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16. Abstract

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Land use and related data were collected on eighteen locations in the Bryan-College Station, Dallas-Fort Worth, and Houston metropolitan areas. Following individual analyses of the study sites, data on all eighteen locations were aggregated for the purpose of statistically analyzing relationships between land use and various related factors. Chapter II of this report describes the categorical and regression approaches to the statistical analysis and reports the results thereof.

A popular approach to forecasting regional urban growth is the use of urban development models. Using information on residential and employment locations, trip origins/destinations, and population and employment projections, these models attempt to predict patterns of future growth in a metropolitan area. Chapter III explores the suitability of urban development models as an alternative approach to modeling the relationship between urban land development and roadway improvements.

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EFFECTS OF ROADWAY IMPROVEMENTS ON ADJACENT LAND USE: AN AGGREGATIVE ANALYSIS AND THE FEASIBILITY OF USING URBAN DEVELOPMENT MODELS

by

John B. Rollins
Assistant Research Economist

Jeffery L. Memmott
Research Associate

and

Jesse L. Buffington
Research Economist

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Texas Transportation Institute
Texas A&M University System
College Station, Texas

PREFACE

The authors wish to express their appreciation to those who have assisted or facilitated this study. Special acknowledgement is due Mr. James W. Barr and Mr. James R. Farrar, Jr., of the Texas State Department of Highways and Public Transportation. Thanks are due to Mrs. Susan Freedman and Mrs. Betty Benson for typing the manuscript.

ABSTRACT

The effect of improving existing urban roadways on surrounding land use is an important consideration in highway agency decisions regarding roadway improvements. Such decisions should consider the economic impact of proposed improvements.

In an effort to identify the kinds of effects which urban roadway improvements have on surrounding land use over time, a study has been made of several urban locations experiencing roadway improvements during the past several years.

Land use and related data were collected on eighteen locations in the Bryan-College Station, Dallas-Fort Worth, and Houston metropolitan areas. Following individual analyses of the study sites, data on all eighteen locations were aggregated for the purpose of statistically analyzing relationships between land use and various related factors. Chapter II of this report describes the categorical and regression approaches to the statistical analysis and reports the results thereof.

A popular approach to forecasting regional urban growth is the use of urban development models. Using information on residential and employment locations, trip origins/destinations, and population and employment projections, these models attempt to predict patterns of future growth in a metropolitan area. Chapter III explores the suitability of urban development models as an alternative approach to modeling the relationship between urban land development and roadway improvements.

SUMMARY OF FINDINGS

This report describes the procedures and results of an aggregative analysis performed on land use and related data for eighteen urban locations in Texas. This analysis represents the culmination of an investigation of the effects of urban roadway improvements on surrounding land use. The relationships between urban land use and certain predictive factors (including type of median treatment) for periods before, during, and after roadway improvement are described and tested for significance by using two statistical approaches, namely, the categorical (primary) approach and the regression approach. In addition, the report explores the suitability of urban development nodels as an alternative approach to modeling the relationship between urban land development and roadway improvements.

The findings of the categorical approach regarding urban land use changes as related to the effects of predictive variables are as follows:

(1) Multi-family residential and commercial land uses vary with location type (abutting or nonabutting).

(2) Commercial development and overall land development are associated with city population growth.

(3) Rates of change in single-family residential, commercial, and overall development differ according to metropolitan area.

(4) Multi-family residential and overall development vary among areas in different stages of development.

(5) Residential and public/semi-public development are associated with ADT growth.

(6) Given the addition of traffic capacity, overall land development appears to be more rapid after improvement than before, when continuous left turn lanes were installed. Raised medians appear to negatively impact overall development.

(7) Given the addition of traffic capacity, single-family residential development is faster in the before period, in the absence of any median treatment. Raised medians are related to slower single-family residential growth during the construction period than before improvement.

(8) Given the addition of traffic capacity, public-governmental and semi-public development is faster during the construction period than before, in the absence of any median treatment. Raised medians are associated with slower development of this type of acreage.

The findings of the regression analysis regarding changes in land use development and effects from various predictive variables are as follows:

(1) Single residential development is higher in nonabutting areas, in the absence of capacity changes and median treatment; and lower in Dallas-Fort Worth and the during construction period. Overall development has a positive impact on single residential development; multiple residential development and commercial development have negative impacts.

(2) Multiple residential development is higher with increased ADT, developed areas, and in the Houston area. Single residential development and overall development have positive impacts

on multiple residential development; streets and roads development has a negative impact.

(3) Commercial development is higher in abutting areas, and the Dallas-Fort Worth area; and lower in undeveloped areas. Single residential development has a negative impact on commercial development.

(4) Public/semipublic development is higher in the Houston area, and with increased ADT.

(5) Streets and Roads development is higher in the developed areas and the before construction period; and lower in the undeveloped areas in the absence of median treatment.

(6) Overall development is higher with increased ADT, in developed areas, and in the Houston area; and lower in the undeveloped areas. Single residential development, multiple residential development, and commercial development all have a positive impact on overall development.

In conclusion, the results of the aggregative analysis suggest that the rate of net overall land development is not significantly changed due to roadway improvements of the type represented by this small sample. However, roadway improvements do affect the development rates of specific types of land uses more than they impact overall development. Also, ADT (a factor closely related to road improvements) is significantly related to residential, public, and overall development. Finally, residential and overall development is related somewhat to median treatment. A larger sample of road improvement projects should clarify these relationships.

The findings of the review of urban development models, with respect to their suitability for use in relating urban land use changes to roadway improvements, are as follows:

(1) Currently operational models are of two types:

(a) Lowry derivative models - a group of models, e. g. PLUM, that are based on relationships among residential, employment, and shopping locations.

(b) EMPIRIC model - a model consisting of a set of simultaneous regression equations which involve residential and employment locations.

(2) Computerized versions of these models are available from the Urban Planning Division of the Federal Highway Administration. There is no charge to non-profit organizations for the computer tapes and program documentation.

(3) Each of these models requires substantial input data. Program and data management, including annual updating of input data and population/employment forecasting, involves a major effort by planners and support staff.

(4) Some of the models work acceptably well for estimating general benchmarks for future regional growth and for assessing relative overall impacts of alternative transportation policies. However, none of the models can accurately predict land development in small areas such as the eighteen study areas considered in this study. It is concluded, therefore, that urban development models are not suitable for analyzing relationships between land development and roadway improvements in relatively small sections of urban areas.

The report concludes with recommendations for investigating urban land use changes before, during, and after roadway improvements. Some suggestions are made for further refinement of the recommended analytical approach.

METRIC CONVERSION FACTORS
RELEVANT TO THIS REPORT

Approximate Conversions to Metric Measures

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

IMPLEMENTATION STATEMENT

The report relates the findings of a statistical evaluation of the relationships between urban land use and certain predictive factors, for periods before, during, and after roadway improvements. Further, recommendations are made with respect to the use of urban development models within the context of this study.

The findings of the study can be of immediate use in decisions regarding roadway improvements in urban areas. The indicated associations between land use and various predictive factors suggest how land uses can be expected to change before, during, and after roadway improvements. Further, the results indicate how different types of median treatment tend to affect land use changes, given the addition of traffic capacity to a facility. This knowledge can be useful in SDHPT policy formulation regarding urban roadway improvements and also for analyzing land use effects of proposed roadway improvements in environmental documents.

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CHAPTER I. INTRODUCTION

PURPOSE AND OBJECTIVE OF STUDY

The near completion of the Interstate Highway System and the increasing shortage of funds for future highway construction have caused state highway agencies to concentrate on upgrading and increasing the capacity of existing streets and highways. Much research has been done in the past concerning the impacts of new highway construction, but little has been done to examine the effects where an existing highway is upgraded. In order to optimize net public benefits, highway agencies need information of this type to help predict the effects from an improvement on an existing facility.

To help fill the data gap, 18 case studies have been made on land use and traffic volumes due to improvement of existing highways or streets. This study aggregates the findings of the 18 individual case studies and looks at the effects that highway improvements have on land use changes. The aggregative effects of such improvements on traffic growth patterns are presented in Texas Transportation Institute (TTI) Research Report 225-23. The results of the case studies are reported in TTI Research Reports 225-3 through 225-21, except for 225-8. This study also examines existing urban development models to determine their adaptability for estimating the land development effects of highway improvements.

The study objectives addressed in this report are as follows:

1. Develop a mathematical model to estimate the influence of increasing the capacity of existing urban streets and highways on the rate of land development of area properties.

2. Determine the feasibility of modifying and adapting one of the existing urban development models to estimate the influence of improving urban streets and highways on the rate of land development.

CONTENTS OF REPORT

The report consists of three major sections. The first section, Chapter II, includes the aggregative analysis of the findings of the 18 case study areas. The results of two types of analysis are presented in this section as follows: (1) categorical analysis and (2) regression analysis. Also, the conclusions of the aggregative analysis are presented.

The second section, Chapter III, of the report contains the results of the evaluation of several urban development models. The description, availability, cost, and applicability of each model are presented in this section. Conclusions regarding the use of these models are presented at the end of this section.

The third section, Chapter IV, contains the overall conclusion of this study and the recommendations for further research.

SOURCES OF DATA

Data for the aggregative analysis were taken from the 18 case study reports. The original data sources for each study are published separately in these reports. City and metropolitan area population changes for the study periods used in each case study were determined from data obtained from the U.S. Bureau of Census reports [3,4,5], a SDHPT report [6], a North Central Texas Council of Governments report [8], and the Houston City

Planning Department [7].

Data on the urban development models were obtained from published reports and persons involved in the development and use of each model.

CHAPTER II. AGGREGATIVE ANALYSIS

In order to examine some general relationships between land use and various factors which affect land use, information on the eighteen study areas (Table A1 in the Appendix) was aggregated into a single data base for purposes of statistical analysis. This chapter discusses the data limitations and the reasons for conducting a categorical analysis as well as a regression analysis. The models for each of these analyses and the results are presented separately in this chapter.

LIMITATIONS OF THE DATA

The data contain three limitations which temper any conclusions about associations between land use changes and various predictive factors. First, there is a small number of observations on each variable, relative to the number of variables considered in the analysis. This implies that: (1) multiple and/or interactive effects of the predictive variables cannot be analyzed, and (2) significant relationships between the dependent variable (DV) and independent variables (IV) are more difficult to detect than would be the case with more observations. Failure to examine interactions among independent variables can result in some significant effects going undetected. For example, a predictive variable might not by itself appear to impact land use. But when it is allowed to vary by levels of some other predictive variable(s), i.e., when the interaction is considered, then the impact of the variable on land use might be found to be significant. However, the small sample size does not preclude the estimation of basic relationships between the DV and IV, specified in individual main effects (single-IV) models.

Second, there are no control areas to compare with the study areas. Hence, it cannot be conclusively determined whether a given land use change is attributable primarily to a roadway improvement, to other factors, or to a combination thereof.

However, it should be recognized that good controls for land use changes are difficult to obtain. An area chosen as a control might not be independent of the corresponding study area, so that differences in land use changes between the study and control areas might not be attributable solely to the roadway design improvement. In addition, it is possible that a control area would not remain untreated for the span of years required for a before-during-after study. It might be expected that SDHPT would improve roadways in both areas, since the control area would be so similar to the study area. Hence, in many cases a potential control area might bear more dissimilarities to the study area than desirable for a good control.

Finally, it is expected that cross-sectional correlation exists among some of the observations. The eighteen study locations are grouped into three metropolitan areas, so that any exogenous influence affecting one location can be expected to impact other locations in the same metro area. This cross-sectional association among locations within metro area can possibly affect the validity of tests for significance between the DV and IV by incorrectly indicating significance in some cases [1]. However, the problem can be overcome by using binary variables to represent each metropolitan area, and using a generalized linear regression estimation procedure. The binary variables can be added into the regression equations so that any significant effects of a metropolitan area on the sample regression line can be estimated and tested.

The limitations in the data do not prevent the use of regression analysis in this study, even though a much larger sample size, along with control areas, would be required to estimate, with greater precision, the effects from a proposed highway improvement on various categories of land use.

CATEGORICAL ANALYSIS

The object of aggregating and analyzing data on land use changes is to gain some insight into associations between land use changes and related predictive factors, including alterations in roadway design.[1] These relationships are complex, however, so that comprehensive definition and estimation of the structural relationships between land use changes and associated predictive factors require a large and good quality[2] data base. Given the scope of this study and the limited availability of primary data for desired study years, the more simplified categorical analytical approach was used for the primary analysis.

The land use data collected during the course of this study were combined with data on possible predictive factors to create a data base for analyzing land use changes. Rates of change in land use of a particular type (residential, commercial, etc.) were compared pair-wise for periods

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[1] See the appendix for details of the data and the analysis.

[2] For a detailed discussion of frequently encountered statistical problems and their implications, see, for example, Kmenta [1].

before, during, and after roadway design changes. These comparisons of rates of change (dependent variables) were then examined statistically for significant associations with selective predictive factors (independent variables) by using two-way frequency tables and Chi-square tests.

The rationale for testing the significance of associations between land use changes and certain predictive factors is that rates of land use change are thought to be affected by a combination of factors including roadway improvements. In some cases, other factors might overshadow roadway improvements in impacting land use, while in other instances roadway changes might strongly interact with other factors in accomodating land use changes. Although data were not available for testing the possible effects of roadway improvements alone on land use changes, the effects of other factors on land use were analyzed before, during, and after implementation of roadway improvements. While land use changes so analyzed reflect the combined impacts of roadway improvements and other factors, rather than the impact solely of the roadway improvement, the identification of factors significantly associated with land use changes is of use in decision making vis-a-vis roadway improvements and their possible effects on land use.

Description of Model

The relationships between land use changes and certain predictive factors considered in this analysis were assessed via a test of the following null hypothesis:

> H_o^1: For a given type of land use, the rate of change before, during, and after improvement is not affected by certain predictive factors.

The relationships involved in testing H_0^1 were formulated as:

$$Y_i = f(X_j)$$

where Y_i is a variable that relates the rate of change in the i^{th} type of land use (i = single-family residential, commercial, etc.) during one period to that during a previous period. The period-to-period comparisons for the Y_i were before-after, before-during, and during-after. X_j represents the j^{th} predictive factor affecting land use changes (j = location type, stage of development, etc.). The X_j were classified according to levels of the predictive factors, e.g., levels of the factor "location type" were defined as "abutting" and "nonabutting."

Hence, H_0^1 states that Y_i is not associated with X_j. The statistical tests related to H_0^1 involved assessing the degree of association between the Y_i and X_j.

A second hypothesis test was undertaken in order to examine the possible effects of different types of median treatment (Table A18) on urban roadways which are widened. The null hypothesis H_0^2 is:

> H_0^2: For a given type of land use, the rate of change before, during, and after improvement is not affected by median treatment involving continuous left turn lanes or raised medians, given the addition of traffic capacity.

To test H_0^2, land use changes were related to median treatment as follows:

$$Y_i = f(D)$$

where Y_i is as defined for H_0^1. The variable D is defined as:

D = "none", when capacity is added but neither continuous left turn lanes nor raised medians were added to the existing roadway.

= "left turn lane", when both capacity and left turn lanes, but not raised medians, were added.

= "raised median", when both capacity and raised medians, but not continuous left turn lanes, were added.

The nominal or ordinal - i.e., classified - nature of the dependent and independent variables lends them well to categorical analysis, as opposed to a parametric technique such as linear regression. Although categorical independent variables fit easily into an ordinary least squares model so long as the dependent variable is continuous, regression is inappropriate when the dependent variable is dichotomous [2]. Therefore, an approach appropriate for analyzing cross classified categorical data, one employing the chi-square statistic, was used in this study.

In accordance with a before-during-after analysis design, for each study location (Table A1 in appendix), data (observations) on each variable were collected for four points in time (t):[3]

t = 0, some year prior to formal SDHPT planning of the roadway improvement (on average, about 4.5 years prior to t = 1).

t = 1, the year in which planning/construction began.

t = 2, the year after construction was completed.

t = 3, the most recent year for which data were available.

The "before" period is defined as the period of time from t = 0 to t = 1, the "during" period as t = 1 to t = 2, and the "after" period as t = 2 to t = 3.

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[3]The specific years corresponding to t = 0,1,2,3 vary among study areas.

The basic data from which the dependent variables (DV) were constructed consist of acreage in six types of land use at each study location (see Tables A2-A7):

(1) Residential, single-family, including mobile homes

(2) Residential, multi-family

(3) Commercial, including industrial

(4) Public-governmental and semi-public

(5) Streets and roads

(6) Undeveloped

For each location, the average annual change in each type of acreage, as a proportion of total acreage in the tract, was calculated for the before, during, and after periods. Pair-wise comparisons of those rates - before-after, before-during, and during-after - were then made to determine whether the rate of change in each land use type in the later period was greater than or less than the rate of change in the earlier period. These relative rates of change comprised the basis for assigning frequencies to categories ("faster" or "slower" rate of development from one period to the next) of the DV (Tables A9, A11, A13).

Certain factors thought to influence rates of land use change over time were included in the analysis as predictive or independent variables (IV). The following factors were selected and categorized as indicated to form the IV (Tables A8, A10, A12, A14):

(1) Location type - abutting, or nonabutting

(2) City population growth - faster or slower rate of growth over time, on the basis of before-after, before-during, and during-after period comparisons

(3) Metropolitan area - Bryan/College Station, Dallas/Ft.Worth, or Houston metro areas

(4) Stage of development - largely undeveloped, developing, or fully developed as of t = 1

(5) Traffic volume growth - faster or slower rate of growth over time, on the basis of before-after, before-during, and during-after period comparisons. ADT counts were made on the improved roadway in each study location.

It is thought that land use varies according to whether or not a tract abuts a roadway. In this study, each tract is classified as abutting or nonabutting with respect to the improved roadway in its study location.

City population growth is thought to encourage land development. It is included in this study to examine its association with each type of land use, as well as with overall land development.

Metropolitan area is included as a predictive variable in order to account for regional economic and/or demographic differences which are not reflected in municipal population changes. For example, both the Dallas and Ft. Worth municipalities experienced population declines during a period in the 1970's, although the Dallas-Ft. Worth metropolitan region continued to grow during this period.

Land use changes might also vary according to the stage of development of an area. For example, development might be faster in areas having more land available for development than in relatively heavily developed areas.

Growth in ADT on the improved roadway is thought to affect land development. Its relationship with different types of land development is examined.

The DV and IV constitute a set of cross-classified data on which some statistical tests were performed. The tests are intended to shed light on associations among land use changes, urban roadway design changes, and other predictive factors, as alluded to in the null hypotheses H_0^1 and H_0^2. However, it should be recognized that the strength and validity of the inferences regarding the DV and IV are limited to the extent that there exist certain limitations in the data.

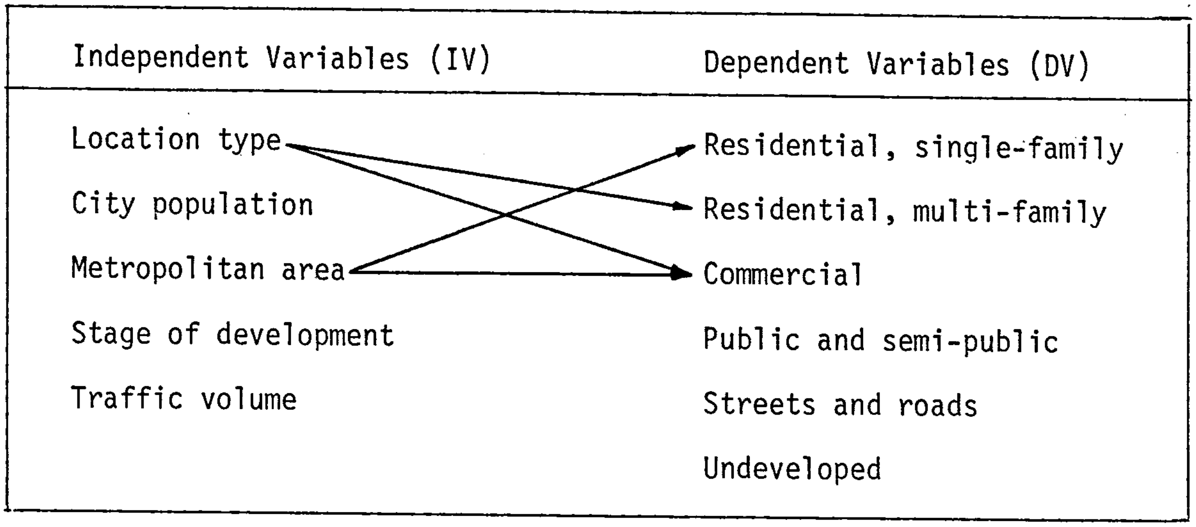
Results of the Analysis

Main-effects models were estimated for combinations of the DV and IV, and the results for the first null hypothesis, H_0^1, and the second null hypothesis, H_0^2, are presented under each land use category. The results of the H_0^1 tests of significance between the rates of land use change and the various predictive factors are presented in Tables A15 - A17 in the appendix and illustrated in Tables 1-3 in the text. The arrows indicate that a significant relationship was found between the indicated predictive factor (IV) and the associated land use. The results of the H_0^2 tests are presented in Tables A19-A20 in the appendix.

In general, the analysis of many of the models of DV-IV relationships indicate that the null hypothesis, H_0^1, be rejected, i.e., that there is a statistically significant relationship between land use changes and the predictive factors considered. On the other hand, the analysis indicates that the null hypothesis, H_0^2, be accepted for most of the DV-IV relationships, i.e., there is not a statistically significant relationship between land use changes and median treatment, given the addition of traffic capacity.

The specific results of statistically significant relationships for each land use are presented below.

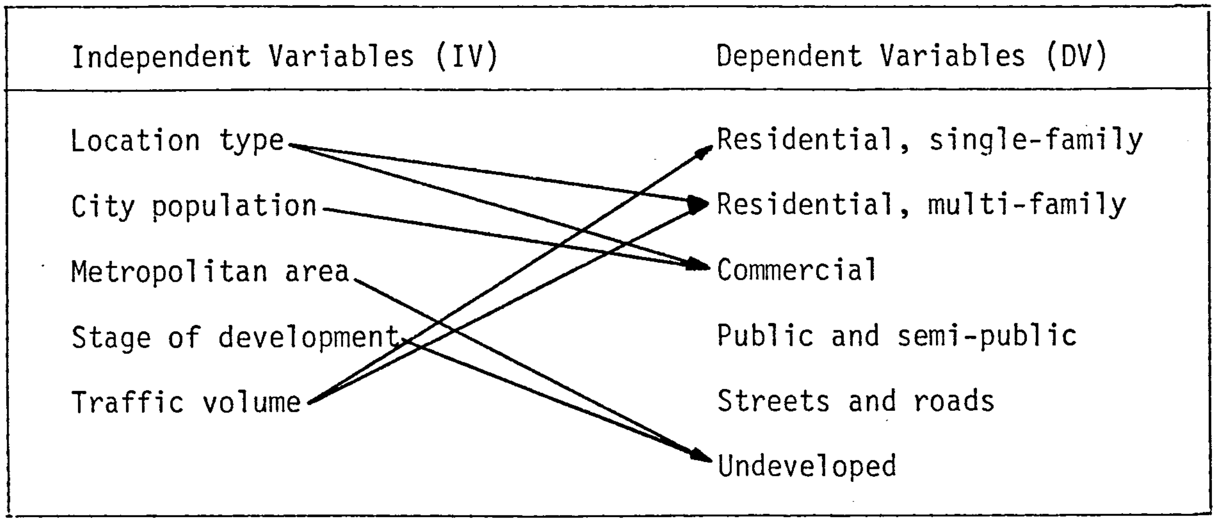
Table 1. Before - After Comparison[a]



[a] The arrows indicate that a significant relationship was found between the indicated predictive factor and the associated land use.

The level of significance is .10.

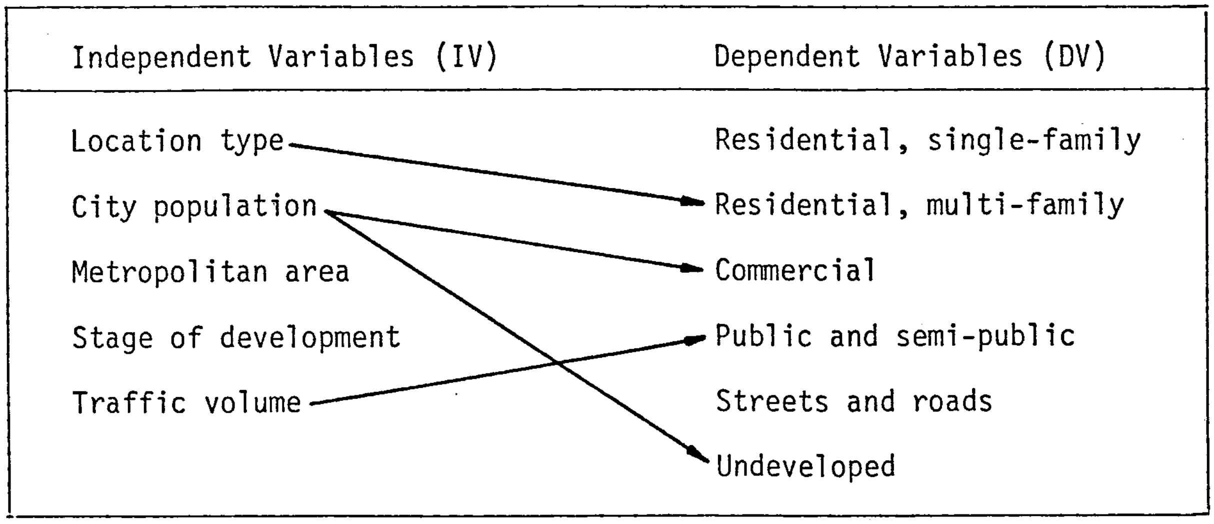
Table 2. Before - During Comparison[a]



[a] The arrows indicate that a significant relationship was found between the indicated predictive factor and the associated land use.

The level of significance is .10.

Table 3. During - After Comparison[a]



[a] The arrows indicate that a significant relationship was found between the indicated predictive factor and the associated land use.

The level of significance is .10.

Residential Single-Family (RS)

The significant RS period comparisons involving the H_0^1 test are as follows:

- Before-After Comparison. RS acreage developed faster during the after period than during the before period in the Dallas-Ft. Worth metro area. No difference was found in before-after rates of RS development in either the Houston or Bryan/College Station metro area.

Before-During Comparison. RS acreage developed more slowly in areas experiencing increased ADT growth. This could be due to the higher valuation of acreage as commercial property, due to enhanced access to the area.

During-After Comparison. The rate of RS development did not differ significantly between periods.

Overall, RS development seems to slow in response to ADT growth on the improved roadway. This could be due to both the enhanced value of abutting land for commercial use and the decreased desirability of abutting land for residential use. However, no significant relationship between commercial development and ADT growth was detected.

In addition, RS development varied by metro area. However, without a more detailed model of RS behavior, specific causes of the variation by metro area are not clearly identifiable (this point is discussed further in the conclusions to this chapter.).

The significant RS period comparisons involving the H_0^2 test are as follows:

Without Median Treatment. RS development was faster in the during period than in the before period in the absence of any median treatment, given the addition of capacity (Table A20).

With Median Treatment. For the before-during period comparison, RS development was slower when the median treatment consisted of raised medians, but apparently was not significantly related to continuous left turn lanes.

The results of the H_0^2 tests suggest that, at least in some cases, land use changes vary with type of median treatment. However, the H_0^2 tests made no distinction between land use changes in abutting and nonabutting areas, due to the small sample size. This potentially confounding factor allows for the possibility that land use changes vary more according to type of abutment than to type of median treatment.

Residential Multi-Family (RM)

The significant RM period comparisons involving the H_0^1 tests are as follows:

Before-After. The average annual rate of RM development in nonabutting areas was faster during the after period than during the before period. In abutting areas, RM development was slower during the after period than during the before period. During the before period the annual rate of RM development was faster, on average, in abutting areas than in nonabutting areas. During the after period the annual rate of RM development was faster, on average, in nonabutting areas than in abutting areas.

Before-During. The rate of RM development in nonabutting areas was faster in the during period than in the before period. In abutting areas, the rate of RM development was slower in the during period than in the before period. In the during period, the annual rate of RM development was, on average, faster in abutting areas than in nonabutting areas.

RM acreage developed more slowly in areas experiencing faster ADT growth and more rapidly in areas where ADT growth was slower from one period to the next.

During-After. The rate of RM development in nonabutting areas was faster in the after period than in the during period. In abutting areas, the rate was slower in the after period than in the during period.

In both the before and during period, abutting RM acreage developed faster than nonabutting RM acreage. In the after period, however, RM development was faster in nonabutting areas than in abutting areas (see Table A3, average DRM values by period). This might be due to the relatively higher valuation of abutting acreage in commercial use (rather than residential use) as traffic volume and access are enhanced in the area, leading to relatively greater RM development of nonabutting tracts.

Overall, RM development is affected by ADT growth and by location with respect to the improved roadway. As with RS development, ADT growth could render abutting land more valuable for commercial use and less attractive for residential use. This hypothesis is corroborated by the effect of location type on RM development, i.e., RM development was faster in nonabutting areas and slower in abutting areas.

The results of the H_0^2 tests show no significant RM period comparisons. Therefore, it might be concluded that RM land use changes do not vary with type of median treatment. Due to the small data base this conclusion may be inaccurate.

Commercial (C)

The significant C period comparisons involving the H_0^1 tests are as follows:

Before-After. The average annual rate of C development in nonabutting areas was faster during the after period than it was during the before period. In abutting areas, the rate was slower during the after period than during the before period. In both the before period and the after period, the rate of C development was, on average, faster in abutting areas than it was in nonabutting areas.

C development was slower in the Houston metro area but slightly faster in the Bryan-College Station area. In the Dallas-Ft. Worth area, there was no appreciable difference between the rates of C development in the before and after periods.

Before-During. The rate of C development in nonabutting areas was faster in the during period than it was in the before period. In abutting areas, the rate was slower in the during period than in the before period. In the during period, the rate of C development was, on average, faster in abutting areas than it was in nonabutting acres.

C acreage developed faster in areas experiencing faster population growth across periods. An influx of additional citizens into an area can be expected to lead to increased development of supporting commercial facilities.

During-After. C development was faster in areas having faster population growth.

During a single period, abutting acreage developed faster than nonabutting acreage (see Table A4, average DC values by period). This was the case for all periods.

Overall, C development responded to variations in location type, population growth, and metro area. While abutting C acreage developed faster than nonabutting during any given period, the rate of nonabutting C development was faster post-construction or during construction than preconstruction. This suggests that: (a) abutting acreage is more attractive than nonabutting for C development, but (b) improved access to an area appears to make nonabutting acreage more attractive for C development than it was prior to roadway improvement.

Given the limited ability to model land use changes, the precise relationships between population growth and roadway improvement, metro area and improvement, and possibly population growth and metro area are not as clear as that between location type and roadway improvement. Differences in C development by location type over time could be due primarily to roadway improvement (this can only by hypothesized, since there are no control areas). However, differences by population growth or metro area are not, without more detailed modeling, so apparently related directly to roadway improvement.

The results of the H_0^2 tests show no significant C period comparisons, indicating that C land use changes do not vary with type of median treatment. Again, the lack of adequate data may not produce significant results.

Public-Governmental and Semi-Public (P)

The results of P period comparisons involving the H_0^1 tests are as follows:

Before-After. There was no significant difference between the rates of development of P acreage across period, with respect to any of the independent variables.

Faster P development from the before period to the after period was associated with faster net overall land development[4] across periods.

Before-During. There was no significant difference between the rates of development of P acreage across periods, with respect to any of the independent variables.

P development tended to be faster in areas where RS development and/or net overall land development was faster in the during period than in the before period.

During-After. P acreage developed faster in areas having faster ADT growth.

The relationship of P development to RS and overall development and to ADT growth suggests that P development occurs in response to an increased level of population-related activities and development. In this context, P development may be related to roadway improvement via its

[4]Net developed acres are the number of acres of undeveloped land converted to a developed use. Net development does not account for changes from one developed use to another.

relationship to RS development. Although RS development and ADT growth are negatively related, the improved access to an area provided by an improved roadway could contribute to the development of parks, churches, and other forms of P development.

The results of the H_0^2 tests show no significant P period relationship, thus indicating that P land use changes do not vary with type of median treatment.

Streets and Roads (SR)

The findings of SR period comparisons involving the H_0^1 tests are as follows:

Before-After. SR development was faster across periods when RS development was faster.

Before-During. SR development was faster when RM development was faster.

During-After. SR development was faster when RM development was faster.

The rates of SR development did not differ significantly, across time periods, with respect to any of the independent variables. Rather, SR development was associated with development of RS and RM acreage.

SR development may be related to roadway improvement via its relationship to residential development. As RS and RM development respond to ADT growth and location type, respectively, SR development is affected.

The results of the H_0^2 tests show no significant SR period relationship, thus indicating that SR land use changes do not vary with type of median treatment.

Undeveloped (U)

The findings of U period comparisons involving the H_0^1 tests are as follows:

Before-After. The rate of change in net overall land development (the opposite of the rate of change in U) did not differ significantly from the before period to the after period.

Before-During. The rate of net land development was faster in the Bryan-College Station area and slower in the Houston area from the before period to the during period. There was no significant difference in the rate of land development across periods in the Dallas-Ft. Worth area.

Net land development was slower in the during period than in the before period in the primarily undeveloped areas. In developing and fully developed areas, however there was no difference between the rates of land development in the before and during periods. It may be that areas already moderately developed are more attractive for further development than are areas having relatively little development.

During-After. Land developed faster in areas experiencing faster population growth across periods and slower in areas with slower population growth from the during period to the after period.

The results do not suggest a strong relationship between overall development and roadway improvements, relative to the relationships found between residential/commercial development and factors seemingly closely related to improvements (ADT growth, location type). One conclusion of this comparison of results is that roadway improvements affect the development rates of specific types of land uses more than they impact overall development.

The results of the H_0^2 tests are as follows:

Continuous Left Turn Lanes. Although relatively weak in the level of significance, this test suggests that given additional capacity, land developed more rapidly after improvement than before improvement when continuous left turn lanes were implemented.

Raised Medians. Raised medians were apparently associated with slower overall development (Table A19).

The analysis suggests that land use changes before, during, and after roadway improvements are related to several predictive factors. These relationships can be summarized as follows:

1. Both multi-family residential and commercial land uses vary according to location type. Multi-family residential development could be spurred in the general area due to better access to the location and specifically in non-abutting areas as abutting acreage becomes more highly valued in commercial use due to increased traffic volume on the improved facility. This increased traffic volume might also make some nonabutting acreage more attractive for commercial development due both to the relatively higher value of abutting commercial tracts and to increased customer traffic in the area due to the improved roadway.
2. City population growth is positively associated with commercial development and overall land development.
3. Rates of change in single-family residential, commercial, and

overall land development differ according to metropolitan areas.

4. Multi-family residential and overall development vary among areas in different stages of development.
5. Residential and public/semi-public development are related to ADT growth. Increased traffic volume tends to render an area less attractive for residential use and more valuable in commercial use (although no significant relationship between C development and ADT growth was found in this analysis). Improved access to an area seems to contribute to P development, e.g., parks, schools, churches.
6. Some types of land use appear to be related more to other types of land development than to any of the predictive factors included in this study. Public and semi-public development is positively related to single-family residential development and overall land development. Development of streets and roads is positively associated with residential development. Any impacts of roadway improvement on these types of land use would, then, appear to be via other types of land development.
7. Some evidence was found to suggest that the type of median treatment implemented can affect relative rates of land use change, especially single family residential and net overall land development. In those cases where they do, the two median treatments considered appear to have opposite effects on land use changes.

REGRESSION ANALYSIS

There are several limitations, discussed earlier, which restrict the use of regression analysis. The most important factor is the small sample size, consisting of the 18 case study areas. However, by combining the time-series data for each study area with the cross-sectional data for all 18 areas and dividing each area into abutting or nonabutting land use, a potential sample size of 108 is created. Even though some data are missing from the data set, each equation presented in this section has at least 93 observations, giving an adequate sample size for regression analysis.

Description of Regression Models

A regression analysis must assume some functional relationship between the dependent variables and the independent variables. The same data set, discussed previously in the categorical analysis, is used in the regression analysis presented in this section.

Land use changes are divided into 6 different categories which are used as the dependent variables (DV),

(1) DRS = the percentage annual change in the proportion of single residential acreage.

(2) DRM = the percentage annual change in the proportion of multiple residential acreage.

(3) DC = the percentage annual change in the proportion of commercial and industrial acreage.

(4) DP = the percentage annual change in the proportion of public and semi-public acreage.

(5) DSR = the percentage annual change in the proportion of streets and roads acreage.

(6) DU = The percentage annual change in the proportion of undeveloped acreage.

Several exogenous variables are assumed to potentially affect changes in the land use categories listed above. Two continuous exogenous variables (CV) are used,

(1) DADT = the percentage annual change in ADT,

(2) DPOP = the percentage annual change in population;

and six different sets of binary variables (BV),

(1) abutting or nonabutting location type

B1 = 1 if land is nonabutting study route,
= 0 otherwise.

B2 = 1 if land is abutting study route,
= 0 otherwise.

(2) stage of area development

S1 = 1 if area undeveloped (less that 20%),
= 0 otherwise.

S2 = 1 if area developing (20-80%),
= 0 otherwise.

S3 = 1 if area developed (greater than 80%)
= 0 otherwise.

(3) metropolitan area

M1 = 1 if area located in Bryan-College Station,
= 0 otherwise.

M2 = 1 if area located in Dallas-Fort Worth,
= 0 otherwise.

M3 = 1 if area located in Houston,

= 0 otherwise.

(4) time period

P1 = 1 if before construction period,

= 0 otherwise.

P2 = 1 if during construction period,

= 0 otherwise.

P3 = 1 if after construction,

= 0 otherwise.

(5) capacity change of study route

C1 = 1 if there was a 2 lane capacity change,

= 0 otherwise.

C2 = 1 if there was a 4 lane capacity change,

= 0 otherwise.

C3 = 1 if there was no capacity change,

= 0 otherwise.

(6) median treatment of study route

R1 = 1 if changed to raised median,

= 0 otherwise.

R2 = 1 if changed to continuous left turns,

= 0 otherwise.

R3 = 1 if no median treatment,

= 0 otherwise.

Two separate models are used to estimate the relationship between the dependent variables and the exogenous variables. Model I is given as:

$$DV_i = \alpha_{io} + \alpha_{ij}CV_{ij} + \beta_{ik}BV_{ik} + \psi_{i,jk}CV_{ij} \cdot BV_{ik}$$

where: i = index for type of land use i = 1 ···, 6

j = index for the continuous exogenous variables j = 1, 2

k = index for the binary variables k = 1, ···, 17.

Ordinary least squares (OLS) is used to estimate the coefficients of Model I, which will be unbiased and consistent estimates of the coefficients. However, since there would be a high likelihood of the presence of some correlation between the disturbances in different equations, Aiken's generalized least squares (GLS) is also used to estimate Model I, giving more efficient estimates of the coefficients.

The second model presents a slightly more complicated relationship between the dependent variables and the exogenous variables. The changes in a particular land use are assumed to be affected by changes in other land uses. The functional form for Model II is given as:

$$DV_i = \alpha_{io} + \alpha_{ij}CV_{ij} + \beta_{ik}BV_{ik} + \psi_{i,jk}CV_{ij} \cdot BV_{ik} + \delta_{im}DV_m \quad i \neq m$$

where: m = type of land use in each of the other five equations.

Model II is the same as Model I except the other land uses have been added as explanatory variables. Model II is a simultaneous equation model, so to obtain consistent estimates of the coefficients, two-stage least squares (2SLS) is used. In addition, this model would be expected to have a significant correlation between the disturbances across equations, so Model II is also estimated using three-stage least squares (3SLS) to improve the efficiency of the estimated coefficients.

Results of the Analysis

Tables 4 and 5 present the results of estimating the equations in Model I. The results of Model II are presented in Tables 6 and 7. The coefficients for the final equations were determined by selectively eliminating those variables which were not statistically significant. It is not surprising that a relatively large number of variables have been eliminated. The sample is not large enough to estimate all the influences which may be present in the population. Also, there is evidence of some multicollinearity, i.e., some independent variables may be so highly correlated that one or more variables may dominate another, or a combination of variables may exert a significant influence while the contribution of each variable separately is weak.

In addition, one binary variable from each set of binary variables must be taken out in estimating the regression coefficients. The reason is that one binary variable in a given set is a linear combination of the others. Inclusion of these variables would make estimation of the coefficients indeterminate. This does not provide any limitation to interpreting the results. Each estimated coefficient for the binary variables measures the difference in the mean change in acreage for that particular land use between the presence of that characteristic and its absence.

For example, in the first equation, DRS, the binary variable B1 measures the difference in the mean change in single residential acreage between nonabutting land and abutting land. When a continuous explanatory variable is present, the estimated coefficients for the binary variables measure the mean difference for a given level of the continuous explanatory variable. For example, in the second equation, DRM, the

Table 4 Model I Estimated Coefficients Using Ordinary Least Squares

Dependent Variables	Constant	Independent Variables													R^2	F Stat
		DADT	B1	S1	S3	M2	M3	P1	P2	C3	DADT·M3	DADT·S3	DADT·B2	DADT·P2		
DRS	-0.1473 (-0.76)[a]		0.5294* (3.02)			-0.4328* (-2.44)			-0.4030* (-1.92)	0.3496** (1.61)					.1575	4.72*
DRM	-0.1197 (-0.90)	0.0263* (3.21)			0.5772* (2.05)		1.0304* (4.22)				-0.0251* (-1.97)			0.0211* (2.32)	.4480	15.09*
DC	1.4721* (6.13)		-1.1608* (-4.19)	-0.7818* (-2.29)		0.5588* (2.00)									.2069	8.87*
DP	-0.0728 (-1.19)	0.0090* (1.68)			0.6317* (4.11)							-0.0195* (-3.14)	0.0105* (1.72)		.2344	7.19*
DSR	0.0778** (1.32)			-0.1459** (-1.42)	0.4030* (3.62)			0.2140* (2.49)							.1930	8.13*
DU	-1.1282* (-4.50)	-0.0279* (-2.83)		1.1241* (2.65)	-1.6523* (-3.33)		-1.0288* (-2.67)								.3262	11.38*

[a] t statistic is listed below each coefficient in parentheses

* significant at 5 percent level

** significant at 10 percent level

Table 5 Model I Estimated Coefficients Using Aiken's Generalized Least Squares

Dependent Variables	Constant	Independent Variables											
		DADT	B1	S1	S3	M2	M3	P1	P2	R3	DADT·M3	DADT·S3	DADT·P2
DRS	-0.1304 (-0.87)[a]		0.4189* (2.92)			-0.3232* (-2.25)			-0.1532** (-1.36)	0.1219 (0.95)			
DRM	-0.1224 (-0.94)	0.0302* (4.53)			0.6066* (2.19)		0.9497* (4.29)				-0.0188* (-2.21)		0.0112* (1.85)
DC	1.2676* (5.89)		-0.6833* (-3.29)	-0.6493* (-2.14)		0.4739* (2.05)							
DP	-0.0694 (-1.15)	0.0143* (3.50)			0.5852* (3.90)							-0.0146* (-2.87)	
DSR	0.0973** (1.38)				0.4490* (4.97)			0.1826* (2.61)		-0.1001 (-1.24)			
DU	-0.9989 (-4.63)	-0.0372* (-5.46)		0.6192* (1.93)	-1.5775* (-4.39)		-0.8159* (-2.93)						

$R^2 = 0.2324$

[a] t statistic is listed below each coefficient in parentheses

* significant at 5 percent level

** significant at 10 percent level

Table 6 Model II Estimated Coefficients Using Two-Stage Least Squares

Dependent Variables	Constant	Independent Variables													R^2	F STAT
		Exogenous Variables								Endogenous Variables						
		DADT	B1	S1	S3	M3	P1	DADT·M3	DADT·S3	DRS	DRM	DC	DSR	DU		
DRS	0.1420** (1.34)[a]										-0.2984* (-2.49)	-0.4592* (-5.18)		-0.2595* (-2.94)	.2231	9.10*
DRM	-0.3879* (-2.04)	0.0274* (3.30)				0.7210* (2.67)		-0.0382* (-2.98)		0.6773* (1.88)			-1.2109* (-1.73)	-0.4488* (-3.15)	.4507	12.58*
DC	1.5543 (6.32)		-0.8451* (-2.34)	-0.7314* (-2.27)						-0.6572 (-1.06)					.2157	8.71*
DP	-0.0734 (-1.19)	0.0145* (3.32)			0.6000* (3.89)				-0.0147* (-2.62)						.2104	8.44*
DSR	0.0327 (0.74)				0.4612* (5.02)		0.1339* (1.87)								.2280	14.17*
DU	-0.0064 (-0.03)				-0.8576* (-3.12)					-1.4410* (-3.03)	-1.0365* (-9.84)	-1.0609* (-5.84)			.6787	49.65*

[a]t statistic is listed below each coefficient in parentheses

* significant at 5 percent level

** significant at 10 percent level

Table 7 Model II Estimated Coefficients Using Three-Stage Least Squares

Dependent Variables	Constant	Independent Variables												
		Exogenous Variables								Endogenous Variables				
		DADT	B1	S1	S3	M3	P1	DADT·M3	DADT·S3	DRS	DRM	DC	DSR	DU
DRS	0.1274 (1.26)[a]										-0.2907* (-3.09)	-0.4936* (-6.15)		-0.2855* (-4.13)
DRM	-0.3586* (-2.09)	0.0208* (3.17)				0.4895* (2.67)		-0.0236* (-2.61)		1.1042* (3.56)			-1.8196* (-3.61)	-0.5453* (-4.81)
DC	1.4944* (6.33)		-0.7612* (-2.28)	-0.6819 (-2.26)						-0.8999** (-1.54)				
DP	-0.0144 (-0.25)	0.0077* (2.14)			0.4996* (3.44)				-0.0072** (-1.56)					
DSR	0.0325 (0.78)				0.4752* (5.30)		0.1278* (2.31)							
DU	0.0637 (0.40)				-0.6533* (-3.42)					-1.6610* (-5.65)	-1.0587* (-11.80)	-1.1580* (-8.93)		

$R^2 = 0.3413$

[a]t statistic is listed below each coefficient in parentheses

* significant at 5 percent level

** significant at 10 percent level

binary variable S3 measures the difference in the mean change in multiple residential acreage between developed areas and those which are not, for a given percent change in ADT.

In spite of the above limitations, some interesting results were obtained. The F-statistics in each of the OLS equations and 2SLS equations are significant with the R^2 ranging from .1575 to .4480 using OLS and from .2104 to .6787 using 2SLS.

The inclusion of the other dependent variables as explanatory variables generally increases the amount of variation which is explained by the regression equation. The overall estimation using the system estimations improved. The R^2 value for the GLS equations is .2324 compared to .3413 for the 3SLS. The R^2 for each of the equations using 2SLS is higher than OLS except for the DP equation. However, some of the exogenous variables which are significant in Model I are not significant in Model II. The interaction between the dependent variables removes some of the additional explanatory power which these variables provide. Their effects are incorporated through the effects from the significant endogenous variables in each equation.

Change in Single Residential Acreage (DRS)

In Model I, the mean percent change in the proportion of single residential acreage is significantly higher (about 42%) in nonabutting areas than in abutting areas; significantly lower (about 32%) in the Dallas-Fort Worth area compared to the other two areas; and significantly lower (about 15%) in the second period, the during construction period, than the other two periods. In addition some weaker influences were estimated for capacity changes and median treatment. Improvements which involved no capacity change or a median treatment seem to have a positive influence on DRS.

The estimated coefficients for DRS in Model II contain three endogenous variables, but all the exogenous variables become statistically insignificant. Changes in multiple residential development and commercial development have a negative impact on changes in single residential development and total overall development has a positive impact. This would indicate the exogenous variables in this equation provide relatively little additional explanatory power not incorporated into the endogenous variables.

As expected, the change in single residential land use in this sample is affected by improvements along the study route and the competition from alternative land uses, as well as overall development. However changes in population are not significant in this sample. This may be due to the population data used in the analysis. Changes in population are on a citywide basis rather than for the area in each case study. Therefore the distributional effects from highway improvements would not be captured.

Change in Multiple Residential Acreage (DRM)

In Model I, changes in ADT have a significant positive impact on the proportion of multiple residential acreage. In addition the third stage of area development has a positive impact, about 60% higher for a given level of ADT growth, compared to the undeveloped or developing areas. There is also a strong positive influence in the Houston area. DRM is about 95% higher in Houston than the other two metropolitan areas if the ADT growth rate is zero, but as the ADT growth rate increases, for every 1% change in ADT, the impact in Houston is much smaller on the proportion of multiple residential development (about .01%) compared to about .03%

in the other areas. The effect of the second period, P2, goes in just the opposite direction, with the effects about .01% higher during the second period compared to the other two periods.

The estimated coefficients in Model II include three of the exogenous variables from Model I, and three endogenous variables, single residential development, streets and roads development, and overall development. Changes in ADT still have a positive effect, along with the Houston metropolitan area. In addition changes in single residential development, along with changes in overall development have a positive impact on changes in multiple residential development.

Conversely, increases in the proportion of streets and roads have a negative impact. This may be due to the relatively small change in street and road acreage compared to multiple residential acreage in this sample. In addition, two areas in College Station and one in Dallas have extreme values favoring a negative relationship. Study Area 3 in College Station has DRM = 7.234 and DSR = 0.190, Study Area 4, also in College Station, has DRM = 0.000 and DSR = 2.628. Study Area 14 in Dallas has DRM = 0.375 and DSR = 2.906. Since most of the other data points are near zero, a negative relationship between DRM and DSR is statistically significant in this sample. There may also be a distributional effect, i.e., the effects of one study route may go outside the study area and possibly into another study area.

The rate of change in the proportion of multiple residential development is positively affected by increases in ADT, the third stage of area development, the Houston metropolitan area, single residential development and overall development. Streets and roads development has a negative impact in this sample. Again, DPOP is not significant, along with the abutting or nonabutting land use, capacity change, or median treatment.

Change in Commercial Acreage (DC)

In Model I, the percent change in the proportion of commercial development is about 68% higher in abutting areas compared to nonabutting areas, about 65% lower in the undeveloped areas (S1) than the other ones. In addition DC is 47% higher in the Dallas-Fort Worth area compared to the other two metropolitan areas.

S1 and B1 remain significant in Model II along with single residential development. Increases in the proportion of single residential development have a significantly negative impact on changes in commercial development.

Overall, abutting land use and Dallas-Fort Worth have a positive impact on changes in commercial development. Undeveloped areas and single residential development have a negative impact. Changes in population are not significant, as well as the period, capacity changes, and median treatment.

Change in Public Acreage (DP)

The significant coefficients are the same in both Model I and Model II, though the estimates are slightly different. The mean percent change in the proportion of public acreage is significantly higher in developed areas (about 50%) than the other areas, when the ADT growth rate is zero. For every 1% increase in ADT growth, there is about a .01% increase in the proportion of public acreage in undeveloped or developing areas.

However there is no statistically significant increase in developed areas as ADT increases. This may be the result of the development process. As an area is growing and ADT increasing, the proportion of public acreage, such as schools, churches, etc., may be affected. As the area becomes more developed, the proportion of public acreage is higher, but not as sensitive to increased ADT growth.

Changes in population are not statistically significant in this sample, as well as abutting or nonabutting land use, metropolitan area, the period, size of capacity change, or median treatment.

Change in Streets and Roads Acreage (DSR)

In Model I the mean percent change in the proportion of streets and roads is significantly higher (about 45%) in the developed areas and significantly higher in the "before" period (about 18%) than the other two periods. In addition, weaker influences were estimated, with a slightly lower DSR in the undeveloped areas or in the absence of any median treatment.

No endogenous variables are significant in Model II. Two exogenous variables remain significant, the proportion of street and road development is significantly higher in the developed areas and in the "before" period of study route improvements. These results may be due to the relatively small variation in the DSR data, which was described earlier in connection with the DRM equations. The small sample size, combined with the relatively small variation in the sample data prevents potentially significant explanatory variables from being estimated.

Again, changes in population are not significant, along with changes in ADT, abutting or nonabutting land use, the metropolitan area, the period, capacity changes and median treatments.

Changes in Undeveloped Acreage (DU)

DU measures the percent change in the proportion of undeveloped acreage, so the effects on overall development would be measured by the negative of the coefficients presented in Tables 4 through 7.

In Model I, increases in ADT have a positive impact on overall development in the sample. In addition, for any given percent change in ADT, the mean percent change in overall development is significantly higher (about 82%) in the Houston area, significantly higher (about 158%) in the developed areas, and significantly lower (about 62%) in the undeveloped areas.

Only the positive impact in the developed areas remains significant in Model II. Three endogenous variables are significant. Single residential development, multiple residential development, and commercial development all have a positive influence on overall development.

Not surprisingly, increased ADT, the Houston area, and the stage of area development have significant impacts on overall development. In addition, when the endogenous variables are added, several categories of development are statistically significant. This is partially a result of the specification of the variables, the proportional change in overall development in each area is a linear combination of the categories of development for that area. That would account for a portion of the highly significant endogenous variables in Tables 6 and 7 for DU.

Changes in population are not significant in explaining overall development in this sample. Other variables which are not significant include abutting or nonabutting land use, the period, capacity change, or median treatment.

Comparison of Regression Analysis to Categorical Analysis

Comparison of the results in the categorical analysis with those obtained using regression analysis reveals some similarities, a few differences, and some results which cannot be directly compared. It is not surprising each analysis suggests some different significant relationships between the dependent and independent variables.

One factor would be the estimation techniques themselves. The categorical analysis is purposely limited to one explanatory variable, due to lack of observations, which means any interactions the variables may have with another explanatory variable or set of variables must be ignored. That interaction, of course, is incorporated into and is the basis for multiple regression analysis used in this study.

Another factor is the definition of the dependent variable. The regression analysis uses a continuous dependent variable, the percent change in the proportion of a particular land use. In order to use categorical analysis the dependent variable is transformed into either a slower or faster growth category, making the variable dichotomous. This loss of information by placing the dependent variable into categories, may result in some differences in the statistical significance of some independent variables.

The above mentioned differences make comparisons between the two results difficult, but some similar patterns do emerge. Both methods found faster single residential development with no median treatment, faster commercial development in abutting areas, and faster public development with faster ADT growth.

Different results were obtained for multiple residential development. The categorical analysis found slower multiple residential development with faster ADT growth, while the regression analysis found a positive relationship between DRM and DADT. The reason for the difference is the emphasis regression analysis places on relative magnitudes of the variables whereas categorical analysis relies on the number of observations within a particular category, without regard to the underlying magnitudes.

As an example, Study Area 3 in College Station has two extreme values for DADT and DRM, DADT = 77.966 when DRM = 4.024, and DADT = 120.364 when DRM = 7.235. The simple correlation between DADT and DRM is this sample is .5795, indicating a significant positive relationship. Even if the two extreme data points in College Station are taken out, an estimated positive relationship is still present in the sample data, though the relationship is not as strong, the simple correlation drops to .1283.

In addition, a positive relationship between DRM and DADT does seem reasonable from a traffic generation view. Multiple residential development would generate more traffic than other forms of development, such as single residential development. Even though there is some crowding out, particularly from commercial development, that effect may not be very strong, since multiple residential development can be observed to survive and sometimes prosper in highly developed areas.

Other influences significant in one analysis are not significant in the other analysis. In addition, some conclusions in one analysis are not directly comparable to the other analysis. As an example, the categorical analysis can be used to test if the growth of a particular variable has significantly speeded up or slowed down between two periods. Since the regression analysis must assume a particular functional form, the trend in growth rates must be assumed rather than tested. In this study a linear relationship was assumed, which may not accurately represent the time relationship.

Due to the differing statistical methods used in categorical analysis and regression analysis, along with necessary data transformations, many of the results are different and sometimes not comparable. However, this does not diminish their usefulness. Each analysis has certain benefits as well as limitations and the results from both the categorical analysis and the regression analysis can be valuable in assessing the effects on land use from a proposed highway improvement project.

CONCLUSIONS OF AGGREGATIVE ANALYSIS

Although hampered by certain statistical problems, most notably a small sample size, the categorical analysis and the regression analysis were able to shed some light on the relationships between land use changes and certain predictive factors. In addition, they provided some information on the effects of two different types of median treatment on land use.

The categorical analysis indicates that several factors are related to land use changes before, during, and after urban roadway improvements. These factors, while associated with land use changes, do not appear to fully explain changing rates of land development before, during, and after improvements. Without control areas, it cannot be ascertained whether or not roadway improvements in and of themselves affect land use patterns. Without examining interactions among the independent variables, it is difficult to readily explain some of the analytical results. Differences among metropolitan areas seem related to single-family residential, commercial, and overall development. But without information on how, e.g., population trends vary within metro areas, specific causes of variation in these land use patterns by metro area are not readily identifiable.

Thus, on the basis of the available information, the results of the categorical analysis appear consistent with the hypothesis that roadway improvements work in conjunction with other factors in accomodating land use changes. This is evidenced particularly by the relationships of multi-family residential and commercial development to location type and of single-family residential development to ADT growth.

Some of the evidence was found to suggest that the installation of raised medians, given the addition of capacity, has a depressing effect on land development. Although based on a relatively small sample, this finding implies that the type of median treatment should be considered in roadway improvements.

The regression analysis gives similar overall results. There are several factors which influence land use development, though the direct effects from roadway improvements seem to be relatively weak. There seems to be an interaction among a number of variables which influence land use changes as a result of roadway improvements. It is difficult to isolate the individual effects. The land use effects from median treatments are relatively weak in this sample.

The results of the study are relevant to SDHPT policy decisions. When considering an urban roadway improvement, the Department should recognize that the improvement could possibly impact various types of land use in the surrounding areas. Of course, any effects of the improvement on land use would be limited to the extent that other predictive factors, such as metropolitan/regional growth and local zoning ordinances, affect land development.

In addition, the effects of the type of median treatment planned as part of the proposed improvement on land use should be considered. In general, the type of median treatment deployed at a location is determined by local government preference, not by SDHPT. While analytical results regarding the effects of median treatments were comparatively weak, it is recommended that the type of median treatment be taken into account by the policy-determining agency.

CHAPTER III. URBAN DEVELOPMENT MODELS

A popular approach to forecasting urban growth is the use of urban development models. These models, utilizing information on residential and employment locations, trip origins/destinations, transportation facilities, and population and employment projections, attempt to predict patterns of future growth in a metropolitan area. This chapter explores the suitability of using urban development models to explain the relationship between land development and urban roadway improvements.

DESCRIPTION OF MODELS

Initial attempts at developing urban development models began in the early 1960's. Since that time, many types of models have been formulated. Most of the models fall into one of the following categories [10].

(1) Lowry derivative models - a group of models [11] based on a set of relationships among residential, employment, and (in some cases) shopping locations. These models require exogenously determined forecasts of population growth and employment.

(2) EMPIRIC models - a group of many applications of the same model [12,13]. The model consists of a simultaneous system of regression equations. It includes residential and employment locations.

(3) Research models - a small assortment of potentially applicable but not generally operational models. Examples are the revised Herbert-Stevens model [14], the Birch model [15], and the National Bureau of Economic Research model [16].

Models of the third type have not been sufficiently developed beyond the development or pilot application stage to be generally useable in analyses of land development in urban areas. Currently, the Federal Highway Administration (FHWA) maintains computerized versions of models of the first two varieties but not of the third. The Lowry derivative and EMPIRIC models are discussed further below.

Lowry Derivative Models

Of the Lowry derivative models, the most frequently applied has been the Projective Land Use Model (PLUM) in any of its several versions [17]. The Lowry-type models hypothesize that, given a spatial distribution of employment and a description of interzonal travel times in an urban area, it is possible to estimate the location of employees' residences.

Input data requirements include detailed population and employment information by small areas or zones, land use data, and information on auto and transit networks for a given base year. Interzonal travel times (between home and work zones), employment and population forecasts, and policy constraints are required for each forecast year.

The output of the model is a demographic and land use profile of each zone for the forecast year. The model forecasts, or allocates, residential locations for the area under consideration.

The Lowry-type model is not one whose parameters are statistically estimated. It is, rather, an "input-output" type of model in which a set of parameters controls the allocation of places of employment, residence, and, in some cases, shopping. Residential allocations, or estimates of the number of people living in a particular area, are based on trips to work, in particular the probability (P_{ij}) of an individual's living in area i and working in area j.

A model can be tested for forecasting accuracy by making a forecast of employment and residence (and, if applicable, shopping) locations for a period for which these locations are known. If considered necessary by the model's user, the parameters can be adjusted, or calibrated, in order to alter the forecast.

An improved version of the PLUM models is the Disaggregated Residential Allocation Model (DRAM) [10], currently being put into operational form by FHWA. By reformulating the residential portion of PLUM, DRAM provides improved estimates of model parameters.

The residential portion of the Lowry model allocates increments of residential locators (people) to their places of residence in response to increments in basic employment and to changes in transportation facilities. This response is determined primarily by a probability distribution function describing trips from home to work. The probability P_{ij} that a person lives in zone i and and works in zone j is a function of travel time for a work trip and of characteristics of residential and work zones (e.g., relative attractiveness and travel cost of zone i to zone j, compared with all other residential zones to zone j; number of employees in zone j).

Most Lowry-type models have failed to estimate the complete P_{ij} (work trip) function using actual data.[5] Some models have used observed

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[5] An exception is the Voorhees Urban Systems Model [24] application in the Dallas-Ft.Worth region. This application, similar in approach to DRAM, obtained properly calibrated model parameters via appropriate specification of the P_{ij} function, explicitly taking into account orgin/destination characteristics and work-trip travel costs.

work trip data to describe interzonal travel times, without taking into account the effects of the characteristics (relative neighborhood attractiveness, travel cost, number of employees) of residential and work zones. Others have empirically expressed the number of residential locators as a function of residential zone characteristics while failing to explicitly consider the distribution of work trips. Neither approach results in proper estimation of model parameters.

Employing a reformulated Lowry-type model incorporating improvements borrowed from British modeling efforts [18], DRAM explicitly considers origin and destination characteristics and the work trip distribution with its related travel costs. This improved model produces more satisfactory parameter estimates and hence better forecasts of residential allocations.

EMPIRIC Model

The EMPIRIC Activity Allocation Model has been applied to several cities across the U.S. [17]. Like the Lowry-derivative models, its aims are to allocate regional projections of future population, employment, and land use among urban-area zones and to assess the relative impacts of alternative planning policies on the future distribution of regional growth.

Input data requirements include detailed population, employment, and land use information, similar to that required for other urban development models. Using data for two points in time (about ten years apart), forecasts of future activity are generated for ten, twenty, thirty, etc., years into the future, subject to specific regional planning policies.

Unlike the input-output structure of the Lowry-derivative models, the EMPIRIC model consists of a system of simultaneous regression equations.

The variables in the equations are expressed as changes in zone-level shares of regional population, employment, etc. Variable selection and parameter estimation are accomplished via a step-wise regression procedure. Also available are ordinary and two-stage least squares regression options. Future activity (employment, housing) forecasts are derived from estimated changes in activity shares for each zone, as reflected by the estimated parameters.

The EMPIRIC model lacks a theoretical structure, relying on a step-wise selection procedure rather than an *a priori* theory to determine which variables to include in the equations. This lack of a substantive theoretical form has led to criticisms that the model is not properly specified and is non-behavioral [10].

AVAILABILITY AND COSTS OF MODELS

Computerized versions of the PLUM and EMPIRIC models are available from the Urban Planning Division of the Federal Highway Administration. There is no charge to non-profit organizations for the computer tapes and program documentation. DRAM is currently being put into operational form by FHWA. The model should be available in late 1981 or early 1982 [19].

Each model requires substantial input data that must be updated annually. Program and data management for a given study region, including on-going data updating and population/employment forecasting, constitutes a year-round job for one or more planners and support staff. Data assembly alone requires at least six to twelve man-months of professional effort, with perhaps twice that level of technical support effort [17, 20].

APPLICATION OF MODELS

Urban development models are a structured approach to predicting future growth and hence land use in a metropolitan area. Utilizing information on characteristics of residential and work zones and on travel costs from home to work, the models predict or allocate land use within the framework of projected regional population growth, employment, and transportation facilities.

The models serve two basic functions. One is to provide a general outline of future regional growth in terms of land use trends. Another is to assess relative overall impacts of alternative transportation policies on regional land use trends.

The models are designed for conducting analyses on a regional level. Some of the models perform acceptably well in this context.[6] However, no urban development model can accurately predict land development for relatively small areas, those of less than perhaps 200 serial zones (roughly 40 square miles or more) in size [19, 21, 22, 23]. Designed to predict general benchmarks, they cannot model land use changes and related factors for a specific, small area such as the eighteen locations examined in this study. Urban development models are meant for application only on a regional level such as the Dallas-Fort Worth metropolitan area.

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[6]Examples include DRAM, discussed above, and the Urban Growth Simulation [21], a PLUM version currently in use by the North Central Texas Council of Governments (NCTCOG). As mentioned above, the NCTCOG sponsored the application of a Lowry-type model [24] having improvements similar to those of DRAM.

CONCLUSIONS

Based on the foregoing review of urban development models, two conclusions can be drawn. First, of the models which are either currently or soon to be both operational and available, DRAM appears to be superior, due to its improvements to the Lowry-type models and resultant improved estimation of model parameters.[7] An improved Lowry-type model such as DRAM should be used in any situation requiring an urban development model.

The second conclusion is that the analysis of small urban areas, such as those considered in this study, cannot be successfully performed using an urban development model. Individual sections of an urban area are much too small to be modeled within the framework of an urban development model. Such locations should rather be analyzed using a technique such as that used in this study.

The recommended approach to investigating and modeling relationships between land use and transportation facility improvements is to use statistical techniques such as that described in Chapter II of this report. Data should be compiled either from existing records or through primary observations, or a combination of both, as done in this study. Using these data, relationships between land development and predictive factors should be modeled, using an appropriate statistical method such as categorical analysis (used in this study) or, data permitting, standard multiple regression analysis.

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[7] As described above, a successful model currently in use is the Urban Growth Simulation Model [21].

CHAPTER IV. CONCLUSIONS AND RECOMMENDATIONS

The aggregative analysis phase of this study investigated the influence of urban roadway improvements on surrounding land development and considered the feasibility of using urban development models to analyze such land use changes. The results of this phase of the study are summarized below.

CONCLUSIONS

The recommended approach to estimating the influence of improvements on land use involves statistical analysis of improved urban locations. In this regard, an empirical study of eighteen locations in the Bryan/College Station, Dallas/Ft. Worth, and Houston metropolitan areas was undertaken.

For each study location, primary data were compiled on the following:

(1) Acreage in each type of land use.

(2) Certain factors thought to influence the rate of land development:

- (a) Location type
- (b) City population growth
- (c) Metropolitan area
- (d) Stage of development
- (e) Traffic volume growth

These data were analyzed two ways: (1) with two-way frequency tables, using Chi-square tests to find significant relationships between a particular type of land use and a predictive factor, and (2) with multiple regression, using t-statistics to test significant relationship between the variables.

The statistical analysis was limited in the extent to which relationships between land development and predictive variables could be specified. The limitations were due to the following:

(1) Sample size - not large enough to adequately investigate interactive effects of the independent variables and possibly detect some significant main effects of predictive variables on land use. Failure to examine interactions among independent variables in the categorical analysis can result in some significant effects going undetected.

(2) Lack of control (comparison) areas - precluded definitive tests for influences on land development attributable solely to roadway improvements. Although it is difficult to obtain adequate comparison areas for any study such as this, the use of comparison areas would be helpful in isolating the impact of a roadway improvement on land use.

(3) Cross-sectional correlation among study sites within a metropolitan area can reduce the reliability of the statistical test by possibly incorrectly indicating significance in some cases, when that correlation is not correctly specified.

In spite of these limitations, considerable insight was gained into the relationships between land development and several predictive factors. The analysis indicated that land development is affected differentially by various factors, as discussed in Chapter II. While the effect of roadway improvements on land use could not be isolated and quantified in the categorical analysis, the analysis suggested that roadway improvements accomodate land development. This is evidenced particularly by the responses of both multi-family residential and commercial development to abutting/nonabutting locational differences and of residential development to ADT growth. A further indication that roadway improvements accomodate land development is the results of the H_0^2 test, in particular the more rapid overall development of land in response to continuous left turn lane implementation and the apparent depressing effect of raised medians on overall land development.

The regression analysis provided some estimates of the effects some of these factors have on land use development. Each estimation technique provided slightly different results with respect to the statistically significant variables and the magnitude of the estimated coefficients, but the results were generally quite consistent with the categorical analysis in view of the small sample size. The results provide some measure of the effects a proposed roadway improvement would have on various categories of land use.

Chapter III considered the feasibility of using urban development models to analyze land use changes and related factors in urban locations such as the eighteen areas considered in this study. It was found that a modeling approach using an improved Lowry-type model can provide satisfactory regional-level forecasts of future growth and land use trends and assess relative impacts of alternative transportation policies on regional land use.

The urban development models are not, however, suited for analyzing land use patterns on less than a regional basis. They are unable to accurately model land use changes and related predictive factors in relatively small sections of a given urban region. It is concluded, therefore, that no attempt should be made to adapt any urban development model to the analysis of land use changes and roadway improvements in specific-locations within urban regions.

RECOMMENDATIONS FOR FURTHER RESEARCH

In light of the limitations encountered in the aggregative analysis, further analysis is indicated. The principal benefit to be derived from further model development and estimation would be to overcome the three limitations cited in the analysis presented in this report.

Increased sample size would allow a more detailed specification of the model. Interactive effects among the independent variables could be taken into account, resulting in a model that would better represent the associations between land development and the independent variables.

Control, or comparison, areas would allow the isolation of effects on land use due specifically to roadway improvements. The effects could then be quantified separately instead of being obscured by the effects of other predictive variables.

Locations selected from a broader spectrum of cities around the state would enhance the ability of the model to detect and estimate significant relationships between land development and predictive factors. A broader sample of locations would be more representative of land use behavior with respect to roadway improvements and other influential factors.

Additional research would rely primarily on secondary data available from most of the SMSA's in the state. Primary data collection would be minimized or, more likely, not undertaken.

Locations would be selected for which data on all variables are available. Most SMSA's have compiled data annually since 1970, storing most or all of it on computer tapes. This approach to data collection would minimize the time and costs of compiling a sufficient data base.

Additional model development efforts would be directed toward a more rigorous formulation of relationships among the dependent and independent variables. Annual data, rather than periodic data, would aid in performing more powerful significance tests and in better quantifying the individual effects of predictive factors on land development. Specification and quantification of interactions among the independent variables and possibly relationships among various types of land use would be facilitated by a larger data base.

Further refinement of the analytical approach presented in this report is recommended. The analysis results obtained in this study specify certain influences on land use change but have not been able to conclusively isolate the influence of roadway improvements on land use. Additional model refinement is suggested for developing more detailed information on the impact of roadway improvements on urban land use, to further assist SDHPT in decision making regarding such improvements.

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APPENDIX

This appendix presents tabular data and test results of the aggregative analysis. Names of variables used either directly in the analysis or to construct additional variables employed in the analysis are as follows:

DEPENDENT VARIABLES

LOC_NUM: Identification number of each study location, corresponding to the number of the individual report on that location (e.g., LOC_NUM = 3 for the State Highway 30 area in College Station, reported in Research Report 225-3 of this project).

LOC_NAME: Name of the study location, e.g., College Station, Highway 30.

PERIOD: Period, equal to 0,1,2,3. For simplicity of exposition, this variable was called "t" in Chapter II. The period from t = 0 to t = 1 is the "before" period, from 1 to 2 is the "during " period, and from 2 to 3 is the "after" period.

YEAR: Years for which land use data were collected. The years correspond to PERIOS = 0,1,2,3, for each location

ACRES: Total number of abutting (A) or nonabutting (N) acres in the study location.

RS: Single-family residential acreage (A or N).

RM: Multi-family residential acreage (A or N).

C: Commercial (including industrial) acreage (A or N).

P: Public-governmental and semi-public acreage (A or N).

SR: Streets and roads acreage (A or N).

U: Undeveloped acreage (A or N).

PRS: Proportion of total acres (A or N) in single-family residential use, equal to RS divided by ACRES.

PRM: Proportion of total acres (A or N) in multi-family residential use, equal to RM divided by ACRES.

PC: Proportion of total acres (A or N) in commercial use, equal to C divided by ACRES.

PP: Proportion of total acres (A or N) in public-governmental or semi-public use, equal to P divided by ACRES.

PSR: Proportion of total acres (A or N) in streets and roads use, equal to SR divided by ACRES.

PU: Proportion of total acres (A or N) in undeveloped use, equal to U divided by ACRES (1-PU gives the proportion of total acres in developed use). For a given LOC-NUM, LOC-TYPE, and PERIOD, the six values PRS, PRM, ..., PU sum to 1.00.

DRS: Average annual change in single-family residential acreage, i.e., rate of change in RS acreage or, alternatively, rate of RS developement.

DRM: Average annual change in multi-family residential acreage.

DC: Average annual change in commercial (including industrial) acreage.

DP: Average annual change in public-governmental and semi-public acreage.

DU: Average annual change in undeveloped acreage. Reversing the sign of each value of DU will give the average annual rate of net overall land development. Net developed acres are the number of acres of undeveloped land converted to a developed use. Net overall land development does not account for changes from one developed use to another.

The average annual change in each type of land use is non-compounded and is defined (for either A or N) as follows, from period t-1 to t:

$$DL_{ijt} = [(\frac{L_{ijt} - L_{ij,t-1}}{YEAR_{jt} - YEAR_{j,t-1}})/ACRES_j] \times 100\%$$

where: L_i = acreage devoted to land use of type i

i = single-family residential, multi-family residential, ..., undeveloped

j = study location, j = 1,2,...,18

t = 1,2,3

Using abutting single-family residential acreage at Location 5 (Bryan, East 29th Street), for the "before" period, provides the following example (see Table A2):

$$DRS_{51} = [(\frac{16.39 - 16.07}{1965 - 1958})/37.9] \times 100\%$$

$$= .1206\% \text{ per year}$$

This value is the average annual rate at which abutting single-family residential acreage in the East 29th Street area of Bryan developed during the period prior to improvement of the treated roadway in that location.

Note that the rate of change is expressed not as "acres per year" but rather as a proportion of total (abutting) acres at Location 5. Defining the rate of change in this manner permits the comparison of rates of change among areas of different size. For example, for a given type of land use, a change of 25 acres per year (over, say, a five-year period) in a tract of 500 acres represents slower development than a change of 10 acres per year in a 100-acre tract over the same five-year period. Not taking into account the relative sizes of the 500- and 100-acre tracts could lead one to erroneously conclude that the 500-acre tract had developed more rapidly.

PREDICTIVE VARIABLES

LOC-TYPE: Location type. Each study location is divided into abutting and nonabutting sections, according to proximity to the improved roadway in that location.

POP: City population in t = 0,1,2,3.

DPOP: Average annual (non-compounded) percent change in city population, in the before, during, and after periods. City population change (average percent per year) for the jth location is defined as:

$$DPOP_{jt} = [(\frac{POP_{jt} - POP_{j,t-1}}{TPOP_{jt} - TPOP_{j,t-1}})/POP_{j,t-1}] \times 100\%$$

where TPOP = 1,2,3

TPOP = approximation of YEAR, since population values were sometimes unavailable for the same years as YEAR.

METRO: Metropolitan area - Bryan/College Station, Dallas/Fort Worth, Houston

STAGE: Stage of development, equal to 1 (largely undeveloped), 2 (developing), or 3 (fully developed). The stages are defined as of t = 1. The ranges are defined by $\pm$ 1 standard deviation from the mean of the ratios of developed acres to total acres in the study locations. This corresponds to approximately less than 20% developed for Stage 1, between 20% and 80% developed for Stage 2, and above 80% developed for Stage 3.

ADT: Average daily traffic count on the improved roadway in each study location, at t = 0,1,2,3.

DADT: Average annual (non-compounded) change in ADT, in the before, during, and after periods. Traffic volume change (average percent per year) for the jth location is defined as:

$$DADT_{jt} = [(\frac{ADT_{jt} - ADT_{j,t-1}}{TADT_{jt} - TADT_{j,t-1}})/ADT_{j,t-1}] \times 100\%$$

where TADT = 1,2,3

TADT = approximation of YEAR, since ADT values were sometimes unavailable for the same years as YEAR.

TL: Addition of through lanes (capacity) as part of the roadway improvement at a location. Equal to 1 if capacity was added, and or equal to 0 if no through lanes were added.

CLT: Addition of continuous left turn lanes as part of the roadway improvement at a location. Equal to 1 if turn lanes were added, and equal to 0 if no lanes were added.

RMED: Addition of raised medians as part of the roadway improvement at a location. Equal to 1 if raised medians were added, and equal to 0 if they were not.

D: A variable that indicates the type of median treatment as part of the roadway improvement at a location, given that through lanes were added. Equal to "NONE" if TL = 1, CLT = 0, and RMED = 0. Equal to "L_T_LANE" if TL = 1, CLT = 1, and RMED = 0. Equal to "R_MEDIAN" if TL =1, CLT = 0, and RMED = 1. Equal to "." (missing) if TL = 0.

Each rate-of-change variable is classified according to whether its value increased ("faster" rate of change) or declined ("slower" rate of change) from one period to the next (equal rates of change across periods result in a "slower" classification). Variables for the first five types of land use (RS, RM, C, P, SR) are classifed as follows, for each location and for either A or N:

$$R\_DRS_{t-s,t} = \text{faster if } DRS_t > DRS_{t-s}$$
$$= \text{slower if } DRS_t < DRS_{t-s}$$

$$\text{where } t = 2,3$$
$$s = 1,2 \text{ when } t=3, \text{ or } 1 \text{ when } t=2$$

For example, for a during-after period comparison of single-family residential development (location 3, nonabutting):

$$DRS_2 = .1807$$
$$DRS_3 = .8570$$
$$R\_DRS_{23} = \text{faster}$$

For undeveloped land use, the inequality is reversed. Thus $R\_DU_{t-s,t}$ indicates relative net overall land development rather than a relative change in undeveloped acreage:

$$R\_DU_{t-s,t} = \text{faster if } DU_t < DU_{t-s}$$
$$= \text{slower if } DU_t > DU_{t-s}$$

Variables for city population growth and ADT growth are defined similarly to those for the first five types of land use:

$$R\_DPOP_{t-s,t} = \text{faster if } DPOP_t > DPOP_{t-s}$$
$$= \text{slower if } DPOP_t < DPOP_{t-s}$$

$$R\text{-}DADT_{t-s,t} = \text{faster if } DADT_t > DADT_{t-s}$$
$$= \text{slower if } DADT_t < DPOP_{t-s}$$

The sets of dependent and independent variables chosen for the analysis are as follows (D was used exclusively in H_o^2):

Dependent Variables	Independent Variables
$R\text{-}DRS_{t-s,t}$	LOC-TYPE
$R\text{-}DRM_{t-s,t}$	$R\text{-}DPOP_{t-s,t}$
$R\text{-}DC_{t-s,t}$	METRO
$R\text{-}DP_{t-s,t}$	STAGE
$R\text{-}SR_{t-s,t}$	$R\text{-}DADT_{t-s,t}$
$R\text{-}DU_{t-s,t}$	D

Given the categorical nature of the data, statistical tests using the chi-square statistic were used in the analysis [2]. Specifically, the FREQ ("frequency") procedure of the SAS software package [10] was used to generate crosstabulation tables. These tables show cell frequencies and chi-square values for main effects models involving one dependent variable and one independent variable in each model.

Each table shows, for each cross-classification cell, the observed and expected frequencies, on the basis of which a cell chi-square value is calculated. The sum of the cell chi-square equals the overall chi-square for the model. The level of significance chosen for overall chi-square values is .90.

The direction of the association between a dependent variable and an independent variable at the levels coincident in a particular cell is indicated by the relative values of the observed and expected frequencies in the cell. An observed frequency greater than the expected suggests a positive relationship, while an observed frequency less than the expected suggests a negative association.

NOTES ON TABLES

In Tables A2-A8, observations are missing for some periods. This is because either: (1) data were unavailable, or (2) no value was calculated (e.g., DRS is, by definition, not calculated for PERIOD = 0). Missing observations are indicated by ".".

In Tables A9, A10, A13, and A14, Location 13 has been omitted. Data were unavailable for PERIOD = 3 (the "after" period) at that location, since the "during" period ended in 1978, the last year for which any data were available. Hence, no "after" period was defined for Location 13, with the result that no "before-after" or "during-after" comparisons of rates of land development could be made for that location.

For the same reason, Location 13 is also omitted from Tables A15 and A17. These tables show a total of 34 observations (seventeen locations, each with abutting and nonabutting sections).

Table A18 indicates missing values of D, a variable which indicates the type of median treatment at a location, given the addition of capacity as part of the roadway improvement at that location. At Location 15, no additional through lanes were added, so this location was not used in the H_0^2 test which involved locations that received additional capacity as part of the improvement.

Table A19 shows that 32 observations (16 locations, each with abutting and nonabutting sections) were used in that test. Location 13 was omitted because no "after" period was defined at that location, as explained above. Location 15 was omitted because no capacity was added at that location, and hence this location was not compatible with the remaining sixteen locations, all of which received additional capacity.

Location 15 also was omitted from the test shown in Table A20, which used 34 observations (seventeen locations). Location 13 was included here because the test compared the "before" and "during" periods and thus did not involve the "after" period (undefined at Location 13).

TABLE A1. STUDY LOCATION NAMES AND IDENTIFICATION NUMBERS

OBS	LOC_NAME	LOC_NUM
1	COLLEGE STATION, HWY. 30	3
2	COLLEGE STATION, TEXAS AVE. S.	4
3	BRYAN, EAST 29 ST.	5
4	BRYAN, N. TEXAS AVE.	6
5	HOUSTON, W. 43 AVE.	7
6	HOUSTON, GESSNER RD.	9
7	HOUSTON, ANTOINE DR.	10
8	ARLINGTON, FM 157, SECTION ONE	11
9	HOUSTON, WESTHEIMER RD., SECTION ONE	12
10	ARLINGTON, COLLINS ST.	13
11	HOUSTON, WESTHEIMER RD., SECTION TWO	14
12	ARLINGTON, FM 157, SECTION TWO	15
13	HOUSTON, WESTHEIMER RD., SECTION THREE	16
14	DALLAS, S.H. 352	17
15	DALLAS, S.H. 356	18
16	FT. WORTH, W. BERRY ST.	19
17	FT. WORTH, VICKERY BLVD.	20
18	HURST, PIPELINE RD.	21

TABLE A2. SINGLE-FAMILY RESIDENTIAL ACREAGE

------------------- LOC_TYPE=A METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
1	3	0	1968	152.32	0.00	.	0.000000
2	3	1	1970	152.32	0.00	0.00000	0.000000
3	3	2	1974	152.32	0.00	0.00000	0.000000
4	3	3	1977	152.32	0.00	0.00000	0.000000
5	4	0	1968	106.92	6.50	.	0.060793
6	4	1	1970	106.92	6.50	0.00000	0.060793
7	4	2	1975	106.92	5.70	-0.14964	0.053311
8	4	3	1977	106.92	5.70	0.00000	0.053311
9	5	0	1958	37.90	16.07	.	0.424011
10	5	1	1965	37.90	16.39	0.12062	0.432454
11	5	2	1970	37.90	16.57	0.09499	0.437203
12	5	3	1977	37.90	15.91	-0.24877	0.419789
13	6	0	1958	249.57	41.42	.	0.165965
14	6	1	1964	249.57	47.35	0.39601	0.189726
15	6	2	1970	249.57	55.25	0.52757	0.221381
16	6	3	1977	249.57	59.79	0.25988	0.239572

------------------- LOC_TYPE=A METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
17	11	0	1964	156.88	0.39	.	0.002486
18	11	1	1969	156.88	0.39	0.0000	0.002486
19	11	2	1976	156.88	0.39	0.0000	0.002486
20	11	3	1978	156.88	0.00	-0.1243	0.000000
21	13	0	1969	59.99	8.62	.	0.143691
22	13	1	1974	59.99	8.62	0.0000	0.143691
23	13	2	1978	59.99	8.62	0.0000	0.143691
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	25.14	.	0.198782
26	15	1	1968	126.47	15.79	-1.4786	0.124852
27	15	2	1970	126.47	1.91	-5.4875	0.015102
28	15	3	1978	126.47	0.46	-0.1433	0.003637
29	17	0	1959	94.15	27.83	.	0.295592
30	17	1	1964	94.15	27.66	-0.0361	0.293787
31	17	2	1971	94.15	28.70	0.1578	0.304833
32	17	3	1978	94.15	28.02	-0.1032	0.297610
33	18	0	1958	361.14	0.18	.	0.000498
34	18	1	1961	361.14	0.24	0.0055	0.000665
35	18	2	1967	361.14	0.24	0.0000	0.000665
36	18	3	1978	361.14	0.00	-0.0060	0.000000
37	19	0	1964	47.14	0.00	.	0.000000
38	19	1	1968	47.14	0.00	0.0000	0.000000
39	19	2	1973	47.14	0.00	0.0000	0.000000
40	19	3	1978	47.14	0.00	0.0000	0.000000
41	20	0	1964	59.14	13.56	.	0.229286
42	20	1	1968	59.14	11.91	-0.6975	0.201387
43	20	2	1975	59.14	6.31	-1.3527	0.106696
44	20	3	1978	59.14	5.52	-0.4453	0.093338
45	21	0	1963	89.46	4.23	.	0.047284
46	21	1	1966	89.46	0.99	-1.2072	0.011066
47	21	2	1970	89.46	0.78	-0.0587	0.008719
48	21	3	1978	89.46	0.63	-0.0210	0.007042

TABLE A2. SINGLE-FAMILY RESIDENTIAL ACREAGE

------------------- LOC_TYPE=A METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
49	7	0	1960	66.16	47.71	.	0.721131
50	7	1	1965	66.16	47.71	0.0000	0.721131
51	7	2	1975	66.16	48.71	0.1511	0.736245
52	7	3	1978	66.16	48.71	0.0000	0.736245
53	9	0	1962	109.17	2.26	.	0.020702
54	9	1	1968	109.17	2.71	0.0687	0.024824
55	9	2	1972	109.17	2.26	-0.1031	0.020702
56	9	3	1978	109.17	0.78	-0.2259	0.007145
57	10	0	1964	47.35	26.37	.	0.556917
58	10	1	1968	47.35	26.72	0.1848	0.564308
59	10	2	1972	47.35	26.20	-0.2746	0.553326
60	10	3	1978	47.35	25.97	-0.0810	0.548469
61	12	0	1962	174.98	10.38	.	0.059321
62	12	1	1964	174.98	9.97	-0.1172	0.056978
63	12	2	1970	174.98	4.81	-0.4915	0.027489
64	12	3	1978	174.98	0.00	-0.3436	0.000000
65	14	0	1962	190.29	4.86	.	0.025540
66	14	1	1964	190.29	4.69	-0.0447	0.024647
67	14	2	1970	190.29	0.39	-0.3766	0.002050
68	14	3	1978	190.29	0.00	-0.0256	0.000000
69	16	0	1964	305.85	35.24	.	0.115220
70	16	1	1970	305.85	29.08	-0.3357	0.095079
71	16	2	1973	305.85	38.77	1.0561	0.126761
72	16	3	1978	305.85	21.61	-1.1221	0.070656

------------------- LOC_TYPE=N METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
73	3	0	1968	429.00	10.87	.	0.025338
74	3	1	1970	429.00	10.87	0.00000	0.025338
75	3	2	1974	429.00	13.97	0.18065	0.032564
76	3	3	1977	429.00	25.00	0.85703	0.058275
77	4	0	1968	424.26	21.95	.	0.051737
78	4	1	1970	424.26	36.33	1.69472	0.085631
79	4	2	1975	424.26	36.33	0.00000	0.085631
80	4	3	1977	424.26	46.51	1.19974	0.109626
81	5	0	1958	218.41	92.94	.	0.425530
82	5	1	1965	218.41	95.74	0.18314	0.438350
83	5	2	1970	218.41	98.10	0.21611	0.449155
84	5	3	1977	218.41	97.62	-0.03140	0.446958
85	6	0	1958	463.94	42.96	.	0.092598
86	6	1	1964	463.94	58.07	0.54281	0.125167
87	6	2	1970	463.94	61.78	0.13328	0.133164
88	6	3	1977	463.94	72.83	0.34025	0.156982

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
89	11	0	1964	595.82	1.43	.	0.002400
90	11	1	1969	595.82	0.68	-0.02518	0.001141
91	11	2	1976	595.82	0.68	0.00000	0.001141
92	11	3	1978	595.82	0.39	-0.02434	0.000655
93	13	0	1969	313.03	202.97	.	0.648404
94	13	1	1974	313.03	202.97	0.00000	0.648404
95	13	2	1978	313.03	202.97	0.00000	0.648404

TABLE A2. SINGLE-FAMILY RESIDENTIAL ACREAGE

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	140.98	.	0.206834
98	15	1	1968	681.61	133.31	-0.22506	0.195581
99	15	2	1970	681.61	142.40	0.66680	0.208917
100	15	3	1978	681.61	145.87	0.06364	0.214008
101	17	0	1959	661.30	172.85	.	0.261379
102	17	1	1964	661.30	179.07	0.18811	0.270785
103	17	2	1971	661.30	204.79	0.55562	0.309678
104	17	3	1978	661.30	211.40	0.14279	0.319673
105	18	0	1958	553.29	25.02	.	0.045220
106	18	1	1961	553.29	27.96	0.17712	0.050534
107	18	2	1967	553.29	24.85	-0.09368	0.044913
108	18	3	1978	553.29	14.01	-0.17811	0.025321
109	19	0	1964	293.54	126.55	.	0.431117
110	19	1	1968	293.54	124.95	-0.13627	0.425666
111	19	2	1973	293.54	123.77	-0.08040	0.421646
112	19	3	1978	293.54	117.86	-0.40267	0.401513
113	20	0	1964	151.02	70.59	.	0.467422
114	20	1	1968	151.02	70.01	-0.09601	0.463581
115	20	2	1975	151.02	67.71	-0.21757	0.448351
116	20	3	1978	151.02	67.51	-0.04414	0.447027
117	21	0	1963	454.74	232.98	.	0.512337
118	21	1	1966	454.74	237.48	0.32986	0.522232
119	21	2	1970	454.74	255.32	0.98078	0.561464
120	21	3	1978	454.74	268.03	0.34938	0.589414

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RS	DRS	PRS
121	7	0	1960	428.84	278.76	.	0.650033
122	7	1	1965	428.84	319.39	1.8949	0.744777
123	7	2	1975	428.84	322.10	0.0632	0.751096
124	7	3	1978	428.84	323.04	0.0731	0.753288
125	9	0	1962	380.12	143.81	.	0.378328
126	9	1	1968	380.12	164.68	0.9151	0.433232
127	9	2	1972	380.12	158.18	-0.4275	0.416132
128	9	3	1978	380.12	156.24	-0.0851	0.411028
129	10	0	1964	437.95	211.76	.	0.483526
130	10	1	1968	437.95	213.10	0.0765	0.486585
131	10	2	1972	437.95	209.42	-0.2101	0.478182
132	10	3	1978	437.95	208.45	-0.0369	0.475968
133	12	0	1962	484.32	186.97	.	0.386046
134	12	1	1964	484.32	199.71	1.3152	0.412351
135	12	2	1970	484.32	207.42	0.2653	0.428271
136	12	3	1978	484.32	143.96	-1.6379	0.297241
137	14	0	1962	326.82	14.13	.	0.043235
138	14	1	1964	326.82	55.48	6.3261	0.169757
139	14	2	1970	326.82	55.49	0.0005	0.169788
140	14	3	1978	326.82	51.81	-0.1408	0.158528
141	16	0	1964	615.19	241.13	.	0.391960
142	16	1	1970	615.19	241.78	0.0176	0.393017
143	16	2	1973	615.19	235.39	-0.3462	0.382630
144	16	3	1978	615.19	255.99	0.6697	0.416115

TABLE A2. SINGLE-FAMILY RESIDENTIAL ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DRS	PRS
0	A	.	0.1704
0	N	.	0.3057
1	A	-0.1745	0.1638
1	N	0.7322	0.3273
2	A	-0.3504	0.1534
2	N	0.0937	0.3317
3	A	-0.1547	0.1457
3	N	0.0656	0.3107

TABLE A3. MULTI-FAMILY RESIDENTIAL ACREAGE

------------------ LOC_TYPE=A METRO=BCS ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
1	3	0	1968	152.32	0.00	.	0.000000
2	3	1	1970	152.32	12.26	4.02442	0.080488
3	3	2	1974	152.32	56.34	7.23477	0.369879
4	3	3	1977	152.32	61.34	1.09419	0.402705
5	4	0	1968	106.92	0.00	.	0.000000
6	4	1	1970	106.92	0.00	0.00000	0.000000
7	4	2	1975	106.92	0.00	0.00000	0.000000
8	4	3	1977	106.92	0.00	0.00000	0.000000
9	5	0	1958	37.90	2.00	.	0.052770
10	5	1	1965	37.90	2.01	0.00377	0.053034
11	5	2	1970	37.90	2.85	0.44327	0.075198
12	5	3	1977	37.90	2.79	-0.02262	0.073615
13	6	0	1958	249.57	0.00	.	0.000000
14	6	1	1964	249.57	0.00	0.00000	0.000000
15	6	2	1970	249.57	0.00	0.00000	0.000000
16	6	3	1977	249.57	1.65	0.09445	0.006611

------------------ LOC_TYPE=A METRO=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
17	11	0	1964	156.88	0.00	.	0.0000000
18	11	1	1969	156.88	0.00	0.000000	0.0000000
19	11	2	1976	156.88	0.00	0.000000	0.0000000
20	11	3	1978	156.88	0.00	0.000000	0.0000000
21	13	0	1969	59.99	0.00	.	0.0000000
22	13	1	1974	59.99	0.00	0.000000	0.0000000
23	13	2	1978	59.99	0.00	0.000000	0.0000000
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	0.00	.	0.0000000
26	15	1	1968	126.47	0.00	0.000000	0.0000000
27	15	2	1970	126.47	0.00	0.000000	0.0000000
28	15	3	1978	126.47	3.87	0.382502	0.0306001
29	17	0	1959	94.15	0.00	.	0.0000000
30	17	1	1964	94.15	0.00	0.000000	0.0000000
31	17	2	1971	94.15	0.00	0.000000	0.0000000
32	17	3	1978	94.15	0.00	0.000000	0.0000000
33	18	0	1958	361.14	0.31	.	0.0008584
34	18	1	1961	361.14	0.00	-0.028613	0.0000000
35	18	2	1967	361.14	0.00	0.000000	0.0000000
36	18	3	1978	361.14	0.00	0.000000	0.0000000
37	19	0	1964	47.14	0.00	.	0.0000000
38	19	1	1968	47.14	0.00	0.000000	0.0000000
39	19	2	1973	47.14	0.00	0.000000	0.0000000
40	19	3	1978	47.14	0.00	0.000000	0.0000000
41	20	0	1964	59.14	0.01	.	0.0001691
42	20	1	1968	59.14	0.01	0.000000	0.0001691
43	20	2	1975	59.14	0.01	0.000000	0.0001691
44	20	3	1978	59.14	0.01	0.000000	0.0001691
45	21	0	1963	89.46	0.00	.	0.0000000
46	21	1	1966	89.46	0.00	0.000000	0.0000000
47	21	2	1970	89.46	0.00	0.000000	0.0000000
48	21	3	1978	89.46	0.00	0.000000	0.0000000

TABLE A3. MULTI-FAMILY RESIDENTIAL ACREAGE

------------------ LOC_TYPE=A METRO=HOU ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
49	7	0	1960	66.16	0.00	.	0.000000
50	7	1	1965	66.16	0.00	0.00000	0.000000
51	7	2	1975	66.16	0.00	0.00000	0.000000
52	7	3	1978	66.16	0.00	0.00000	0.000000
53	9	0	1962	109.17	0.00	.	0.000000
54	9	1	1968	109.17	4.59	0.70074	0.042045
55	9	2	1972	109.17	18.15	3.10525	0.166254
56	9	3	1978	109.17	18.15	0.00000	0.166254
57	10	0	1964	47.35	0.00	.	0.000000
58	10	1	1968	47.35	0.00	0.00000	0.000000
59	10	2	1972	47.35	0.00	0.00000	0.000000
60	10	3	1978	47.35	0.00	0.00000	0.000000
61	12	0	1962	174.98	0.00	.	0.000000
62	12	1	1964	174.98	14.53	4.15190	0.083038
63	12	2	1970	174.98	19.84	0.50577	0.113384
64	12	3	1978	174.98	19.84	0.00000	0.113384
65	14	0	1962	190.29	0.00	.	0.000000
66	14	1	1964	190.29	9.30	2.44364	0.048873
67	14	2	1970	190.29	29.70	1.78675	0.156078
68	14	3	1978	190.29	58.49	1.89119	0.307373
69	16	0	1964	305.85	7.35	.	0.024031
70	16	1	1970	305.85	18.14	0.58798	0.059310
71	16	2	1973	305.85	22.73	0.50025	0.074317
72	16	3	1978	305.85	49.02	1.71914	0.160275

------------------ LOC_TYPE=N METRO=BCS ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
73	3	0	1968	429.00	0.00	.	0.000000
74	3	1	1970	429.00	0.00	0.00000	0.000000
75	3	2	1974	429.00	9.50	0.55361	0.022145
76	3	3	1977	429.00	17.90	0.65268	0.041725
77	4	0	1968	424.26	0.00	.	0.000000
78	4	1	1970	424.26	0.00	0.00000	0.000000
79	4	2	1975	424.26	16.72	0.78820	0.039410
80	4	3	1977	424.26	51.64	4.11540	0.121718
81	5	0	1958	218.41	3.40	.	0.015567
82	5	1	1965	218.41	3.50	0.00654	0.016025
83	5	2	1970	218.41	6.60	0.28387	0.030218
84	5	3	1977	218.41	8.24	0.10727	0.037727
85	6	0	1958	463.94	0.00	.	0.000000
86	6	1	1964	463.94	0.00	0.00000	0.000000
87	6	2	1970	463.94	0.00	0.00000	0.000000
88	6	3	1977	463.94	0.29	0.00893	0.000625

------------------ LOC_TYPE=N METRO=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
89	11	0	1964	595.82	0.00	.	0.0000000
90	11	1	1969	595.82	0.00	0.00000	0.0000000
91	11	2	1976	595.82	44.03	1.05569	0.0738982
92	11	3	1978	595.82	58.56	1.21933	0.0982847
93	13	0	1969	313.03	0.00	.	0.0000000
94	13	1	1974	313.03	10.85	0.69322	0.0346612
95	13	2	1978	313.03	14.72	0.30908	0.0470242

TABLE A3. MULTI-FAMILY RESIDENTIAL ACREAGE

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	3.17	.	0.0046508
98	15	1	1968	681.61	27.94	0.72681	0.0409912
99	15	2	1970	681.61	35.01	0.51863	0.0513637
100	15	3	1978	681.61	35.01	0.00000	0.0513637
101	17	0	1959	661.30	0.00	.	0.0000000
102	17	1	1964	661.30	0.00	0.00000	0.0000000
103	17	2	1971	661.30	0.00	0.00000	0.0000000
104	17	3	1978	661.30	0.43	0.00929	0.0006502
105	18	0	1958	553.29	0.31	.	0.0005603
106	18	1	1961	553.29	0.31	0.00000	0.0005603
107	18	2	1967	553.29	0.31	0.00000	0.0005603
108	18	3	1978	553.29	0.45	0.00230	0.0008133
109	19	0	1964	293.54	20.79	.	0.0708251
110	19	1	1968	293.54	21.44	0.05536	0.0730394
111	19	2	1973	293.54	22.58	0.07767	0.0769231
112	19	3	1978	293.54	22.58	0.00000	0.0769231
113	20	0	1964	151.02	0.33	.	0.0021851
114	20	1	1968	151.02	0.22	-0.018210	0.0014568
115	20	2	1975	151.02	0.22	0.000000	0.0014568
116	20	3	1978	151.02	0.22	0.000000	0.0014568
117	21	0	1963	454.74	3.67	.	0.0080705
118	21	1	1966	454.74	3.67	0.000000	0.0080705
119	21	2	1970	454.74	10.12	0.354598	0.0222545
120	21	3	1978	454.74	11.44	0.036284	0.0251572

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	RM	DRM	PRM
121	7	0	1960	428.84	3.87	.	0.009024
122	7	1	1965	428.84	3.87	0.00000	0.009024
123	7	2	1975	428.84	3.87	0.00000	0.009024
124	7	3	1978	428.84	4.28	0.03187	0.009980
125	9	0	1962	380.12	0.00	.	0.000000
126	9	1	1968	380.12	13.46	0.59016	0.035410
127	9	2	1972	380.12	70.05	3.72185	0.184284
128	9	3	1978	380.12	77.39	0.32183	0.203594
129	10	0	1964	437.95	15.61	.	0.035643
130	10	1	1968	437.95	33.07	0.99669	0.075511
131	10	2	1972	437.95	72.48	2.24969	0.165498
132	10	3	1978	437.95	73.85	0.05214	0.168627
133	12	0	1962	484.32	0.00	.	0.000000
134	12	1	1964	484.32	22.44	2.31665	0.046333
135	12	2	1970	484.32	44.46	0.75776	0.091799
136	12	3	1978	484.32	176.06	3.39651	0.363520
137	14	0	1962	326.82	0.00	.	0.000000
138	14	1	1964	326.82	2.45	0.37482	0.007496
139	14	2	1970	326.82	18.66	0.82665	0.057096
140	14	3	1978	326.82	69.47	1.94335	0.212563
141	16	0	1964	615.19	0.00	.	0.000000
142	16	1	1970	615.19	0.00	0.00000	0.000000
143	16	2	1973	615.19	16.65	0.90216	0.027065
144	16	3	1978	615.19	64.73	1.56309	0.105220

TABLE A3. MULTI-FAMILY RESIDENTIAL ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DRM	PRM
0	A	.	0.0043
0	N	.	0.0081
1	A	0.6602	0.0204
1	N	0.3190	0.0194
2	A	0.7542	0.0531
2	N	0.6889	0.0500
3	A	0.3035	0.0842
3	N	0.7918	0.0994

TABLE A4. COMMERCIAL AND INDUSTRIAL ACREAGE

------------------ LOC_TYPE=A METRO=BCS ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
1	3	0	1968	152.32	0.91	.	0.005974
2	3	1	1970	152.32	2.41	0.49238	0.015822
3	3	2	1974	152.32	2.96	0.09027	0.019433
4	3	3	1977	152.32	9.04	1.33053	0.059349
5	4	0	1968	106.92	2.25	.	0.021044
6	4	1	1970	106.92	2.25	0.00000	0.021044
7	4	2	1975	106.92	22.25	3.74111	0.208100
8	4	3	1977	106.92	25.62	1.57594	0.239618
9	5	0	1958	37.90	0.68	.	0.017942
10	5	1	1965	37.90	0.68	0.00000	0.017942
11	5	2	1970	37.90	3.48	1.47757	0.091821
12	5	3	1977	37.90	3.36	-0.04523	0.088654
13	6	0	1958	249.57	18.94	.	0.075891
14	6	1	1964	249.57	31.09	0.81140	0.124574
15	6	2	1970	249.57	60.94	1.99343	0.244180
16	6	3	1977	249.57	65.88	0.28277	0.263974

------------------ LOC_TYPE=A METRO=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
17	11	0	1964	156.88	3.31	.	0.021099
18	11	1	1969	156.88	3.57	0.0331	0.022756
19	11	2	1976	156.88	15.23	1.0618	0.097081
20	11	3	1978	156.88	26.39	3.5569	0.168218
21	13	0	1969	59.99	3.10	.	0.051675
22	13	1	1974	59.99	13.02	3.3072	0.217036
23	13	2	1978	59.99	13.92	0.3751	0.232039
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	10.04	.	0.079386
26	15	1	1968	126.47	22.22	1.9261	0.175694
27	15	2	1970	126.47	49.85	10.9235	0.394165
28	15	3	1978	126.47	65.65	1.5616	0.519095
29	17	0	1959	94.15	8.58	.	0.091131
30	17	1	1964	94.15	8.87	0.0616	0.094211
31	17	2	1971	94.15	8.87	0.0000	0.094211
32	17	3	1978	94.15	10.87	0.3035	0.115454
33	18	0	1958	361.14	52.62	.	0.145705
34	18	1	1961	361.14	104.53	4.7913	0.289445
35	18	2	1967	361.14	186.51	3.7834	0.516448
36	18	3	1978	361.14	289.25	2.5863	0.800936
37	19	0	1964	47.14	15.31	.	0.324777
38	19	1	1968	47.14	15.74	0.2280	0.333899
39	19	2	1973	47.14	15.74	0.0000	0.333899
40	19	3	1978	47.14	16.02	0.1188	0.339839
41	20	0	1964	59.14	0.14	.	0.002367
42	20	1	1968	59.14	15.34	6.4254	0.259385
43	20	2	1975	59.14	21.61	1.5146	0.365404
44	20	3	1978	59.14	27.13	3.1113	0.458742
45	21	0	1963	89.46	24.68	.	0.275877
46	21	1	1966	89.46	24.48	-0.0745	0.273642
47	21	2	1970	89.46	27.83	0.9362	0.311089
48	21	3	1978	89.46	39.91	1.6879	0.446121

TABLE A4. COMMERCIAL AND INDUSTRIAL ACREAGE

-------------------- LOC_TYPE=A METRO=HOU --------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
49	7	0	1960	66.16	2.50	.	0.037787
50	7	1	1965	66.16	3.02	0.15719	0.045647
51	7	2	1975	66.16	2.50	-0.07860	0.037787
52	7	3	1978	66.16	2.50	0.00000	0.037787
53	9	0	1962	109.17	11.37	.	0.104149
54	9	1	1968	109.17	30.21	2.87625	0.276724
55	9	2	1972	109.17	37.47	1.66254	0.343226
56	9	3	1978	109.17	31.85	-0.85799	0.291747
57	10	0	1964	47.35	0.00	.	0.000000
58	10	1	1968	47.35	0.23	0.12144	0.004857
59	10	2	1972	47.35	0.75	0.27455	0.015839
60	10	3	1978	47.35	0.98	0.08096	0.020697
61	12	0	1962	174.98	35.66	.	0.203795
62	12	1	1964	174.98	45.83	2.90605	0.261916
63	12	2	1970	174.98	69.06	2.21263	0.394674
64	12	3	1978	174.98	101.13	2.29098	0.577952
65	14	0	1962	190.29	13.30	.	0.069893
66	14	1	1964	190.29	21.18	2.07052	0.111304
67	14	2	1970	190.29	36.75	1.36371	0.193126
68	14	3	1978	190.29	65.34	1.87805	0.343371
69	16	0	1964	305.85	82.86	.	0.270917
70	16	1	1970	305.85	77.02	-0.31824	0.251823
71	16	2	1973	305.85	94.72	1.92905	0.309694
72	16	3	1978	305.85	151.81	3.73320	0.496354

-------------------- LOC_TYPE=N METRO=BCS --------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
73	3	0	1968	429.00	0.00	.	0.0000000
74	3	1	1970	429.00	5.05	0.58858	0.0117716
75	3	2	1974	429.00	7.62	0.14977	0.0177622
76	3	3	1977	429.00	27.51	1.54545	0.0641259
77	4	0	1968	424.26	0.25	.	0.0005893
78	4	1	1970	424.26	0.25	0.00000	0.0005893
79	4	2	1975	424.26	5.07	0.22722	0.0119502
80	4	3	1977	424.26	5.67	0.07071	0.0133644
81	5	0	1958	218.41	3.30	.	0.0151092
82	5	1	1965	218.41	2.12	-0.07718	0.0097065
83	5	2	1970	218.41	5.70	0.32782	0.0260977
84	5	3	1977	218.41	8.32	0.17137	0.0380935
85	6	0	1958	463.94	5.99	.	0.0129112
86	6	1	1964	463.94	2.07	-0.14082	0.0044618
87	6	2	1970	463.94	9.13	0.25362	0.0196793
88	6	3	1977	463.94	7.27	-0.05727	0.0156701

-------------------- LOC_TYPE=N METRO=DFW --------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
89	11	0	1964	595.82	4.75	.	0.007972
90	11	1	1969	595.82	5.14	0.01309	0.008627
91	11	2	1976	595.82	12.80	0.18366	0.021483
92	11	3	1978	595.82	14.97	0.18210	0.025125
93	13	0	1969	313.03	4.39	.	0.014024
94	13	1	1974	313.03	10.88	0.41466	0.034757
95	13	2	1978	313.03	20.95	0.80424	0.066926

TABLE A4. COMMERCIAL AND INDUSTRIAL ACREAGE

------------------ LOC_TYPE=N METRO=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	43.91	.	0.064421
98	15	1	1968	681.61	57.43	0.39671	0.084256
99	15	2	1970	681.61	71.72	1.04825	0.105221
100	15	3	1978	681.61	84.98	0.24317	0.124675
101	17	0	1959	661.30	0.00	.	0.000000
102	17	1	1964	661.30	0.86	0.02601	0.001300
103	17	2	1971	661.30	1.85	0.02139	0.002798
104	17	3	1978	661.30	2.51	0.01426	0.003796
105	18	0	1958	553.29	46.25	.	0.083591
106	18	1	1961	553.29	71.28	1.50795	0.128829
107	18	2	1967	553.29	129.78	1.76219	0.234561
108	18	3	1978	553.29	283.93	2.53278	0.513167
109	19	0	1964	293.54	13.97	.	0.047591
110	19	1	1968	293.54	15.37	0.11923	0.052361
111	19	2	1973	293.54	17.39	0.13763	0.059242
112	19	3	1978	293.54	20.23	0.19350	0.068917
113	20	0	1964	151.02	7.49	.	0.0495961
114	20	1	1968	151.02	7.52	0.004966	0.0497947
115	20	2	1975	151.02	9.88	0.223244	0.0654218
116	20	3	1978	151.02	11.43	0.342118	0.0756853
117	21	0	1963	454.74	3.36	.	0.0073888
118	21	1	1966	454.74	3.58	0.016126	0.0078726
119	21	2	1970	454.74	10.09	0.357897	0.0221885
120	21	3	1978	454.74	15.10	0.137716	0.0332058

------------------ LOC_TYPE=N METRO=HOU ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	C	DC	PC
121	7	0	1960	428.84	9.83	.	0.022922
122	7	1	1965	428.84	13.91	0.19028	0.032436
123	7	2	1975	428.84	12.31	-0.03731	0.028705
124	7	3	1978	428.84	11.78	-0.04120	0.027469
125	9	0	1962	380.12	35.52	.	0.093444
126	9	1	1968	380.12	42.85	0.32139	0.112728
127	9	2	1972	380.12	49.93	0.46564	0.131353
128	9	3	1978	380.12	54.57	0.20344	0.143560
129	10	0	1964	437.95	37.33	.	0.085238
130	10	1	1968	437.95	66.28	1.65259	0.151341
131	10	2	1972	437.95	64.28	-0.11417	0.146775
132	10	3	1978	437.95	66.92	0.10047	0.152803
133	12	0	1962	484.32	3.10	.	0.006401
134	12	1	1964	484.32	5.05	0.20131	0.010427
135	12	2	1970	484.32	10.06	0.17241	0.020771
136	12	3	1978	484.32	55.93	1.18388	0.115481
137	14	0	1962	326.82	2.80	.	0.008567
138	14	1	1964	326.82	2.34	-0.07038	0.007160
139	14	2	1970	326.82	14.95	0.64307	0.045744
140	14	3	1978	326.82	8.84	-0.23369	0.027049
141	16	0	1964	615.19	11.02	.	0.017913
142	16	1	1970	615.19	0.92	-0.27363	0.001495
143	16	2	1973	615.19	14.05	0.71143	0.022838
144	16	3	1978	615.19	73.49	1.93241	0.119459

TABLE A4. COMMERCIAL AND INDUSTRIAL ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DC	PC
0	A	.	0.1000
0	N	.	0.0299
1	A	1.4342	0.1554
1	N	0.2717	0.0394
2	A	1.8478	0.2335
2	N	0.4077	0.0583
3	A	1.3644	0.3099
3	N	0.5013	0.0919

TABLE A5. PUBLIC-GOVERNMENTAL AND SEMI-PUBLIC ACREAGE

------------------ LOC_TYPE=A METRO=BCS ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
1	3	0	1968	152.32	0.00	.	0.000000
2	3	1	1970	152.32	0.00	0.00000	0.000000
3	3	2	1974	152.32	7.53	1.23588	0.049435
4	3	3	1977	152.32	7.53	0.00000	0.049435
5	4	0	1968	106.92	20.22	.	0.189113
6	4	1	1970	106.92	20.22	0.00000	0.189113
7	4	2	1975	106.92	20.22	0.00000	0.189113
8	4	3	1977	106.92	20.22	0.00000	0.189113
9	5	0	1958	37.90	3.91	.	0.103166
10	5	1	1965	37.90	3.91	0.00000	0.103166
11	5	2	1970	37.90	3.91	0.00000	0.103166
12	5	3	1977	37.90	4.49	0.21862	0.118470
13	6	0	1958	249.57	39.96	.	0.160115
14	6	1	1964	249.57	40.52	0.03740	0.162359
15	6	2	1970	249.57	40.52	0.00000	0.162359
16	6	3	1977	249.57	40.52	0.00000	0.162359

------------------ LOC_TYPE=A METRO=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
17	11	0	1964	156.88	0.00	.	0.000000
18	11	1	1969	156.88	10.33	1.31693	0.065847
19	11	2	1976	156.88	10.33	0.00000	0.065847
20	11	3	1978	156.88	10.33	0.00000	0.065847
21	13	0	1969	59.99	24.12	.	0.402067
22	13	1	1974	59.99	24.12	0.00000	0.402067
23	13	2	1978	59.99	24.12	0.00000	0.402067
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	2.34	.	0.018502
26	15	1	1968	126.47	0.00	-0.37005	0.000000
27	15	2	1970	126.47	0.00	0.00000	0.000000
28	15	3	1978	126.47	0.00	0.00000	0.000000
29	17	0	1959	94.15	2.96	.	0.031439
30	17	1	1964	94.15	2.96	0.00000	0.031439
31	17	2	1971	94.15	2.96	0.00000	0.031439
32	17	3	1978	94.15	2.04	-0.13959	0.021668
33	18	0	1958	361.14	0.00	.	0.000000
34	18	1	1961	361.14	0.00	0.00000	0.000000
35	18	2	1967	361.14	0.00	0.00000	0.000000
36	18	3	1978	361.14	0.00	0.00000	0.000000
37	19	0	1964	47.14	18.25	.	0.387145
38	19	1	1968	47.14	18.25	0.00000	0.387145
39	19	2	1973	47.14	18.25	0.00000	0.387145
40	19	3	1978	47.14	18.25	0.00000	0.387145
41	20	0	1964	59.14	0.00	.	0.000000
42	20	1	1968	59.14	0.00	0.00000	0.000000
43	20	2	1975	59.14	0.00	0.00000	0.000000
44	20	3	1978	59.14	0.00	0.00000	0.000000
45	21	0	1963	89.46	8.47	.	0.094679
46	21	1	1966	89.46	7.55	-0.34280	0.084395
47	21	2	1970	89.46	7.24	-0.08663	0.080930
48	21	3	1978	89.46	11.34	0.57288	0.126761

------------------ LOC_TYPE=A METRO=HOU ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
49	7	0	1960	66.16	3.00	.	0.045345
50	7	1	1965	66.16	3.00	0.0000	0.045345
51	7	2	1975	66.16	3.00	0.0000	0.045345
52	7	3	1978	66.16	3.00	0.0000	0.045345
53	9	0	1962	109.17	4.91	.	0.044976
54	9	1	1968	109.17	23.70	2.8686	0.217093
55	9	2	1972	109.17	23.70	0.0000	0.217093
56	9	3	1978	109.17	23.70	0.0000	0.217093

TABLE A5. PUBLIC-GOVERNMENTAL AND SEMI-PUBLIC ACREAGE

------------------- LOC_TYPE=A METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
57	10	0	1964	47.35	0.41	.	0.0086589
58	10	1	1968	47.35	0.41	0.0000	0.0086589
59	10	2	1972	47.35	0.41	0.0000	0.0086589
60	10	3	1978	47.35	0.41	0.0000	0.0086589
61	12	0	1962	174.98	7.08	.	0.0404618
62	12	1	1964	174.98	3.18	-1.1144	0.0181735
63	12	2	1970	174.98	3.28	0.0095	0.0187450
64	12	3	1978	174.98	7.52	0.3029	0.0429763
65	14	0	1962	190.29	0.00	.	0.0000000
66	14	1	1964	190.29	0.00	0.0000	0.0000000
67	14	2	1970	190.29	0.00	0.0000	0.0000000
68	14	3	1978	190.29	0.00	0.0000	0.0000000
69	16	0	1964	305.85	5.29	.	0.0172961
70	16	1	1970	305.85	20.74	0.8419	0.0678110
71	16	2	1973	305.85	20.97	0.0251	0.0685630
72	16	3	1978	305.85	8.62	-0.8076	0.0281838

------------------- LOC_TYPE=N METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
73	3	0	1968	429.00	2.13	.	0.004965
74	3	1	1970	429.00	2.13	0.00000	0.004965
75	3	2	1974	429.00	6.63	0.26224	0.015455
76	3	3	1977	429.00	12.36	0.44522	0.028811
77	4	0	1968	424.26	0.00	.	0.000000
78	4	1	1970	424.26	0.00	0.00000	0.000000
79	4	2	1975	424.26	37.50	1.76778	0.088389
80	4	3	1977	424.26	43.71	0.73186	0.103026
81	5	0	1958	218.41	9.84	.	0.045053
82	5	1	1965	218.41	10.23	0.02551	0.046839
83	5	2	1970	218.41	10.52	0.02656	0.048166
84	5	3	1977	218.41	10.52	0.00000	0.048166
85	6	0	1958	463.94	0.00	.	0.000000
86	6	1	1964	463.94	0.00	0.00000	0.000000
87	6	2	1970	463.94	0.00	0.00000	0.000000
88	6	3	1977	463.94	0.00	0.00000	0.000000

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
89	11	0	1964	595.82	0.00	.	0.000000
90	11	1	1969	595.82	85.30	2.86328	0.143164
91	11	2	1976	595.82	85.30	0.00000	0.143164
92	11	3	1978	595.82	85.30	0.00000	0.143164
93	13	0	1969	313.03	2.52	.	0.008050
94	13	1	1974	313.03	3.68	0.07411	0.011756
95	13	2	1978	313.03	3.68	0.00000	0.011756
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	33.28	.	0.048826
98	15	1	1968	681.61	33.71	0.01262	0.049456
99	15	2	1970	681.61	37.02	0.24281	0.054313
100	15	3	1978	681.61	37.02	0.00000	0.054313
101	17	0	1959	661.30	1.86	.	0.002813
102	17	1	1964	661.30	1.86	0.00000	0.002813
103	17	2	1971	661.30	14.11	0.26463	0.021337
104	17	3	1978	661.30	18.82	0.10175	0.028459
105	18	0	1958	553.29	1.64	.	0.002964
106	18	1	1961	553.29	2.56	0.05543	0.004627
107	18	2	1967	553.29	2.70	0.00422	0.004880
108	18	3	1978	553.29	2.23	-0.00772	0.004030
109	19	0	1964	293.54	32.60	.	0.111058
110	19	1	1968	293.54	32.60	0.00000	0.111058
111	19	2	1973	293.54	32.60	0.00000	0.111058
112	19	3	1978	293.54	37.66	0.34476	0.128296

TABLE A5. PUBLIC-GOVERNMENTAL AND SEMI-PUBLIC ACREAGE

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
113	20	0	1964	151.02	2.15	.	0.0142365
114	20	1	1968	151.02	2.15	0.00000	0.0142365
115	20	2	1975	151.02	2.15	0.00000	0.0142365
116	20	3	1978	151.02	2.15	0.00000	0.0142365
117	21	0	1963	454.74	33.61	.	0.0739104
118	21	1	1966	454.74	30.05	-0.26095	0.0660817
119	21	2	1970	454.74	32.85	0.15393	0.0722391
120	21	3	1978	454.74	40.41	0.20781	0.0888640

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	P	DP	PP
121	7	0	1960	428.84	18.67	.	0.0435361
122	7	1	1965	428.84	18.37	-0.01399	0.0428365
123	7	2	1975	428.84	18.37	0.00000	0.0428365
124	7	3	1978	428.84	18.37	0.00000	0.0428365
125	9	0	1962	380.12	7.36	.	0.0193623
126	9	1	1968	380.12	7.36	0.00000	0.0193623
127	9	2	1972	380.12	3.46	-0.25650	0.0091024
128	9	3	1978	380.12	0.39	-0.13461	0.0010260
129	10	0	1964	437.95	21.15	.	0.0482932
130	10	1	1968	437.95	21.15	0.00000	0.0482932
131	10	2	1972	437.95	21.15	0.00000	0.0482932
132	10	3	1978	437.95	21.15	0.00000	0.0482932
133	12	0	1962	484.32	2.55	.	0.0052651
134	12	1	1964	484.32	11.01	0.87339	0.0227329
135	12	2	1970	484.32	13.94	0.10083	0.0287826
136	12	3	1978	484.32	13.94	0.00000	0.0287826
137	14	0	1962	326.82	0.00	.	0.0000000
138	14	1	1964	326.82	0.00	0.00000	0.0000000
139	14	2	1970	326.82	0.00	0.00000	0.0000000
140	14	3	1978	326.82	0.00	0.00000	0.0000000
141	16	0	1964	615.19	3.88	.	0.0063070
142	16	1	1970	615.19	14.80	0.29584	0.0240576
143	16	2	1973	615.19	13.66	-0.06177	0.0222045
144	16	3	1978	615.19	24.16	0.34136	0.0392724

TABLE A5. PUBLIC-GOVERNMENTAL AND SEMI-PUBLIC ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DP	PP
0	A	.	0.0857
0	N	.	0.0241
1	A	0.1799	0.0990
1	N	0.2181	0.0340
2	A	0.0658	0.1017
2	N	0.1392	0.0409
3	A	0.0087	0.0861
3	N	0.1194	0.0482

TABLE A6. STREETS AND ROADS ACREAGE

------------------ LOC_TYPE=A METRC=BCS ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
1	3	0	1968	152.32	19.34	.	0.126970
2	3	1	1970	152.32	20.05	0.23306	0.131631
3	3	2	1974	152.32	21.21	0.19039	0.139246
4	3	3	1977	152.32	21.21	0.00000	0.139246
5	4	0	1968	106.92	22.99	.	0.215021
6	4	1	1970	106.92	28.61	2.62813	0.267583
7	4	2	1975	106.92	29.65	0.19454	0.277310
8	4	3	1977	106.92	30.04	0.18238	0.280958
9	5	0	1958	37.90	4.41	.	0.116359
10	5	1	1965	37.90	4.41	0.00000	0.116359
11	5	2	1970	37.90	4.41	0.00000	0.116359
12	5	3	1977	37.90	4.41	0.00000	0.116359
13	6	0	1958	249.57	36.67	.	0.146933
14	6	1	1964	249.57	36.67	0.00000	0.146933
15	6	2	1970	249.57	36.67	0.00000	0.146933
16	6	3	1977	249.57	36.67	0.00000	0.146933

------------------ LOC_TYPE=A METRC=DFW ------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
17	11	0	1964	156.88	31.86	.	0.203085
18	11	1	1969	156.88	33.40	0.196328	0.212902
19	11	2	1976	156.88	35.54	0.194871	0.226543
20	11	3	1978	156.88	37.09	0.494008	0.236423
21	13	0	1969	59.99	12.97	.	0.216203
22	13	1	1974	59.99	13.07	0.033339	0.217870
23	13	2	1978	59.99	13.07	0.000000	0.217870
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	25.99	.	0.205503
26	15	1	1968	126.47	25.99	0.000000	0.205503
27	15	2	1970	126.47	25.99	0.000000	0.205503
28	15	3	1978	126.47	25.99	0.000000	0.205503
29	17	0	1959	94.15	4.75	.	0.050451
30	17	1	1964	94.15	5.65	0.191184	0.060011
31	17	2	1971	94.15	6.05	0.060693	0.064259
32	17	3	1978	94.15	6.13	0.012139	0.065109
33	18	0	1958	361.14	39.65	.	0.109791
34	18	1	1961	361.14	43.24	0.331358	0.119732
35	18	2	1967	361.14	56.15	0.595798	0.155480
36	18	3	1978	361.14	61.38	0.131654	0.169962
37	19	0	1964	47.14	12.73	.	0.270047
38	19	1	1968	47.14	12.73	0.000000	0.270047
39	19	2	1973	47.14	12.73	0.000000	0.270047
40	19	3	1978	47.14	12.73	0.000000	0.270047
41	20	0	1964	59.14	8.14	.	0.137639
42	20	1	1968	59.14	9.68	0.650998	0.163679
43	20	2	1975	59.14	9.68	0.000000	0.163679
44	20	3	1978	59.14	9.68	0.000000	0.163679
45	21	0	1963	89.46	19.20	.	0.214621
46	21	1	1966	89.46	19.20	0.000000	0.214621
47	21	2	1970	89.46	19.20	0.000000	0.214621
48	21	3	1978	89.46	19.54	0.047507	0.218422

TABLE A6. STREETS AND ROADS ACREAGE

------------------- LOC_TYPE=A METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
49	7	0	1960	66.16	10.95	.	0.165508
50	7	1	1965	66.16	10.95	0.000000	0.165508
51	7	2	1975	66.16	10.95	0.000000	0.165508
52	7	3	1978	66.16	10.95	0.000000	0.165508
53	9	0	1962	109.17	21.12	.	0.193460
54	9	1	1968	109.17	21.12	0.000000	0.193460
55	9	2	1972	109.17	21.44	0.073280	0.196391
56	9	3	1978	109.17	21.44	0.000000	0.196391
57	10	0	1964	47.35	18.29	.	0.386272
58	10	1	1968	47.35	18.29	0.000000	0.386272
59	10	2	1972	47.35	18.29	0.000000	0.386272
60	10	3	1978	47.35	18.29	0.000000	0.386272
61	12	0	1962	174.98	27.34	.	0.156246
62	12	1	1964	174.98	29.26	0.548634	0.167219
63	12	2	1970	174.98	31.12	0.177163	0.177849
64	12	3	1978	174.98	31.12	0.000000	0.177849
65	14	0	1962	190.29	27.72	.	0.145672
66	14	1	1964	190.29	28.08	0.094592	0.147564
67	14	2	1970	190.29	29.52	0.126123	0.155132
68	14	3	1978	190.29	31.58	0.135320	0.165957
69	16	0	1964	305.85	38.72	.	0.126598
70	16	1	1970	305.85	40.39	0.091003	0.132058
71	16	2	1973	305.85	41.15	0.082829	0.134543
72	16	3	1978	305.85	41.97	0.053621	0.137224

------------------- LOC_TYPE=N METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
73	3	0	1968	429.00	6.43	.	0.014988
74	3	1	1970	429.00	13.75	0.85315	0.032051
75	3	2	1974	429.00	22.57	0.51399	0.052611
76	3	3	1977	429.00	22.57	0.00000	0.052611
77	4	0	1968	424.26	4.23	.	0.009970
78	4	1	1970	424.26	11.10	0.80965	0.026163
79	4	2	1975	424.26	18.37	0.34271	0.043299
80	4	3	1977	424.26	35.92	2.06831	0.084665
81	5	0	1958	218.41	68.20	.	0.312257
82	5	1	1965	218.41	68.20	0.00000	0.312257
83	5	2	1970	218.41	68.88	0.06227	0.315370
84	5	3	1977	218.41	68.88	0.00000	0.315370
85	6	0	1958	463.94	26.60	.	0.057335
86	6	1	1964	463.94	26.60	0.00000	0.057335
87	6	2	1970	463.94	26.60	0.00000	0.057335
88	6	3	1977	463.94	26.60	0.00000	0.057335

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
89	11	0	1964	595.82	7.84	.	0.013158
90	11	1	1969	595.82	13.47	0.18898	0.022607
91	11	2	1976	595.82	25.80	0.29563	0.043302
92	11	3	1978	595.82	32.38	0.55218	0.054345
93	13	0	1969	313.03	54.06	.	0.172699
94	13	1	1974	313.03	56.59	0.16165	0.180781
95	13	2	1978	313.03	57.12	0.04233	0.182475

TABLE A6. STREETS AND ROADS ACREAGE

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	66.00	.	0.096830
98	15	1	1968	681.61	66.00	0.00000	0.096830
99	15	2	1970	681.61	66.00	0.00000	0.096830
100	15	3	1978	681.61	66.00	0.00000	0.096830
101	17	0	1959	661.30	47.89	.	0.072418
102	17	1	1964	661.30	47.89	0.00000	0.072418
103	17	2	1971	661.30	53.46	0.12033	0.080841
104	17	3	1978	661.30	53.46	0.00000	0.080841
105	18	0	1958	553.29	111.95	.	0.202335
106	18	1	1961	553.29	133.87	1.32059	0.241953
107	18	2	1967	553.29	135.70	0.05512	0.245260
108	18	3	1978	553.29	146.12	0.17121	0.264093
109	19	0	1964	293.54	87.44	.	0.297881
110	19	1	1968	293.54	87.44	0.00000	0.297881
111	19	2	1973	293.54	87.44	0.00000	0.297881
112	19	3	1978	293.54	86.29	-0.07835	0.293963
113	20	0	1964	151.02	27.89	.	0.184678
114	20	1	1968	151.02	28.17	0.046351	0.186532
115	20	2	1975	151.02	29.26	0.103108	0.193749
116	20	3	1978	151.02	29.26	0.000000	0.193749
117	21	0	1963	454.74	78.91	.	0.173528
118	21	1	1966	454.74	78.91	0.000000	0.173528
119	21	2	1970	454.74	78.91	0.000000	0.173528
120	21	3	1978	454.74	78.91	0.000000	0.173528

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	SR	DSR	PSR
121	7	0	1960	428.84	67.94	.	0.158427
122	7	1	1965	428.84	67.94	0.00000	0.158427
123	7	2	1975	428.84	67.94	0.00000	0.158427
124	7	3	1978	428.84	67.94	0.00000	0.158427
125	9	0	1962	380.12	69.29	.	0.182285
126	9	1	1968	380.12	69.29	0.00000	0.182285
127	9	2	1972	380.12	71.36	0.13614	0.187730
128	9	3	1978	380.12	71.36	0.00000	0.187730
129	10	0	1964	437.95	60.35	.	0.137801
130	10	1	1968	437.95	60.35	0.00000	0.137801
131	10	2	1972	437.95	61.28	0.05309	0.139925
132	10	3	1978	437.95	61.28	0.00000	0.139925
133	12	0	1962	484.32	56.09	.	0.115812
134	12	1	1964	484.32	57.95	0.19202	0.119652
135	12	2	1970	484.32	65.47	0.25378	0.135179
136	12	3	1978	484.32	65.47	0.00000	0.135179
137	14	0	1962	326.82	12.47	.	0.038156
138	14	1	1964	326.82	31.46	2.90527	0.096261
139	14	2	1970	326.82	34.25	0.14228	0.104798
140	14	3	1978	326.82	36.63	0.09103	0.112080
141	16	0	1964	615.19	55.15	.	0.089647
142	16	1	1970	615.19	65.42	0.27823	0.106341
143	16	2	1973	615.19	67.97	0.13817	0.110486
144	16	3	1978	615.19	80.74	0.41516	0.131244

TABLE A6. STREETS AND ROADS ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DSR	PSR
0	A	.	0.1770
0	N	.	0.1295
1	A	0.2777	0.1844
1	N	0.3753	0.1390
2	A	0.9424	0.1896
2	N	0.1258	0.1455
3	A	0.0622	0.1907
3	N	0.1894	0.1489

TABLE A7. UNDEVELOPED ACREAGE

LOC_TYPE=A METRO=BCS

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
1	3	0	1968	152.32	132.07	.	0.867056
2	3	1	1970	152.32	117.60	-4.7499	0.772059
3	3	2	1974	152.32	64.28	-8.7513	0.422006
4	3	3	1977	152.32	53.20	-2.4247	0.349265
5	4	0	1968	106.92	54.96	.	0.514029
6	4	1	1970	106.92	49.34	-2.6281	0.461467
7	4	2	1975	106.92	29.10	-3.7860	0.272166
8	4	3	1977	106.92	25.34	-1.7583	0.237000
9	5	0	1958	37.90	10.83	.	0.285752
10	5	1	1965	37.90	10.50	-0.1244	0.277045
11	5	2	1970	37.90	6.68	-2.0158	0.176253
12	5	3	1977	37.90	6.94	0.0980	0.183113
13	6	0	1958	249.57	112.58	.	0.451096
14	6	1	1964	249.57	93.94	-1.2448	0.376407
15	6	2	1970	249.57	56.19	-2.5210	0.225147
16	6	3	1977	249.57	45.06	-0.6371	0.180551

LOC_TYPE=A METRO=DFW

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
17	11	0	1964	156.88	121.32	.	0.773330
18	11	1	1969	156.88	109.19	-1.5464	0.696010
19	11	2	1976	156.88	95.39	-1.2566	0.608044
20	11	3	1978	156.88	83.07	-3.9266	0.529513
21	13	0	1969	59.99	11.18	.	0.186364
22	13	1	1974	59.99	1.16	-3.3406	0.019337
23	13	2	1978	59.99	0.26	-0.3751	0.004334
24	13	3	.	59.99	.	.	.
25	15	0	1963	126.47	62.96	.	0.497826
26	15	1	1968	126.47	62.47	-0.0775	0.493951
27	15	2	1970	126.47	48.72	-5.4361	0.385230
28	15	3	1978	126.47	30.50	-1.8008	0.241164
29	17	0	1959	94.15	50.03	.	0.531386
30	17	1	1964	94.15	49.01	-0.2167	0.520552
31	17	2	1971	94.15	47.57	-0.2185	0.505258
32	17	3	1978	94.15	47.09	-0.0728	0.500159
33	18	0	1958	361.14	268.38	.	0.743147
34	18	1	1961	361.14	213.13	-5.0996	0.590159
35	18	2	1967	361.14	118.24	-4.3792	0.327408
36	18	3	1978	361.14	10.51	-2.7119	0.029102
37	19	0	1964	47.14	0.85	.	0.018031
38	19	1	1968	47.14	0.42	-0.2280	0.008910
39	19	2	1973	47.14	0.42	0.0000	0.008910
40	19	3	1978	47.14	0.14	-0.1188	0.002970
41	20	0	1964	59.14	22.44	.	0.379439
42	20	1	1968	59.14	21.21	-0.5200	0.358641
43	20	2	1975	59.14	20.54	-0.1618	0.347311
44	20	3	1978	59.14	15.81	-2.6660	0.267332
45	21	0	1963	89.46	32.88	.	0.367539
46	21	1	1966	89.46	37.24	1.6246	0.416275
47	21	2	1970	89.46	34.41	-0.7909	0.384641
48	21	3	1978	89.46	18.04	-2.2873	0.201654

TABLE A7. UNDEVELOPED ACREAGE

------------------- LOC_TYPE=A METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
49	7	0	1960	66.16	2.00	.	0.030230
50	7	1	1965	66.16	1.48	-0.1572	0.022370
51	7	2	1975	66.16	1.00	-0.0726	0.015115
52	7	3	1978	66.16	1.00	0.0000	0.015115
53	9	0	1962	109.17	69.51	.	0.636713
54	9	1	1968	109.17	26.84	-6.5143	0.245855
55	9	2	1972	109.17	6.15	-4.7380	0.056334
56	9	3	1978	109.17	13.25	1.0839	0.121370
57	10	0	1964	47.35	1.93	.	0.040760
58	10	1	1968	47.35	1.70	-0.1214	0.035903
59	10	2	1972	47.35	1.70	0.0000	0.035903
60	10	3	1978	47.35	1.70	0.0000	0.035903
61	12	0	1962	174.98	94.52	.	0.540176
62	12	1	1964	174.98	72.21	-6.3750	0.412676
63	12	2	1970	174.98	46.87	-2.4136	0.267859
64	12	3	1978	174.98	15.37	-2.2503	0.087839
65	14	0	1962	190.29	144.41	.	0.758894
66	14	1	1964	190.29	127.04	-4.5641	0.667613
67	14	2	1970	190.29	93.93	-2.9000	0.493615
68	14	3	1978	190.29	34.88	-3.8789	0.183299
69	16	0	1964	305.85	136.39	.	0.445938
70	16	1	1970	305.85	120.48	-0.8670	0.393919
71	16	2	1973	305.85	87.51	-3.5933	0.286121
72	16	3	1978	305.85	32.82	-3.5763	0.107308

------------------- LOC_TYPE=N METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
73	3	0	1968	429.00	409.57	.	0.954709
74	3	1	1970	429.00	397.20	-1.4417	0.925874
75	3	2	1974	429.00	368.71	-1.6603	0.859464
76	3	3	1977	429.00	323.66	-3.5004	0.754452
77	4	0	1968	424.26	397.83	.	0.937703
78	4	1	1970	424.26	376.58	-2.5044	0.887616
79	4	2	1975	424.26	310.27	-3.1259	0.731320
80	4	3	1977	424.26	240.81	-8.1860	0.567600
81	5	0	1958	218.41	40.73	.	0.186484
82	5	1	1965	218.41	38.62	-0.1380	0.176823
83	5	2	1970	218.41	28.61	-0.9166	0.130992
84	5	3	1977	218.41	24.83	-0.2472	0.113685
85	6	0	1958	463.94	388.39	.	0.837156
86	6	1	1964	463.94	377.20	-0.4020	0.813036
87	6	2	1970	463.94	366.43	-0.3869	0.789822
88	6	3	1977	463.94	356.95	-0.2919	0.769388

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
89	11	0	1964	595.82	581.80	.	0.976469
90	11	1	1969	595.82	491.23	-3.0402	0.824460
91	11	2	1976	595.82	427.21	-1.5350	0.717012
92	11	3	1978	595.82	404.22	-1.9293	0.678426
93	13	0	1969	313.03	49.09	.	0.156822
94	13	1	1974	313.03	28.06	-1.3436	0.089640
95	13	2	1978	313.03	13.59	-1.1556	0.043414

TABLE A7. UNDEVELOPED ACREAGE

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
96	13	3	.	313.03	.	.	.
97	15	0	1963	681.61	394.27	.	0.578439
98	15	1	1968	681.61	363.22	-0.9111	0.532885
99	15	2	1970	681.61	329.46	-2.4765	0.483356
100	15	3	1978	681.61	312.73	-0.3068	0.458811
101	17	0	1959	661.30	438.70	.	0.663390
102	17	1	1964	661.30	431.62	-0.2141	0.652684
103	17	2	1971	661.30	387.09	-0.9620	0.585347
104	17	3	1978	661.30	374.68	-0.2681	0.566581
105	18	0	1958	553.29	368.12	.	0.665329
106	18	1	1961	553.29	317.31	-3.0611	0.573497
107	18	2	1967	553.29	259.95	-1.7278	0.469826
108	18	3	1978	553.29	106.55	-2.5205	0.192575
109	19	0	1964	293.54	12.19	.	0.041528
110	19	1	1968	293.54	11.74	-0.0383	0.039995
111	19	2	1973	293.54	9.76	-0.1349	0.033249
112	19	3	1978	293.54	8.92	-0.0572	0.030388
113	20	0	1964	151.02	42.57	.	0.281883
114	20	1	1968	151.02	42.95	0.0629	0.284399
115	20	2	1975	151.02	41.80	-0.1088	0.276785
116	20	3	1978	151.02	40.45	-0.2980	0.267845
117	21	0	1963	454.74	102.21	.	0.224766
118	21	1	1966	454.74	101.05	-0.0850	0.222215
119	21	2	1970	454.74	67.45	-1.8472	0.148327
120	21	3	1978	454.74	40.85	-0.7312	0.089832

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	YEAR	ACRES	U	DU	PU
121	7	0	1960	428.84	49.77	.	0.116057
122	7	1	1965	428.84	5.36	-2.0712	0.012499
123	7	2	1975	428.84	4.25	-0.0259	0.009910
124	7	3	1978	428.84	3.43	-0.0637	0.007998
125	9	0	1962	380.12	124.14	.	0.326581
126	9	1	1968	380.12	82.48	-1.8266	0.216984
127	9	2	1972	380.12	27.14	-3.6396	0.071399
128	9	3	1978	380.12	20.17	-0.3056	0.053062
129	10	0	1964	437.95	91.75	.	0.209499
130	10	1	1968	437.95	44.00	-2.7258	0.100468
131	10	2	1972	437.95	9.34	-1.9785	0.021327
132	10	3	1978	437.95	6.30	-0.1157	0.014385
133	12	0	1962	484.32	235.61	.	0.486476
134	12	1	1964	484.32	188.16	-4.8986	0.388503
135	12	2	1970	484.32	142.97	-1.5551	0.295197
136	12	3	1978	484.32	28.96	-2.9425	0.059795
137	14	0	1962	326.82	297.42	.	0.910042
138	14	1	1964	326.82	235.09	-9.5358	0.719326
139	14	2	1970	326.82	203.47	-1.6125	0.622575
140	14	3	1978	326.82	160.07	-1.6599	0.489780
141	16	0	1964	615.19	304.01	.	0.494173
142	16	1	1970	615.19	292.27	-0.3181	0.475089
143	16	2	1973	615.19	267.47	-1.3438	0.434778
144	16	3	1978	615.19	116.08	-4.9217	0.188690

TABLE A7. UNDEVELOPED ACREAGE

AVERAGE VALUES

PERIOD	LOC_TYPE	DU*	PU
0	A	.	0.4482
0	N	.	0.5026
1	A	-2.0417	0.3761
1	N	-1.9163	0.4409
2	A	-2.4117	0.2679
2	N	-1.4552	0.3736
3	A	-1.5840	0.1925
3	N	-1.6674	0.3120

*Changing the signs of the DU values will give values for net overall land development.

TABLE A8. INDEPENDENT VARIABLES

LOC_TYPE=A METRO=BCS

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
1	3	0	.	68	590	.	.
2	3	1	9.2079	70	1510	77.966	3
3	3	2	4.3606	74	8780	120.364	3
4	3	3	1.5782	77	13720	18.755	3
5	4	0	.	68	4510	.	.
6	4	1	9.2079	70	6140	18.071	3
7	4	2	4.3606	75	11980	19.023	3
8	4	3	1.5782	77	23900	49.750	3
9	5	0	.	58	1880	.	.
10	5	1	0.0891	65	4020	16.261	2
11	5	2	4.7107	70	5560	7.662	2
12	5	3	3.6927	77	8345	7.156	2
13	6	0	.	58	4330	.	.
14	6	1	0.0347	64	4335	0.019	2
15	6	2	4.0111	70	4840	1.942	2
16	6	3	3.6927	77	5150	0.915	2

LOC_TYPE=A METRO=DFW

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
17	11	0	.	64	12500	.	.
18	11	1	10.1076	69	13470	1.5520	3
19	11	2	8.0413	76	22220	9.2799	3
20	11	3	8.1353	78	18420	-8.5509	3
21	13	0	.	69	12895	.	.
22	13	1	8.6327	74	14785	2.9314	1
23	13	2	6.1048	78	16554	2.9912	1
24	13	3	.	.	.	.	1
25	15	0	.	63	13200	.	.
26	15	1	4.8225	68	18560	8.1212	2
27	15	2	11.6303	70	23140	12.3384	2
28	15	3	5.3029	78	30280	3.8570	2
29	17	0	.	59	7870	.	.
30	17	1	2.9639	64	10200	5.9212	2
31	17	2	1.7976	71	11310	1.5546	2
32	17	3	0.0021	78	13410	2.6525	2
33	18	0	.	58	15620	.	.
34	18	1	2.2538	61	15890	0.5762	2
35	18	2	2.4234	67	22100	6.5135	2
36	18	3	0.0021	78	25860	1.5467	2
37	19	0	.	64	17200	.	.
38	19	1	1.0444	68	16725	-0.6904	1
39	19	2	-2.1316	73	16350	-0.4484	1
40	19	3	0.1212	78	17333	1.2024	1
41	20	0	.	64	8000	.	.
42	20	1	1.0444	68	7600	-1.2500	2
43	20	2	-1.6997	75	15450	14.7556	2
44	20	3	1.3435	78	14489	-2.0734	2
45	21	0	.	63	7348	.	.
46	21	1	12.5853	66	9089	7.8978	2
47	21	2	12.9448	70	11407	6.3758	2
48	21	3	1.2108	78	15603	4.5981	2

TABLE A8. INDEPENDENT VARIABLES

------------------- LOC_TYPE=A METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
49	7	0	.	60	13743	.	.
50	7	1	3.8449	65	13227	-0.751	1
51	7	2	3.8142	75	10779	-1.851	1
52	7	3	4.5780	78	7480	-10.202	1
53	9	0	.	62	3566	.	.
54	9	1	4.0055	68	15034	53.599	2
55	9	2	3.1044	72	29467	24.001	2
56	9	3	4.5446	78	38925	5.349	2
57	10	0	.	64	2742	.	.
58	10	1	3.4665	68	2604	-1.2582	1
59	10	2	3.1044	72	5402	26.8625	1
60	10	3	4.5446	78	9417	12.3874	1
61	12	0	.	62	20460	.	.
62	12	1	4.4643	64	20880	1.0264	2
63	12	2	3.6158	70	24700	3.0492	2
64	12	3	4.2193	78	41070	8.2844	2
65	14	0	.	62	16208	.	.
66	14	1	4.4643	64	22113	18.2163	2
67	14	2	3.6158	70	23654	1.1615	2
68	14	3	4.2193	78	42513	9.9661	2
69	16	0	.	64	6506	.	.
70	16	1	3.6158	70	14784	21.2061	2
71	16	2	3.0172	73	34870	45.2877	2
72	16	3	4.6003	78	47364	7.1660	2

------------------- LOC_TYPE=N METRO=BCS -------------------

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
73	3	0	.	68	.	.	.
74	3	1	9.2079	70	.	.	3
75	3	2	4.3606	74	5440	.	3
76	3	3	1.5782	77	5190	-1.5319	3
77	4	0	.	68	2810	.	.
78	4	1	9.2079	70	2810	0.0000	3
79	4	2	4.3606	75	2807	-0.0214	3
80	4	3	1.5782	77	2830	0.4097	3
81	5	0	.	58	946	.	.
82	5	1	0.0891	65	1270	4.8928	2
83	5	2	4.7107	70	1500	3.6220	2
84	5	3	3.6927	77	4910	32.4762	2
85	6	0	.	58	573	.	.
86	6	1	0.0347	64	1071	14.4852	2
87	6	2	4.0111	70	1559	7.5941	2
88	6	3	3.6927	77	2150	5.4156	2

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
89	11	0	.	64	9440	.	.
90	11	1	10.1076	69	15490	12.8178	3
91	11	2	8.0413	76	23080	6.9999	3
92	11	3	8.1353	78	41200	39.2548	3
93	13	0	.	69	11750	.	.
94	13	1	8.6327	74	15580	6.5191	1
95	13	2	6.1048	78	16170	0.9467	1

TABLE A8. INDEPENDENT VARIABLES

------------------- LOC_TYPE=N METRO=DFW -------------------

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
96	13	3	.	.	.	.	1
97	15	0	.	63	7472	.	.
98	15	1	4.8225	68	18290	28.9561	2
99	15	2	11.6303	70	27000	23.8108	2
100	15	3	5.3029	78	46690	9.1157	2
101	17	0	.	59	8236	.	.
102	17	1	2.9639	64	6767	-3.5673	2
103	17	2	1.7976	71	7450	1.4419	2
104	17	3	0.0021	78	6138	-2.5158	2
105	18	0	.	58	9970	.	.
106	18	1	2.2538	61	18775	29.4383	2
107	18	2	2.4234	67	42370	20.9454	2
108	18	3	0.0021	78	79910	8.0546	2
109	19	0	.	64	11400	.	.
110	19	1	1.0444	68	12375	2.1382	1
111	19	2	-2.1316	73	12125	-0.4040	1
112	19	3	0.1212	78	14049	3.1736	1
113	20	0	.	64	18232	.	.
114	20	1	1.0444	68	18499	0.3661	2
115	20	2	-1.6997	75	19025	0.4062	2
116	20	3	1.3435	78	19168	0.2505	2
117	21	0	.	63	16321	.	.
118	21	1	12.5853	65	14600	-3.5149	2
119	21	2	12.9448	70	12456	-3.6712	2
120	21	3	1.2108	78	12085	-0.3723	2

------------------- LOC_TYPE=N METRO=HOU -------------------

OBS	LOC_NUM	PERIOD	DPOP	TADT	ADT	DADT	STAGE
121	7	0	.	60	8190	.	.
122	7	1	3.8449	65	7249	-2.2979	1
123	7	2	3.8142	75	10433	4.3923	1
124	7	3	4.5780	78	10962	1.6901	1
125	9	0	.	62	4000	.	.
126	9	1	4.0055	68	5397	5.8208	2
127	9	2	3.1044	72	6381	4.5581	2
128	9	3	4.5446	78	7287	2.3664	2
129	10	0	.	64	10813	.	.
130	10	1	3.4665	68	11437	1.4427	1
131	10	2	3.1044	72	14849	7.4582	1
132	10	3	4.5446	78	18668	4.2865	1
133	12	0	.	62	.	.	.
134	12	1	4.4643	64	.	.	2
135	12	2	3.6158	70	11049	.	2
136	12	3	4.2193	78	39904	32.6444	2
137	14	0	.	62	.	.	.
138	14	1	4.4643	64	.	.	2
139	14	2	3.6158	70	.	.	2
140	14	3	4.2193	78	34813	.	2
141	16	0	.	64	2629	.	.
142	16	1	3.6158	70	10000	46.7288	2
143	16	2	3.0172	73	11815	6.0500	2
144	16	3	4.6003	78	20095	14.0161	2

TABLE A9. BEFORE-AFTER COMPARISON OF RATES OF DEVELOPMENT

LOC_TYPE=A

OBS	LOC_NUM	R_DRS13	R_DRM13	R_DC13	R_DP13	R_DSR13	R_DU13
1	3	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
2	4	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
3	5	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
4	6	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
5	7	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
6	9	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
7	10	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
8	11	SLOWER	SLOWER	FASTER	SLOWER	FASTER	FASTER
9	12	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
10	14	FASTER	SLOWER	SLOWER	SLOWER	FASTER	SLOWER
11	15	FASTER	FASTER	SLOWER	FASTER	SLOWER	FASTER
12	16	SLOWER	FASTER	FASTER	SLOWER	SLOWER	FASTER
13	17	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
14	18	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
15	19	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
16	20	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	FASTER
17	21	FASTER	SLOWER	FASTER	FASTER	FASTER	FASTER

LOC_TYPE=N

OBS	LOC_NUM	R_DRS13	R_DRM13	R_DC13	R_DP13	R_DSR13	R_DU13
18	3	FASTER	FASTER	FASTER	FASTER	SLOWER	FASTER
19	4	SLOWER	FASTER	FASTER	FASTER	FASTER	FASTER
20	5	SLOWER	FASTER	FASTER	SLOWER	SLOWER	FASTER
21	6	SLOWER	FASTER	FASTER	SLOWER	SLOWER	SLOWER
22	7	SLOWER	FASTER	SLOWER	FASTER	SLOWER	SLOWER
23	9	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
24	10	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
25	11	FASTER	FASTER	FASTER	SLOWER	FASTER	SLOWER
26	12	SLOWER	FASTER	FASTER	SLOWER	SLOWER	SLOWER
27	14	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
28	15	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
29	16	FASTER	FASTER	FASTER	FASTER	FASTER	FASTER
30	17	SLOWER	FASTER	SLOWER	FASTER	SLOWER	FASTER
31	18	SLOWER	FASTER	FASTER	SLOWER	SLOWER	SLOWER
32	19	SLOWER	SLOWER	FASTER	FASTER	SLOWER	FASTER
33	20	FASTER	FASTER	FASTER	SLOWER	SLOWER	FASTER
34	21	FASTER	FASTER	FASTER	FASTER	SLOWER	FASTER

TABLE A10. PREDICTIVE FACTORS FOR BEFORE-AFTER COMPARISON

------------------------- LOC_TYPE=A -------------------------

OBS	LOC_NUM	R_DPOP13	METRO	STAGE	R_DADT13
1	3	SLOWER	BCS	3	SLOWER
2	4	SLOWER	BCS	3	FASTER
3	5	FASTER	BCS	2	SLOWER
4	6	FASTER	BCS	2	FASTER
5	7	FASTER	HOU	1	SLOWER
6	9	FASTER	HOU	2	SLOWER
7	10	FASTER	HOU	1	FASTER
8	11	SLOWER	DFW	3	SLOWER
9	12	SLOWER	HOU	2	FASTER
10	14	SLOWER	HOU	2	SLOWER
11	15	FASTER	DFW	2	SLOWER
12	16	FASTER	HOU	2	SLOWER
13	17	SLOWER	DFW	2	SLOWER
14	18	SLOWER	DFW	2	FASTER
15	19	SLOWER	DFW	1	FASTER
16	20	FASTER	DFW	2	SLOWER
17	21	SLOWER	DFW	2	SLOWER

------------------------- LOC_TYPE=N -------------------------

OBS	LOC_NUM	R_DPOP13	METRO	STAGE	R_DADT13
18	3	SLOWER	BCS	3	FASTER
19	4	SLOWER	BCS	3	FASTER
20	5	FASTER	BCS	2	FASTER
21	6	FASTER	BCS	2	SLOWER
22	7	FASTER	HOU	1	FASTER
23	9	FASTER	HOU	2	SLOWER
24	10	FASTER	HOU	1	FASTER
25	11	SLOWER	DFW	3	FASTER
26	12	SLOWER	HOU	2	FASTER
27	14	SLOWER	HOU	2	SLOWER
28	15	FASTER	DFW	2	SLOWER
29	16	FASTER	HOU	2	SLOWER
30	17	SLOWER	DFW	2	FASTER
31	18	SLOWER	DFW	2	SLOWER
32	19	SLOWER	DFW	1	FASTER
33	20	FASTER	DFW	2	SLOWER
34	21	SLOWER	DFW	2	FASTER

TABLE A12. PREDICTIVE FACTORS FOR BEFORE-DURING COMPARISON

LOC_TYPE=A

OBS	LOC_NUM	R_DPOP12	METRO	STAGE	R_DADT12
1	3	SLOWER	BCS	3	FASTER
2	4	SLOWER	BCS	3	FASTER
3	5	FASTER	BCS	2	SLOWER
4	6	FASTER	BCS	2	FASTER
5	7	SLOWER	HOU	1	SLOWER
6	9	SLOWER	HOU	2	SLOWER
7	10	SLOWER	HOU	1	FASTER
8	11	SLOWER	DFW	3	FASTER
9	12	SLOWER	HOU	2	FASTER
10	13	SLOWER	DFW	1	FASTER
11	14	SLOWER	HOU	2	SLOWER
12	15	FASTER	DFW	2	FASTER
13	16	SLOWER	HOU	2	FASTER
14	17	SLOWER	DFW	2	SLOWER
15	18	FASTER	DFW	2	FASTER
16	19	SLOWER	DFW	1	FASTER
17	20	SLOWER	DFW	2	FASTER
18	21	FASTER	DFW	2	SLOWER

LOC_TYPE=N

OBS	LOC_NUM	R_DPOP12	METRO	STAGE	R_DADT12
19	3	SLOWER	BCS	3	SLOWER
20	4	SLOWER	BCS	3	SLOWER
21	5	FASTER	BCS	2	SLOWER
22	6	FASTER	BCS	2	SLOWER
23	7	SLOWER	HOU	1	FASTER
24	9	SLOWER	HOU	2	SLOWER
25	10	SLOWER	HOU	1	FASTER
26	11	SLOWER	DFW	3	SLOWER
27	12	SLOWER	HOU	2	SLOWER
28	13	SLOWER	DFW	1	SLOWER
29	14	SLOWER	HOU	2	SLOWER
30	15	FASTER	DFW	2	SLOWER
31	16	SLOWER	HOU	2	SLOWER
32	17	SLOWER	DFW	2	FASTER
33	18	FASTER	DFW	2	SLOWER
34	19	SLOWER	DFW	1	SLOWER
35	20	SLOWER	DFW	2	FASTER
36	21	FASTER	DFW	2	SLOWER

TABLE A11. BEFORE-DURING COMPARISON OF RATES OF DEVELOPMENT

LOC_TYPE=A

OBS	LOC_NUM	R_DRS12	R_DRM12	R_DC12	R_DP12	R_DSR12	R_DU12
1	3	SLOWER	FASTER	SLOWER	FASTER	SLOWER	FASTER
2	4	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
3	5	SLOWER	FASTER	FASTER	SLOWER	SLOWER	FASTER
4	6	FASTER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
5	7	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
6	9	SLOWER	FASTER	SLOWER	SLOWER	FASTER	SLOWER
7	10	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
8	11	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
9	12	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
10	13	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
11	14	SLOWER	SLOWER	SLOWER	SLOWER	FASTER	SLOWER
12	15	SLOWER	SLOWER	FASTER	FASTER	SLOWER	FASTER
13	16	FASTER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
14	17	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	FASTER
15	18	SLOWER	FASTER	SLOWER	SLOWER	FASTER	SLOWER
16	19	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
17	20	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
18	21	FASTER	SLOWER	FASTER	FASTER	SLOWER	FASTER

LOC_TYPE=N

OBS	LOC_NUM	R_DRS12	R_DRM12	R_DC12	R_DP12	R_DSR12	R_DU12
19	3	FASTER	FASTER	SLOWER	FASTER	SLOWER	FASTER
20	4	SLOWER	FASTER	FASTER	FASTER	SLOWER	FASTER
21	5	FASTER	FASTER	FASTER	FASTER	FASTER	FASTER
22	6	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
23	7	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
24	9	SLOWER	FASTER	FASTER	SLOWER	FASTER	FASTER
25	10	SLOWER	FASTER	SLOWER	SLOWER	FASTER	SLOWER
26	11	FASTER	FASTER	FASTER	SLOWER	FASTER	SLOWER
27	12	SLOWER	SLOWER	SLOWER	SLOWER	FASTER	SLOWER
28	13	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
29	14	SLOWER	FASTER	FASTER	SLOWER	SLOWER	SLOWER
30	15	FASTER	SLOWER	FASTER	FASTER	SLOWER	FASTER
31	16	SLOWER	FASTER	FASTER	SLOWER	SLOWER	FASTER
32	17	FASTER	SLOWER	SLOWER	FASTER	FASTER	FASTER
33	18	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
34	19	FASTER	FASTER	FASTER	SLOWER	SLOWER	FASTER
35	20	SLOWER	FASTER	FASTER	SLOWER	FASTER	FASTER
36	21	FASTER	FASTER	FASTER	FASTER	SLOWER	FASTER

TABLE A13. DURING-AFTER COMPARISON OF RATES OF DEVELOPMENT

LOC_TYPE=A

OBS	LOC_NUM	R_DRS23	R_DRM23	R_DC23	R_DP23	R_DSR23	R_DU23
1	3	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
2	4	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
3	5	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
4	6	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
5	7	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
6	9	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
7	10	FASTER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
8	11	SLOWER	SLOWER	FASTER	SLOWER	FASTER	FASTER
9	12	FASTER	SLOWER	FASTER	FASTER	SLOWER	SLOWER
10	14	FASTER	FASTER	FASTER	SLOWER	FASTER	FASTER
11	15	FASTER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
12	16	SLOWER	FASTER	FASTER	SLOWER	SLOWER	SLOWER
13	17	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
14	18	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
15	19	SLOWER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
16	20	FASTER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
17	21	FASTER	SLOWER	FASTER	FASTER	FASTER	FASTER

LOC_TYPE=N

OBS	LOC_NUM	R_DRS23	R_DRM23	R_DC23	R_DP23	R_DSR23	R_DU23
18	3	FASTER	FASTER	FASTER	FASTER	SLOWER	FASTER
19	4	FASTER	FASTER	SLOWER	SLOWER	FASTER	FASTER
20	5	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
21	6	FASTER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
22	7	FASTER	FASTER	SLOWER	SLOWER	SLOWER	FASTER
23	9	FASTER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER
24	10	FASTER	SLOWER	FASTER	SLOWER	SLOWER	SLOWER
25	11	SLOWER	FASTER	SLOWER	SLOWER	FASTER	FASTER
26	12	SLOWER	FASTER	FASTER	SLOWER	SLOWER	FASTER
27	14	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	FASTER
28	15	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER	SLOWER
29	16	FASTER	FASTER	FASTER	FASTER	FASTER	FASTER
30	17	SLOWER	FASTER	SLOWER	SLOWER	SLOWER	SLOWER
31	18	SLOWER	FASTER	FASTER	SLOWER	FASTER	FASTER
32	19	SLOWER	SLOWER	FASTER	FASTER	SLOWER	SLOWER
33	20	FASTER	SLOWER	FASTER	SLOWER	SLOWER	FASTER
34	21	SLOWER	SLOWER	SLOWER	FASTER	SLOWER	SLOWER

TABLE A14. PREDICTIVE FACTORS FOR DURING-AFTER COMPARISON

LOC_TYPE=A

OBS	LOC_NUM	R_DPOP23	METRO	STAGE	R_DADT23
1	3	SLOWER	BCS	3	SLOWER
2	4	SLOWER	BCS	3	FASTER
3	5	SLOWER	BCS	2	SLOWER
4	6	SLOWER	BCS	2	SLOWER
5	7	FASTER	HOU	1	SLOWER
6	9	FASTER	HOU	2	SLOWER
7	10	FASTER	HOU	1	SLOWER
8	11	FASTER	DFW	3	SLOWER
9	12	FASTER	HOU	2	FASTER
10	14	FASTER	HOU	2	FASTER
11	15	SLOWER	DFW	2	SLOWER
12	16	FASTER	HOU	2	SLOWER
13	17	SLOWER	DFW	2	FASTER
14	18	SLOWER	DFW	2	SLOWER
15	19	FASTER	DFW	1	FASTER
16	20	FASTER	DFW	2	SLOWER
17	21	SLOWER	DFW	2	SLOWER

LOC_TYPE=N

OBS	LOC_NUM	R_DPOP23	METRO	STAGE	R_DADT23
18	3	SLOWER	BCS	3	FASTER
19	4	SLOWER	BCS	3	FASTER
20	5	SLOWER	BCS	2	FASTER
21	6	SLOWER	BCS	2	SLOWER
22	7	FASTER	HOU	1	SLOWER
23	9	FASTER	HOU	2	SLOWER
24	10	FASTER	HOU	1	SLOWER
25	11	FASTER	DFW	3	FASTER
26	12	FASTER	HOU	2	FASTER
27	14	FASTER	HOU	2	SLOWER
28	15	SLOWER	DFW	2	SLOWER
29	16	FASTER	HOU	2	FASTER
30	17	SLOWER	DFW	2	SLOWER
31	18	SLOWER	DFW	2	SLOWER
32	19	FASTER	DFW	1	FASTER
33	20	FASTER	DFW	2	SLOWER
34	21	SLOWER	DFW	2	FASTER

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER COMPARISON

TABLE OF R_DRS13 BY METRO

R_DRS13 / METRO FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	BCS	DFW	HOU	TOTAL
FASTER	1 2.4 0.8 2.94 10.00 12.50	7 4.1 2.0 20.59 70.00 50.00	2 3.5 0.7 5.88 20.00 16.67	10 29.41
SLOWER	7 5.6 0.3 20.59 29.17 87.50	7 9.9 0.8 20.59 29.17 50.00	10 8.5 0.3 29.41 41.67 83.33	24 70.59
TOTAL	8 23.53	14 41.18	12 35.29	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	4.899	DF= 2	PROB=0.0863
PHI	0.380		
CONTINGENCY COEFFICIENT	0.355		
CRAMER'S V	0.380		
LIKELIHOOD RATIO CHISQUARE	4.944	DF= 2	PROB=0.0844

* Location 13 omitted.

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER COMPARISON

TABLE OF R_DRM13 BY LOC_TYPE

R_DRM13 / LOC_TYPE (FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT)	A	N	TOTAL
FASTER	4 8.5 2.4 11.76 23.53 23.53	13 8.5 2.4 38.24 76.47 76.47	17 50.00
SLOWER	13 8.5 2.4 38.24 76.47 76.47	4 8.5 2.4 11.76 23.53 23.53	17 50.00
TOTAL	17 50.00	17 50.00	34* 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	9.529	DF=	1	PROB=0.0020
PHI	-0.529			
CONTINGENCY COEFFICIENT	0.468			
CRAMER'S V	0.529			
LIKELIHOOD RATIO CHISQUARE	10.034	DF=	1	PROB=0.0015
CONTINUITY ADJ. CHI-SQUARE	9.647	DF=	1	PROB=0.0019

* Location 13 omitted.

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER COMPARISON

TABLE OF R_DC13 BY LOC_TYPE

R_DC13 / LOC_TYPE FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	A	N	TOTAL
FASTER	6 8.5 0.7 17.65 35.29 35.29	11 8.5 0.7 32.35 64.71 64.71	17 50.00
SLOWER	11 8.5 0.7 32.35 64.71 64.71	6 8.5 0.7 17.65 35.29 35.29	17 50.00
TOTAL	17 50.00	17 50.00	34* 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	2.941	DF=	1	PROB=0.0863
PHI	-0.294			
CONTINGENCY COEFFICIENT	0.282			
CRAMER'S V	0.294			
LIKELIHOOD RATIO CHISQUARE	2.985	DF=	1	PROB=0.0840
CONTINUITY ADJ. CHI-SQUARE	3.059	DF=	1	PROB=0.0803

* Location 13 omitted

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER COMPARISON

TABLE OF R_DC13 BY METRO

R_DC13 / FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	METRO: BCS	DFW	HOU	TOTAL
FASTER	6 4.0 1.0 17.65 35.29 75.00	8 7.0 0.1 23.53 47.06 57.14	3 6.0 1.5 8.82 17.65 25.00	17 50.00
SLOWER	2 4.0 1.0 5.88 11.76 25.00	6 7.0 0.1 17.65 35.29 42.86	9 6.0 1.5 26.47 52.94 75.00	17 50.00
TOTAL	8 23.53	14 41.18	12 35.29	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	5.286	DF=	2	PROB=0.0712
PHI	0.394			
CONTINGENCY COEFFICIENT	0.367			
CRAMER'S V	0.394			
LIKELIHOOD RATIO CHISQUARE	5.519	DF=	2	PROB=0.0633

* Location 13 omitted.

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER COMPARISON

TABLE OF R_DP13 BY R_DU13

R_DP13 / R_DU13 (FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT)	FASTER	SLOWER	TOTAL
FASTER	8 4.2 3.4 23.53 72.73 61.54	3 6.8 2.1 8.82 27.27 14.29	11 32.35
SLOWER	5 8.8 1.6 14.71 21.74 38.46	18 14.2 1.0 52.94 78.26 85.71	23 67.65
TOTAL	13 38.24	21 61.76	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	8.192	DF= 1	PROB=0.0042
PHI	0.491		
CONTINGENCY COEFFICIENT	0.441		
CRAMER'S V	0.491		
LIKELIHOOD RATIO CHISQUARE	8.258	DF= 1	PROB=0.0041
CONTINUITY ADJ. CHI-SQUARE	8.155	DF= 1	PROB=0.0043

* Location 13 omitted.

TABLE A15. SIGNIFICANCE TEST, BEFORE-AFTER CCMPARISON

TABLE OF R_DSR13 BY R_DRS13

R_DSR13 / R_DRS13 (FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT)	FASTER	SLOWER	TOTAL
FASTER	4 1.8 2.8 11.76 66.67 40.00	2 4.2 1.2 5.88 33.33 8.33	6 17.65
SLOWER	6 8.2 0.6 17.65 21.43 60.00	22 19.8 0.3 64.71 78.57 91.67	28 82.35
TOTAL	10 29.41	24 70.59	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	4.871	DF= 1	PROB=0.0273
PHI	0.378		
CONTINGENCY COEFFICIENT	0.354		
CRAMER'S V	0.378		
LIKELIHOOD RATIO CHISQUARE	4.460	DF= 1	PROB=0.0347
CONTINUITY ADJ. CHI-SQUARE	4.534	DF= 1	PROB=0.0332

* Location 13 omitted.

TABLE A16. SIGNIFICANCE TEST, BEFORE-DURING COMPARISON

TABLE OF R_DRS12 BY R_DADT12

R_DRS12 / R_DADT12 (FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT)	FASTER	SLOWER	TOTAL
FASTER	3 5.3 1.0 8.33 25.00 18.75	9 6.7 0.8 25.00 75.00 45.00	12 33.33
SLOWER	13 10.7 0.5 36.11 54.17 81.25	11 13.3 0.4 30.56 45.83 55.00	24 66.67
TOTAL	16 44.44	20 55.56	36 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	2.756	DF= 1	PROB=0.0969
PHI	-0.277		
CONTINGENCY COEFFICIENT	0.267		
CRAMER'S V	0.277		
LIKELIHOOD RATIO CHISQUARE	2.861	DF= 1	PROB=0.0908
CONTINUITY ADJ. CHI-SQUARE	2.927	DF= 1	PROB=0.0871

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DRM12 BY LOC_TYPE

R_DRM12 (FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT)	LOC_TYPE A	N	TOTAL
FASTER	4 7.5 1.6 11.11 26.67 22.22	11 7.5 1.6 30.56 73.33 61.11	15 41.67
SLOWER	14 10.5 1.2 38.89 66.67 77.78	7 10.5 1.2 19.44 33.33 38.89	21 58.33
TOTAL	18 50.00	18 50.00	36 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	5.600	DF= 1	PROB=0.0180
PHI	-0.394		
CONTINGENCY COEFFICIENT	0.367		
CRAMER'S V	0.394		
LIKELIHOOD RATIO CHISQUARE	5.776	DF= 1	PROB=0.0163
CONTINUITY ADJ. CHI-SQUARE	5.714	DF= 1	PROB=0.0168

TABLE A16. SIGNIFICANCE TEST, BEFORE-DURING COMPARISON

TABLE OF R_DRM12 BY R_DADT12

R_DRM12 / R_DADT12 FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	FASTER	SLOWER	TOTAL
FASTER	4 6.7 1.1 11.11 26.67 25.00	11 8.3 0.9 30.56 73.33 55.00	15 41.67
SLOWER	12 9.3 0.8 33.33 57.14 75.00	9 11.7 0.6 25.00 42.86 45.00	21 58.33
TOTAL	16 44.44	20 55.56	36 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	3.291	DF=	1	PROB=0.0696
PHI	-0.302			
CONTINGENCY COEFFICIENT	0.289			
CRAMER'S V	0.302			
LIKELIHOOD RATIO CHISQUARE	3.382	DF=	1	PROB=0.0659
CONTINUITY ADJ. CHI-SQUARE	3.430	DF=	1	PROB=0.0640

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DC12 BY LOC_TYPE

R_DC12 / LOC_TYPE: FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT	A	N	TOTAL
FASTER	8 10.5 0.6 22.22 38.10 44.44	13 10.5 0.6 36.11 61.90 72.22	21 58.33
SLOWER	10 7.5 0.8 27.78 66.67 55.56	5 7.5 0.8 13.89 33.33 27.78	15 41.67
TOTAL	18 50.00	18 50.00	36 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	2.857	DF= 1	PROB=0.0910
PHI	-0.282		
CONTINGENCY COEFFICIENT	0.271		
CRAMER'S V	0.282		
LIKELIHOOD RATIO CHISQUARE	2.901	DF= 1	PROB=0.0885
CONTINUITY ADJ. CHI-SQUARE	2.971	DF= 1	PROB=0.0847

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DC12 BY R_DPOP12

R_DC12   R_DPOP12

FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	FASTER	SLOWER	TOTAL
FASTER	9 5.8 1.7 25.00 42.86 90.00	12 15.2 0.7 33.33 57.14 46.15	21 58.33
SLOWER	1 4.2 2.4 2.78 6.67 10.00	14 10.8 0.9 38.89 93.33 53.85	15 41.67
TOTAL	10 27.78	26 72.22	36 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	5.713	DF=	1	PROB=0.0168
PHI	0.398			
CONTINGENCY COEFFICIENT	0.370			
CRAMER'S V	0.398			
LIKELIHOOD RATIO CHISQUARE	6.511	DF=	1	PROB=0.0107
CONTINUITY ADJ. CHI-SQUARE	5.989	DF=	1	PROB=0.0144

TABLE A16. SIGNIFICANCE TEST, BEFORE-DURING COMPARISON

TABLE OF R_DP12 BY R_DRS12

R_DP12 / R_DRS12 (FREQUENCY, EXPECTED, CELL CHI2, PERCENT, ROW PCT, COL PCT)	FASTER	SLOWER	TOTAL
FASTER	6 3.7 1.5 16.67 54.55 50.00	5 7.3 0.7 13.89 45.45 20.83	11 30.56
SLOWER	6 8.3 0.7 16.67 24.00 50.00	19 16.7 0.3 52.78 76.00 79.17	25 69.44
TOTAL	12 33.33	24 66.67	36 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	3.207	DF= 1	PROB=0.0733
PHI	0.298		
CONTINGENCY COEFFICIENT	0.286		
CRAMER'S V	0.298		
LIKELIHOOD RATIO CHISQUARE	3.117	DF= 1	PROB=0.0775
CONTINUITY ADJ. CHI-SQUARE	3.176	DF= 1	PROB=0.0747

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DP12 BY R_DU12

R_DP12 (FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT)	R_DU12: FASTER	SLOWER	TOTAL
FASTER	9 5.5 2.2 25.00 81.82 50.00	2 5.5 2.2 5.56 18.18 11.11	11 30.56
SLOWER	9 12.5 1.0 25.00 36.00 50.00	16 12.5 1.0 44.44 64.00 88.89	25 69.44
TOTAL	18 50.00	18 50.00	36 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	6.415	DF=	1	PROB=0.0113
PHI	0.422			
CONTINGENCY COEFFICIENT	0.389			
CRAMER'S V	0.422			
LIKELIHOOD RATIO CHISQUARE	6.805	DF=	1	PROB=0.0091
CONTINUITY ADJ. CHI-SQUARE	6.545	DF=	1	PROB=0.0105

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DSR12 BY R_DRM12

R_DSR12 / R_DRM12 FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	FASTER	SLOWER	TOTAL
FASTER	7 4.2 1.9 19.44 70.00 46.67	3 5.8 1.4 8.33 30.00 14.29	10 27.78
SLOWER	8 10.8 0.7 22.22 30.77 53.33	18 15.2 0.5 50.00 69.23 85.71	26 72.22
TOTAL	15 41.67	21 58.33	36 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED CCUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	4.573	DF=	1	PROB=0.0325
PHI	0.356			
CONTINGENCY COEFFICIENT	0.336			
CRAMER'S V	0.356			
LIKELIHOOD RATIO CHISQUARE	4.588	DF=	1	PROB=0.0322
CONTINUITY ADJ. CHI-SQUARE	4.596	DF=	1	PROB=0.0320

TABLE A16. SIGNIFICANCE TEST. BEFORE-DURING COMPARISON

TABLE OF R_DU12 BY METRO

R_DU12 / FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	METRO: BCS	DFW	HOU	TOTAL
FASTER	7 4.0 2.3 19.44 38.89 87.50	8 8.0 0.0 22.22 44.44 50.00	3 6.0 1.5 8.33 16.67 25.00	18 50.00
SLOWER	1 4.0 2.3 2.78 5.56 12.50	8 8.0 0.0 22.22 44.44 50.00	9 6.0 1.5 25.00 50.00 75.00	18 50.00
TOTAL	8 22.22	16 44.44	12 33.33	36 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED CCUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	7.500	DF=	2	PROB=0.0235
PHI	0.456			
CONTINGENCY COEFFICIENT	0.415			
CRAMER'S V	0.456			
LIKELIHOOD RATIO CHISQUARE	8.202	DF=	2	PROB=0.0166

TABLE A16. SIGNIFICANCE TEST, BEFORE-DURING COMPARISON

TABLE OF R_DU12 BY STAGE

R_DU12 / FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	STAGE 1	2	3	TOTAL
FASTER	1 4.0 2.3 2.78 5.56 12.50	13 11.0 0.4 36.11 72.22 59.09	4 3.0 0.3 11.11 22.22 66.67	18 50.00
SLOWER	7 4.0 2.3 19.44 38.89 87.50	9 11.0 0.4 25.00 50.00 40.91	2 3.0 0.3 5.56 11.11 33.33	18 50.00
TOTAL	8 22.22	22 61.11	6 16.67	36 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	5.894	DF=	2	PROB=0.0525
PHI	0.405			
CONTINGENCY COEFFICIENT	0.375			
CRAMER'S V	0.405			
LIKELIHOOD RATIO CHISQUARE	6.473	DF=	2	PROB=0.0393

TABLE A17. SIGNIFICANCE TEST, DURING-AFTER COMPARISON

TABLE OF R_DRM23 BY LOC_TYPE

R_DRM23 — FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	LOC_TYPE A	N	TOTAL
FASTER	4	10	14
	7.0	7.0	
	1.3	1.3	
	11.76	29.41	41.18
	28.57	71.43	
	23.53	58.82	
SLOWER	13	7	20
	10.0	10.0	
	0.9	0.9	
	38.24	20.59	58.82
	65.00	35.00	
	76.47	41.18	
TOTAL	17	17	34*
	50.00	50.00	100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	4.371	DF= 1	PROB=0.0365
PHI	-0.359		
CONTINGENCY COEFFICIENT	0.338		
CRAMER'S V	0.359		
LIKELIHOOD RATIO CHISQUARE	4.485	DF= 1	PROB=0.0342
CONTINUITY ADJ. CHI-SQUARE	4.493	DF= 1	PROB=0.0340

* Location 13 omitted.

TABLE A17. SIGNIFICANCE TEST, DURING-AFTER COMPARISON

TABLE OF R_DC23 BY R_DPOP23

R_DC23 / R_DPOP23 FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	FASTER	SLOWER	TOTAL
FASTER	12 9.0 1.0 35.29 70.59 66.67	5 8.0 1.1 14.71 29.41 31.25	17 50.00
SLOWER	6 9.0 1.0 17.65 35.29 33.33	11 8.0 1.1 32.35 64.71 68.75	17 50.00
TOTAL	18 52.94	16 47.06	34* 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	4.250	DF= 1	PROB=0.0393
PHI	0.354		
CONTINGENCY COEFFICIENT	0.333		
CRAMER'S V	0.354		
LIKELIHOOD RATIO CHISQUARE	4.345	DF= 1	PROB=0.0371
CONTINUITY ADJ. CHI-SQUARE	4.368	DF= 1	PROB=0.0366

* Location 13 omitted.

TABLE A17. SIGNIFICANCE TEST, DURING-AFTER COMPARISON

TABLE OF R_DP23 BY R_DADT23

R_DP23 / FREQUENCY / EXPECTED / CELL CHI2 / PERCENT / ROW PCT / COL PCT	R_DADT23: FASTER	SLOWER	TOTAL
FASTER	5 3.1 1.2 14.71 62.50 38.46	3 4.9 0.8 8.82 37.50 14.29	8 23.53
SLOWER	8 9.9 0.4 23.53 30.77 61.54	18 16.1 0.2 52.94 69.23 85.71	26 76.47
TOTAL	13 38.24	21 61.76	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

CHI-SQUARE	2.608	DF= 1	PROB=0.1063
PHI	0.277		
CONTINGENCY COEFFICIENT	0.267		
CRAMER'S V	0.277		
LIKELIHOOD RATIO CHISQUARE	2.552	DF= 1	PROB=0.1101
CONTINUITY ADJ. CHI-SQUARE	2.614	DF= 1	PROB=0.1059

* Location 13 omitted.

TABLE A17. SIGNIFICANCE TEST, DURING-AFTER COMPARISON

TABLE OF R_DSR23 BY R_DRM23

R_DSR23 / R_DRM23 FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	FASTER	SLOWER	TOTAL
FASTER	5 2.9 1.6 14.71 71.43 35.71	2 4.1 1.1 5.88 28.57 10.00	7 20.59
SLOWER	9 11.1 0.4 26.47 33.33 64.29	18 15.9 0.3 52.94 66.67 90.00	27 79.41
TOTAL	14 41.18	20 58.82	34* 100.00

STATISTICS FOR 2-WAY TABLES

WARNING: OVER 5% OF THE CELLS HAVE EXPECTED COUNTS LESS THAN 5.
TABLE IS SO SPARSE THAT CHI-SQUARE MAY NOT BE A VALID TEST.

Statistic	Value			
CHI-SQUARE	3.331	DF=	1	PROB=0.0680
PHI	0.313			
CONTINGENCY COEFFICIENT	0.299			
CRAMER'S V	0.313			
LIKELIHOOD RATIO CHISQUARE	3.322	DF=	1	PROB=0.0684
CONTINUITY ADJ. CHI-SQUARE	3.353	DF=	1	PROB=0.0671

* Location 13 omitted.

TABLE A17. SIGNIFICANCE TEST, DURING-AFTER COMPARISON

TABLE OF R_DU23 BY R_DPOP23

R_DU23 / R_DPOP23 FREQUENCY EXPECTED CELL CHI2 PERCENT ROW PCT COL PCT	FASTER	SLOWER	TOTAL
FASTER	10 7.4 0.9 29.41 71.43 55.56	4 6.6 1.0 11.76 28.57 25.00	14 41.18
SLOWER	8 10.6 0.6 23.53 40.00 44.44	12 9.4 0.7 35.29 60.00 75.00	20 58.82
TOTAL	18 52.94	16 47.06	34* 100.00

STATISTICS FOR 2-WAY TABLES

CHI-SQUARE	3.265	DF= 1	PROB=0.0708
PHI	0.310		
CONTINGENCY COEFFICIENT	0.296		
CRAMER'S V	0.310		
LIKELIHOOD RATIO CHISQUARE	3.344	DF= 1	PROB=0.0674
CONTINUITY ADJ. CHI-SQUARE	3.400	DF= 1	PROB=0.0652

*Location 13 omitted.

TABLE A18. TYPE OF MEDIAN TREATMENT AT EACH LOCATION

OBS	LOC_NUM	TL	CLT	RMED	D
1	3	1	0	0	NONE
2	4	1	1	0	L_T_LANE
3	5	1	0	0	NONE
4	6	1	0	0	NONE
5	7	1	0	0	NONE
6	9	1	0	1	R_MEDIAN
7	10	1	0	1	R_MEDIAN
8	11	1	1	0	L_T_LANE
9	12	1	0	1	R_MEDIAN
10	13	1	1	0	L_T_LANE
11	14	1	0	1	R_MEDIAN
12	15	0	1	0	.
13	16	1	0	1	R_MEDIAN
14	17	1	1	0	L_T_LANE
15	18	1	0	1	R_MEDIAN
16	19	1	1	0	L_T_LANE
17	20	1	1	0	L_T_LANE
18	21	1	0	0	NONE

Table A19. MEDIAN TREATMENT TEST, BEFORE-DURING COMPARISON

TABLE OF R_DU13 BY D

R_DU13 / D Frequency Expected Cell Chi2 Percent Row Pct Col Pct	L_T_LANE	NONE	R_MEDIAN	TOTAL
FASTER	6 3.75 1.16 18.75 50.00 60.00	4 3.75 0.13 12.50 33.33 40.00	2 4.50 1.18 6.25 16.67 16.67	12 37.50
SLOWER	4 6.25 0.90 12.50 20.00 40.00	6 6.25 0.10 18.75 30.00 60.00	10 7.50 0.91 31.25 50.00 83.33	20 62.50
TOTAL	10 31.25	10 31.25	12 37.50	32* 100.00

Statistics for 2-way Tables

Warning: Over 5% of the cells have expected counts less than 5.
Table is so sparse that Chi-Square may not be a valid test.

Chi-Square 4.410 DF = 2 PROB = 0.1141

*Locations 13 and 15 omitted.

TABLE A20. MEDIAN TREATMENT TEST, BEFORE-DURING COMPARISON

TABLE OF R_DRS12 BY D

R_DRS12 D

Frequency Expected Cell Chi2 Percent Row Pct Col Pct	L_T_LANE	NONE	R_MEDIAN	TOTAL
FASTER	4 3.88 0.06 11.76 36.36 33.33	6 3.24 1.53 17.65 54.55 60.00	1 3.88 1.46 2.94 9.09 8.33	11 32.35
SLOWER	8 8.12 0.42 23.53 34.78 66.67	4 6.76 1.06 11.77 17.39 40.00	11 8.12 1.01 32.35 47.83 91.67	23 67.65
TOTAL	12 35.29	10 29.42	12. 35.29	34* 100.00

Statistics for 2-way Tables

Warning: Over 5% of the cells have expected counts less than 5.
Table is so sparse that Chi-Square may not be a valid test.

Chi-Square 6.6427 DF = 2 PROB = 0.0390

*Location 15 omitted.