roads would receive a special benefit.[45]

The Net Access Equation

With the exception of property characteristics, the above difference in the type of access was the method utilized in the present study to measure the value of access. All properties were evaluated, both separately and jointly, for such factors as access and location with respect to the interchange complex. The special benefit associated with access was defined in terms of frontage road location. The equation $SB = VP_f - VP_n$ was used to denote the relationship between access differentials. This equation can be further elaborated to include a variable to adjust for locational differences. The identity for net access benefits is now $SB_a = (VP_f - VP_n) \pm L_n$, where:

SB_a = Net access special benefit to abutting remainders attributed to frontage roads, adjusted for locational differences along the facility.

VP_f = Net differential in value of remainder abutting on a facility constructed with frontage roads minus value of nonabutting comparable.

VP_n = Net differential in value of remainder abutting on a facility constructed without frontage roads minus value of nonabutting comparable.

L_n = Net adjustment for differences in location along the facility with respect to interchanges and ramps.

The coefficient SB_a derived from an aggregative study such as this can logically only be utilized as a general "rule of thumb" in the appraisal of specific access features of any particular remainder. Nevertheless, the equation defines the factors to be considered and illustrates the landscape to be evaluated for the appraisal of access in the overall "bundle" of factors that are considered by the professional appraiser.

Values can also be derived wholly from the use of comparables which reflect the above value adjustments necessary to evaluate the highway access (special benefit) attributable to the remainder "after." In this case, coefficient values would not be needed. Such a technique would require comparables of the type indicated in the formula to arrive at the estimate of special benefits in the form of access. To enumerate, there would need to be comparables for the abutting remainders with frontage roads, abutting remainders without frontage roads, and nonabutting properties near the subject remainder. It is unlikely that comparables of every type could be found nearby. Additionally, some locational differences would need to be taken into account. Seldom would you find abutting nonfrontage comparables nearby to the subject property. Almost equally as difficult would be the location and selection of nonabutting comparables. This is especially true in the case of odd shaped remainders. These comparables must be selected to reflect general benefits or damages due to the highway which cannot be taken into account in determining the value of the remainder "after."

The key to the utilization of either method—that is, relying on coefficients from aggregate studies to adjust comparables or wholly on comparables—is: one, selecting comparables with characteristics as similar to the subject property as possible, and two, making necessary adjustments (using coefficients or otherwise) to the comparables. The end result will be a value placed on access. The value of access coupled with the values placed on the other features of the remainder "after" will be the appraiser's final estimate which will be compared with the remainder value "before" to determine damages and enhancements to properties under consideration.

This approach has stressed the role played by comparable properties in the various appraisals involved in a partial taking, with emphasis on valuing access as a specific benefit. An effort has been made to indicate how coefficients derived from aggregate analyses can be used in the appraisal of remainders associated with property acquired for highway purposes.

REFERENCES

1. U. S. Department of Commerce, Bureau of Public Roads, *Manual For Highway Severance Damage Studies*, Washington, D. C.: Highway and Land Administration Division, 1961, p. 1.
2. *Interim Report to the Texas Highway Department, Project RP-14*, Texas Transportation Institute, Texas A&M University, 1959, p. 34.
3. Bayard O. Wheeler, *The Effect of Freeway Access Upon Suburban Real Property Values*, Washington: State Council For Highway Research, 1956, p. 98.
4. U. S. Congress, *Federal Aid Highway Act of 1944*, Public Law 521, 78th Congress, 2d Session, 1944, p. 5.
5. U. S., *Statutes at Large*, Vol. 70, p. 374.
6. U. S., Bureau of Public Roads, *Federal Laws, Regulations, and Other Materials Relating to Highways*, p. 127.
7. *Right of Way Manual*, Book 1, Edition III, Texas Highway Department, Right of Way Division, p. 38.
8. Texas, *Constitution*, Art. I, Sec. 17.
9. *Taylor County v. Olds* (Tex. Civ. App.), 67 S. W. 2d 1102.
10. W. E. Kuhn, *The Evolution of Economic Thought*, Chicago: Southwestern Publishing Company, 1963, p. 8.
11. Arthur M. Weimer, "History of Value Theory For the Appraiser," *Selected Readings in Real Estate Appraisal*, Chicago: American Institute of Real Estate Appraisers, 1953, p. 52.
12. *Ibid.*, p. 53.
13. *Ibid.*, p. 54.
14. *Ibid.*, p. 56.
15. *Ibid.*
16. George L. Schmutz, *Condemnation Appraisal Handbook* (Revised by Edwin M. Rams), Englewood Cliffs: Prentice-Hall, Inc., 1963, p. 130.
17. Department of Commerce, *op. cit.*, p. 5.
18. *Ibid.*, p. 78.
19. *Ibid.*, p. 82.
20. *Ibid.*
21. Schmutz, *op. cit.*, p. 175.
22. *Ibid.*, p. 185.
23. Herbert Mohring and Mitchell Harwitz, *Highway Benefits: An Analytical Framework*, Illinois: Northwestern University Press, 1962, p. 9.
24. William G. Adkins, *Effects of Expressways on Urban Land Values*, Paper Presented to First Institute For Tax Assessors, Austin, Texas, December 7-8, 1959, p. 4.
25. *State v. Meyer*, 403 S. W. 2d 366.
26. Richard V. Ratcliff, *A Restatement of Appraisal Theory*, Madison: University of Wisconsin, 1963, p. 48.
27. Charles T. Davies, "Bridging the Gap Between Land Economic Studies and Their Application I," *American Right of Way Association, Proceedings*, Denver, Colorado, June 5-10, 1966, p. 18.
28. Floyd I. Thiel, "Bridging the Gap Between Land Economic Studies and Their Application II," *Ibid.*, p. 21.
29. American Institute of Real Estate Appraisers, *The Appraisal of Real Estate*, Chicago: American Institute of Real Estate Appraisers, 1964, p. 19.
30. For a detailed discussion of the economics of market value, eminent domain, the approximation of market value, and the property market, see my paper, *Economic Theory and Land Acquisition*, presented to the Regional Watershed Planning Economists' Conference, San Antonio, Texas, February 11-13, 1963.
31. American Institute of Real Estate Appraisers, *The Appraisal of Real Estate*, *op. cit.*, p. 36.
32. *Ibid.*, p. 43.

33. *Ibid.*, p. 33.

34. *Ibid.*, p. 35.

35. Stanley L. McMichael, *McMichael's Appraising Manual.* Englewood Cliffs: Prentice-Hall, Inc., 1964, p. 28.

36. American Institute of Real Estate Appraisers, *op. cit.*, p. 46.

37. *Ibid.*, p. 63.

38. U. S., *Constitution.*

39. Schmutz, *op. cit.*, p. 94.

40. *Ibid.*, p. 97.

41. *Ibid.*

42. *State v. Carpenter* (Tex. Civ. App.). 89 S. W. 2d 194.

43. W. G. Adkins and Jesse L. Buffington, *An Analysis of Right of Way Appraisal Problems*, Research Report 100-1F. Texas Transportation Institute, Texas A&M University, 1967.

44. *Ibid.*

45. *Ibid.*

APPENDIX A

Mathematical Derivation of Least Squares Parameters

If an estimator is needed for land prices in an area, one method would be to take a simple arithmetic average of all land prices in that area. However, if size of the parcel being sold was believed to influence the price of the land then a better method of land price estimation would take this factor into account. This could be done by plotting on a graph the points of the land price and its corresponding size. A line could then be drawn through these points so that the sum of the distances to this line from these points is at a minimum. But this will encounter some difficulty because a line could be drawn so that it was lying any distance above one point and the same distance below another point. The sum of the distances to the line would be at a minimum at zero. Any distances could be used and virtually any line "fitted" to the data. In order to overcome this the deviations are squared and then summed, hence sum of squares. This residual sum of squares is to be minimized. Mathematically, this is done as follows:

If a linear relationship exists between land prices (called Y) and size of property being sold (called X), an estimate of Y ($\hat{Y}$) can be expressed as $\hat{Y} = a + bX$ where the values given to a and b are such that the residual sum of squares is to be at a minimum.

Let

$$R = Y - \hat{Y}$$
$$= Y - a - bX$$

The residual R must be squared and summed over all points.

$$\sum_{i=1}^{N} R_i^2 = \sum_{i=1}^{N} (Y_i - a - bX_i)^2$$

To find the values of a and b so that ΣR^2 is at a minimum the partial derivatives taken with respect to a and b and equated to zero must be found.

or

$$(1) \qquad \frac{\partial \left(\sum_{i=1}^{N} (Y_i - a - bX_i)^2 \right)}{\partial a}$$
$$= 2 \sum_{i=1}^{N} (Y_i - a - bX_i) = 0$$

$$(2) \qquad \frac{\partial \left(\sum_{i=1}^{N} (Y_i - a - bX_i)^2 \right)}{\partial b}$$
$$= 2 \sum_{i=1}^{N} (Y_i - a - bX_i) = 0$$

Solving for a in equation (1) gives

$$\frac{\sum_{i=1}^{N} Y_i - b \sum_{i=1} X_i}{N} = a$$

or

$$a = \overline{Y} - b\overline{X}$$

Solving for b in equation (2) gives

$$\frac{\sum_{i=1}^{N} X_i Y_i - \frac{\sum_{i=1}^{N} Y_i \sum_{i=1}^{N} X_i}{N}}{\sum_{i=1}^{N} X_i^2 - \frac{\left(\sum_{i=1}^{N} X \right)^2}{N}} = b$$

or

$$b = \frac{\sum_{i=1}^{N} (Y_i - \overline{Y})(X_i - \overline{X})}{\sum_{i=1}^{N} (X_i - \overline{X})^2}$$

Thus a and b can now be determined so that the residual sum of squares is at a minimum.

The multiple regression model, $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \ldots B_NX_N$ can have any number of independent variables (X's). Thus, any measurable factors that are considered to affect the price of land may be taken into account using this technique. The development of the multiple regression equation is simi-

ANOVA Table

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Corrected S of S	N-1	$\sum_{i=1}^{N} (Y_i - \bar{Y})^2$		
Regression S of S	M	$B'y$	$\frac{B'y}{M}$	$\frac{\text{Regression Mean Square}}{\text{Residual Mean Square}}$
Residual	N-M-1	$\sum_{i=1}^{N} (Y_i - \hat{Y}_i)^2$	$\frac{\sum_{i=1}^{N} (Y_i - \hat{Y}_i)^2}{N-M-1}$	

lar to the simple one above except a set of normal equations must be solved.

In order to determine the relative and statistical significance of the factors used in the regression model, the total sum of squares must be partitioned in the following manner:

$$\text{Total Sum of Squares} = \sum_{i=1}^{N} Y_i^2$$

$$\text{Corrected Sum of Squares} = \sum_{i=1}^{N} Y_i^2 - \frac{\left(\sum_{i=1}^{N} Y_i\right)^2}{N}$$

Corrected Sum of Squares = Sum of Squares Due to Regression + Sum of Squares of Deviations About Regression Line.

To determine if the regression is significant, the following analysis of variance table is constructed and F test performed.

Where B' is the beta vector, y is the sum of cross products vector, and M is the number of independent variables excluding B_0. The level of confidence that may be placed in a regression equation is a function of the degrees of freedom and the corresponding F ratio. Generally, if the F ratio ≤ 1 little or no confidence may be placed in the regression equation. This simply means that the arithmetic mean of Y is probably as good an estimator of Y as the regression equation.

The other analysis of variance table used in this study is constructed so that the significance of the independent variables can be tested. This is accomplished using an F test with the same ratio criterion as above. As an indication of relative contribution of the model the variables can be ranked based upon either this F ratio or upon their respective mean square term.

APPENDIX B

The Total Cost and Land Cost Least Squares Models

The Total Cost Model

Since the discrete variables consisted of more than one level it was not possible to interpret the model as a single equation, therefore, the solutions are presented as Table 8 with all calculated values given. The alpha term in the equation is the Y intercept. This is the value that would be given to land if all independent variables were equal to zero.

The regression statement says, in effect, that within this range of observations, if the land parcel was acquired by negotiation then $1,300.69 would be subtracted from the estimated cost Y_1. If the parcel was not granted access then $64.71 would be added to Y_1. Thus, each discrete variable ("how property was acquired," "type of property," "access granted," "property severance," and "area where property was located") contributes to the estimated total cost. The amount contributed is determined by the particular characteristics of each individual land parcel. The influence of the interaction terms are calculated similarly except that now the levels of two variables must be considered in order to determine the correct coefficient. As an example, if the land parcel were obtained from Area Seven and was not divided ("severance x area") then the contribution from this set of circumstances will be minus $2,335.87. The statistical significance of the regression is shown in the analysis of variance, Table 23.

The reduction in sum of squares attributable to the coefficients can be tested for significance by the use of the "F" test. In this case the regression is statistically

TABLE 23. RIGHT OF WAY COST TOTAL COST MODEL OVERALL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	30,454,442,000		
Due to Coefficients	37	16,812,423,000	454,389,810	10.125**
Error	304	13,642,019,000	44,875,062	

**Significant at .99 level of confidence.

TABLE 24. TOTAL COST MODEL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	30,454,442,000		
How Acquired	1	179,540,900	179,540,900	4.00*
Type of Property	4	844,505,200	211,126,300	4.71**
Access	1	1,072,160	1,072,160	.02
Severance	1	35,341	35,341	.00
Area	9	2,910,667,300	323,407,480	7.21**
How Acquired x Area	9	1,098,074,000	122,008,230	2.72**
Access x Severance	1	153,112,070	153,112,070	3.41'
Severance x Area	9	858,790,860	95,421,206	2.13*
Size of Taking	1	946,293,300	946,293,300	21.09**
Size of Remainder	1	195,874,810	195,874,810	4.36*
Error	304	13,642,021,000	44,875,069	

*Significant at .95 level of confidence.
**Significant at .99 level of confidence.
'Significant at .90 level of confidence.

significant at the .99 level of probability. This indicates that there was a functional relationship between the dependent variable "total cost" and the various independent variables that were used. It also indicates that the regression equation is more useful as a prediction of the total cost than an arithmetic mean.

Table 24 demonstrates the significance of the individual coefficients. The "F" test indicates that with two exceptions all variables were statistically significant at the .90 level of confidence. Access and severance were left in the "total" model as they subsequently became significant in the "damage" model. The logic of this change in statistical significance will be examined in the model dealing with damages. From this table it is possible to visualize the influence and interplay of the various factors observed in arriving at the statistical estimation of the total cost paid for an individual parcel in the study.

The Land Cost Model

The second step in the analysis of the data was the development of the total land cost model. In this instance the response variable Y_2 equals the total land cost of each parcel observed in the sample. The independent variables are the same as those utilized in the total cost model. This is a necessary logical model design in that the dependent variables themselves are interrelated in the sense that they are additive, resulting in the coefficients also being additive. Due to the multileveled nature of the discrete variables, it was not feasible to interpret the analysis as a single equation, therefore, the solutions are presented as the "land cost" column in Table 8, with all calculated values indicated. The alpha term in the equation is the intercept: the value that would be attributed to land if all independent variables examined in the model were equal to zero. The interpretation of the coefficients is the same methodology utilized in the previous model.

The derivation of the estimated total cost of any given parcel involves the selection of the applicable characteristics, or independent variables, of the parcel as calculated in the "total land cost" table, summing the values, in dollars, of the variables and their interactions to arrive at the given individual estimate.

TABLE 25. RIGHT OF WAY COST LAND COST MODEL OVERALL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	24,125,576,000		
Due to Co-efficients	37	11,697,116,000	316,138,270	7.73**
Error	304	12,428,460,000	40,883,092	

**Significant at .99 level of confidence.

The percentage of variation in the dependent variable that is explained by the analysis is again expressed as a double set of calculations. Dividing the sums of squares due to regression by the total sum of squares yields .54745 for the total land cost model. Dividing the sums of squares due to the coefficients by the corrected sum of squares yields .48484 for the model. The statistical significance of the model is indicated in the analysis of variance, Table 25.

The reduction in sum of squares attributable to coefficients is again tested for significance by the use of the "F" test. In the case of the land cost analysis, the model is statistically significant at the .99 level of probability. The indication of a functional relationship between the dependent variable "land cost" and the complex of independent variables is still implied by this analysis.

Table 26 illustrates the significance of the individual coefficients relating to the land cost model. The "F" test is again calculated for three levels of statistical confidence. Access, expressed as the absence or presence of frontage roads in the analysis, is not significant as a factor in the land cost model. This is a logical consequence due to the nature of the appraisal process since this is a factor interrelated with the calculation of damages. Since the land cost model is designed as an indicator of only price paid for land, not including that paid for damages, access would not be expected to be

TABLE 26. LAND COST MODEL ANALYSIS OF VARIANCE

Source	d.f.	Sum of Squares	Mean Squares	F
Total	341	24,125,576,000		
How Acquired	1	148,988,120	148,988,120	3.64'
Type of Property	4	488,470,580	122,117,650	2.99*
Access	1	6,598,605	6,598,605	.16
Severance	1	13,061,433	13,061,433	.32
Area	9	3,035,667,600	337,296,400	8.25**
How Acquired x Area	9	1,155,838,900	128,426,550	3.14**
Access x Severance	1	98,910,968	98,910,968	2.42
Severance x Area	9	753,654,250	83,739,360	2.05*
Size of Taking	1	468,035,710	468,035,710	11.45**
Size of Remainder	1	58,188,610	58,188,610	1.42
Error	304	12,428,463,000	40,883,102	

*Significant at .95 level of confidence.
**Significant at .99 level of confidence.
'Significant at .90 level of confidence.

a major determinate of the estimate. It does, however, become significant in the "damage" model examined in a previous section.

It should be remembered that the present model is an estimation of only the cost of land and does not include damages which are analyzed in a separate model. The internal interrelationships and statistical significance of the individual variables is logical when examined in the framework of appraisal theory. The variables "access," "severance," and "size of remainder" would not enter into consideration as factors in the price paid for the parcel taken, but would be a determinate in evaluating the amount of damages associated with an individual parcel. Their lack of significance in the present model is an indication of the internal consistency of the model under examination.

The behavior of the "F" tests for the access and severance variables in the models perhaps deserves additional consideration. Neither variable was significant in either the "total cost" or "land cost" model. However, they both became significant in the "damages" model. Statistically, this can be explained by recalling the fact that what is being tested is that the individual coefficients are different from zero. If one was zero, there would be no regression because there would not exist a functional rate of change between the independent and dependent variables.

The value of the access coefficients in the "total cost" model were ±$64.71 and the value of the severance coefficients were ±$15.43. Both of these are somewhat small and close to zero and affect in only a minute way the rate of change of the total cost of right of way. The magnitudes of these coefficients in the "land cost" and "damage" models are almost the same but with opposite signs, therefore, when the two models are summed to obtain the "total cost" model, the summation of the coefficients for access and for severance almost results in cancellation. This means that the coefficients are relatively close to zero and are found to be nonsignificant in this particular instance.

The coefficients are also found to be nonsignificant in the "land cost" model. This is true even though at first glance the coefficients seem to be far from zero. The access coefficient equals ± $160.54 and the severance coefficient equals ±$296.60. However, upon closer examination, the coefficients were not large when expressed as a percentage of the means obtained by holding all other variables constant. The presence of access as a percentage of the mean was only 4.68 percent and the absence of access was 5.17 percent. Severance of the property was only 9.98 percent of the mean and no severance was only 8.32 percent. Viewed in this manner it can be seen that in the "land cost" model the coefficients in question added less than 10 percent to the means in estimating the land cost.

APPENDIX C

Price-Profile Case Studies

Ten observations were selected for the purpose of case study from those included in the random cost model. These were selected in order to demonstrate the relative predictability of the statistical model in relation to the actual cost incurred in acquiring the parcels. One observation was selected from each of the ten geographic areas utilized in the model.

From these case studies it is possible to visualize the influence and interplay of the various factors observed in arriving at a statistical estimation of the total price paid for an individual parcel and how that price was divided between land cost and damages. It can be inferred from the information contained in these case studies that a model such as the one used in this analysis yields a fairly reliable estimate of the contribution of the various factors to the price-profile of the parcel and consequently, the total price that would be required to acquire the parcel. Table 27 illustrates the efficiency of the statistical equations in the estimation of total price, land cost, and damages paid for the ten case studies under consideration.

TABLE 27. SUMMARY OF THE TEN CASE STUDIES

	Average Total Price	= Average Land Cost	+ Average Damages
Estimated Value	$9,276.39	$6,715.80	$2,560.61
Actual Value	8,425.18	6,030.42	2,394.77
Difference in Value	851.21	685.38	165.84
Percentage Differential	10.10	11.37	6.93

The format used for the presentation of each case study consists of the following parts:

1. A paragraph relating the physical characteristics of the particular parcel, including the actual total price, land cost, and damages.

2. A bar chart showing the contribution of each variable to the estimated total price, land cost, and damages. This illustrates the relative influence each variable had in the estimation of the three costs. To arrive at the net estimated cost for any one of the three costs, the negative contribution is subtracted from the positive contribution.

3. A table giving the dollar and percentage contributions of the individual variables to the estimates of total price, land cost, and damages paid.

Case Number One

This parcel was acquired through the process of condemnation. It was a residence at the time of taking. The size of the taking was 19.28 acres and the size of the remainder was 203.55 acres. The remainder was divided by the facility (approximately 182 acres on the south side and approximately 20 acres on the north side). The actual total cost of acquiring the parcel was $14,313.07, land cost was $10,473.70, and damages paid amounted

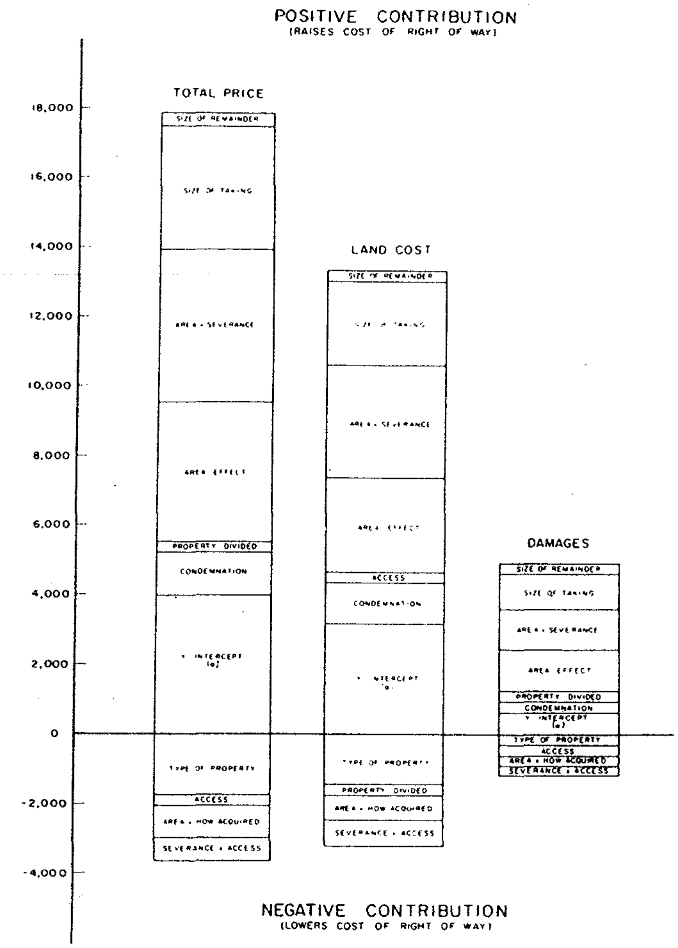


Figure 17. Contribution of individual characteristics to estimated total price, land cost, and damages, case study one.

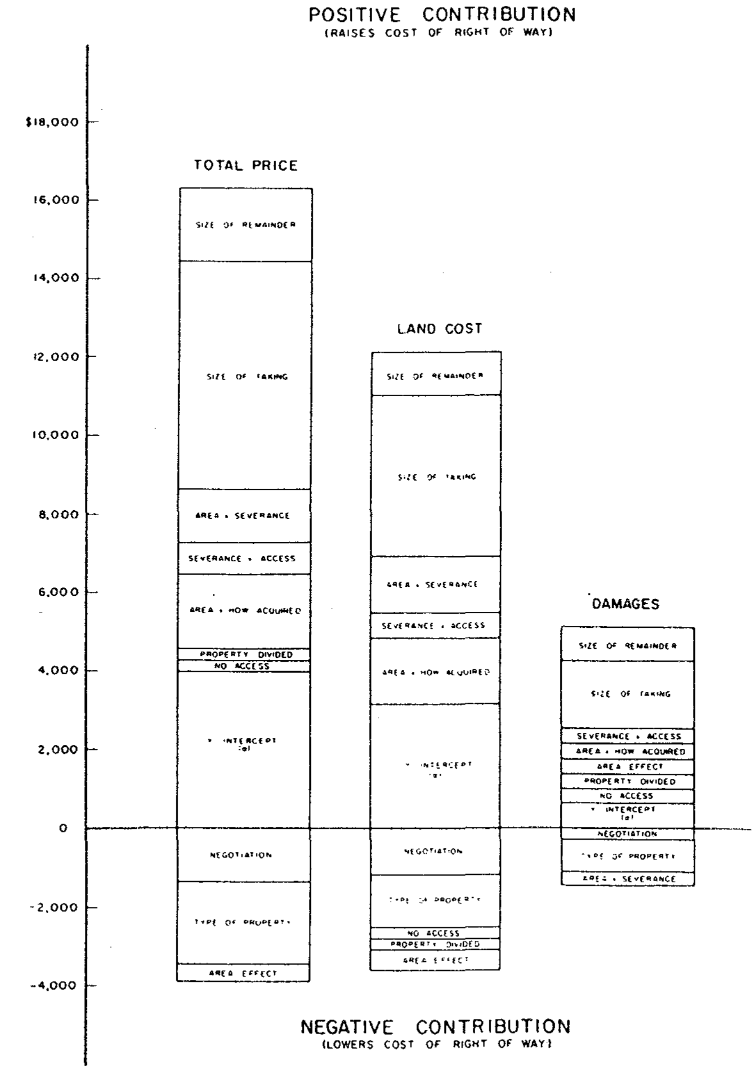


Figure 18. Contribution of individual characteristics to estimated total price, land cost, and damages, case study two.

to $3,839.37. Access was granted to the remainder. Figure 17 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for the individual parcel are given in Table 28.

Case Number Two

This parcel was acquired through negotiation. It was unimproved at the time of taking. The size of the taking was 31.60 acres and the size of the remainder was 452.40 acres. The remainder was divided by the facility. The actual total price of the parcel was $10,668.95, land cost was $7,458.78, and damages were $3,210.17. Access was not granted to the remainder. Figure 18 illustrates the contribution of each variable to the estimated

TABLE 28. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY ONE

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	27.97	$ 3,268.67	31.21	$ 734.28	19.13
Condemnation	1,300.69	9.09	1,184.86	11.31	115.83	3.02
Type of Property	– 1,851.42	– 12.94	– 1,605.33	– 15.33	– 246.09	– 6.41
Access	– 64.71	– .45	160.54	1.53	– 225.36	– 5.87
Property Divided	15.43	.11	– 296.60	– 2.83	312.03	8.13
Area Effect	4,059.99	28.37	2,899.69	27.68	1,160.30	30.22
Area x How Acquired	– 879.42	– 6.14	– 491.67	– 4.69	– 387.75	– 10.10
Severance x Access	– 758.03	– 5.30	– 609.26	– 5.82	– 148.77	– 3.88
Area x Severance	4,504.30	31.47	3,228.22	30.82	1,276.09	33.24
Size of Taking	3,561.21	24.88	2,504.47	23.91	1,056.74	27.53
Size of Remainder	421.97	2.95	230.45	2.20	191.53	4.99
Total Estimate	$14,312.97	100.00	$10,474.04	100.00	$3,838.93	100.00

TABLE 29. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY TWO

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	33.59	$ 3,268.67	38.54	$ 734.28	21.38
Negotiation	– 1,300.69	–10.92	– 1,184.86	–13.97	– 115.83	– 3.37
Type of Property	– 2,175.99	–18.26	– 1,350.61	–15.92	– 825.37	–24.03
No Access	64.71	.54	– 160.54	1.89	225.26	6.56
Property Divided	15.43	.13	– 296.60	3.50	312.03	9.08
Area Effect	– 464.34	– 3.90	– 584.39	6.89	120.06	3.50
Area x How Acquired	1,968.28	16.52	1,608.83	18.97	359.46	10.47
Severance x Access	758.03	6.36	609.26	7.18	148.77	4.33
Area x Severance	1,347.41	11.31	1,449.35	17.09	– 101.94	– 2.97
Size of Taking	5,836.84	48.98	4,104.84	48.40	1,732.00	50.43
Size of Remainder	1,863.89	15.64	1,017.90	12.00	845.99	24.63
Total Estimate	$11,916.51	100.00	$ 8,481.85	100.00	$3,434.71	100.00

total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for the individual parcel are given in Table 29.

Case Number Three

This parcel was acquired through negotiation. It was unimproved at the time of taking. The size of the taking was 13.43 acres and the size of the remainder was 109.97 acres. The remainder was divided by the facility. The actual total price of the parcel was $637.58, land cost was $538.81, and damages were $98.77. Access was granted to the remainder. Figure 19 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 30.

Case Number Four

This parcel was acquired through negotiation. It was unimproved at the time of taking. The size of the taking was 2.92 acres and the size of the remainder was 8.50 acres. The remainder was not divided by the facility. The actual total price of the parcel was $1,696.50, land cost was $1.621.10, and damages amounted to $75.40. Access was granted to the remainder. Figure 20 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 31.

Case Number Five

This parcel was acquired by condemnation. It was a commercial business at the time of taking. The size of the taking was 27.04 acres and the size of the remain-

TABLE 30. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY THREE

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$4,002.94	558.37	$ 3,268.67	671.49	$ 734.28	319.04
Negotiation	–1,300.69	–181.43	– 1,184.86	–243.41	–115.83	– 50.33
Type of Property	–2,175.99	–303.53	– 1,350.61	–277.46	–825.37	–358.62
Access	– 64.71	– 9.03	160.54	32.98	–225.26	– 97.88
Property Divided	15.43	2.15	– 296.60	– 60.93	312.03	135.58
Area Effect	–2,523.38	–351.98	– 2,417.19	– 496.57	–106.19	– 46.14
Area x How Acquired	950.69	132.61	970.08	199.29	– 19.39	– 8.42
Severance x Access	– 758.03	–105.74	– 609.26	–125.16	–148.77	– 64.64
Area x Severance	– 363.10	– 50.65	– 46.00	– 9.45	–317.09	–137.78
Size of Taking	2,480.66	346.03	1,744,56	358.39	736.10	319.83
Size of Remainder	453.08	63.20	247.43	50.83	205.64	89.35
Total Estimate	$ 716.90	100.00	$ 486.78	100.00	$230.15	100.00

TABLE 31. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY FOUR

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$4,002.94	249.60	$ 3,268.67	208.86	$734.28	1,892.96
Negotiation	–1,300.69	– 81.10	– 1,184.86	– 75.71	–115.83	– 298.61
Type of Property	–2,175.99	–135.68	– 1,350.61	– 86.30	–825.37	–2,127.79
Access	– 64.71	– 4.03	160.54	10.26	–225.26	– 580.72
Property Not Divided	– 15.43	– .96	296.60	18.95	–312.03	– 804.41
Area Effect	–1,760.82	–109.79	– 1,432.31	– 91.52	–328.51	– 846.89
Area x How Acquired	1,102.21	68.73	630.57	40.29	471.65	1,215.91
Severance x Access	758.03	47.27	609.26	38.93	148.77	383.53
Area x Severance	483.84	30.17	168.70	10.78	315.14	812.43
Size of Taking	539.35	33.63	379.31	24.24	160.05	412.61
Size of Remainder	35.02	2.18	19.13	1.22	15.90	40.99
Total Estimate	$1,603.75	100.00	$ 1,565.00	100.00	$ 38.79	100.00

TABLE 32. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY FIVE

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$4,002.94	30.19	$ 3,268.67	40.88	$ 734.28	13.95
Condemnation	1,300.69	9.81	1,184.86	14.82	115.83	2.20
Type of Property	6,222.73	46.92	4,784.06	59.83	1,438.68	27.32
Access	−64.71	−.49	160.54	2.01	−225.26	−4.28
Property Divided	15.43	.12	−296.60	−3.71	312.03	−5.93
Area Effect	−3,005.29	−22.66	−3,293.46	−41.19	288.16	−5.47
Area x How Acquired	676.84	5.10	−1,246.64	−15.59	1,923.48	36.53
Severance x Access	−758.03	−5.72	−609.26	−7.62	−148.77	−2.83
Area x Severance	−1,343.59	−10.13	−135.11	−1.69	−1,208.47	−22.95
Size of Taking	4,994.56	37.66	3,512.50	43.93	1,482.06	28.15
Size of Remainder	1,219.52	9.20	666.00	8.33	553.52	10.51
Total Estimate	$13,261.09	100.00	$ 7,996.56	100.00	$5,265.54	100.00

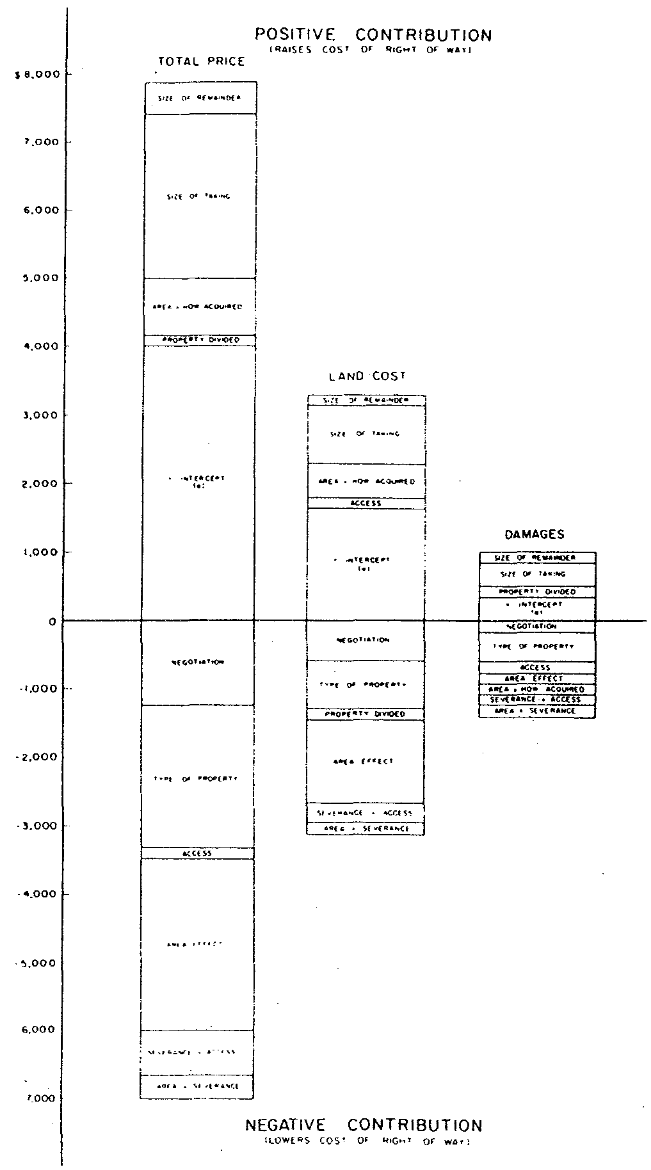


Figure 19. Contribution of individual characteristics to estimated total price, land cost, and damages, case study three.

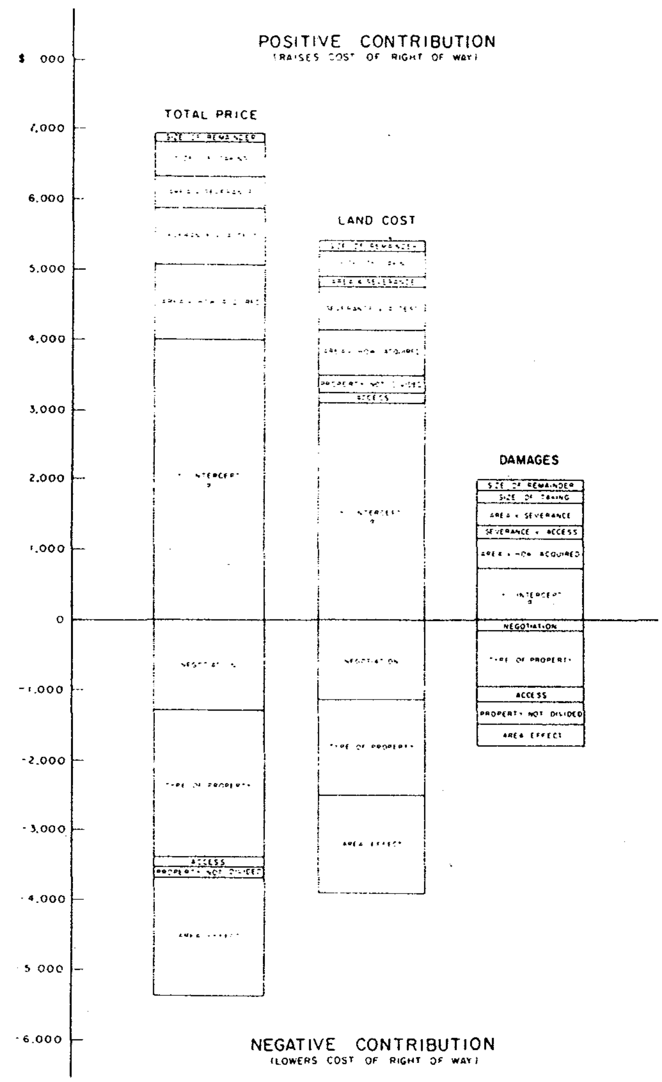


Figure 20. Contribution of individual characteristics to estimated total price, land cost, and damages, case study four.

der was 296.00 acres. The remainder was divided by the facility. The actual total price of the parcel was $9,386.50, land cost was $5,164.64, and damages were $4,221.86. Access was granted to the remainder. Figure 21 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 32.

Case Number Six

This parcel was acquired through the process of negotiation. It was a commercial business at the time of taking. The size of the taking was 8.00 acres and the size of the remainder was 1,169.35 acres. The remainder was not divided by the facility. The actual total price of the parcel was $22,785.00, land cost was $20,832.00, and damages were $1,953.00. Access was granted to the remainder. Figure 22 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 33.

Case Number Seven

This parcel was acquired by the process of negotiation. It was a residence at the time of taking. The size of the taking was 16.34 acres and the size of the remainder was 246.89 acres. The remainder was divided by the facility. The actual total price of the parcel was $6,768.91, land cost was $4,254.19, and damages were $2,514.72. Access was granted to the remainder. Figure 23 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 34.

Case Number Eight

This parcel was acquired by the process of condemnation. It was unimproved at the time of taking. The size of the taking was 9.01 acres and the size of the remainder was 116.95 acres. The remainder was not divided by the facility. The actual total cost of the parcel was $1,172.53, land cost was $976.41, and damages amounted to $196.13. Access was granted to the remainder. Figure 24 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 35.

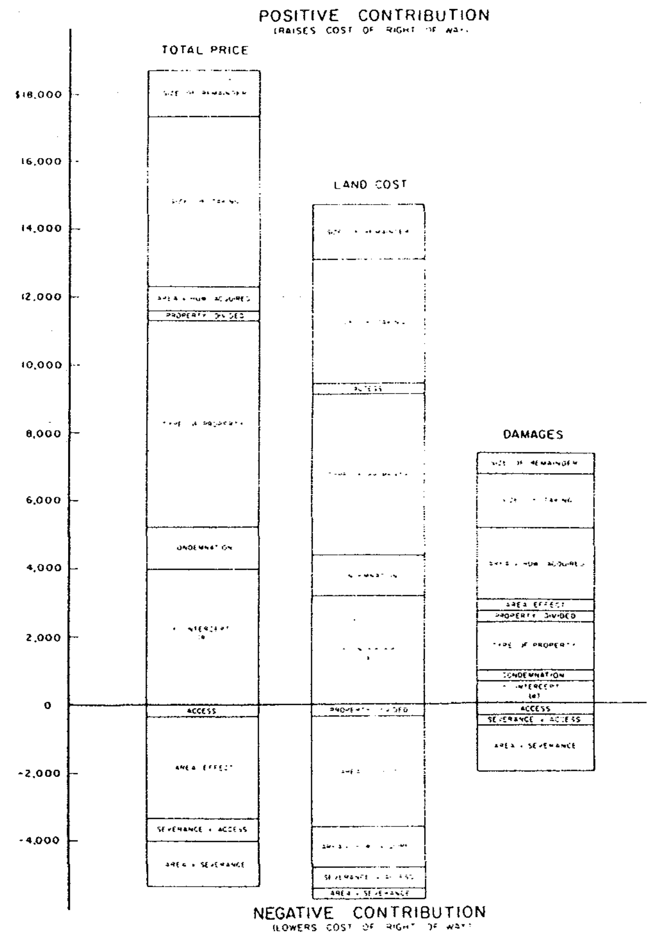


Figure 21. Contribution of individual characteristics to estimated total price, land cost, and damages case study five.

TABLE 33. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY SIX

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	16.46	$ 3,268.67	15.45	$ 734.28	23.18
Negotiation	− 1,300.69	− 5.35	− 1,184.86	− 5.60	− 115.83	− 3.66
Type of Property	6,222.73	25.59	4,784.06	22.62	1,438.68	45.41
Access	− 64.71	− .27	160.54	.76	− 225.26	− 7.11
Property Not Divided	− 15.43	− .06	296.60	1.40	− 312.03	− 9.85
Area Effect	9,669.53	39.76	10,490.86	49.60	− 821.34	−25.92
Area x How Acquired	− 5,868.26	−24.13	− 6,383.89	−30.18	515.63	16.28
Severance x Access	758.03	3.12	609.26	2.88	148.77	4.70
Area x Severance	4,621.30	19.00	5,441.13	25.72	− 819.84	−25.88
Size of Taking	1,477.68	6.08	1,039.20	4.91	438.48	13.84
Size of Remainder	4,817.72	19.81	2,631.04	12.44	2,186.68	69.02
Total Estimate	$24,320.84	100.00	$21,152.61	100.00	$3,168.22	100.00

TABLE 34. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY SEVEN

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	55.95	$ 3,268.67	75.96	734.28	25.75
Negotiation	– 1,300.69	–18.18	– 1,184.86	–27.54	– 115.83	– 4.06
Type of Property	– 1,851.42	–25.88	– 1,605.33	–37.31	– 246.09	– 8.63
Access	– 64.71	– .90	160.54	3.73	– 225.26	– 7.90
Property Divided	15.43	.22	– 296.60	– 6.89	312.03	10.94
Area Effect	3,288.27	45.96	2,138.75	49.70	1,149.52	40.31
Area x How Acquired	– 2,548.26	–35.62	– 1,799.41	–41.82	– 748.85	–26.26
Severance x Access	– 758.03	–10.59	– 609.26	–14.16	– 148.77	– 5.22
Area x Severance	2,335.87	32.65	1,552.36	36.08	783.51	27.47
Size of Taking	3,018.16	42.18	2,122.57	49.33	895.60	31.40
Size of Remainder	1,017.19	14.22	555.50	12.91	461.68	16.19
Total Estimate	$ 7,154.75	100.00	$ 4,302.93	100.00	$2,851.82	100.00

TABLE 35. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY EIGHT

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	277.78	$ 3,268.67	249.56	$ 734.28	–559.41
Condemnation	1,300.69	90.26	1,184.86	90.46	115.83	88.24
Type of Property	– 2,175.99	–151.00	– 1,350.61	–103.12	– 825.37	–628.81
Access	– 64.71	– 4.49	160.54	12.26	– 225.26	–171.61
Property Not Divided	– 15.43	– 1.07	296.60	22.64	– 312.03	–237.72
Area Effect	– 3,090.02	–214.43	– 2,786.20	–212.72	– 303.82	–231.46
Area x How Acquired	– 1,464.40	–101.62	– 1,232.14	– 94.07	– 232.26	–176.95
Severance x Access	758.03	52.60	609.26	46.52	148.77	113.34
Area x Severance	43.85	3.04	– 274.73	– 20.98	318.58	242.71
Size of Taking	1,664.24	115.49	1,170.40	89.36	493.84	376.23
Size of Remainder	481.83	33.44	263.14	20.09	218.70	166.62
Total Estimate	$ 1,441.03	100.00	$ 1,309.79	100.00	$ 131.26	100.00

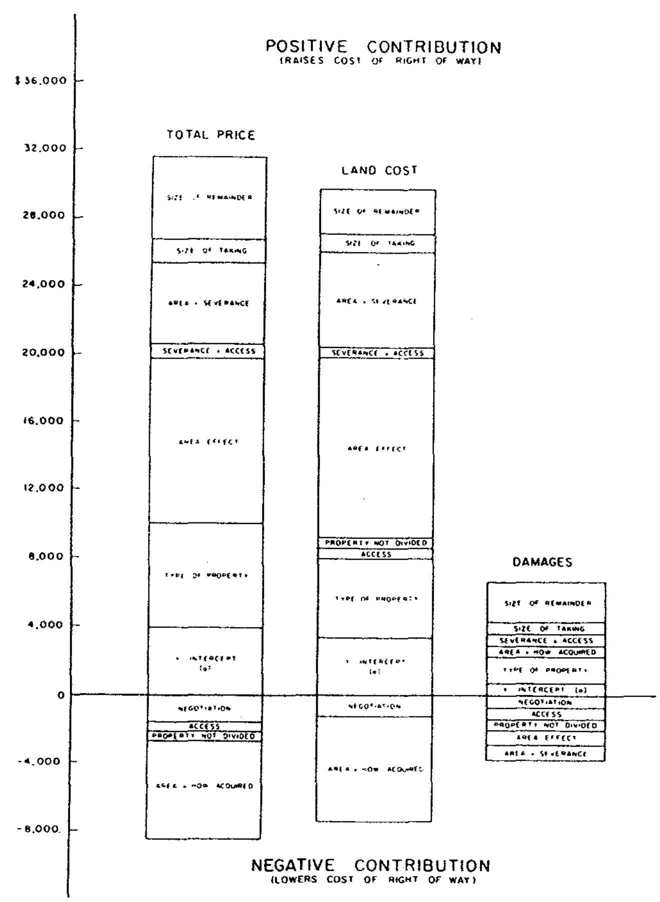


Figure 22. Contribution of individual characteristics to estimated total price, land cost, and damages, case study six.

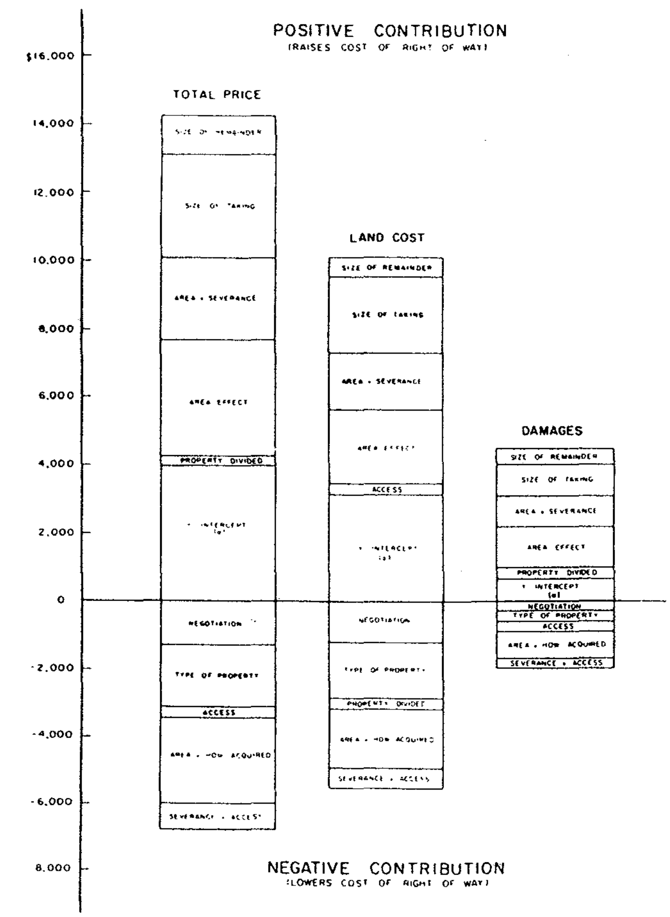


Figure 23. Contribution of individual characteristics to estimated total price, land cost, and damages, case study seven.

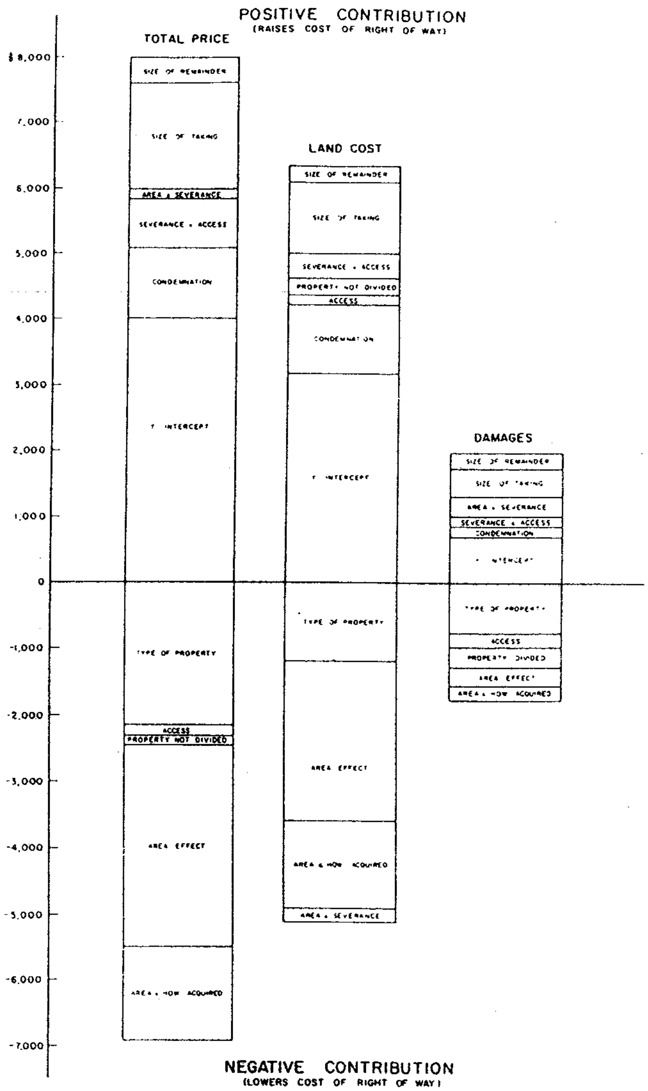


Figure 24. Contribution of individual characteristics to estimated total price, land cost, and damages, case study eight.

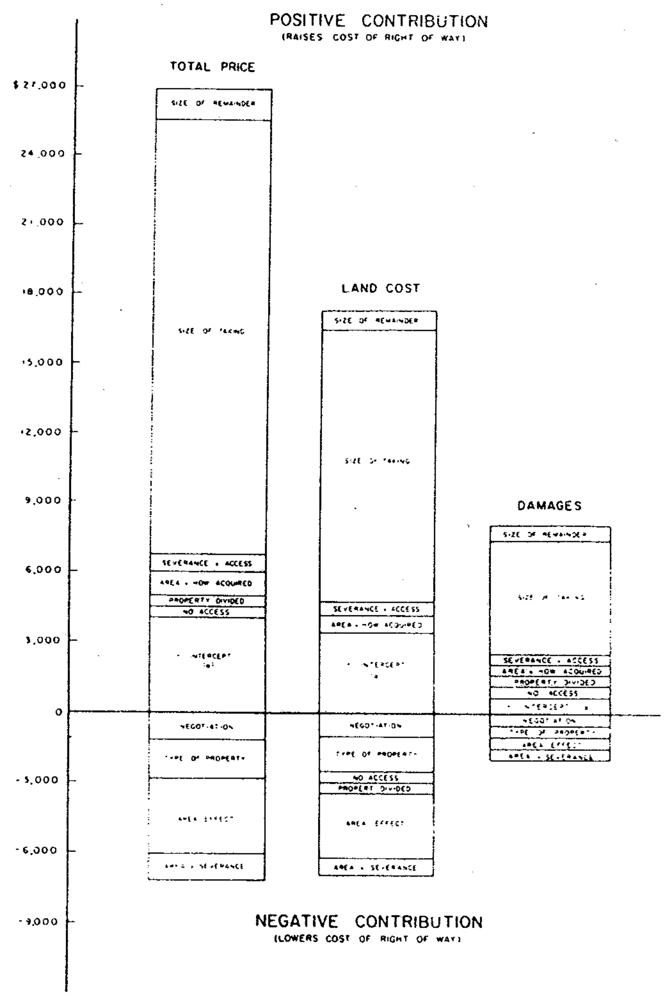


Figure 25. Contribution of individual characteristics to estimated total price, land cost, and damages, case study nine.

TABLE 36. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY NINE

Variable	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	23.95	$ 3,268.67	31.05	$ 734.28	11.87
Negotiation	− 1,300.69	− 7.78	− 1,184.86	− 11.26	− 115.83	− 1.87
Type of Property	− 1,851.42	− 11.08	− 1,605.33	− 15.25	− 246.09	− 3.98
No Access	64.71	.39	− 160.54	− 1.53	225.26	3.64
Property Divided	15.43	.09	− 296.60	− 2.82	312.03	5.04
Area Effect	− 3,337.22	− 19.97	− 2,835.22	− 26.93	− 502.00	− 8.11
Area x How Acquired	1,103.63	6.60	869.46	8.26	234.17	3.78
Severance x Access	758.03	4.54	609.26	5.79	148.77	2.40
Area x Severance	− 1,153.08	− 6.90	− 826.26	− 7.85	− 326.82	− 5.28
Size of Taking	16,755.04	100.25	11,783.23	111.94	4,971.81	80.36
Size of Remainder	1,656.08	9.91	904.41	8.59	751.67	12.15
Total Estimate	$16,713.45	100.00	$10,526.22	100.00	$6,187.25	100.00

Case Number Nine

This parcel was acquired by the process of negotiation. It was a residence at the time of taking. The size of the taking was 90.71 acres and the size of the remainder was 401.96 acres. The remainder was divided by the facility. The actual total cost of the parcel was $15,650.93, land cost was $8,063.94, and damages were $7,587.00. Access was not granted to the remainder. Figure 25 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 36.

Case Number Ten

This parcel was acquired by the process of negotiation. The property was unimproved at the time of taking. The size of the taking was 12.96 acres and the size of the remainder was 35.05 acres. The remainder was not divided by the facility. The actual total price of the parcel was $1,171.87, land cost was $920.64, and damages amounted to $251.23. Access was not granted to the remainder. Figure 26 illustrates the contribution of each variable to the estimated total price, land cost, and damages. The dollar amount and percentage contribution of the model estimation of total price, land cost, and damages for this parcel are given in Table 37.

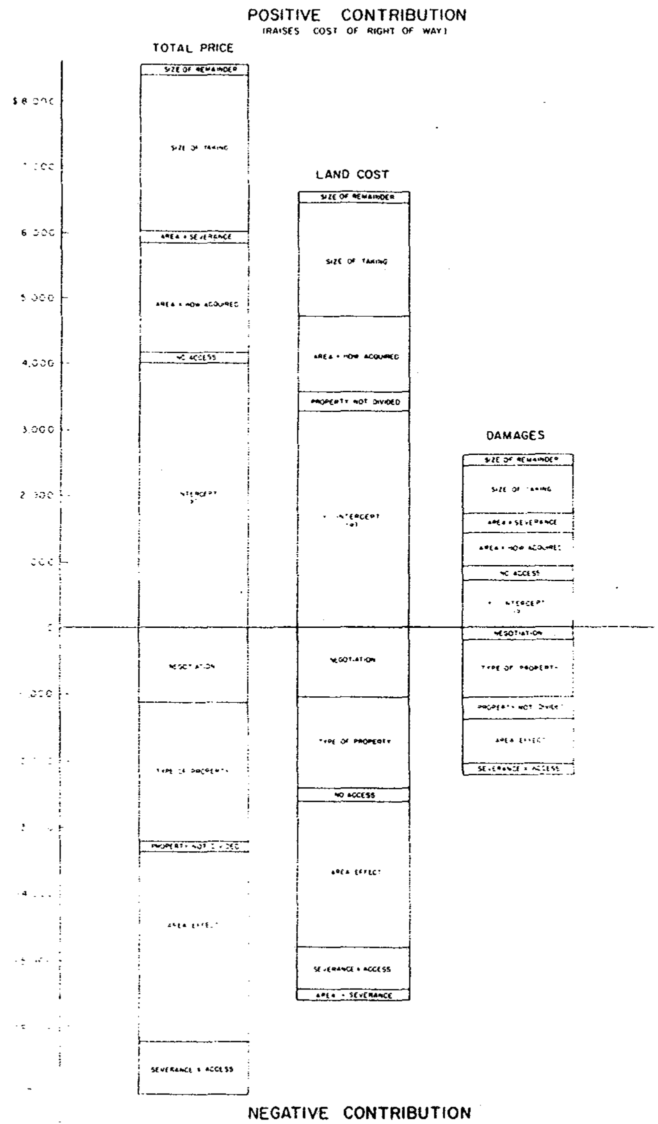


Figure 26. Contribution of individual characteristics to estimated total price, land cost, and damages, case study ten.

TABLE 37. DOLLAR AND PERCENTAGE CONTRIBUTION OF INDIVIDUAL VARIABLES CASE STUDY TEN

Variables	Total Price	Percent Contribution	Land Cost	Percent Contribution	Damages	Percent Contribution
α (Intercept)	$ 4,002.94	302.66	$ 3,268.67	378.67	$734.28	159.82
Negotiation	−1,300.69	98.34	− 1,184.86	−137.26	−115.83	− 25.21
Type of Property	−2,175.99	− 164.52	− 1,350.61	−156.47	−825.37	−179.65
No Access	64.71	4.89	− 160.54	− 18.60	225.26	49.03
Property Not Divided	− 15.43	− 1.17	296.60	34.36	−312.03	− 67.92
Area Effect	−2,836.72	214.48	− 2,180.53	−252.61	−656.19	−142.83
Area x How Acquired	−1,624.93	122.84	1,133.91	131.36	490.80	106.83
Severance x Access	− 758.03	57.31	− 609.26	− 70.58	−148.77	32.38
Area x Severance	178.82	13.52	− 112.54	− 13.04	291.40	63.43
Size of Taking	2,393.84	181.00	1,683.50	195.03	710.34	154.61
Size of Remainder	144.41	10.92	78.86	9.14	65.54	14.27
Total Estimate	$1,322.59	100.00	$ 863.20	100.00	$459.43	100.00

APPENDIX D

Supporting Tables Utilized In Land Value Analysis

TABLE 38. PRICE PER ACRE BY MONTH-YEAR SOLD FOR ALL LAND SALES UTILIZED IN LAND VALUE ANALYSIS

Price Per Acre	-100 To -80	-80 To -60	-60 To -40	-40 To -20	-20 To 0	0 To 20	20 To 40	40 To 60	60 To 80	80 To 100	Total
0 - 2,000	5	16	19	24	24	33	29	25	3	1	179
2,000 - 4,000	4	9	15	18	6	20	11	9	0	0	92
4,000 - 6,000	1	5	12	11	9	15	8	6	0	0	67
6,000 - 8,000	1	5	2	7	8	15	7	2	0	0	47
8,000 - 10,000	0	1	5	5	4	13	8	5	2	0	43
10,000 - 12,000	0	6	4	4	4	6	12	3	0	0	39
12,000 - 14,000	1	2	4	3	2	5	4	1	0	0	24
14,000 - 16,000	0	2	1	1	2	6	7	1	0	0	20
16,000 - 18,000	0	1	4	3	1	3	1	2	1	0	16
18,000 - Over	0	6	12	11	36	56	53	12	1	3	190
Total	12	53	78	87	96	172	140	66	7	4	715

TABLE 39. PRICE PER ACRE BY LAND USE FOR ALL LAND SALES UTILIZED IN LAND VALUE ANALYSIS

Price Per Acre	Land Use: Unimproved	Agricultural Land	Rural Residence	Urban Residence	Commercial Business	Industrial	Total
0 - 2,000	83	33	15	34	8	5	178
2,000 - 4,000	49	4	3	25	10	1	92
4,000 - 6,000	27	3	0	23	13	1	67
6,000 - 8,000	19	1	1	17	6	3	47
8,000 - 10,000	19	3	1	16	4	0	43
10,000 - 12,000	17	0	1	19	2	1	39
12,000 - 14,000	7	0	0	15	0	0	24
14,000 - 16,000	2	0	1	13	2	1	19
16,000 - 18,000	5	0	0	10	2	0	17
18,000 - 20,000	4	0	1	3	2	0	10
20,000 - 22,000	1	1	0	8	1	0	11
22,000 - 24,000	1	0	0	5	1	0	7
24,000 - 26,000	3	0	1	5	1	3	13
26,000 - 28,000	3	0	0	8	3	1	15
28,000 - Over	20	0	2	98	9	5	134
Total	260	45	26	299	64	21	715

TABLE 40. PERCENTAGE DISTRIBUTION OF LAND SALES IN RELATION TO TIME PERIODS UTILIZED IN LAND VALUE ANALYSIS

Period	Abutting (Percent) Frontage	Nonfrontage	Nonabutting (Percent)	Total Percent
Before	37.21	57.69	56.25	52.87
After	62.79	42.31	43.75	47.13
Total	100.00	100.00	100.00	100.00

TABLE 42. LAND USE BY INFLUENCE OF SURROUNDING LAND FOR ALL LAND SALES UTILIZED IN LAND VALUE ANALYSIS

Land Use	Influence of Surrounding Land: Negative	No Effect	Positive	Total
Unimproved	105	122	33	260
Agricultural Land	4	39	2	45
Rural Residence	12	13	1	26
Urban Residence	175	74	50	299
Commercial Business	16	40	8	64
Industrial	2	18	1	21
Total	314	306	95	715

TABLE 41. LAND USE CHANGES IN THE BEFORE AND AFTER PERIODS—NONABUTTING SALES

Land Use	Before	Percent	After	Percent	Total	Percent
Unimproved	105	33.33	76	31.02	181	32.32
Agricultural	8	2.54	10	4.08	18	3.21
Rural Residence	10	3.17	6	2.45	16	2.86
Urban Residence	151	47.94	131	53.47	282	50.36
Commercial Business	25	7.94	17	6.94	42	7.50
Industrial	16	5.08	5	2.04	21	3.75
Total	315	100.00	245	100.00	560	100.00

TABLE 43. LAND USE BY TOPOGRAPHY FOR ALL LAND SALES UTILIZED IN LAND VALUE ANALYSIS

Land Use	Topography					
	Wooded	Cleared	Total	Rolling	Flat	Total
Unimproved	41	219	260	60	200	260
Agricultural Land	21	24	45	35	10	45
Rural Residence	11	15	26	10	16	26
Urban Residence	38	261	299	52	247	299
Commercial Business	9	55	64	8	56	64
Industrial	6	15	21	10	11	21
Total	126	589	715	175	540	715

TABLE 44. LAND USE DISTRIBUTION BY TIME OF SALE UTILIZED IN LAND VALUE ANALYSIS

Land Use	Before	After	Total
Unimproved	135	125	260
Agricultural Land	14	31	45
Rural Residence	15	11	26
Urban Residence	164	135	299
Commercial Business	36	28	64
Industrial	16	5	21
Total	380	335	715

TABLE 45. CHANGES IN VALUE OF PROPERTIES WITH NO FRONTAGE ROADS BY LAND CLASSIFICATION CATEGORY

Category	Before Period (In Dollars)	After Period (In Dollars)	Difference (In Dollars)	Percent Change
Unimproved (Per Acre)	2,594	6,188	3,594	138.55
Agricultural (Per Acre)	749	1,026	277	36.98
Commercial Business (Sq. Ft.)	.01331	NA	NA	NA
Urban Residential (Sq. Ft.)	.04192	.08844	.04652	110.97

TABLE 46. CHANGES IN VALUE OF PROPERTIES WITH FRONTAGE ROADS BY LAND CLASSIFICATION CATEGORY

Category	Before Period (In Dollars)	After Period (In Dollars)	Difference (In Dollars)	Percent Change
Unimproved (Per Acre)	2,715	10,621	7,906	291.19
Agricultural (Per Acre)	2,193	3,264	1,071	48.83
Commercial Business (Sq. Ft.)	1.03338	1.87455	0.84117	81.39
Urban Residential (Sq. Ft.)	.15409	.18649	0.03240	21.02

TABLE 47. CHANGES IN VALUE OF NONABUTTING PROPERTIES BY LAND CLASSIFICATION CATEGORY

Category	Before Period (In Dollars)	After Period (In Dollars)	Difference (In Dollars)	Percent Change
Unimproved (Per Acre)	6,585	13,391	6,806	103.36
Agricultural (Per Acre)	1,171	855	− 316	− 26.99
Rural Residence (Per Acre)	7,423	3,589	− 3,834	− 51.65
Urban Residence (Sq. Ft.)	0.35773	0.62824	0.27051	75.62
Commercial Business (Sq. Ft.)	0.40831	0.34457	−0.06374	− 15.61
Industrial (Sq. Ft.)	0.45994	0.48067	0.02073	4.51

TABLE 48. TABLE UTILIZED IN CALCULATION OF DEPTH AND WIDTH FACTORS

Maximum Depth/Width (In Feet)	Length of Interval (In Feet)
0 - 100	10
101 - 200	20
201 - 300	30
301 - 400	40
401 - 500	50
501 - 600	60
601 - 700	70
701 - 800	80
801 - 900	90
901 - 1000	100
1001 - 1100	110
1101 - 1200	120
1201 - 1300	130
1301 - 1400	140
1401 - 1500	150
1501 - Over	160

APPENDIX E

Additional Material Utilized in Overall Study

CONSUMER PRICE INDEX

As a means of measuring price changes, constant dollars were calculated and presented in the analysis of this report. The actual dollars were multiplied by the reciprocal of the Consumer Price Index for the United States, as published by the U. S. Department of Commerce, Bureau of Labor Statistics, to arrive at the constant dollar value.

Below is a listing of the Consumer Price Index and its reciprocal for each year involved. The base was 1947-49 = 100.

Year	Index	Reciprocal
1956	116.2	0.861
1957	120.2	0.832
1958	123.5	0.810
1959	124.6	0.803
1960	126.5	0.791
1961	127.9	0.782
1962	129.3	0.773
1963	131.0	0.764
1964	132.6	0.754
1965	134.4	0.744

Location of Study Areas in Random Cost Model

Block Number	Interstate Highway Number	County	Project Number	Limits
1	10	Waller and Fort Bend	I-10-7(35)748 9012-3-15	From FM 1463 in Katy To FM 359 in Brookshire
2	10	Jefferson	I-10-8(26)846 9020-3-12	From 0.2 miles north of Walden Road To FM 365
3	20	Smith	I-20-6(5)537 9010-2-3	From Van Zandt County line east To 0.5 miles east of U.S. 69 south of Lindale
4	30	Bowie	I-30-3(21)144 9019-4-9	From Whaley west To west of FM 2552
5	35	Williamson	I-35-3(24)260 9014-5-9	From 3.3 miles north of Georgetown To 2.0 miles south of Georgetown
6	35W	Denton	I-35W-6(51)451 9018-5-10	From Interstate 35 interchange in Denton S.W. To FM 407
7	35W	Denton	I-35W-6(47) 9018-5-11	From FM 407 To Tarrant County line
8	30	Hopkins	I-30-2(19)80 9001-4-6	From Caney Creek east To Franklin County line
9	20	Smith	I-20-6(6)551 9010-2-5	From near U.S. 69 east To near U.S. 271 8.3 miles west of Gregg Cty ln
10	20	Kaufman	I-20-5(16)489 9018-2-7	From U.S. 80 interchange near Brushy Creek To near State Highway 34

Location of Study Areas in Land Sale Model

Study Area Number	Interstate Highway Number	County	Project Numbers	Limits
1	45	Montgomery	I-45-1(51)85 I-45-1(33)91	From U.S. 75 north To League line road
2	45	Walker	I-45-2(1)113	Intersection of FM 1374 and Intersection of S.H. 30
3	35E	Dallas	I-35E-6(38)441	From S.H. 114 Intersection north To Dallas city limits
4	20	Taylor	I-20-2(17)274	From Loop 320 east To Callahan County line
5	45	Navarro	I-45-3(36)229	From U.S. 287 To Ellis County line
6	35	Hill	I-35-4(37)372	From S.H. 22 To IH 35E
7	45	Harris	I-45-1(21)57 I-45-1(38)60 I-45-1(37)67	From Little York Road north To Montgomery County line
8	20	Smith	I-20-6(5)537 I-20-6(14)551 I-20-6(6)551 I-20-6(8)565	From Van Zandt County line To Gregg County line
9	10	Colorado	I-10-6(1)705	From S.H. 71 To FM 102

APPENDIX F

The Land Sale Data Edit Program

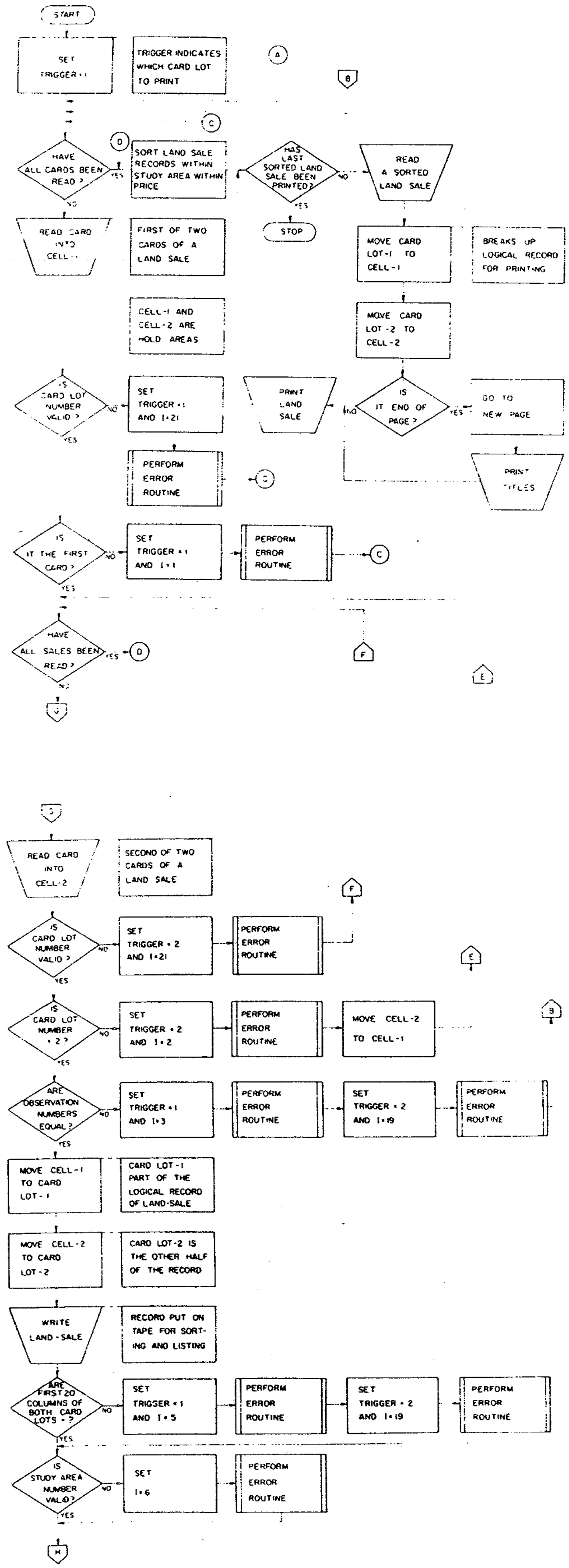
In any statistical analysis, reasonable accuracy of input data is a necessity. The program included in the study was developed in order to check the land sale data prior to analysis. The editing of information was accomplished at two stages of data processing; during input and output. Input editing ensured that the data were accurate and in proper form for the processing procedure. This increased the probability of data reliability. The procedures included the following tests and operations:

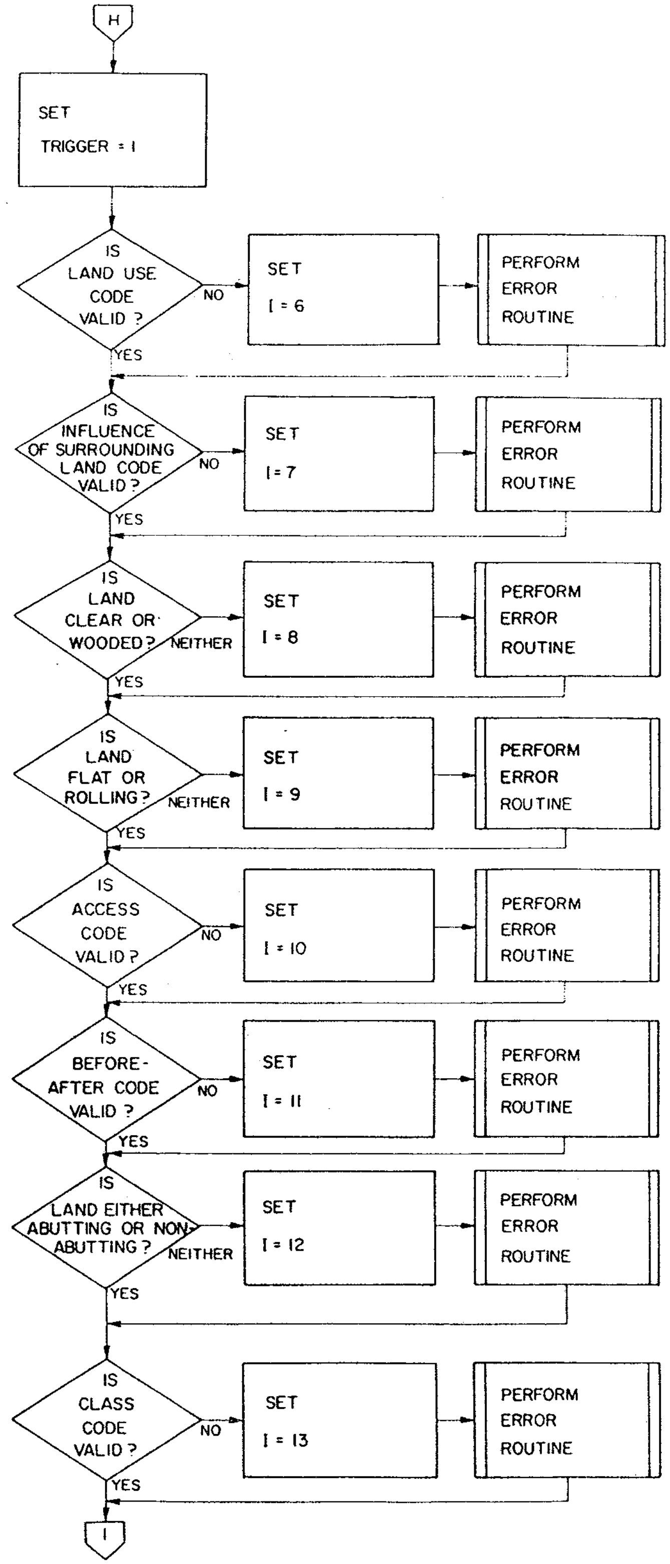
1. Field content—determines numeric and alphabetic field correctness.
2. Accuracy of numeric data.
3. Completeness of data.
4. Code compatibility.
5. Rearranges character sequence, if necessary.
6. Expand or compress data.
7. Remove non-numeric data from input data to be used in arithmetic operations.
8. Examine internal consistency.
9. Check for correspondence of data with files.

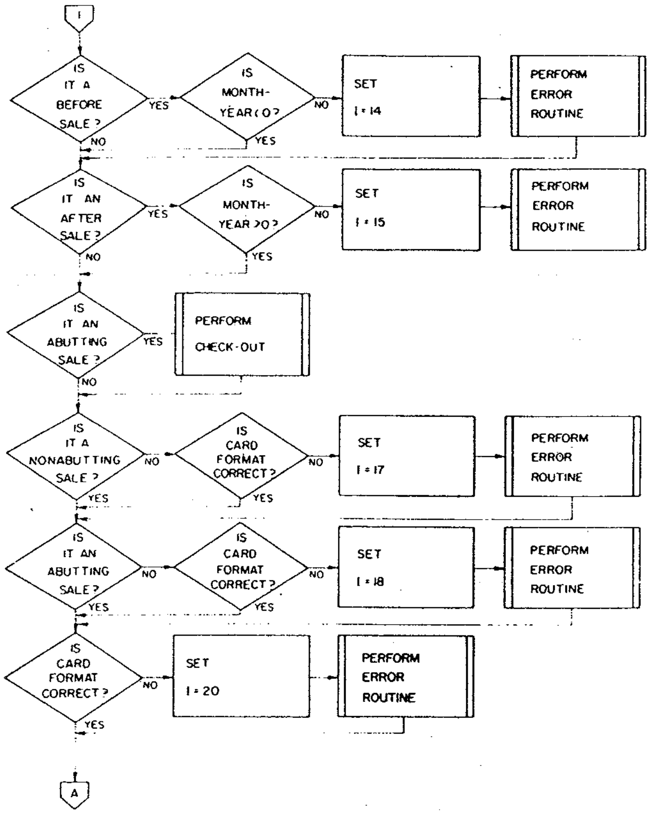
The second stage included output editing for report generation. This consisted of the following steps:

1. Select the required items for the file and organize them into readable words:
2. Assign desired words to report output.
3. Sort the items for each report into sequence by name, number, quantity involved or other elements of data.
4. Develop breaks in the data or major and minor classes and compute subtotals and totals for each category.
5. Prepare report titles, page headings, page numbers, and special symbols.
6. Delete repetitive descriptions and unwanted zeroes.
7. Plan spacing alignment.
8. Count the number of records and calculate the required totals for items going into each report.

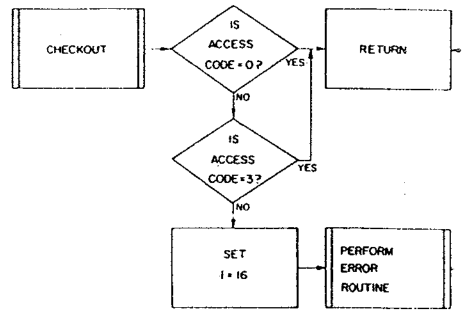
The edit program checks the twenty or more characteristics associated with each of the 700 plus land sales that were gathered within approximately 4,000 feet of the Interstate System. Both magnitude and logical validity are verified. As an example, an illogical situation would exist if the sale were listed as nonabutting and columns 75-80 of card lot one contained numbers. It would be illogical because these columns should be blank and containing no information. An error of magnitude would result whenever the land use code was greater than eight since only seven categories, numbered one through seven, are used. Twenty-one error conditions are checked and any errors found are listed along with the corresponding land sale. The program also sorts correct land sales and outputs a listing of these in descending order of price within each of nine study areas. Utilizing the 7094 computer, over 700 observations are capable of being processed in 4.24 minutes. Over 100 error conditions were detected resulting from measurement of data, coding, and key punching.


START
SET TRIGGER = 1
TRIGGER INDICATES WHICH CARD LOT TO PRINT
A
B
C
D
HAVE ALL CARDS BEEN READ ?
YES
NO
SORT LAND SALE RECORDS WITHIN STUDY AREA WITHIN PRICE
HAS LAST SORTED LAND SALE BEEN PRINTED ?
READ A SORTED LAND SALE
STOP
READ CARD INTO CELL-1
FIRST OF TWO CARDS OF A LAND SALE
MOVE CARD LOT-1 TO CELL-1
BREAKS UP LOGICAL RECORD FOR PRINTING
CELL-1 AND CELL-2 ARE HOLD AREAS
MOVE CARD LOT-2 TO CELL-2
IS CARD LOT NUMBER VALID ?
SET TRIGGER = 1 AND I = 21
PRINT LAND SALE
IS IT END OF PAGE ?
GO TO NEW PAGE
PERFORM ERROR ROUTINE
PRINT TITLES
IS IT THE FIRST CARD ?
SET TRIGGER = 1 AND I = 1
PERFORM ERROR ROUTINE
HAVE ALL SALES BEEN READ ?
F
E
J
READ CARD INTO CELL-2
SECOND OF TWO CARDS OF A LAND SALE
IS CARD LOT NUMBER VALID ?
SET TRIGGER = 2 AND I = 21
PERFORM ERROR ROUTINE
IS CARD LOT NUMBER = 2 ?
SET TRIGGER = 2 AND I = 2
PERFORM ERROR ROUTINE
MOVE CELL-2 TO CELL-1
ARE OBSERVATION NUMBERS EQUAL ?
SET TRIGGER = 1 AND I = 3
PERFORM ERROR ROUTINE
SET TRIGGER = 2 AND I = 19
PERFORM ERROR ROUTINE
MOVE CELL-1 TO CARD LOT-1
CARD LOT-1 PART OF THE LOGICAL RECORD OF LAND SALE
MOVE CELL-2 TO CARD LOT-2
CARD LOT-2 IS THE OTHER HALF OF THE RECORD
WRITE LAND-SALE
RECORD PUT ON TAPE FOR SORTING AND LISTING
ARE FIRST 20 COLUMNS OF BOTH CARD LOTS = ?
SET TRIGGER = 1 AND I = 5
PERFORM ERROR ROUTINE
SET TRIGGER = 2 AND I = 19
PERFORM ERROR ROUTINE
IS STUDY AREA NUMBER VALID ?
SET I = 6
PERFORM ERROR ROUTINE
H

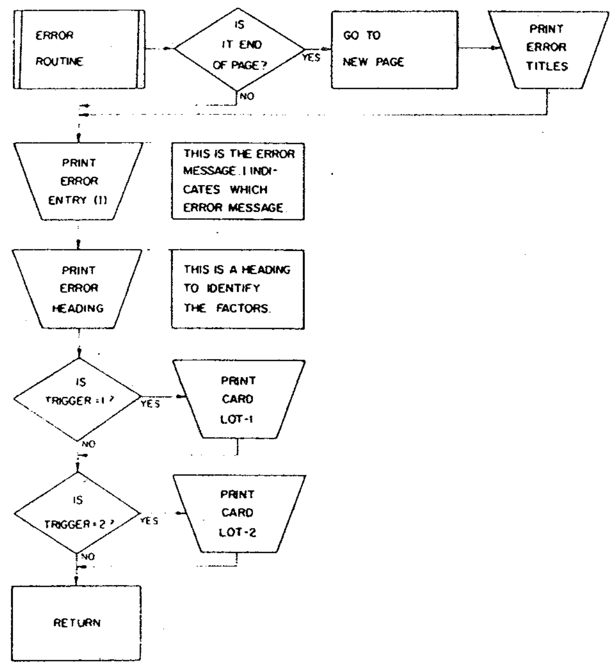

H
SET TRIGGER = 1
IS LAND USE CODE VALID ?
NO
SET I = 6
PERFORM ERROR ROUTINE
YES
IS INFLUENCE OF SURROUNDING LAND CODE VALID ?
NO
SET I = 7
PERFORM ERROR ROUTINE
YES
IS LAND CLEAR OR WOODED ?
NEITHER
SET I = 8
PERFORM ERROR ROUTINE
YES
IS LAND FLAT OR ROLLING ?
NEITHER
SET I = 9
PERFORM ERROR ROUTINE
YES
IS ACCESS CODE VALID ?
NO
SET I = 10
PERFORM ERROR ROUTINE
YES
IS BEFORE-AFTER CODE VALID ?
NO
SET I = 11
PERFORM ERROR ROUTINE
YES
IS LAND EITHER ABUTTING OR NON-ABUTTING ?
NEITHER
SET I = 12
PERFORM ERROR ROUTINE
YES
IS CLASS CODE VALID ?
NO
SET I = 13
PERFORM ERROR ROUTINE
YES
I



I
IS IT A BEFORE SALE ?
YES
NO
IS MONTH-YEAR < 0 ?
NO
YES
SET I = 14
PERFORM ERROR ROUTINE
IS IT AN AFTER SALE ?
YES
NO
IS MONTH-YEAR > 0 ?
NO
YES
SET I = 15
PERFORM ERROR ROUTINE
IS IT AN ABUTTING SALE ?
YES
NO
PERFORM CHECK-OUT
IS IT A NONABUTTING SALE ?
NO
YES
IS CARD FORMAT CORRECT ?
NO
YES
SET I = 17
PERFORM ERROR ROUTINE
IS IT AN ABUTTING SALE ?
NO
YES
IS CARD FORMAT CORRECT ?
NO
YES
SET I = 18
PERFORM ERROR ROUTINE
IS CARD FORMAT CORRECT ?
NO
YES
SET I = 20
PERFORM ERROR ROUTINE
A



CHECKOUT
IS ACCESS CODE = 0 ?
YES
NO
RETURN
IS ACCESS CODE = 3 ?
YES
NO
SET I = 16
PERFORM ERROR ROUTINE



ERROR ROUTINE
IS IT END OF PAGE ?
YES
NO
GO TO NEW PAGE
PRINT ERROR TITLES
PRINT ERROR ENTRY (I)
THIS IS THE ERROR MESSAGE. I INDI-CATES WHICH ERROR MESSAGE
PRINT ERROR HEADING
THIS IS A HEADING TO IDENTIFY THE FACTORS.
IS TRIGGER = 1 ?
YES
NO
PRINT CARD LOT-1
IS TRIGGER = 2 ?
YES
NO
PRINT CARD LOT-2
RETURN

BIBLIOGRAPHY

LEGAL CITATIONS

Rasbury v. *Hale*, 131 S.W. 2d. 334.

State v. *Carpenter*, 89 S.W. 2d. 194.

State v. *Meyer*, 403 S.W. 2d. 366.

Taylor County v. *Olds*, 67 S.W. 3d. 1102.

Texas-New Mexico Pipeline Co. v. *Linberry*, 326 S.W. 2d. 733.

PUBLIC DOCUMENTS

Texas *Constitution.*

U. S., Bureau of Public Roads, *Federal Laws, Regulations, and Other Materials Relating to Highways.*

U. S., Congress, *Federal Aid Highway Act of 1944,* Public Law 521, 78th Congress, 2d. Session, 1944.

U. S., *Constitution.*

U. S., *Statutes at Large,* Vol. 70.

BOOKS

American Institute of Real Estate Appraisers, *The Appraisal of Real Estate.* Text prepared by the Education Committee. Chicago: R. R. Donnelly and Sons, 1964.

Beach, E. G., *Economic Models.* New York, N. Y.: John Wiley & Sons, Inc., 1957.

Boeckh, E. H., *Boeckh's Manual of Appraisals.* Washington: E. H. Boeckh and Associates, 1963.

Diamond, Solomon, *Information and Error.* New York, N. Y.: Basic Books, Inc., 1959.

Draper, N. R. and H. Smith, *Applied Regression Analysis.* New York, N. Y.: John Wiley and Sons, Inc., 1966.

Ezekiel, Mordecai, *Methods of Correlation Analysis.* 2d ed. New York: John Wiley and Sons, 1956.

Isard, Walter, *Methods of Regional Analysis: An Introduction to Regional Science.* Cambridge, Mass.: M.I.T. Press, 1960.

Li, Jerome C. R., *Statistical Inference.* Vol. II. Ann Arbor, Michigan: Edwards Brothers, 1964.

McMichael, Stanley L., *McMichael's Appraising Manual.* 4th ed. Englewood Cliffs, N. J.: Prentice-Hall, 1964.

Ostle, Bernard, *Statistics in Research.* 2d ed. Ames, Iowa: Iowa State University, 1964.

Pearson, Frank A. and Kenneth R. Bennett, *Statistical Methods Applied to Agricultural Economics.* New York, N. Y.: John Wiley & Sons, Inc., 1947.

Schmutz, George L., *Condemnation Appraisal Handbook.* Rev. by Edwin M. Rams. Englewood Cliffs, N. J.: Prentice-Hall, 1963.

Yamane, Taro, *Statistics, An Introductory Analysis.* New York, N. Y.: Harper & Row, 1964.

ARTICLES

Adkins, William G. "Dallas Expressway Economic Impact Studies," *Highway Research Board Bulletin,* No. 169, 1957.

Amick, R. J. and J. C. Purcell. "An Application of Residual Analysis For Determining Relationships Between Selected Variables and Unit Cost," *Journal of Farm Economics,* Vol. 44, No. 5, December, 1962.

Ashley, Roger H. and William F. Berard. "Interchange Development Along 180 Miles of Interstate 94," *Highway Research Board Record,* No. 96, 1965.

Ball, Charles and Michael Teitz. "Expressway and Industrial Location," *Traffic Quarterly,* Vol. 12, No. 4, October, 1958.

Bardwell, George E. and Paul R. Merry. "Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value," *Some Evaluations of Highway Improvement Impacts,* Highway Research Board Bulletin, No. 268, 1960.

Bowersox, Donald J. "Influence of Highways on Selection of Six Industrial Locations," *Highway Research Board Bulletin,* No. 268, 1960.

Covey, Frank M. "Frontage Roads: To Compensate or Not to Compensate," *Northwestern University Law Review,* November-December, 1961.

Cribbins, P. D., W. T. Hill, and H. O. Seagraves. "Economic Impact of Selected Sections of Interstate Routes on Land Value and Land Use," *Highway Research Board Record,* No. 75, 1965.

Enfield, C. W. and John C. McLean. "Controlling the Use of Access," *Highway Research Board Bulletin,* No. 101, 1955.

Franklin, William D., "Benefit-Cost Analysis in Transportation: The Economic Rationale of Resource Allocation," *Traffic Quarterly,* Vol. XXII, No. 1, January, 1968.

Hennes, Robert G., Bayard O. Wheeler and William L. Garrison. "Washington Highway Economic Impact Studies," *Highway Research Board Bulletin,* No. 169, 1957.

Herr, Philip B. "The Regional Impact of Highways," The J. C. Nichols Foundation Research Study, 1958-1959, *Urban Land,* Vol. 19, No. 2, February, 1960.

Holshouser, Eugene C. "An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology," *Some Evaluations of Highway Improvement Impacts, Highway Research Board Bulletin,* No. 268.

Kelly, John F. "Residences and Freeways," *California Highways and Public Works,* Vol. 36, Nos. 3-4, March-April, 1957.

Kelly, John F. "Anderson Study: Retail Business on Frontage Road Shows an Increase of 61 Percent," *California Highways and Public Works,* Vol. 32, Nos. 1, 2, January-February, 1953.

Suits, Daniel B. "Use of Dummy Variables in Regression Equations," *Journal of the American Statistical Association*, Volume 52, December, 1957.

Thiel, Floyd I. "Highway Interchange Area Development," *Highway Research Board Record*, No. 96, 1965.

Taylor, Milton C. "Service on Limited-Access Highways: Organized Pressures and the Public Interest," *Land Economics*, Vol. 25, No. 1, February, 1959.

Weimar, Arthur M. "History of Value Theory for the Appraiser," *Selected Readings in Real Estate Appraisal*, ed. American Institute of Real Estate Appraisers, Chicago: R. R. Donnely and Sons, 1953.

OTHER SOURCES

Franklin, William D., *Economic Theory and Land Acquisition*, presented at Regional Watershed Planning Economists' Conference, San Antonio, Texas, February, 1963.

______________, *Benefit-Cost Analysis, Expressways and Automobiles*, (a Japanese language journal), Tokyo, Japan, 1968.

______________, *Benefit-Cost Analysis in Transportation*, First Canadian Urban Transportation Conference, Federation Canadienne Des Maires Et Des Municipalities, Ottawa, Ontario, Canada, 1968.

______________, *The Quantitative Measurement of Access*, presented at the 47th Annual Meeting of the National Academy of Sciences, National Research Council, Highway Research Board, Washington, D. C. January, 1968.

Garrison, William L. and Marion E. Marts, *The Geographic Impact of Highway Improvement*, University of Washington, Highway Economic Studies, The Department of Geography and the Department of Civil Engineering, July, 1958.

Pendleton, William C. *The Value of Highway Accessibility*, Preliminary draft of paper prepared for U. S. Department of Agriculture (undated).

Texas, *Right of Way Manual*, Book 1, Edition III, Austin, Texas: Texas Highway Department, Right of Way Division.

Vail, Richard W., *Problems in Residual Analysis*, Unpublished M. S. Thesis, Virginia Polytechnic Institute, December, 1957.

Wheeler, Bayard O. *The Effect of Freeway Access Upon Suburban Real Property Values*, Washington State Council for Highway Research, June, 1956.