To the Graduate Council

I am submitting herewith a thesis written by Jason Allen Crouch entitled "Estimation of Traffic Volumes on Rural Local Roads in Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Civil Engineering

Arun Chatterjee, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council

Interim Vice Provost and
Dean of the Graduate School

ESTIMATION OF TRAFFIC VOLUMES ON RURAL LOCAL ROADS IN TENNESSEE

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Jason Allen Crouch
August 2000

DEDICATION

This thesis is dedicated to my loving wife

Moya Gabrielle Myers

whose patience, love, encouragement, and understanding were instrumental in reaching this milestone in my education

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The project would not have come to completion without the assistance of others. "Thank you" to the Tennessee Department of Transportation, particularly Steve Allen and his staff, for the traffic count maps, extra traffic counts collected, advice on the spreadsheet program, and financial support of the project.

Finally, a great deal of thanks is due my wife, Moya, for her patience, encouragement, and strength to see me through to this moment.

ABSTRACT

The research goal was to develop a method for estimating traffic volumes on rural local roads in Tennessee utilizing available data. Tennessee Department of Transportation's (TDOT) current traffic count program on bridges across the state served as the source for this research. TDOT wanted to minimize the need for additional data collection. These traffic counts at bridge locations were compared with similar counts at non-bridge locations in eight counties within Tennessee. Through statistical analysis, including a unique technique called bootstrapping, it was determined that there existed enough variability between bridge and non-bridge counts to prevent direct correlation. The data were then aggregated for each county and using multiple regression, model equations were developed that predict a countywide estimate of rural local road volume at non-bridge locations. This information was combined with the existing bridge counts to develop a countywide average daily traffic volume and vehicle miles of travel for rural local roads. A Microsoft Excel spreadsheet with programming was developed to automate the calculation process.

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CHAPTER I

INTRODUCTION

Traffic volume information is used by highway engineers and planners to make decisions about future highway designs, current traffic control needs, and allocation of limited resources for improvements. Volume data are gathered often by state departments of transportation (DOTs) and by some local agencies. The focus of their efforts usually is on higher classes of roads such as arterials and collectors. A large portion of the road network consisting of local roads is usually excluded from the traffic count programs unless specifically needed for a particular study.

Local roads make up nearly seventy percent of a state's road network, yet do not carry the levels of traffic of the arterials and collectors in the network. The vehicle miles traveled (VMT) on local roads portion of the statewide road network is usually in the range of ten to fifteen percent of total VMT (Seaver et al., 1998). VMT estimates are very important figures in the highway statistics for a state DOT. These are used in traffic accident analyses and in determining air quality emissions estimates from mobile sources. Local road VMT is an important data item for these analyses.

Currently, no standard procedure exists for sampling and gathering traffic volume information for local roads. The Federal Highway Administration (FHWA) expects the state DOTs to develop their own methodology for estimating VMT on local roads. These estimates for local roads are reported to FHWA and in many cases these are outdated and unreliable. The procedures used vary among different state DOTs.

This study examined statistical procedures for estimating traffic volumes on rural local roads in Tennessee. The objective was to develop a cost-effective methodology that utilized available data from the bridge count program and requires little additional data. Although the methodology was influenced by data available from TDOT, certain aspects of the analyses are applicable to other states

CHAPTER II

DATA COLLECTION

The Tennessee Department of Transportation (TDOT) has a program in place that gathers traffic count information for all bridges in the state whose length of span is twenty feet or greater. This average daily traffic (ADT) information became the primary source data for this study. ADT information for bridges is being gathered for each county on a three-year cycle, as it will require at least three years to cover every qualifying bridge in Tennessee with the available manpower and equipment.

The use of bridge counts for ADT estimation for all rural local roads is promising, especially with regard to cost containment. However, this approach has some limitations. Due to the nature of the topography and road network of each county, the bridge locations in a county may not be a representative sample of all local roads in the county. The locations could, in many cases, be concentrated in one area of a county, reducing the predictive value of the counts for other locations. Our proposal was to compare the existing bridge counts with other counts at non-bridge locations randomly selected across the county and to assess the similarity or bias, if any, between the two groups.

Four counties were selected to begin the study. These included Carroll and Fayette Counties in western Tennessee and Bradley and Cocke Counties in eastern Tennessee. TDOT agreed to take a sample of counts at non-bridge locations for this study The four counties did not provide a statistically significant number of sample observations, particularly when broken down into categories of paved and unpaved

roads. As an example, there were no bridge counts taken on unpaved roads in Bradley County. This county is near Chattanooga and has a low percentage of its road mileage unpaved. Thus the chances for obtaining such sample data points in Bradley County are quite low. Also, the geographic mix of the original four counties may have biased the results. The study was then expanded to eight counties to include more of the geographic diversity of the state. It was hoped that the four new counties would enhance the data set and improve the predictive value of any model that would be developed from the observations. This second group of counties included Anderson County in eastern Tennessee, Clay County in the northern section of middle Tennessee, Cheatham County near Nashville, and Giles County in southern middle Tennessee. The eight counties can be seen on the map in Figure 1.

TDOT provided maps showing the locations of the bridge counts, and our next task was to determine just how and where the non-bridge counts should be taken. Each county was divided into a two square mile grid pattern, as in the example in Figure 2. The grid cells were stratified into two groups—cells containing bridge locations and cells containing no bridge count locations. Based on the total number of cells per county, the proportional weight of bridge to non-bridge cells, a 95% confidence level, and preliminary estimates of bridge and non-bridge mean ADT, a sample size was determined for both groups or strata. For example, Giles County was broken into two strata – 81 bridge cells and 84 non-bridge cells for a total of 165 cells. A procedure known as repeated systematic sampling (Scheaffer, 1996) was used to determine the locations for both bridge and non-bridge counts in the county to be used in the analysis. In Giles County, three sets of nine non-bridge locations were selected. The non-bridge

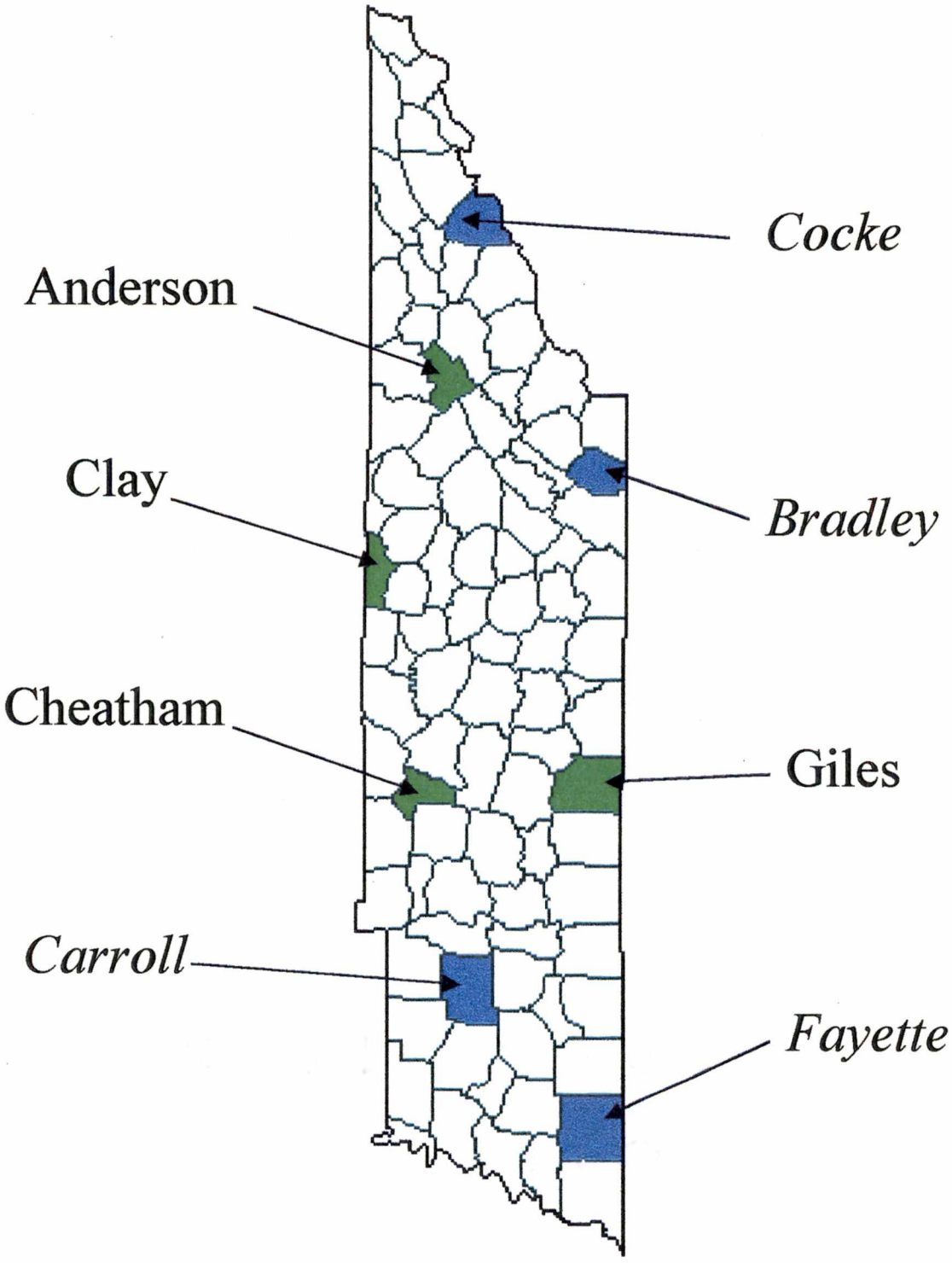
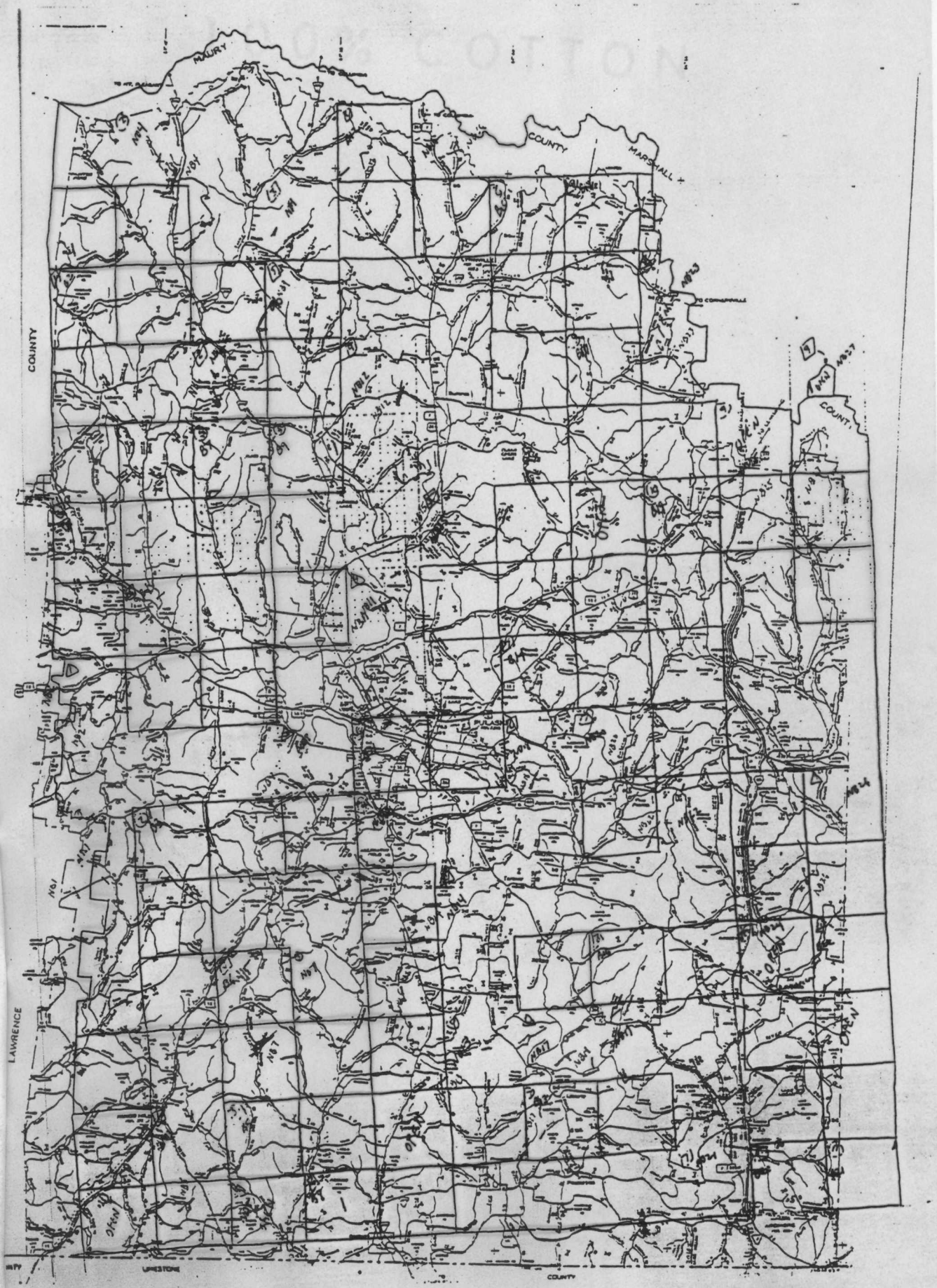


Figure 1: Counties from which ADT data was collected. The first four counties studied are italicized.

Figure 2: The map of Giles County, Tennessee composed of two square mile grid sections is shown as an overlay to the map of Giles County, Tennessee (TDOT, 1996).


COUNTY
MARSHALL
COUNTY
LAWRENCE
COUNTY

grid cells were numbered sequentially; the starting position for selecting a group of nine cells was randomly generated. By changing the starting position for each sample set – a task not available by using only one sample of 27 locations – it was possible to minimize the effect of the topography and ensure better coverage in each county. Within each non-bridge cell selected, the location of the actual count site was selected by randomly selecting x- and y-coordinates within the grid cell. Each grid cell consisted of a 10 x 10 matrix. From the randomly selected x- and y-coordinates, the closest local road location was selected, and at this location, TDOT collected 24-hour traffic count data specifically for this research study.

CHAPTER III

STATISTICAL EVALUATION

Once all of the traffic counts were collected at bridge and non-bridge sites, the analysis of the data began. The hope was that there would be a strong correlation between counts taken at bridge and non-bridge sites. This would be the simplest and least expensive way of estimating local road volumes for TDOT. As can be seen in Tables 1 and 2, the bridge and non-bridge average ADTs and median ADTs of individual counties differ greatly in most cases.

For example, in Clay County, the average bridge location ADT was 63 vehicles per day (vpd), while the non-bridge location average ADT was 446 vpd. Cocke County had a different pattern; the average ADT for bridge locations was 314 vpd, but the non-bridge average ADT was only 169 vpd. However, for all eight counties studied the combined average bridge and non-bridge ADTs were similar (354 vpd versus 350 vpd). The possibility of finding similar results for a composite of all 95 counties in Tennessee was not clear due to the tremendous variability in the eight counties studied. Looking at other measures of correlation, the Pearson correlation on aggregate ADT averages for bridge and non-bridge counts was 0.761 (with a p-value of 0.028). On the other hand, the Spearman correlation – a non-parametric measure of association – was 0.238 (with a p-value of 0.570). This disconcerting finding demanded a different approach. An important goal of this research was to retain the individuality of the counties by creating

Table 1: Summary statistics for the bridge location ADT data.

County	Bridge Counts				
	Average ADT	Median ADT	Standard Deviation	Range	Number of Observations
Anderson	289	210	262	720	10
Bradley	1202	345	2320	8240	12
Carroll	101	100	74	200	10
Cheatham	655	505	583	1520	10
Clay	63	35	86	260	8
Cocke	314	160	369	1130	9
Fayette	113	80	114	460	27
Giles	318	195	380	1700	22
Total	354	140	865	8330	108

Table 2: Summary statistics for the non-bridge location ADT data.

County	Non - Bridge Counts				
	Average ADT	Median ADT	Standard Deviation	Range	Number of Observations
Anderson	442	318	367	1247	22
Bradley	740	295	1222	288	18
Carroll	106	20	169	520	13
Cheatham	426	385	370	1469	14
Clay	446	206	926	4028	18
Cocke	169	140	163	480	12
Fayette	235	175	215	800	22
Giles	201	85	248	938	27
Total	350	167	604	5130	146

a tool that could estimate an average ADT for each county and then obtain statewide estimates.

Visual Data Analysis

In further evaluating the bridge and non-bridge count data, the first task was to determine whether or not normality exists for the sample populations. Looking at the box plot and violin plot for the sample data, it can be seen very clearly that the data is skewed to the right by some mild and extreme outliers. The normal probability plots and stem-and-leaf diagrams confirm our rejection of normality of the sample sets (see Appendix A and B for descriptive statistics reports).

Dispersion

The second issue involved common or uncommon dispersion. Dispersion, or variability, deals with the individual differences in the data set and the degree to which individual observations differ from each other (Lapin, 1997). One of the best tests for equality of variances is the Modified-Levene Equal Variance Test. This test redefines the variables in terms of the difference between the sample median and each data point. An analysis of variance is then performed on the new variables (Hintze, 1998). Looking at the Two-Sample Test Report (found in Appendix C) for the samples, the Modified-Levene Test showed that there was no basis to reject equal variances except in Cheatham and Fayette Counties. All of the normality tests confirmed the rejection of normality stated earlier. The common dispersion found by the Modified Levene leads to a couple

of methods of estimating the location for two samples. These include the Mann-Whitney-Wilcoxon Test and Bootstrapping.

Non-Parametric Estimates

The Mann-Whitney-Wilcoxon Test gives another estimate of the difference in medians between two samples. Using the Two-Sample Test Report (Appendix C), we can examine the results of this test. The result in this test says to accept the null hypothesis for all three tests for most counties. We can interpret this as saying that with 95% confidence, there is no difference in the median ADT for the bridge and non-bridge sites. Clay and Fayette Counties, however, exhibit differences between bridge and non-bridge mean ADTs within each county.

Bootstrapping

In bootstrapping, the idea is to create many samples using the original sample data. For this analysis, 5000 samples were created of the same size as the original sample for both the bridge and non-bridge sample data sets. Means for each of the 5000 bridge ADT samples are found, and mean ADTs for all 5000 non-bridge samples are calculated. Then 5000 differences in means are generated and sorted in ascending order. To get the boundary values for the bootstrapped estimate, we will look at the following positions in the sorted differences. (Mooney, 1993)

95% Confidence Interval

$$\alpha = 0.05 \rightarrow \alpha/2 = 0.025 \rightarrow (1-\alpha/2) = 0.975$$

$$[\alpha/2]*n = (0.025)*(5000) = 125^{th} \text{ position} \rightarrow \text{lower boundary}$$

$$[1-(\alpha/2)]*n = (0.975)*(5000) = 4875^{th} \text{ position} \rightarrow \text{upper boundary}$$

Using these positions, we obtain the interval estimates shown in Table 3 for the difference in mean ADTs for each county. With 95% confidence, this interval tells us that the difference in mean ADT values of bridge and non-bridge locations is between the two boundary values given for each county. Also, if zero is in the interval, we can conclude that there is no statistical difference in the mean ADTs of bridge and non-bridge sites for that county.

Since the distributions of the bridge and non-bridge traffic counts are skewed to the right by some outliers, it may be necessary to examine another bootstrapped interval estimate. The original assumption in bootstrapping includes the assumption of symmetry in bias. A simple adjustment to the endpoints of the bootstrapped interval estimate can account for any bias in the data. This method is called the bias-corrected method of bootstrapping (Mooney, 1993). This method looks at the probability that the bootstrapped statistic (in this case the difference in means) would be less than the actual sample statistic. This probability is then used to adjust the endpoints of the distribution. For example, in the case of Bradley County, the probability that the bootstrapped difference in means is less than the sample difference in means is 0.583

Table 3: Bootstrapped interval estimates for the difference in means.

County	95% Lower Confidence Limit	95% Upper Confidence Limit	Statistically Significant?
Anderson	-365.05	60.32	No
Bradley	-839.72	2035.00	No
Carroll	-111.08	84.54	No
Cheatham	-162.00	623.93	No
Clay	-863.33	-84.69	Yes
Cocke	-68.89	408.61	No
Fayette	-221.47	-29.01	Yes
Giles	-52.07	311.12	No

The corresponding Z value in the normal distribution is 0.21. Now the endpoints of the interval become:

$$P(Z^* < 2(0.21) - 1.96) = 0.0617 = 309^{th} \text{ position} \rightarrow \text{lower boundary}$$

$$P(Z^* < 2(0.21) + 1.96) = 0.9913 = 4957^{th} \text{ position} \rightarrow \text{upper boundary}$$

The lower boundary shifted to the right by 184 positions while the upper boundary shifted to the right by 82 positions. These new positions generate an interval estimate that has been corrected for any bias in the sample data. In performing the bias-corrected method on each estimate, the endpoints for each interval change (some by a large value as can be seen in Table 4), but the overall result remains the same. Only Fayette and Clay Counties show a statistically significant difference in mean ADT values for bridge and non-bridge locations.

Table 4: Bootstrapped interval estimates for the difference in means using the bias-corrected method. Note that none of the conclusions changed from the previous bootstrapping estimates.

County	95% Lower Confidence Limit	95% Upper Confidence Limit	Statistically Significant?
Anderson	-367.50	55.05	No
Bradley	-647.22	2485.83	No
Carroll	-119.92	79.54	No
Cheatham	-158.36	625.79	No
Clay	-1010.61	-105.42	Yes
Cocke	-58.06	425.83	No
Fayette	-222.96	-30.30	Yes
Giles	-41.42	327.51	No

The bootstrapping results confirm the results of the Mann-Whitney-Wilcoxon Test. In all of these tests, Clay and Fayette counties were shown to have non-bridge ADTs significantly larger than those for the bridge locations in their respective counties. These counties are more rural in nature than many of the others in the study. It can be hypothesized that a portion of the remaining rural counties in Tennessee would exhibit similar behavior. This necessitates treating all counties as if there were differences in order to develop an estimation tool that will accommodate all parts of the state.

ADT Information Database

The count data was then input into a spreadsheet with information on the name of the road, ADT value, year of the count, the road surface type—paved or unpaved, and historical ADT information for the location. If the site was a new count station, the closest bridge count location served as the source for historical information. This was

done to keep consistency in the spreadsheet and allow for analysis of older count data. (See Appendix D for the database)

The spreadsheet database includes several fields that are described below. The first few entries for each record represent information gained from the new site. This count location was selected in the sampling method described earlier, which yielded traffic counts for several bridge and non-bridge locations in each county. New site data included the county, an identifying notation for bridge (B) and non-bridge (NB) sites, the name of the road, the road type, and the new ADT value gathered by TDOT. The road type was designated with codes 1 through 5 with each value representing a different road type listed below.

1 – Large Urbanized Areas

2 – Other Urbanized Areas

3 – Small Urbanized Areas

4 – Rural Paved Roads

5 – Rural Unpaved Roads

This classification system comes from the Georgia Department of Transportation's traffic count program (Seaver et al., 1998). As this research was focused on rural local roads, the majority of our roads could be classified as roadtype 4 or 5. Locations that fell on state routes, for example, would be classified as a 3 for exclusion from our analysis since a state route usually is not a local road.

Historical data are listed next for each record in the database. The first section of the historical data is referred to as "close". This represents ADT and roadway information for the closest bridge count site to the location generated in the sampling

procedure. It lists the same information as before—ADT, year of the count (primarily 1997), and the roadtype. The next set of data is labeled "previous" referring to the same location as in the "close" fields, but an earlier date (1995-96). One of our first attempts to estimate the "new" ADT information relied on the older data. Some of the sites listed as "new" have ADT values estimated from a nearby location—another bridge site, a nearby special count on file, or a cycle count location close to the site in question. It is in these cases, that the "new" and "close" locations will have the same data. This repetitive nature requires that these be filtered out of the database prior to analysis. Later analysis did not rely on the historical data and the repetitive data points were added back into the sample data set.

CHAPTER IV

REGRESSION ANALYSIS

Once all of the information for the first four counties was gathered, the task of finding relationships within the data began. The first method attempted was to assess if the new counts that were collected by TDOT had any relationship with data from years past. The thought was to see how well the new data could be predicted by the two groups of older data—the 1997 data and the 1995-96 data. As mentioned previously, some of the counts had been estimated with 1997 data, thus reducing the number of observations useful for this analysis

Filtering out the repetitive counts, 24 observations from the first four counties met the criteria for this analysis. Using multiple regression, the best model for predicting the new counts was the following:

$$newADT = 106.30 + 0.40(closeADT) - 0.38(previousADT)$$

NewADT represents the counts taken by TDOT in 1998 to be predicted, *closeADT* represents the counts from nearby sites taken in 1997, and *previousADT* represents the same nearby site, but older data (1995-96). The R^2 value for this model was only 0.5266, which was not quite as high as hoped. Another value for evaluating a model's predictive value is the Press R^2 or Predictive R^2.

The Press R^2 is a measure of how well a given multiple regression model predicts. It works by holding out one sample observation, then using the remaining observations to develop a model and predict the held out data point. This process is

done once for each observation. The predicted value is compared to the actual value and the difference is called the prediction error. The sum of the squared prediction errors is the PRESS value, where PRESS stands for PREdiction Sum of Squares. The formula for the Press R^2 is shown below.

$$R^2_{PRESS} = 1 - \frac{PRESS}{SS_{total}}$$
$$PRESS = \sum (y_i - \hat{y}_{i,-i})^2$$
$$SS_{total} = \sum (y_i - \bar{y})^2$$

In these formulas y_i represents the actual value, $\bar{y}$ represents the average of the dependent data, and $\hat{y}_{i,-i}$ represents the predicted y value with the i^{th} observation removed (Hintze, 1998).

The R^2_{PRESS} for this model was 0.3445 and the R^2 was 0.5266. Generally speaking, an R^2_{PRESS} of at least half the R^2 value is a good predictive model. Unfortunately, the R^2 is not high enough to be a valid model. Only having 24 sample observations in the regression is one reason for the poor fit of the model. Another reason is the presence of outliers in the data

A second attempt to relate the new data to historical data introduced a geographic aspect to the analysis. The count at a nearby site would be of more predictive value the closer it lies to the new count site. The primary item that affects the similarity of the counts is the number of choices that motorists have to deviate from the path between the two locations. If the sites lie on the same road with no intersecting roads between them, chances are very good that the two locations will share nearly identical traffic As more and more intersecting roads are introduced between the two sites, the variability in the

traffic volumes also increases. This was the basis for a new variable created in the analysis. The variable took into consideration the number of intersections between the new site and the nearby ADT location. The model generated from this process is shown below.

$$newADT = 92.88 + 0.16(closeADT) - 0.27(previousADT) + 7.07 \times 10^{-2}(Inter)$$

The variable *Inter* represents the geographic distance and the number of directional choices a driver experiences between the *newADT* site and the nearby historical data location (see Figure 3). It is calculated by multiplying the number of intersections between the two locations by the ADT of the close location (i.e. the 1997 data). The new variable has some effect improving the model's R^2 to 0.6755 and the R^2_{PRESS} to 0.5142. This indeed has improved our predictability and is an interesting model.

However, the model does have some limitations. Once again, the small number of observations on which the model is based may limit its transferability to other areas of the state. Also, the variable inter is not of a very practical nature. Even obtaining such information in the field for a small sample of observations in each county would require a significant increase in manpower and data archiving that would not be appealing to TDOT.

The previous model brings up a very valid point. Two very important items come to light in regression analysis. The first is to keep the model as simple as possible. Each introduction of a new variable increases the complexity and thus increases the chance for misinterpretation. The second issue is to ensure that the model and its variables are practical for the intended application. It was at this point that our analysis shifted in a slightly different direction.

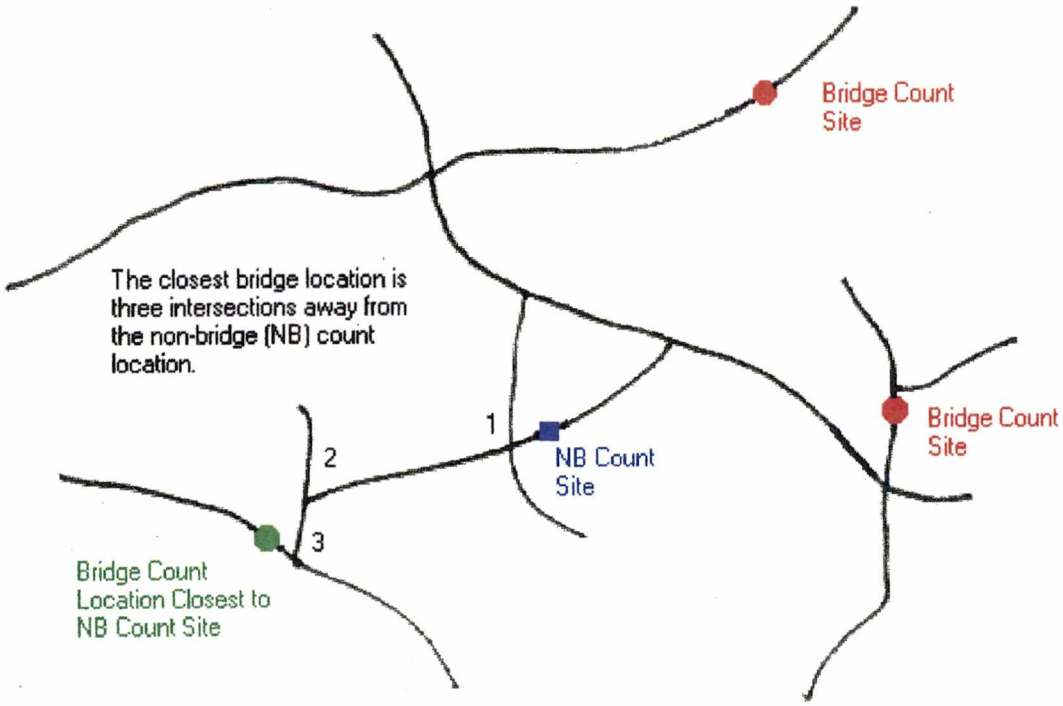


Figure 3: Illustration of the concept of the variable *Inter* which represents the geographic distance between the sites and the number of choices for motorists to travel other routes.

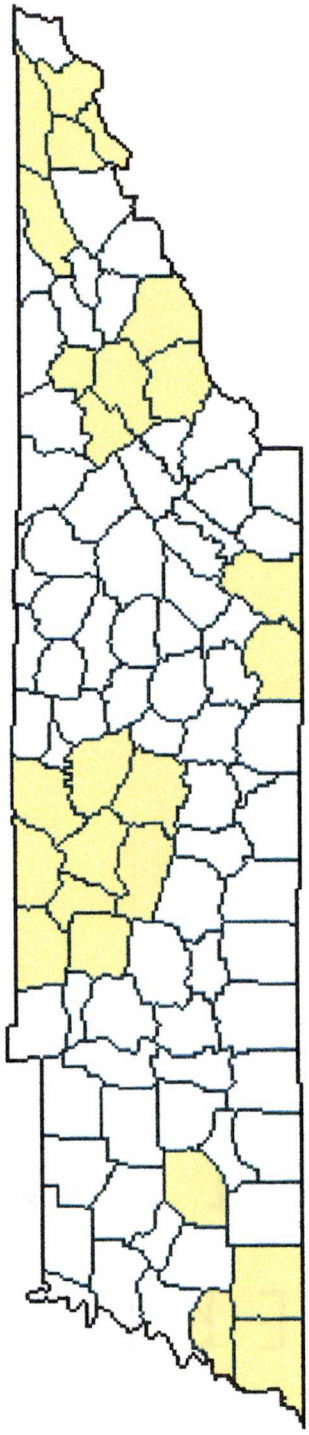
For any estimation tool to be effective and implemented by TDOT, it needs to be as accurate as possible with little additional data collection and manipulation. In that light, why individually estimate a set of non-bridge locations, when an overall county average estimate may be sufficient? The analysis now looked toward taking the existing bridge count location ADTs and using those to estimate an overall countywide non-bridge traffic volume.

CHAPTER V

MODELING

An attempt was made to correlate bridge site ADTs with the non-bridge site ADTs, however, a simple correlation was not strong enough. As discussed earlier, there exists excessive variability between the bridge and non-bridge locations within a county. The question then becomes, "Can non-bridge volumes be estimated based on the existing bridge volumes?" If so, it would be possible to estimate a non-bridge average ADT based on the bridge site counts. This, combined with the known bridge count information could prove useful in estimating an overall ADT for a county. This would lead to a more precise estimation of vehicle miles of travel for each county, a figure that is used for a variety of purposes including the determination of accident rates on rural local roads.

The approach was to stratify both bridge and non-bridge data into classes based on two factors that influence traffic volumes on rural local roads. The first of these is road surface type. As seen in a previous research with the Georgia local roads, whether or not the road surface was paved proved to be a strong predictor of ADT (Seaver et al., 1998). Another strong influence was the county's proximity to a metropolitan area. The Census Bureau establishes what are called Metropolitan Statistical Areas (MSA). These include counties considered to be in the metropolitan area of large cities in the United States. As is shown in Figure 4, Tennessee has 25 counties that are considered by the



Chattanooga MSA	
Hamilton	Marion

Knoxville MSA	
Anderson	Sevier
Blount	Union

Jackson MSA
Madison

Memphis MSA	
Fayette	Tipton
Shelby	

Nashville MSA	
Cheatham	Rutherford
Davidson	Sumner
Dickson	Williamson
Montgomery	Wilson
Robertson	

Tri-Cities MSA	
Carter	Unicoi
Hawkins	Washington
Sullivan	

Figure 4: Metropolitan Statistical Areas (MSAs) in Tennessee.

Census Bureau to be in an MSA. Previous research based on data from Georgia has indicated, and it stands to reason that, counties within MSAs tend to have higher traffic volumes on their road networks (Seaver et al., 1998). This includes rural local roads in a county. Figure 5 shows our stratification of the traffic count locations for this research.

Stratifying the existing data still did not provide enough correlation for using only bridge locations to estimate volumes at non-bridge locations. The approach then turned more to an overall county approach. Such variables as the county sample bridge ADT mean and median were introduced. Several new variables were brought into the analysis hoping that a trend would become evident in the data and prove valuable as a predictive tool The variables that were examined are listed in Table 5. Interactions between the variables were also investigated for their predictive value

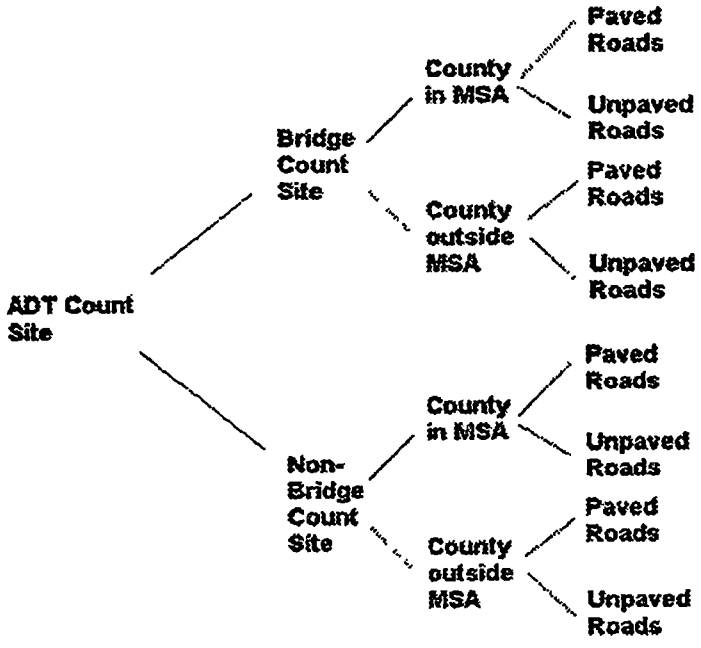


Figure 5: Stratification diagram for the traffic count locations.

Table 5: Multiple regression variables considered in estimating non-bridge location ADT.

Variable Name	Description
Cnty	Name of the County.
Smsa	Value denoting a county as in or out of a Metropolitan Statistical Area (0 = out, 1 = in)
TDOTreg	Denotes within what Tennessee Department of Transportation Region the county lies.
Mean	The average ADT
Nbridmean	The average ADT for non-bridge locations in the county
Med	The median ADT value for bridge locations in the county
Bridstatus	Denotes if the data is for bridge (1) or non-bridge (0) locations
Rdtype	Denotes if the data is for paved (1) or unpaved (0) road surfaces
SmsaXmean	An interaction variable that is the product of the value in Smsa and the average ADT
MsaXrd	An interaction variable equal to the product of the value in Smsa and the value in Rdtype
MsaXbrid	An interaction variable equal to the product of the value in Smsa and the value in Bridstatus
BridXrd	An interaction variable that is the product of the value in Bridstatus and the value in Rdtype
RdXmean	An interaction variable equal to the product of the value in Rdtype and the average ADT
RdXsmsaXmed	A three-variable interaction that is the product of Rdtype, Smsa, and the median bridge ADT
MsaXmed	An interaction variable equal to the product of the value in Smsa and the median bridge ADT
RdXmed	An interaction variable equal to the product of the value in Rdtype and the median bridge ADT
RdXsmsaXmean	A three-variable interaction that is the product of Rdtype, Smsa, and the average ADT

For example, the three-variable interaction between the roadtype, the MSA, and the average ADT works in this manner. If the data point, which represents an overall county condition, is an aggregate for paved roads (roadtype = 1) and the county is outside an MSA (MSA = 0), the mean ADT will not influence the model equation. This is due to the fact that the mean would be multiplied by the value in the MSA variable, which is zero. If the data point had paved roads (roadtype = 1) and is inside the MSA (MSA = 1), the predicted value for a countywide non-bridge ADT would be adjusted by the average bridge location ADT.

One of the objectives of this project was to keep the estimation process simple. Any variable used needs to be of a practical, attainable nature in order for TDOT to implement it. Keeping this in mind, the next step involved taking all of the variables in Table 5 into a regression analysis. All combinations of any number of variables were considered. However, models with greater than three independent variables gained less and less with regard to their R^2 value. Also, some variables and combinations of variables did not make good practical sense. For example, calculating the mean for a series of bridge count locations is a little bit easier than computing the median.

After considering many of the models, the best three variable model was identified, and it used the variables rdtype, mean, and rdXsmsaXmed and took the following form. The multiple regression report is shown in Appendix E.

$$nbridmean = 35.53 - 39.10(rdtype) + 0.796(mean) + 0.646(rdXsmsaXmed)$$

This equation had an R^2 of 0.9613 and an R^2_{PRESS} of 0.9282, both excellent particularly when compared with the results of the earlier attempts. By using the three variable

interaction of rdXsmsaXmed, different equations result depending on the status of the county. Following are the different equations and in what situations they are to be used.

1) With Roadtype = 4 (paved roads) and the County in an MSA

$$\mu_{non-bridge} = -3.57 + 0.796\mu_{bridge} + 0.646 median_{bridge}$$

2) With Roadtype = 5 (unpaved roads) and the County in an MSA

$$\mu_{non-bridge} = 35.63 + 0.796\mu_{bridge}$$

3) With Roadtype = 4 and the County not in an MSA

$$\mu_{non-bridge} = -3.57 + 0.796\mu_{bridge}$$

4) With Roadtype = 5 and the County not in an MSA

$$\mu_{non-bridge} = 35.53 + 0.796\mu_{bridge}$$

Notice that with unpaved roads it makes no difference whether the county is within or outside of a Metropolitan Statistical Area. There tend to be fewer unpaved roads in the MSA counties (Seaver et al., 1998) and thus their behavior can be best modeled by the larger sample set of unpaved roads outside of MSAs.

CHAPTER VI

IMPLEMENTATION

The research effort did not cease with the development of the model equations for estimating VMT based on TDOT's traffic count data collected for bridge locations across the state. In order to assist TDOT with their data recording and reporting efforts, an effort was made to develop a computer program that could be used to store and analyze count data and report VMT estimates for counties across the state.

In order to calculate vehicle miles of travel for a road segment, two items must be known. First, one must have a value for the average daily traffic for the road segment. Second, one must know the length of the road segment in miles. The product of these two values is vehicle miles of travel or VMT. To apply this concept to a class of roads—in this case, rural local roads—the total miles of road of this type in the county and a reliable value for ADT for this class of roads for the county must be known.

The last phase of this project involved automating the process of estimation of ADTs for rural local roads in individual counties in Tennessee. The process begins with the calculation of the mean and median of the bridge location ADTs in each county for paved and unpaved roads, respectively. Next, the non-bridge mean ADT volumes for individual counties are estimated for paved and unpaved roads, respectively. The model equations presented earlier are the tools used to arrive at these estimates. The two values, the mean bridge location ADT and the mean non-bridge location ADT, are averaged to find a countywide ADT for rural local roads. Finally, knowing the miles of

local roads—either paved or unpaved—allows the calculation of VMT for that portion of a county's road system.

The process described above has been automated in a Microsoft Excel spreadsheet. The spreadsheet has four main functions: 1) it provides storage for all bridge location traffic counts which are taken periodically by TDOT; 2) it can estimate bridge location counts for years in which the data were not collected in some counties, giving a full set of data each year for statewide VMT estimation; 3) it estimates VMT for each county; and 4) it can print out the VMT and ADT report for each county in a particular year.

Spreadsheet Program Introduction

The spreadsheet program uses existing traffic count data and computes an overall estimate of vehicle miles of travel on rural local roads for a county. TDOT's current program of collecting traffic counts at bridge locations is the source of the traffic count data. This information is keyed into the spreadsheet by the user for each county and the program uses regression equations to estimate a mean average daily traffic (ADT) value for non-bridge locations within a county. These regression equations based on data from eight counties in Tennessee, were presented in Chapter V.

Input Screen

The spreadsheet page titled "Input", shown in Figure 6, is where the user records in the ADT values as they become available. Also stored on this page is a code

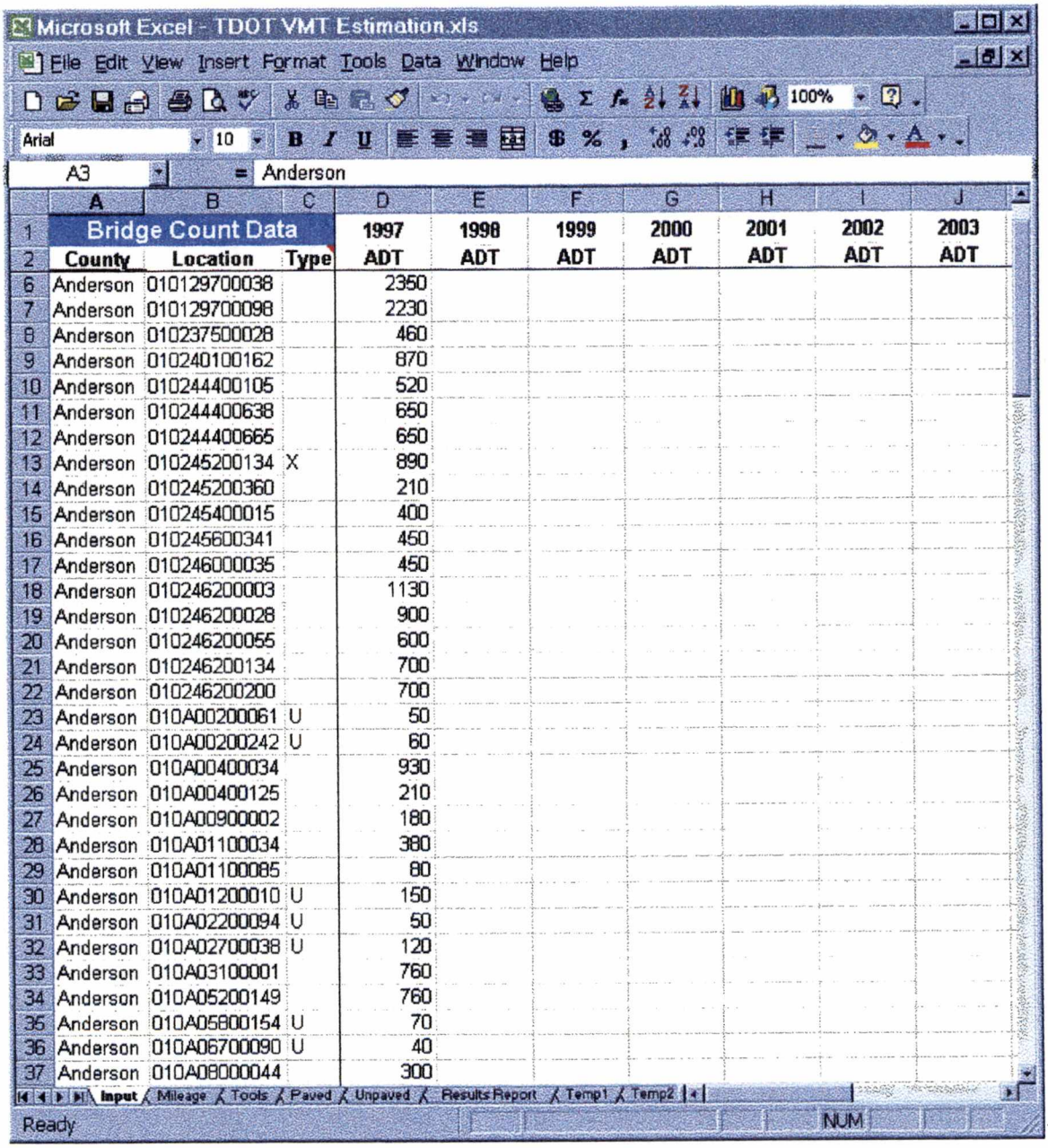
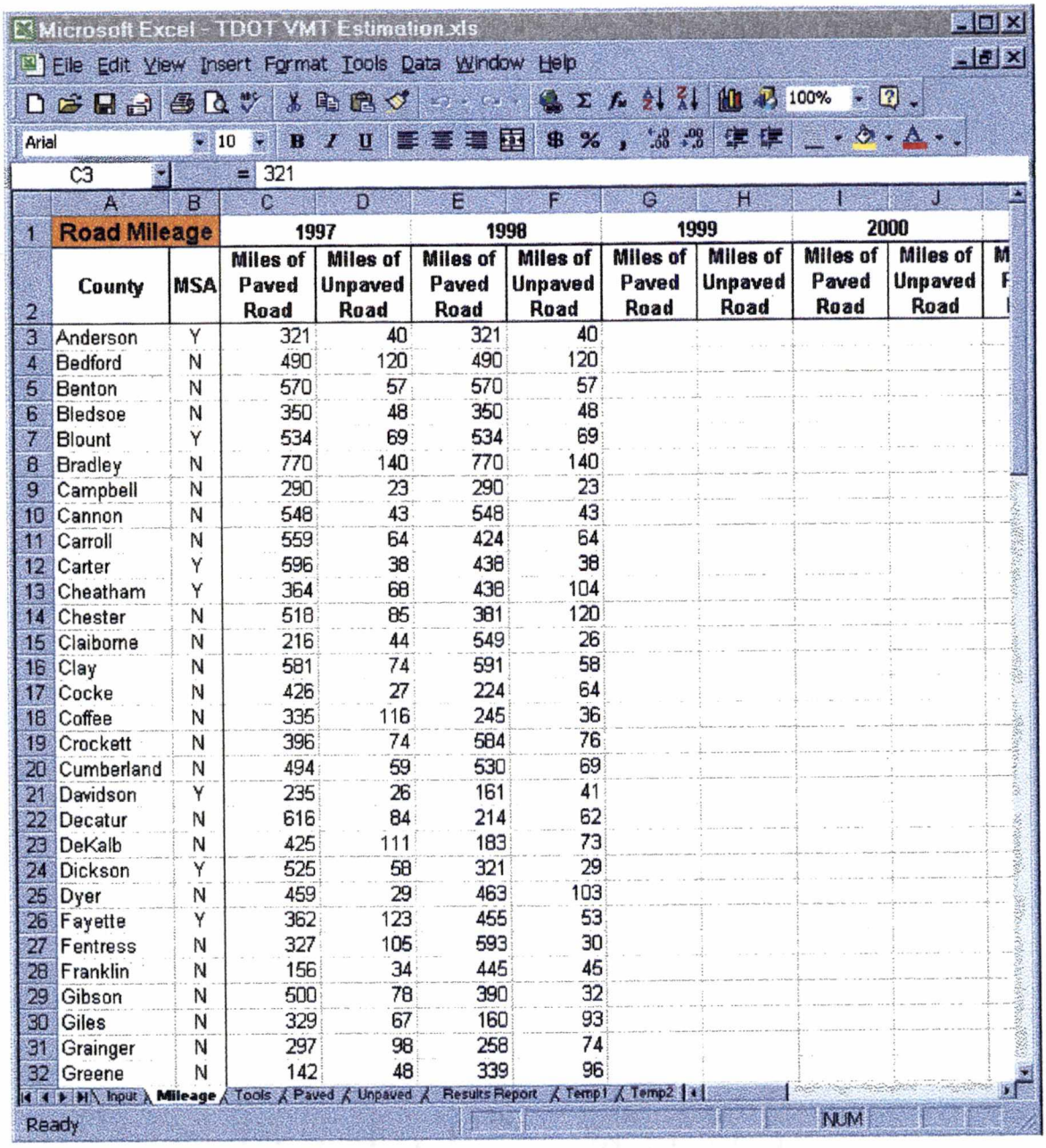


Figure 6: Input screen of the spreadsheet program developed for TDOT.

representing the location of the bridge. This code consists of the county number, the route number, and the log-mile of the site along that route. For example, the first location in Anderson County is 010127000404, representing Anderson County ("01"), the route ("01270"), and the log-mile ("000404"), pinpointing the location at log-mile 4.04 on route 1270 in Anderson County. This twelve-digit code was taken from the "Non-System Bridge List" provided by TDOT. It is also on this page that the user can identify the type of roadway. To the right of the county listing is a column labeled "Type". If the traffic count location was on an unpaved road, the user enters a "U" in this column. If the count is not on a local road, and on a State route, for example, the user places an "X" in the "Type" column. If the space is blank, the program assumes a paved road surface. This scheme tells the spreadsheet software how to handle each count—paved and unpaved roads have different models for estimation of volumes. Non-local roads are not considered in this analysis. All counts from the TDOT bridge count program are entered on this input sheet under the appropriate year, whether paved, unpaved, or non-local road types.

Mileage Screen

In order to estimate vehicle miles of travel on rural local roads, it is necessary to have information regarding the number of miles of rural local roads in each county. The program allows the user to input the number of miles of both paved and unpaved rural local roads per county on the page shown in Figure 7. If the mileage changes from one year to the next, the user can input the new mileage under the



Road Mileage		1997		1998		1999		2000		
County	MSA	Miles of Paved Road	Miles of Unpaved Road	Miles of Paved Road	Miles of Unpaved Road	Miles of Paved Road	Miles of Unpaved Road	Miles of Paved Road	Miles of Unpaved Road	M F
Anderson	Y	321	40	321	40					
Bedford	N	490	120	490	120					
Benton	N	570	57	570	57					
Bledsoe	N	350	48	350	48					
Blount	Y	534	69	534	69					
Bradley	N	770	140	770	140					
Campbell	N	290	23	290	23					
Cannon	N	548	43	548	43					
Carroll	N	559	64	424	64					
Carter	Y	596	38	438	38					
Cheatham	Y	364	68	438	104					
Chester	N	518	85	381	120					
Claiborne	N	216	44	549	26					
Clay	N	581	74	591	58					
Cocke	N	426	27	224	64					
Coffee	N	335	116	245	36					
Crockett	N	396	74	584	76					
Cumberland	N	494	59	530	69					
Davidson	Y	235	26	161	41					
Decatur	N	616	84	214	62					
DeKalb	N	425	111	183	73					
Dickson	Y	525	58	321	29					
Dyer	N	459	29	463	103					
Fayette	Y	362	123	455	53					
Fentress	N	327	105	593	30					
Franklin	N	156	34	445	45					
Gibson	N	500	78	390	32					
Giles	N	329	67	160	93					
Grainger	N	297	98	258	74					
Greene	N	142	48	339	96					

Figure 7: Road mileage input screen in the spreadsheet program developed for TDOT.

appropriate year. If no changes are necessary, the user must copy the previous year's mileage into the space provided for mileage in the current year.

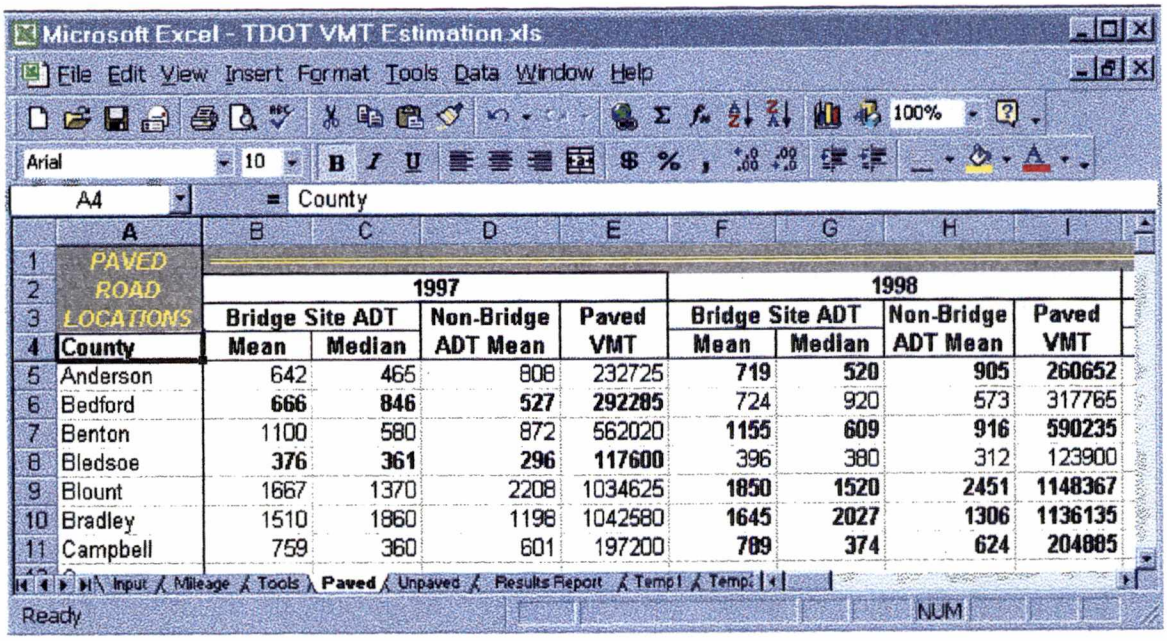
The analysis for this study found that average ADT values for a county are influenced by the county's proximity to a Metropolitan Statistical Area (MSA) as designated by the U.S. Census Bureau. Each county's proximity status is indicated in the row titled "MSA" as "Y" for a county within an MSA, and "N" for counties not included in an MSA. These designations may change following the 2000 Census and can be easily updated by the user.

Screen for ADT Calculations for Paved Local Roads

The calculation of mean and median ADTs for paved bridge count locations occurs on this page (see Figure 8). Also calculated are the estimates of mean ADT for the non-bridge locations and an estimate of rural local paved road VMT. The non-bridge ADT mean is calculated using the regression equations discussed in Chapter V. Paved VMT is calculated using the average of the bridge and non-bridge ADT means multiplied by the paved road mileage for the individual county.

Screen for ADT Calculation for Unpaved Local Roads

The calculation of mean and median ADT for unpaved bridge count locations occurs on the page seen in Figure 9. Also calculated are the estimates of mean ADT for the non-bridge locations and an estimate of rural local unpaved road VMT. These are calculated in the same manner as on the page for paved roads.



Microsoft Excel - TDOT VMT Estimation.xls

File Edit View Insert Format Tools Data Window Help

Arial 10 B I U 100%

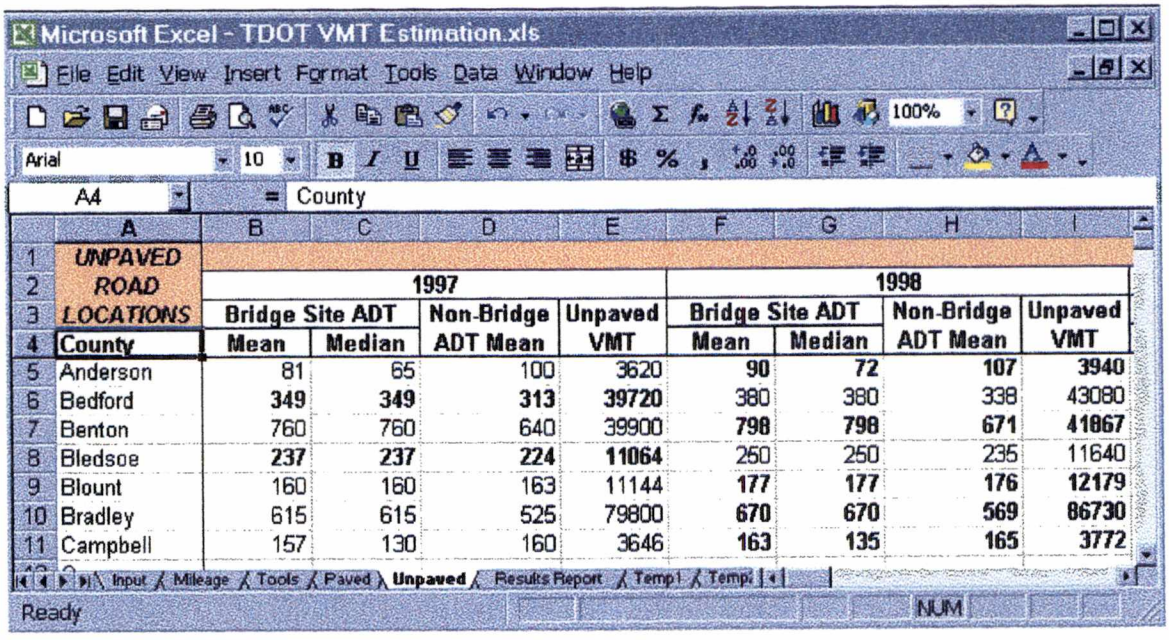
A4 = County

	A	B	C	D	E	F	G	H	I
1	PAVED ROAD								
2		1997				1998			
3	LOCATIONS	Bridge Site ADT		Non-Bridge	Paved	Bridge Site ADT		Non-Bridge	Paved
4	County	Mean	Median	ADT Mean	VMT	Mean	Median	ADT Mean	VMT
5	Anderson	642	465	808	232725	**719**	**520**	**905**	**260652**
6	Bedford	**666**	**846**	**527**	**292285**	724	920	573	317765
7	Benton	1100	580	872	562020	**1155**	**609**	**916**	**590235**
8	Bledsoe	**376**	**361**	**296**	**117600**	396	380	312	123900
9	Blount	1667	1370	2208	1034625	**1850**	**1520**	**2451**	**1148367**
10	Bradley	1510	1860	1198	1042580	**1645**	**2027**	**1306**	**1136135**
11	Campbell	759	360	601	197200	**789**	**374**	**624**	**204885**

Input / Mileage / Tools / Paved / Unpaved / Results Report / Temp1 / Temp

Ready NUM

Figure 8: Spreadsheet page where the calculations for ADT and VMT occur for paved roads in each county.



Microsoft Excel - TDOT VMT Estimation.xls

File Edit View Insert Format Tools Data Window Help

Arial 10 B I U 100%

A4 = County

	A	B	C	D	E	F	G	H	I
1	UNPAVED ROAD								
2		1997				1998			
3	LOCATIONS	Bridge Site ADT		Non-Bridge	Unpaved	Bridge Site ADT		Non-Bridge	Unpaved
4	County	Mean	Median	ADT Mean	VMT	Mean	Median	ADT Mean	VMT
5	Anderson	81	65	100	3620	**90**	**72**	**107**	**3940**
6	Bedford	**349**	**349**	**313**	**39720**	380	380	338	43080
7	Benton	760	760	640	39900	**798**	**798**	**671**	**41867**
8	Bledsoe	**237**	**237**	**224**	**11064**	250	250	235	11640
9	Blount	160	160	163	11144	**177**	**177**	**176**	**12179**
10	Bradley	615	615	525	79800	**670**	**670**	**569**	**86730**
11	Campbell	157	130	160	3646	**163**	**135**	**165**	**3772**

Input / Mileage / Tools / Paved / Unpaved / Results Report / Temp1 / Temp

Ready NUM

Figure 9: Spreadsheet page where the calculations of ADT and VMT occur for unpaved roads in each county.

Screen for Results Report

This page (see Figure 10) displays the results of the program's calculations of each county's average ADT and the estimate of county VMT on rural local roads. For years after 1997, the percent changes in VMT and ADT from the previous year is calculated. When a specific year's data is printed, this page displays exactly what will be printed when the program's "Print Year Report" button is clicked. This feature will be discussed later in the section "Tools Screen".

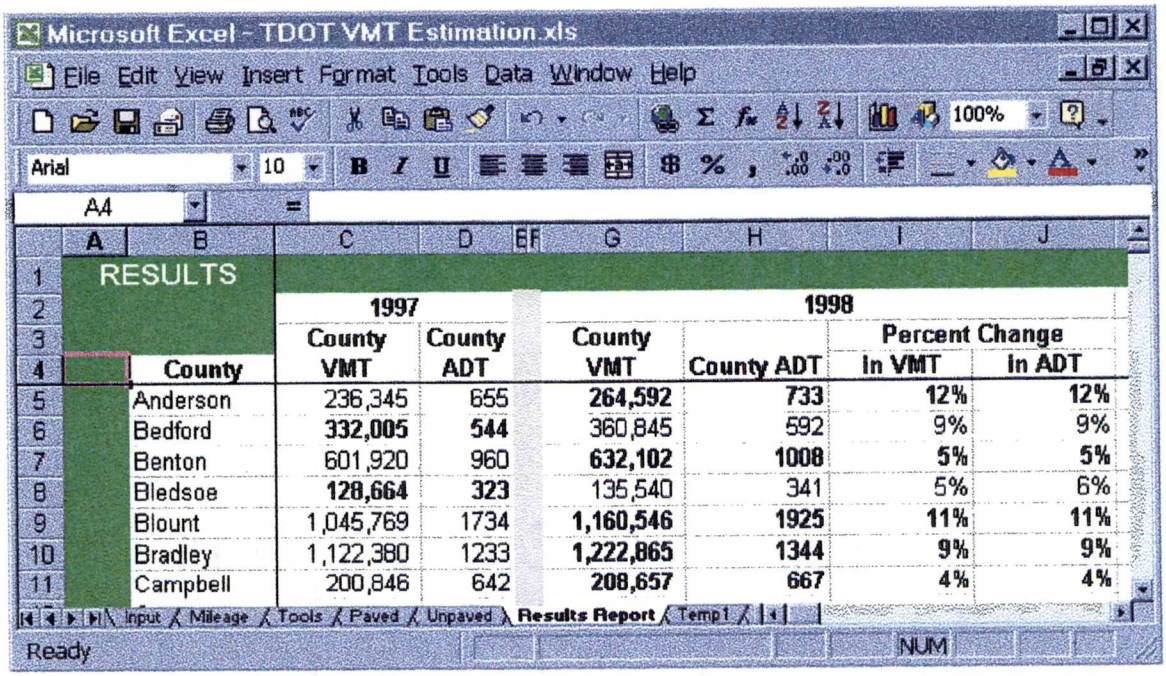


Figure 10: Page where the results of the spreadsheet calculations are shown.

Temp1 and Temp2 Screens

These screens are temporary storage locations for data when the program processes the bridge count information for each county. The user will not need to input any information on these pages and will not see any data appear on these pages.

Tools Screen

This screen (shown in Figure 11) is where the program's control features are housed. There are three control buttons located on this page and each is discussed below.

Process New Data

This control button begins the program's process of separating counts on unpaved and non-local roadtypes and of calculating mean ADT and median ADT values for bridge locations within a county, for both paved and unpaved roadtypes. The means and medians are then transferred to the appropriate page, "Paved" or "Unpaved". After clicking this button, the user will be asked which year of data the program should begin processing. The default year is 1997; if earlier years are entered, the program will not process any data.

Estimate Uncollected Data

Due to the lengthy process of collecting traffic counts at bridge locations across Tennessee, only about one-third of the 95 counties will be collected each year. In order to obtain statewide totals for each year, VMT and ADT information from counties that were not collected in a

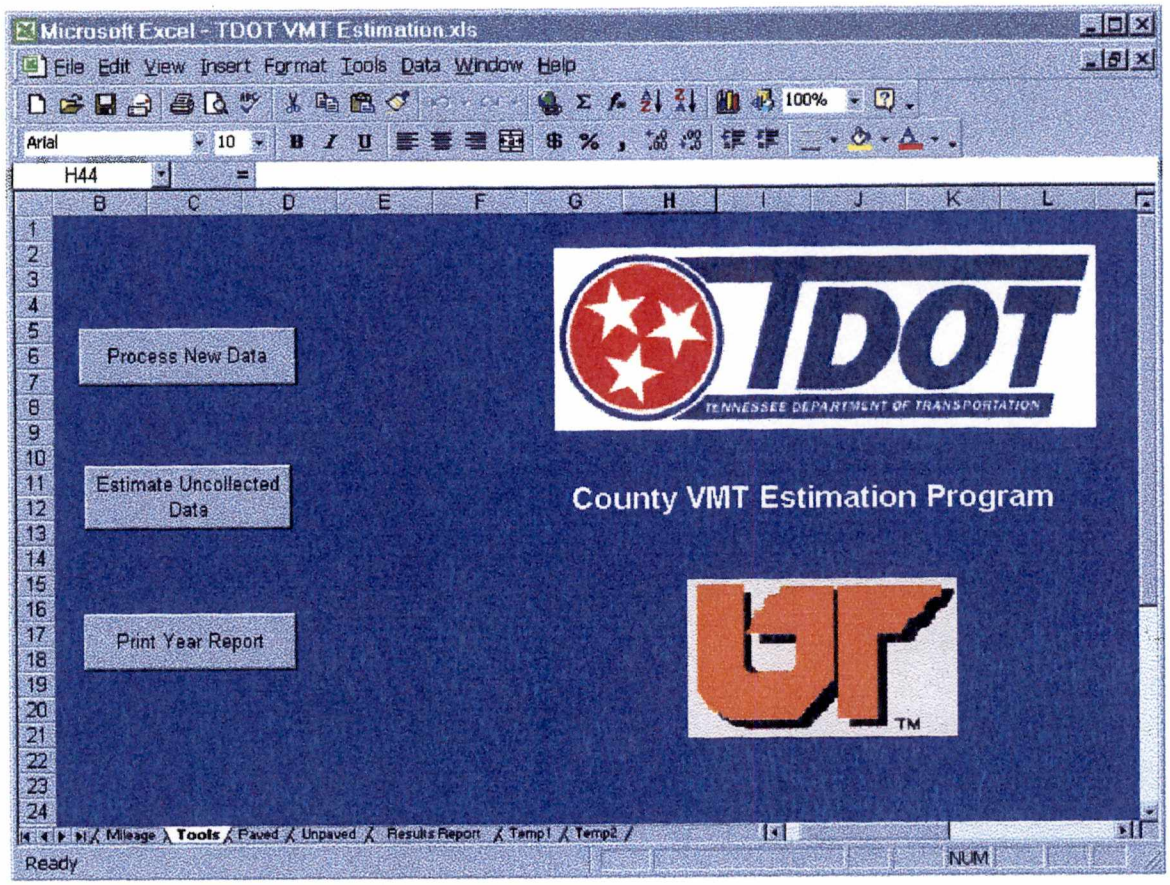


Figure 11: The Tools Screen where the control buttons are located for operating the program.

particular year must be estimated. This control button allows the user to estimate a county's VMT and average ADT from previous data. Once this button is clicked, the user is prompted for the year to estimate, the county to estimate, and the growth factor to use in the estimation. The growth factor must be input as a decimal. For example, an 8% growth factor would be entered as 0.08. Data must be present in the input page for the year 1998 to estimate count information for 1997. For example, if counts were not taken in Blount County in 1997, but were

taken in 1998, the 1997 data could be estimated from the 1998 data using a decay factor. All other years use the previous year to estimate new data with the growth factor. All estimated data will be displayed in **bold** type to distinguish from collected data.

Print Year Report

This control button allows the user to print out a copy of a particular year's data. The report is based on the information on the Results Report screen. A sample report is included at the end of these instructions.

The programming used in the Microsoft Excel spreadsheet was written in Visual Basic and is shown in Appendix F.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The scope of this study was to develop a methodology for estimating traffic volumes on rural local roads in Tennessee. Currently, the Federal Highway Administration has placed the responsibility on state DOTs to develop procedures for gathering this data. With each state having limited resources, the DOTs are looking for cost-effective means of gathering or estimating these traffic volumes, which are very important in accident analyses, air quality estimates, and many other highway statistics.

One of the goals of this study was to provide a cost-effective solution, but also to provide a practical solution. A very sophisticated model is of no use if it is too cumbersome to be easily implemented. The methodology proposed in the study utilized existing traffic count information from TDOT's bridge count program and eliminated the need for volume counts at non-bridge locations. The models developed in the study were also practical in the sense that very common and easily attainable variables were used. These included average and median ADT, road surface type, and the county's proximity to metropolitan areas To increase the practicality and attractiveness of the research, the models were automated in a Microsoft Excel spreadsheet program. This program stores bridge count data, calculates mean and median ADTs for bridge locations, estimates non-bridge ADT mean, and finally estimates county ADT and VMT.

This study was focused on Tennessee data, but does exhibit promise for adaptation to other states especially those where a volume count program at bridge

locations exists. The repeated systematic sampling procedure used for obtaining the non-bridge traffic count locations can generate sample data sets for analyses in other states. It stands to reason that data from other states would exhibit skewness and non-normality similar to the data in Tennessee. In this situation bootstrapping lends itself well to evaluating statistical characteristics of traffic data from other states. The variables examined in developing the model equations are also good candidates for evaluation in other states, however, other important variables may be introduced based on the judgment of the analyst.

The stability of the predictive equations over time is not known. As urban areas increase their push into previously rural locations in the next few years, traffic patterns and road characteristics will change. Therefore, it will become necessary to revisit the models and evaluate their validity with future data. Small adjustments may need to be made to the model equation coefficients or new variables introduced to predict ADT on the rural local roads. In the interest of expediency, the same eight counties and count locations could be evaluated. However, introducing new counties into the study would help to verify the model's predictive value.

With the results of this study, the Tennessee Department of Transportation now has a procedure to generate important estimates of traffic volumes and VMT on the vast network of rural local roads The estimates can aid TDOT and local agencies in evaluating accident rates and many other planning activities such as air pollution emission estimation. Better, that is, more reliable estimates can directly affect the allocation of limited highway dollars to the improvement of safety on local roads.

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REFERENCES

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APPENDICES

APPENDIX A

DESCRIPTIVE STATISTICS REPORT FOR COUNTS AT BRIDGE LOCATIONS

NCSS Descriptive Statistics Report

Filter filter="B" (Bridge Locations Only)

Summary Section of newADT

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
108	354 2592	864 6638	83 20231	10	8340	8330

Counts Section of newADT

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
258	108	0	49	38260	9 35518E+07	7 999784E+07

Means Section of newADT

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	354 2592	140	136 1343	59 50407	38260	
Std Error	83.20231				8985.849	
95% LCL	189 3204	100			20446 6	
95% UCL	519 1981	170			56073 4	
T-Value	4 2578					
Prob Level	0.000044					
Count	108		108	108		

Variation Section of newADT

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	747643 4	864 6638	866.6863	83 20231	282 5	8330
Std Error	593009 2	484.9525		46 66457		
95% LCL	581731.8	762 7134		73.39214		
95% UCL	996649 4	998 3233		96 06371		

Skewness and Kurtosis Section of newADT

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	7 563461	68 94501	7 670408	69.16071	2 440765	2 089947
Std Error	1 967614	44 14871			0 4989637	

Trimmed Section of newADT

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	233.0453	198 9583	174 7354	149.2593	141 9136	142 7778
Trim-Std Dev	258 7829	182 4555	129 0928	67 26046	35 68321	11 67881
Count	97 2	86 4	75 6	54	32 4	10 8

Mean-Deviation Section of newADT

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	367 7641	292 5926	740720 8	4 821724E+09	3 782787E+13
Std Error	50 1264		587518 3	4 527804E+09	3 60529E+13

NCSS Descriptive Statistics Report

Filter filter="B" (Bridge Locations Only)

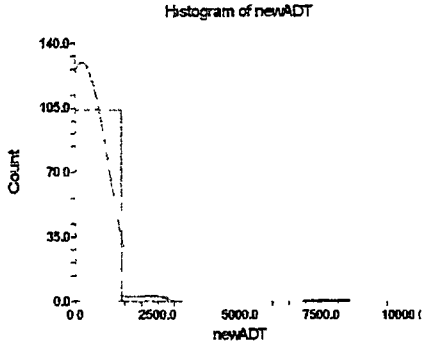
Quartile Section of newADT

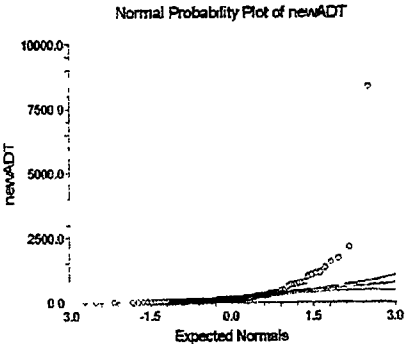
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	20	50	140	332 5	783
95% LCL	10	40	100	210	520
95% UCL	40	80	170	510	1340

Normality Test Section of newADT

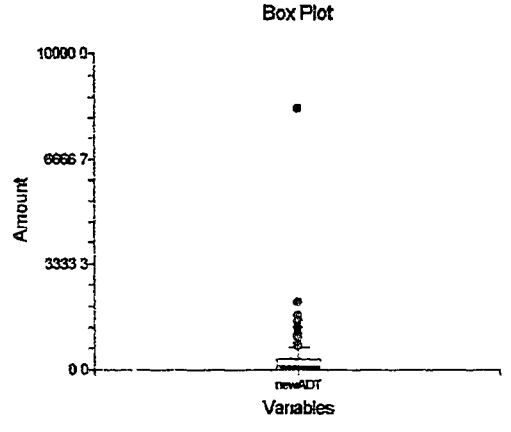
Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0 3351641	0 000000			Reject Normality
Anderson-Darling	20 20212	0 000000			Reject Normality
Martinez-Iglewicz	31 50632		1 04778	1 074535	Reject Normality
Kolmogorov-Smirnov	0 3360034		0 078	0 085	Reject Normality
D'Agostino Skewness	11 4391	0 000000	1 645	1 960	Reject Normality
D'Agostino Kurtosis	8 1144	0 000000	1 645	1 960	Reject Normality
D'Agostino Omnibus	196 6971	0 000000	4 605	5 991	Reject Normality

Plots Section of newADT

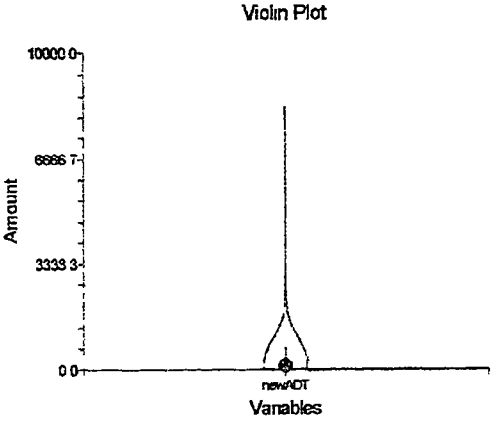




Box Plot Section



Violin Plot Section



APPENDIX B

DESCRIPTIVE STATISTICS REPORT FOR COUNTS AT NON-BRIDGE LOCATIONS

NCSS Descriptive Statistics Report

Filter filter="NB" (Non-Bndge Locations Only)

Summary Section of newADT

Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
146	349 6028	604 4174	50 02193	10	5140	5130

Counts Section of newADT

Rows	Sum of Frequencies	Missing Values	Distinct Values	Sum	Total Sum Squares	Adjusted Sum Squares
258	146	4	109	51042	7 081587E+07	5 297145E+07

Means Section of newADT

Parameter	Mean	Median	Geometric Mean	Harmonic Mean	Sum	Mode
Value	349 6028	167	156 4497	64 8884	51042	10
Std Error	50 02193				7303 203	
95% LCL	250 7364	126			36607 52	
95% UCL	448 4691	244			65476 48	
T-Value	6.9890					
Prob Level	0 000000					
Count	146		146	146		7

Variation Section of newADT

Parameter	Variance	Standard Deviation	Unbiased Std Dev	Std Error of Mean	Interquartile Range	Range
Value	365320 3	604 4174	605 4603	50 02193	359 75	5130
Std Error	183633 1	214 832		17 77962		
95% LCL	293911 7	542 1362		44 86752		
95% UCL	466479 8	682 9933		56 52493		

Skewness and Kurtosis Section of newADT

Parameter	Skewness	Kurtosis	Fisher's g1	Fisher's g2	Coefficient of Variation	Coefficient of Dispersion
Value	5 315406	37 88985	5 370743	36 15711	1 728869	1 674022
Std Error	0 772395	13 50599			0.2491794	

Trimmed Section of newADT

Parameter	5% Trimmed	10% Trimmed	15% Trimmed	25% Trimmed	35% Trimmed	45% Trimmed
Trim-Mean	261 3272	236 0976	220 0323	199 1096	184.9452	172 8904
Tnm-Std Dev	243 4574	188 5876	153 5953	106 0963	66 85024	25 98476
Count	131 4	116.8	102 2	73	43 8	14 6

Mean-Deviation Section of newADT

Parameter	|X-Mean|	|X-Median|	(X-Mean)^2	(X-Mean)^3	(X-Mean)^4
Average	313 0777	279 5616	362818 1	1 161636E+09	4 987706E+12
Std Error	30.14093		182375 3	7 7895E+08	3 619974E+12

NCSS Descriptive Statistics Report

Filter filter="NB" (Non-Bridge Locations Only)

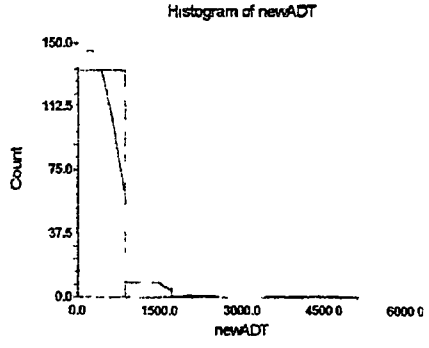
Quartile Section of newADT

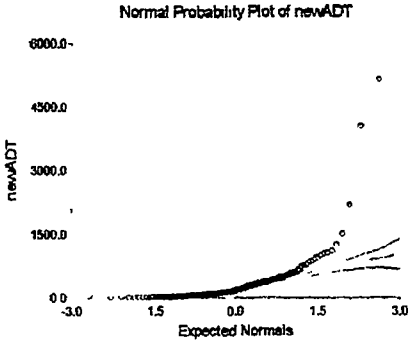
Parameter	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Value	22 4	60	167	419 75	789
95% LCL	10	40	126	339	570
95% UCL	40	85	244	515	1040

Normality Test Section of newADT

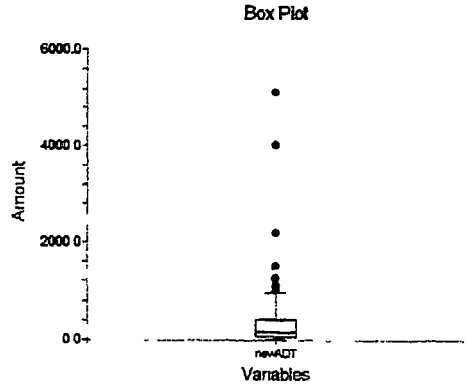
Test Name	Test Value	Prob Level	10% Critical Value	5% Critical Value	Decision (5%)
Shapiro-Wilk W	0 4873042	0 000000			Reject Normality
Anderson-Darling	18 69584	0 000000			Reject Normality
Martinez-Iglewicz	7 529118		1 036435	1 057391	Reject Normality
Kolmogorov-Smirnov	0 2802537		0 067	0.073	Reject Normality
D'Agostino Skewness	11 3334	0 000000	1 645	1 960	Reject Normality
D'Agostino Kurtosis	8 1227	0 000000	1 645	1 960	Reject Normality
D'Agostino Omnibus	194 4251	0 000000	4 605	5 991	Reject Normality

Plots Section of newADT

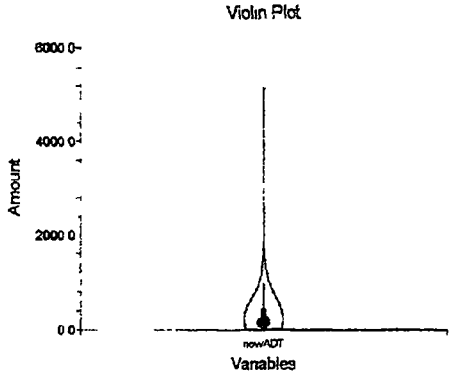




Box Plot Section



Violin Plot Section



APPENDIX C

TWO-SAMPLE T-TEST ON BRIDGE AND NON-BRIDGE SAMPLES FOR EACH COUNTY

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Anderson"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	10	289	261 8078	82.7909	101 714	476 286
filter=NB	22	441 5909	365 6854	77 96438	279 4551	603 7267

Note T-alpha (filter=B) = 2 2622, T-alpha (filter=NB) = 2 0796

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	30	-152 5909	337 8921	128 867	-415 7724	110.5906
Unequal	23 96	-152 5909	449 7434	113 7224	-387 3212	82.13939

Note T-alpha (Equal) = 2 0423, T-alpha (Unequal) = 2 0641

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.1841	0 245672	Accept Ho	0 208899	0.072838
Difference < 0	-1.1841	0 122836	Accept Ho	0 312970	0.116073
Difference > 0	-1 1841	0 877164	Accept Ho	0 002533	0 000271

Difference: (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1 3418	0 192243	Accept Ho	0 251487	0.092722
Difference < 0	-1 3418	0 096121	Accept Ho	0 366555	0.144789
Difference > 0	-1 3418	0 903879	Accept Ho	0 001590	0.000161

Difference: (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	1 1186	0 263318	Cannot reject normality
Kurtosis Normality (filter=B)	-0 5991	0 549101	Cannot reject normality
Omnibus Normality (filter=B)	1 6102	0 447053	Cannot reject normality
Skewness Normality (filter=NB)	1 7939	0 072824	Cannot reject normality
Kurtosis Normality (filter=NB)	-0 0245	0 980471	Cannot reject normality
Omnibus Normality (filter=NB)	3 2188	0.200008	Cannot reject normality
Variance-Ratio Equal-Variance Test	1 9510	0.250428	Cannot reject equal variances
Modified-Levene Equal-Variance Test	0 6602	0 422896	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Anderson"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	79.5	134 5	165	24 59463
filter=NB	140 5	393 5	363	24 59463

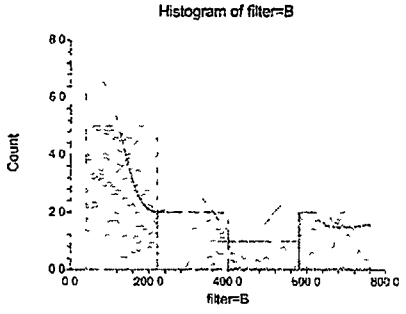
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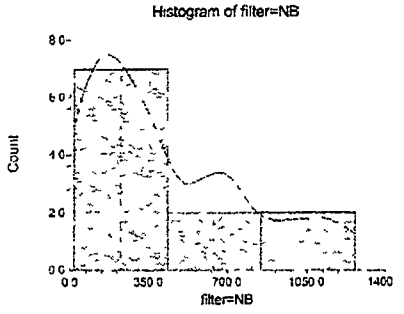
	Exact Probability		Approximation Without Correction				Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			-1 2401	0 214935	Accept Ho	1 2198	0 222549	Accept Ho
Diff<0			-1 2401	0 107468	Accept Ho	-1 2198	0 111274	Accept Ho
Diff>0			-1 2401	0 892532	Accept Ho	-1 2604	0 896244	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 263636	0 4858	050	Accept Ho	0 6387
D(1)<D(2)	0 263636	0 4858	025	Accept Ho	
D(1)>D(2)	0 045455	0 4858	025	Accept Ho	

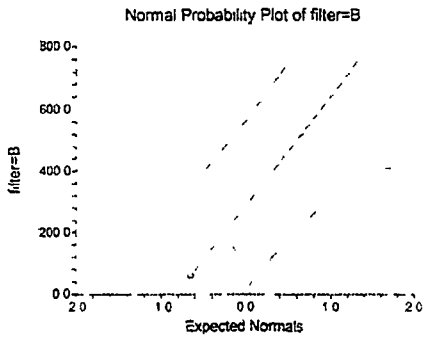
Plots Section

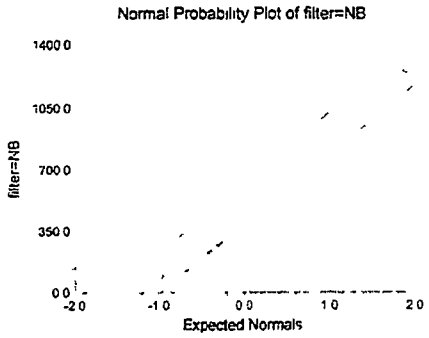


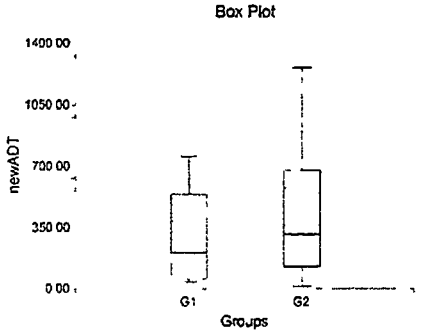


Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Anderson"
Variable	newADT







Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Bradley"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	12	1202 5	2320.67	669 9199	-271.9837	2676.984
filter=NB	18	740	1222 1	288 0518	132 2638	1347 736

Note T-alpha (filter=B) = 2 2010, T-alpha (filter=NB) = 2 1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	28	462 5	1738 54	647 9157	-864 6952	1789 695
Unequal	15 11	462 5	2622 792	729 2232	-1090 824	2015 824

Note T-alpha (Equal) = 2 0484, T-alpha (Unequal) = 2 1301

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0 7138	0 481242	Accept Ho	0 106009	0 029098
Difference < 0	0 7138	0 759379	Accept Ho	0 009597	0 001319
Difference > 0	0 7138	0 240621	Accept Ho	0 171517	0 049857

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	0 6342	0 535412	Accept Ho	0 091417	0 023195
Difference < 0	0 6342	0 732294	Accept Ho	0 012172	0 001819
Difference > 0	0 6342	0 267706	Accept Ho	0 149475	0.040372

Difference: (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	4 0307	0 000056	Reject normality
Kurtosis Normality (filter=B)	3 6105	0 000306	Reject normality
Omnibus Normality (filter=B)	29 2824	0 000000	Reject normality
Skewness Normality (filter=NB)	4 3604	0 000013	Reject normality
Kurtosis Normality (filter=NB)	3 8205	0 000133	Reject normality
Omnibus Normality (filter=NB)	33 6095	0 000000	Reject normality
Variance-Ratio Equal-Variance Test	3 6059	0 026563	Reject equal variances
Modified-Levene Equal-Variance Test	0 4156	0 524376	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Bradley"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	127	205	186	23 61219
filter=NB	89	260	279	23 61219

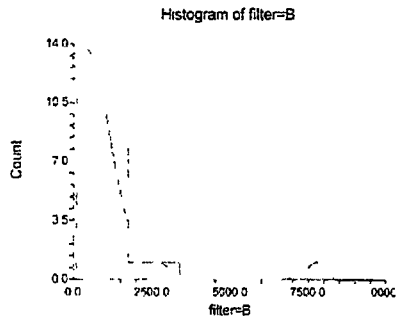
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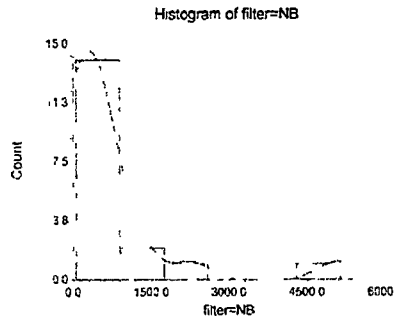
	Exact Probability		Approximation Without Correction				Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			0 8047	0 421011	Accept Ho	0 7835	0 433337	Accept Ho
Diff<0			0 8047	0 789495	Accept Ho	0 8258	0 795554	Accept Ho
Diff>0			0 8047	0 210505	Accept Ho	0 7835	0 216669	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 250000	0 4758	050	Accept Ho	0 7057
D(1)<D(2)	0 027778	0 4758	025	Accept Ho	
D(1)>D(2)	0 250000	0 4758	025	Accept Ho	

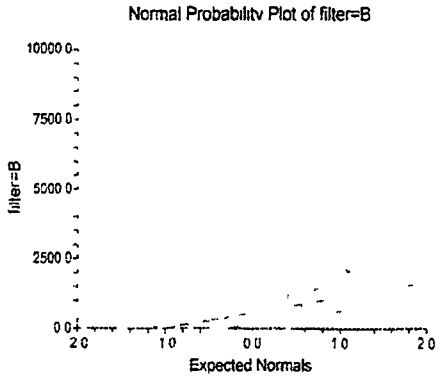
Plots Section

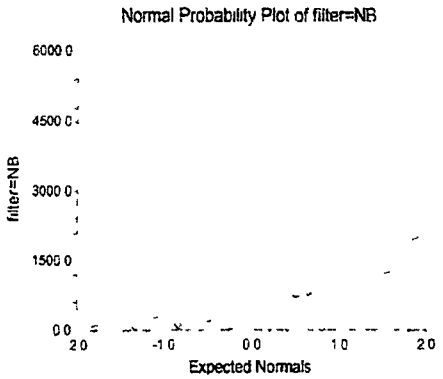


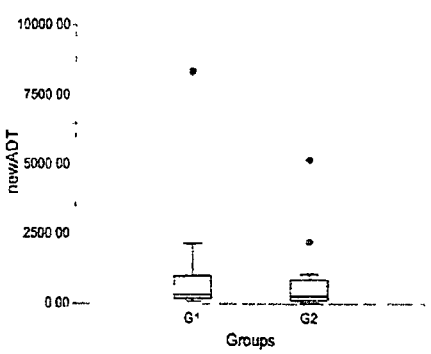


Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Bradley"
Variable	newADT







Two-Sample Test Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Carroll"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	10	101	74 1545	23 44971	47 95307	154 0469
filter=NB	13	106 1538	169 388	46 97979	3.793679	208.514

Note T-alpna (filter=B) = 2 2622, T-alpha (filter=NB) = 2 1788

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	21	-5 153846	136 9389	57 59956	-124 9387	114 631
Unequal	17 29	-5 153846	184 9086	52 50704	-115 7912	105 4835

Note T-alpha (Equal) = 2 0796, T-alpha (Unequal) = 2 1071

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0 0895	0 929551	Accept Ho	0 050837	0 010255
Difference < 0	-0 0895	0 464775	Accept Ho	0 059591	0 012468
Difference > 0	-0 0895	0 535225	Accept Ho	0.041682	0 007969

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0 0982	0 922938	Accept Ho	0 050988	0 010298
Difference < 0	-0 0982	0 461469	Accept Ho	0 060515	0 012692
Difference > 0	-0 0982	0 538531	Accept Ho	0 040995	0.007819

Difference (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	0 1863	0 852219	Cannot reject normality
Kurtosis Normality (filter=B)	-1 9646	0 049457	Reject normality
Omnibus Normality (filter=B)	3 8945	0 142666	Cannot reject normality
Skewness Normality (filter=NB)	2 9437	0 003243	Reject normality
Kurtosis Normality (filter=NB)	1 9783	0 047899	Reject normality
Omnibus Normality (filter=NB)	12 5790	0 001856	Reject normality
Variance-Ratio Equal-Variance Test	5 2178	0 014254	Reject equal variances
Modified-Levene Equal-Variance Test	0 2923	0 594419	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Carroll"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	85 5	140 5	120	15 89281
filter=NB	44 5	135 5	156	15 89281

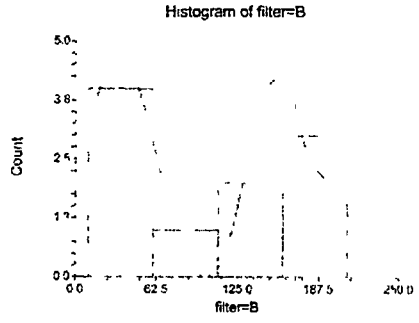
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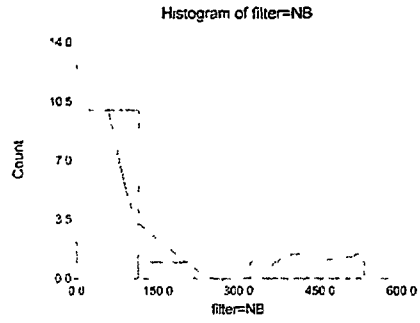
	Exact Probability		Approximation Without Correction				Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			1 2899	0 197088	Accept Ho	1 2584	0 208236	Accept Ho
Diff<0			1 2899	0 901456	Accept Ho	1 3214	0 906808	Accept Ho
Diff>0			1 2899	0 098544	Accept Ho	1 2584	0 104118	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 361538	0 5321	050	Accept Ho	0 3612
D(1)<D(2)	0 153846	0.5321	025	Accept Ho	
D(1)>D(2)	0 361538	0 5321	025	Accept Ho	

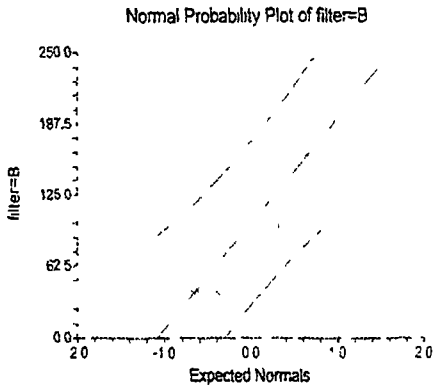
Plots Section

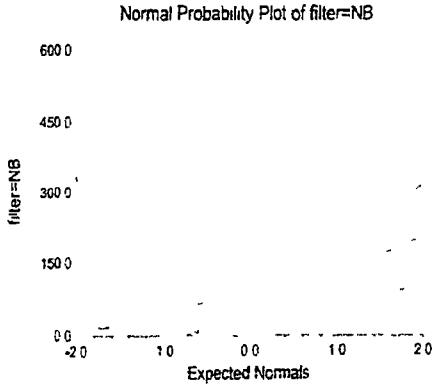


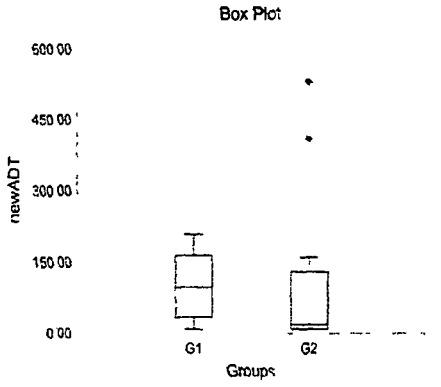


Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Carroll"
Variable	newADT







Two-Sample Test Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Cheatham"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	10	655	583 3095	184 4587	237 7255	1072 275
filter=NB	14	426.2857	370 4796	99 01484	212 3772	640 1943

Note T-alpha (filter=B) = 2 2622, T-alpha (filter=NB) = 2 1604

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	22	228 7143	469 3596	194 3334	-174 3084	631 737
Unequal	14 12	228 7143	691 0175	209 3536	-219 9409	677 3694

Note T-alpha (Equal) = 2 0739, T-alpha (Unequal) = 2 1430

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 1769	0 251806	Accept Ho	0 203161	0 068904
Difference < 0	1 1769	0 874097	Accept Ho	0 002663	0 000296
Difference > 0	1 1769	0 125903	Accept Ho	0 307097	0 111179

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 0925	0 292910	Accept Ho	0 174908	0 054434
Difference < 0	1 0925	0 853545	Accept Ho	0 003601	0 000444
Difference > 0	1 0925	0 146455	Accept Ho	0 272751	0 090986

Difference (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	0 5017	0 615902	Cannot reject normality
Kurtosis Normality (filter=B)	-1 8341	0 066632	Cannot reject normality
Omnibus Normality (filter=B)	3 6158	0 164000	Cannot reject normality
Skewness Normality (filter=NB)	3 0769	0 002091	Reject normality
Kurtosis Normality (filter=NB)	2 8632	0 004194	Reject normality
Omnibus Normality (filter=NB)	17 6654	0 000146	Reject normality
Variance-Ratio Equal-Variance Test	2 4790	0 155244	Cannot reject equal variances
Modified-Levene Equal-Variance Test	6 4750	0 018471	Reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Cheatham"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	79	134	125	17 07825
filter=NB	61	166	175	17 07825

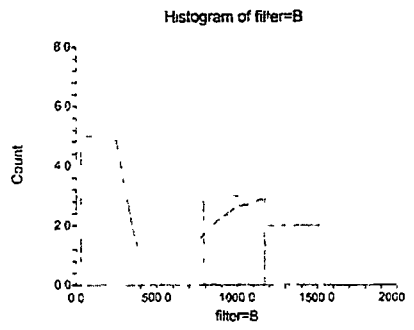
Number Sets of Ties = 0, Multiplicity Factor = 0

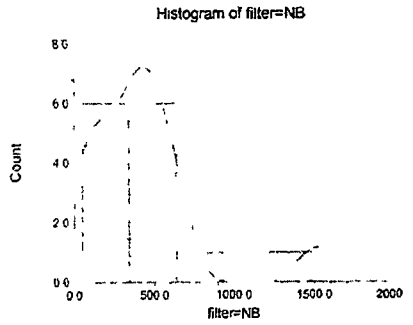
	Exact Probability		Approximation Without Correction			Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0	0 625096	Accept Ho	0 5270	0 598203	Accept Ho	0 4977	0 618689	Accept Ho
Diff<0	0 687452	Accept Ho	0 5270	0 700898	Accept Ho	0 5563	0 710984	Accept Ho
Diff>0	0 312548	Accept Ho	0 5270	0 299102	Accept Ho	0 4977	0 309345	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 428571	0 5245	050	Accept Ho	0 1797
D(1)<D(2)	0 214286	0 5245	025	Accept Ho	
D(1)>D(2)	0 428571	0 5245	025	Accept Ho	

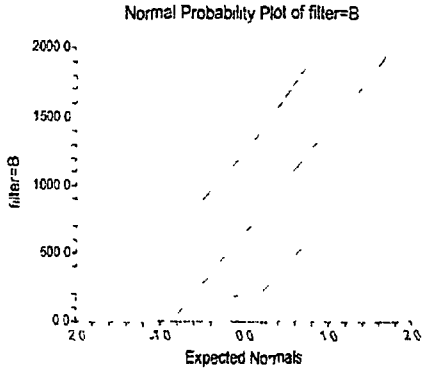
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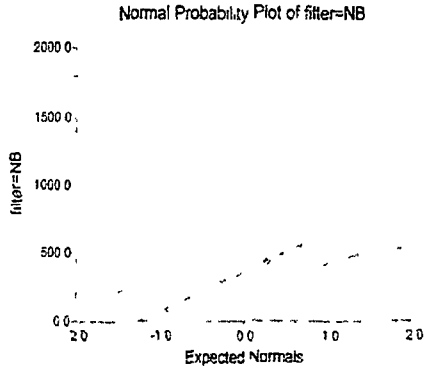


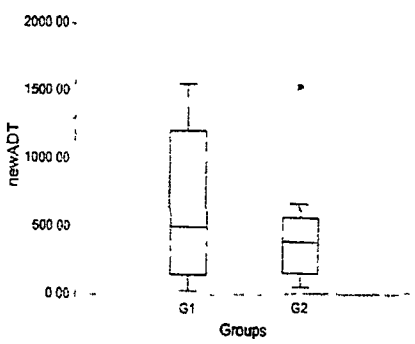


Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Cheatham"
Variable	newADT







Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Clay"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	8	62 5	86 31339	30 51639	-9 659794	134 6598
filter=NB	18	445 5555	925 693	218 1879	-14.78075	905 8918

Note T-alpha (filter=B) = 2 3646, T-alpha (filter=NB) = 2 1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	24	-383 0555	780 48	331 6403	-1067 527	301 4163
Unequal	17 66	-383 0555	929 7083	220 3117	-846 562	80 45087

Note T-alpha (Equal) = 2 0639, T-alpha (Unequal) = 2 1039

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1 1550	0 259448	Accept Ho	0 198520	0 067148
Difference < 0	-1 1550	0 129724	Accept Ho	0 300714	0 108386
Difference > 0	-1 1550	0 870276	Accept Ho	0 002818	0 000313

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1 7387	0 099495	Accept Ho	0 376283	0 159624
Difference < 0	-1 7387	0 049747	Reject Ho	0 510668	0 236136
Difference > 0	-1 7387	0 950253	Accept Ho	0 000450	0 000040

Difference (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	3 2268	0 001252	Reject normality
Kurtosis Normality (filter=B)	2 8899	0 003853	Reject normality
Omnibus Normality (filter=B)	18 7641	0 000084	Reject normality
Skewness Normality (filter=NB)	4 9183	0 000001	Reject normality
Kurtosis Normality (filter=NB)	4 3216	0 000015	Reject normality
Omnibus Normality (filter=NB)	42 8664	0 000000	Reject normality
Variance-Ratio Equal-Variance Test	115 0211	0 000001	Reject equal variances
Modified-Levene Equal-Variance Test	0 9866	0 330481	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Clay"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	29	65	108	17 99715
filter=NB	115	286	243	17 99715

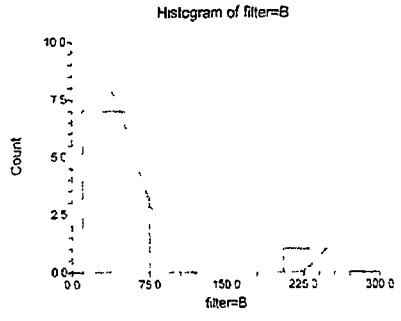
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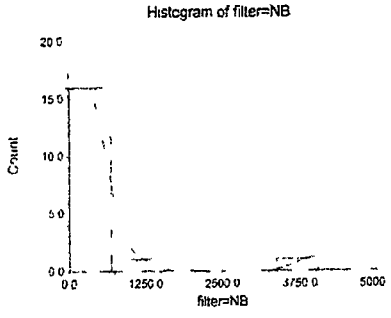
Alternative Hypothesis	Exact Probability Prob Level	Exact Probability Decision (5%)	Approximation Without Correction Z-Value	Approximation Without Correction Prob Level	Approximation Without Correction Decision (5%)	Approximation With Correcti Z-Value	Approximation With Correcti Prob Level	Approximation With Correcti Decision (5%)
Diff<>0			-2 3893	0 016882	Reject Ho	2 3615	0 018202	Reject Ho
Diff<0			-2 3893	0 008441	Reject Ho	-2 3615	0 009101	Reject Ho
Diff>0			-2 3893	0 991559	Accept Ho	-2 4170	0 992177	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 597222	0 5368	050	Reject Ho	0 0235
D(1)<D(2)	0 597222	0 5368	025	Reject Ho	
D(1)>D(2)	0 000000	0 5368	025	Accept Ho	

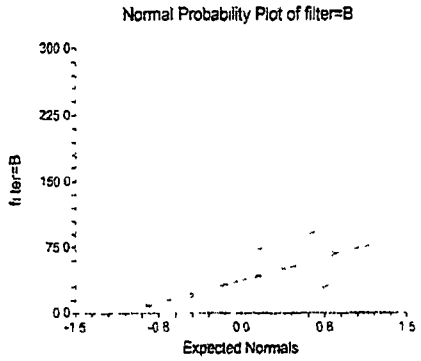
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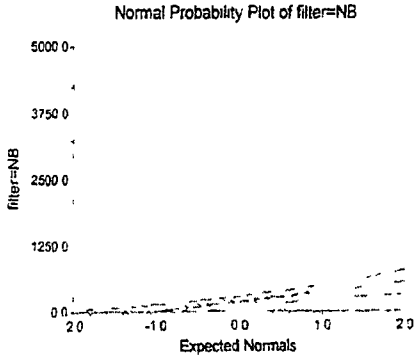


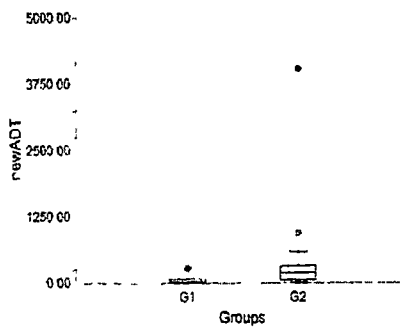


Two-Sample Test Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Clay"
Variable	newADT







Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2.S0
Filter	county = "Cocke"
Variable	newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	9	314 4445	369.2936	123 0979	30 58024	598 3087
filter=NB	12	169 1667	163.0649	47 07277	65 56019	272 7731

Note: T-alpha (filter=B) = 2.3060, T-alpha (filter=NB) = 2 2010

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	19	145 2778	269 8454	118 9906	-103.7725	394 328
Unequal	10 35	145 2778	403 6929	131 7912	-147 0317	437 5872

Note: T-alpha (Equal) = 2.0930, T-alpha (Unequal) = 2 2180

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 2209	0 237052	Accept Ho	0 212713	0 072562
Difference < 0	1 2209	0 881474	Accept Ho	0.002373	0 000264
Difference > 0	1 2209	0 118526	Accept Ho	0.320113	0 116967

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 1023	0.295290	Accept Ho	0 170683	0 050983
Difference < 0	1 1023	0 852355	Accept Ho	0 003686	0 000480
Difference > 0	1 1023	0 147645	Accept Ho	0 269563	0 086806

Difference. (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	2 4543	0 014115	Reject normality
Kurtosis Normality (filter=B)	1 6760	0 093737	Cannot reject normality
Omnibus Normality (filter=B)	8 8327	0 012078	Reject normality
Skewness Normality (filter=NB)	2 4026	0 016279	Reject normality
Kurtosis Normality (filter=NB)	1 2825	0 199658	Cannot reject normality
Omnibus Normality (filter=NB)	7 4173	0 024510	Reject normality
Variance-Ratio Equal-Variance Test	5 1289	0 021613	Reject equal variances
Modified-Levene Equal-Variance Test	1 2593	0 275764	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Cocke"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	67 5	112 5	99	14 05462
filter=NB	40 5	118 5	132	14 05462

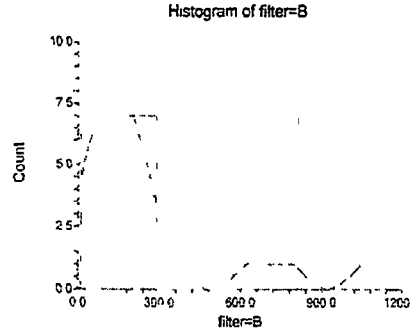
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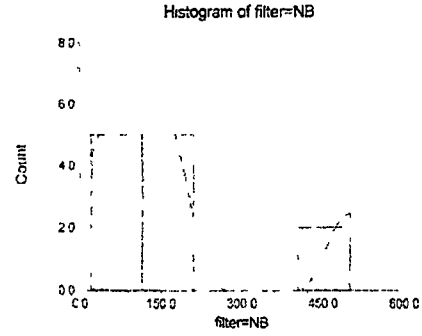
	Exact Probability		Approximation Without Correction				Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			0 9605	0 336785	Accept Ho	0 9250	0 354985	Accept Ho
Diff<0			0 9605	0 831608	Accept Ho	0 9961	0 840402	Accept Ho
Diff>0			0 9605	0 168392	Accept Ho	0 9250	0 177493	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 305556	0 5553	050	Accept Ho	0 6383
D(1)<D(2)	0 111111	0 5553	025	Accept Ho	
D(1)>D(2)	0 305556	0 5553	025	Accept Ho	

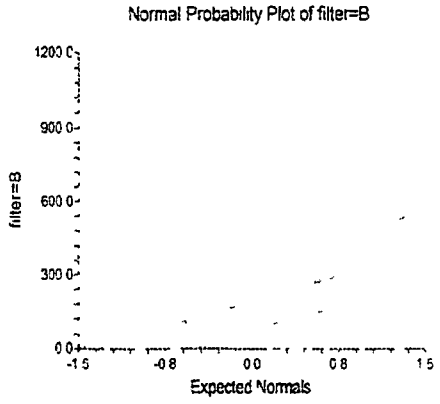
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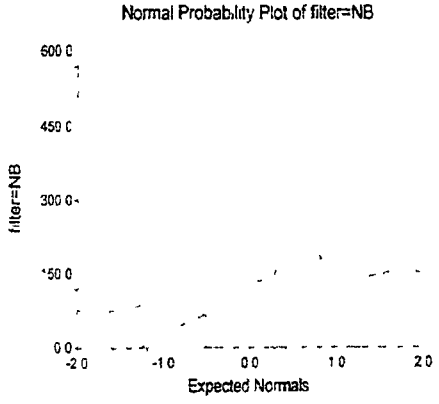


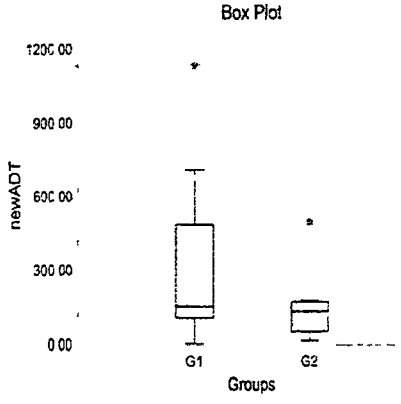


Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Cocke"
Variable	newADT







Two-Sample Test Report

Database C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter county = "Fayette"
Variable newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	27	113 3333	113 7474	21 89069	68 33638	158 3303
filter=NB	22	235 4545	214 4922	45 7299	140 354	330 5551

Note T-alpha (filter=B) = 2 0555, T-alpha (filter=NB) = 2 0796

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	47	-122 1212	166 4744	47.8137	-218 31	-25 93246
Unequal	30 44	-122 1212	242 7867	50 69937	-225 601	-18 64146

Note T-alpha (Equal) = 2.0117, T-alpha (Unequal) = 2 0410

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha= 05)	Power (Alpha=.01)
Difference <> 0	-2.5541	0 013948	Reject Ho	0 705979	0 455534
Difference < 0	-2 5541	0 006974	Reject Ho	0 808451	0 561243
Difference > 0	-2 5541	0 993026	Accept Ho	0 000016	0.000001

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2 4087	0 022261	Reject Ho	0 645161	0 382999
Difference < 0	-2 4087	0 011130	Reject Ho	0 761079	0 490155
Difference > 0	-2 4087	0 988870	Accept Ho	0 000031	0 000002

Difference (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	3 6689	0 000244	Reject normality
Kurtosis Normality (filter=B)	2 6948	0 007042	Reject normality
Omnibus Normality (filter=B)	20 7231	0 000032	Reject normality
Skewness Normality (filter=NB)	2 1137	0 034545	Reject normality
Kurtosis Normality (filter=NB)	0 9230	0 356021	Cannot reject normality
Omnibus Normality (filter=NB)	5 3194	0 069969	Cannot reject normality
Variance-Ratio Equal-Variance Test	3 5558	0 003426	Reject equal variances
Modified-Levene Equal-Variance Test	8 6059	0 005166	Reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Fayette"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	199	577	675	49 69574
filter=NB	395	648	550	49 69574

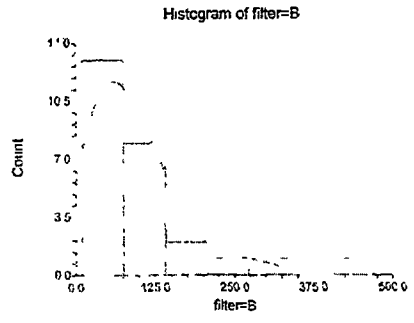
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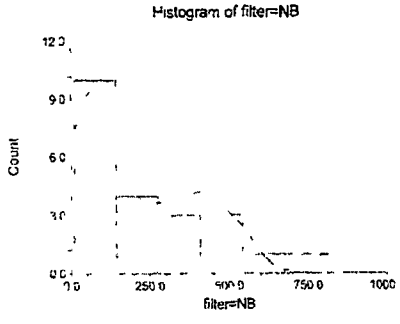
	Exact Probability		Approximation Without Correction				Approximation With Correcti	
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			1 9720	0 048610	Reject Ho	1 9619	0 049770	Reject Ho
Diff<0			1 9720	0 024305	Reject Ho	1 9619	0 024885	Reject Ho
Diff>0			1 9720	0 975695	Accept Ho	1 9821	0 976264	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 360269	0 3906	050	Accept Ho	0 0636
D(1)<D(2)	0 360269	0 3906	025	Accept Ho	
D(1)>D(2)	0 005051	0 3906	025	Accept Ho	

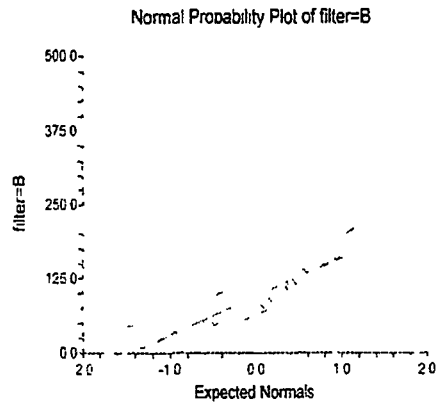
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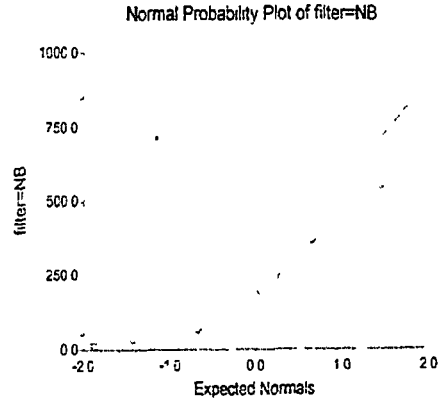


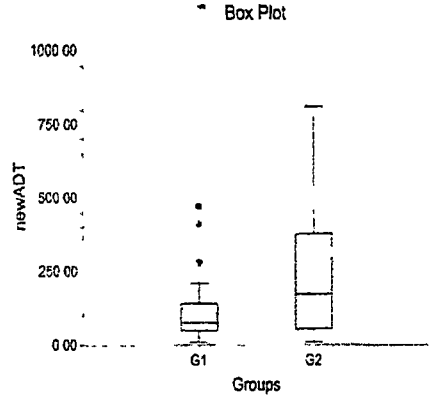


Two-Sample Test Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Fayette"
Variable	newADT







Two-Sample Test Report

Database C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter county = "Giles"
Variable newADT

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
filter=B	22	317 7273	380 137	81 04547	149 184	486 2706
filter=NB	27	201 0741	247 8731	47 7032	103 0187	299 1294

Note T-alpha (filter=B) = 2 0796, T-alpha (filter=NB) = 2 0555

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	47	116 6532	313 9337	90 16598	-64 73736	298 0438
Unequal	34 71	116 6532	453 8118	94 04235	-74 32061	307 627

Note T-alpha (Equal) = 2 0117, T-alpha (Unequal) = 2 0307

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 2938	0 202070	Accept Ho	0 244917	0 092296
Difference < 0	1 2938	0 898965	Accept Ho	0 001749	0 000169
Difference > 0	1 2938	0 101035	Accept Ho	0 355794	0 142419

Difference (filter=B)-(filter=NB)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1 2404	0 223136	Accept Ho	0 226288	0 081805
Difference < 0	1 2404	0 888432	Accept Ho	0 002108	0 000216
Difference > 0	1 2404	0 111568	Accept Ho	0 334106	0 128465

Difference (filter=B)-(filter=NB)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (filter=B)	4 1275	0 000037	Reject normality
Kurtosis Normality (filter=B)	3 6160	0 000299	Reject normality
Omnibus Normality (filter=B)	30 1119	0 000000	Reject normality
Skewness Normality (filter=NB)	3 6932	0 000221	Reject normality
Kurtosis Normality (filter=NB)	2 6389	0 008319	Reject normality
Omnibus Normality (filter=NB)	20 6031	0 000034	Reject normality
Variance-Ratio Equal-Variance Test	2 3519	0 044587	Reject equal variances
Modified-Levene Equal-Variance Test	0 9785	0 327631	Cannot reject equal variances

Two-Sample Test Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Giles"
Variable	newADT

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
filter=B	372	625	550	49 74084
filter=NB	222	600	675	49 74084

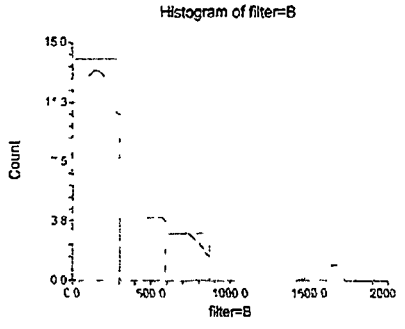
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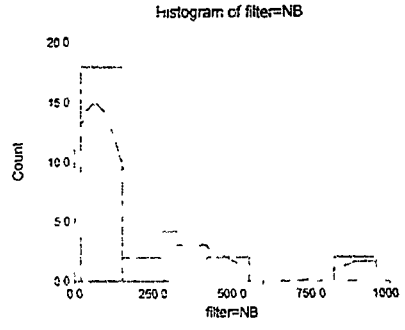
Alternative Hypothesis	Exact Probability Prob Level	Exact Probability Decision (5%)	Approximation Without Correction Z-Value	Approximation Without Correction Prob Level	Approximation Without Correction Decision (5%)	Approximation With Correction Z-Value	Approximation With Correction Prob Level	Approximation With Correction Decision (5%)
Diff<>0			1 5078	0 131602	Accept Ho	1 4978	0 134195	Accept Ho
Diff<0			1 5078	0 934199	Accept Ho	1 5179	0 935476	Accept Ho
Diff>0			1 5078	0 065801	Accept Ho	1 4978	0 067097	Accept Ho

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject Ho if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0 303030	0 3906	050	Accept Ho	0 1691
D(1)<D(2)	0 028620	0 3906	025	Accept Ho	
D(1)>D(2)	0 303030	0 3906	025	Accept Ho	

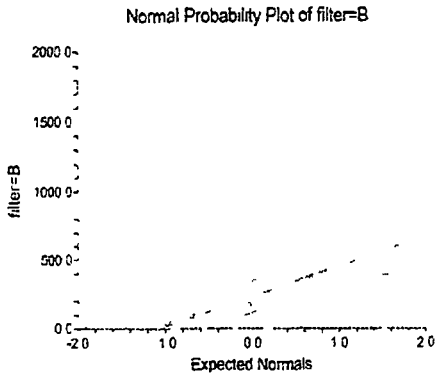
Plots Section

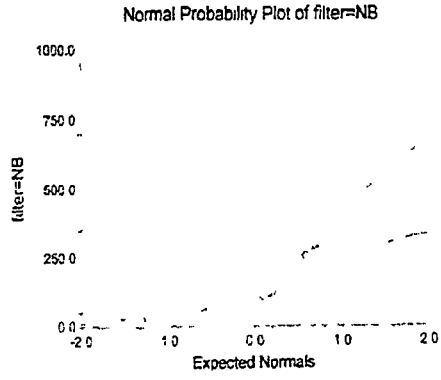


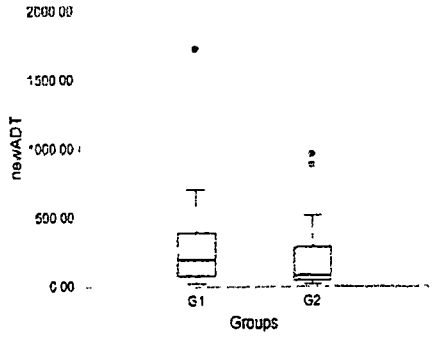


Two-Sample Test Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	county = "Giles"
Variable	newADT







APPENDIX D

SAMPLE OF THE DATABASE OF ADT INFORMATION GATHERED FROM BOTH BRIDGE AND NON-BRIDGE LOCATIONS

	county	utid	filter	msa	region	newloc	rdtypenev	newADT	Intersects	XIntercios	newyear	closeId	closeloc	closetype	closeadt
1	Cocke	B1	B	r	1	Middle Creek Rd	5	110	0	0	97	66	Middle Creek Rd	5	110
2	Cocke	B2	B	r	1	Rays Chapel Rd	5	160	11	550	98	17	Wilsonville	3	50
3	Cocke	B3	B	r	1	O'Neil Rd	5	120	1	80	98	55	O'Neil Rd	5	80
4	Cocke	B4	B	r	1	Rankin Rd	4	200	10	2000	98	27	Clear Creek Rd	4	200
5	Cocke	B5	B	r	1	Big Creek Rd	3	1140	4	760	97	1	Hollow Rd	5	190
6	Cocke	B6	B	r	1	Big Creek Rd	4	710	0	0	97	3	Big Creek Rd	4	710
7	Cocke	B7	B	r	1	Baysinger Rd	5	110	1	70	98	31	Talley Rd	5	70
8	Cocke	B8	B	r	1	Fugate Rd	5	10	3	30	97	45	Fugate Rd	5	10
9	Cocke	B9	B	r	1	Dry Fork Rd	3	270	1	60	97	43	Trail Fork Big Creek	5	60
10	Cocke	NB1	NB	r	1	Bogard Rd	4	500			98	66	Middle Creek Rd	5	110
11	Cocke	NB2	NB	r	1	Huff Hollow Rd	5	500			98	17	Wilsonville	3	50
12	Cocke	NB3	NB	r	1	Hill Rd	5	180			98	8	French Broad River	3	1550
13	Cocke	NB4	NB	r	1	NPS over Rock Cr	4	160			98	59	Liberty Rd	5	150
14	Cocke	NB5	NB	r	1	Hilltop Rd	5	140			98	16	Pigeon River	4	530
15	Cocke	NB6	NB	r	1	Stone Mtn Tower Rd	5	20			98	46	Old Fifteenth Rd	5	90
16	Cocke	NB7	NB	r	1	Bluff Rd	5	90			98	27	Clear Creek Rd	4	200
17	Cocke	NB8	NB	r	1	Grassy Fork Rd	5	50			98	53	Rag Mtn Rd	5	40
18	Cocke	NB9	NB	r	1	Old Fifteenth Rd	5	150			98	13	Old Fifteenth Rd	5	440
19	Cocke	NB10	NB	r	1	Ponderosa Rd	5	40			98	39	Long Creek Rd	5	230
20	Cocke	NB11	NB	r	1	Stokely Rc	5	60			98	44	Trail Fork Big Creek	5	10
21	Cocke	NB12	NB	r	1	Gunter Hollow Rd	5	140			98	39	Long Creek Rd	5	230
22	Carroll	B1	B	r	4	Jax Rd	4	160	0	0	97	32	Jax Rd	4	160
23	Carroll	B2	B	r	4	Old Stage Rd	4	210	2	220	98	90	Griggs Chapel Rd	4	110
24	Carroll	B3	B	r	4	Giles Rd	4	40	0	0	97	36	Giles Rd	5	40
25	Carroll	B4	B	r	4	Old 22 Loop	3	180	3	210	98	73	Bethel Ch Rd	5	70
26	Carroll	B5	B	r	4	Crum Rd	4	150	2	240	98	82	Purdy Rd	4	120
27	Carroll	B6	B	r	4	Flippin Rd	5	60	3	120	98	51	Flippin Rd	5	40
28	Carroll	B7	B	r	4	Brandon Rd	5	40	2	160	90	81	Enoch Cem Rd	4	80
29	Carroll	B8	B	r	4	Hammel Ln	5	10	3	330	98	78	Hawkins Creek Rd	4	110
30	Carroll	B9	B	r	4	Roundhouse Rd	5	140	1	100	98	62	Vale Rd	4	100
31	Carroll	B10	B	r	4	Pleasant Hill Rd	5	20	0	0	97	58	Pleasant Hill Rd	5	20
32	Carroll	NB1	NB	r	4	Latham Chapel Rd	5	100			97	93	Latham Chapel Rd	5	100
33	Carroll	NB2	NB	r	4	Spring Creek Rd	3	530			98	94	Brewer Rd	5	30
34	Carroll	NB3	NB	r	4	Daniel Rd	4	40			98	94	Brewer Rd	5	30
35	Carroll	NB4	NB	r	4	Ferguson Cem Rd	4	10			98	3	Terry Rd	3	320
36	Carroll	NB5	NB	r	4	Morning Sun Cem R	5	10			98	89	Cook Rd	5	30

APPENDIX E

MULTIPLE REGRESSION REPORT FOR THE FINAL MODEL EQUATION

Multiple Regression Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2.S0
Filter	smsa=>0
Dependent	nbridmean

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	35 52645	17 44492	2 0365	0.072173	Accept Ho	0 444063
rdtype	-39 09748	33.58114	-1 1643	0.274249	Accept Ho	0 180998
mean	0 796367	0.1039218	7 6631	0 000031	Reject Ho	0 999999
rdXsmsaXmed	0 6461146	0 1397791	4 6224	0 001250	Reject Ho	0 983387
R-Squared	0 961326					

Model
35 52645-39 09748*rdtype+ .796367*mean+ 6461146*rdXsmsaXmed

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	35.52645	17.44492	-3 93669	74 9896	0 0000
rdtype	-39 09748	33.58114	-115 0633	36 86835	-0 1161
mean	0 796367	0 1039218	0.5612797	1.031454	0 8186
rdXsmsaXmed	0 6461146	0.1397791	0 3299123	0 962317	0 3631
T-Cntical	2 262157				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	547145 3	547145 3			
Model	3	352164.1	117388	74 5709	0 000001	0 999983
Error	9	14167.62	1574 18			
Total(Adjusted)	12	366331 7	30527 64			

Root Mean Square Error	39 67594	R-Squared	0 9613
Mean of Dependent	205 1538	Adj R-Squared	0 9484
Coefficient of Variation	0 193396	Press Value	26287 34
Sum |Press Residuals|	528 9112	Press R-Squared	0 9282

Multiple Regression Report

Database C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter smsa=>0 Dependent nbndmean

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	-0 0364	0.970974	Accepted
Kurtosis	-1 2249	0 220631	Accepted
Omnibus	1 5016	0.471993	Accepted

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1		9	0 061613	17	0 147934
2	-0 063530	10	0 038514	18	-0.167426
3	-0 009767	11	0 006139	19	0.026647
4	-0 131818	12	0 180558	20	-0 163305
5	-0 007264	13	0 021849	21	-0 096543
6	0 174991	14	-0 016614	22	-0 036873
7	0 083509	15	-0.178167	23	0 089845
8	-0 244702	16	-0 025032	24	

Above serial correlations significant if their absolute values are greater than 0 554700
Durbin-Watson Value 2 0922

Predicted Values with Confidence Limits of Means

Row	Actual	Predicted	Std Error of Predicted	95% LCL of Mean	95% UCL of Mean
1	332				
2		260 8228	19 3056	217 1505	304 4951
3	124	85 69758	16 19778	49.05565	122 3395
4		134.276	17 41931	94 87075	173.6812
5	580	593.1194	30 29794	524 5806	661 6581
6		779 4409	56 11423	652 5016	906.3801
8		212 3199	23 18806	159 8649	264 775
9	486	475 453	34 11304	398.2839	552.6221
10		637 3864	42 93887	540.252	734.5209
11	110	71 36297	16.29749	34 49549	108 2304
12		123 1268	16 93817	84 81003	161 4436
13	293	270 3792	19 67963	225 8608	314 8976
14		229 7645	18 62247	187 6376	271.8915
15	86	86.49394	16 19856	49 85026	123 1376
16		104 014	16 3833	66 95243	141.0756
17	138	146 0713	25 44778	88 50441	203.6382
18		164 478	24 61099	108.804	220.1519
19	25	72.15934	16 28633	35 3171	109 0016
20		55.43563	16.6558	17.75759	93.11368
21	259	204 2808	18 71027	161 9552	246 6063
22		202 688	18.73535	160 3057	245.0703
23	60				
24		83 30848	16 19945	46 66278	119 9542
25	330	358.776	25 87696	300 2383	417.3137
26		259 2301	19.25041	215 6827	302.7776
27	137	116 7559	16 71395	78 94631	154.5655
28		144 6287	17.96032	103.9997	185 2578
29	70	107 9204	23.71505	54.2732	161.5675
30		52.17467	28.80332	-12.98297	117 3323
31	29	78.53027	16 22077	41.83635	115.2242
32		58 6211	16.56391	21 15093	96.09126

Multiple Regression Report

Database C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter smsa=>0
Dependent nbndmean

Predicted Values with Confidence Limits of Individuals

Row	Actual	Predicted	Std Error of Predicted	95% LCL of Individual	95% UCL of Individual
1	332				
2		260.8228	44 12353	161 0085	360 6372
3	124	85 69758	42.85497	-11.24709	182 6423
4		134.276	43 33142	36 25347	232.2985
5	580	593 1194	49.92139	480 1893	706 0494
6		779.4409	68.724	623 9764	934.9053
8		212.3199	45.95504	108 3624	316.2775
9	486	475.453	52.32476	357 0862	593 8198
10		637.3864	58 46304	505 1339	769 639
11	110	71.36297	42 89275	-25.66718	168.3931
12		123.1268	43 14025	25.53679	220.7169
13	293	270.3792	44.28846	170.1918	370 5667
14		229.7645	43.82895	130.6166	328.9125
15	86	86 49394	42 85526	-10 45139	183 4393
16		104.014	42 92543	6.909951	201 1181
17	138	146.0713	47 13565	39 44304	252.6996
18		164.478	46.6892	58 85965	270 0963
19	25	72.15934	42 88852	-24 86122	169 1799
20		55.43563	43 03017	-41 90539	152 7766
21	259	204 2808	43.86632	105 0483	303 5133
22		202.688	43.87703	103 4313	301.9448
23	60				
24		83 30848	42.8556	-13 63762	180 2546
25	330	358.776	47 36873	251 6205	465.9315
26		259.2301	44.09941	159.4703	358 9899
27	137	116.7559	43 05272	19 36389	214.1479
28		144.6287	43 55173	46.10788	243.1496
29	70	107.9204	46.22319	3.356235	212.4845
30		52.17467	49.02868	-58.73591	163 0853
31	29	78 53027	42.86366	-18.43406	175 4946
32		58 6211	42 99469	-38 63964	155.8818

Multiple Regression Report

Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	smsa=>0
Dependent	nbridmean

Residual Report

Row	Actual	Predicted	Residual	Percent Error	MSEi
1	332				
2		260.8228			
3	124	85 69758	38 30242	30.89	1550 891
4		134 276			
5	580	593 1194	-13.11936	2 26	1719 341
6		779.4409			
8		212.3199			
9	486	475.453	10 54702	2 17	1717.628
10		637.3864			
11	110	71 36297	38.63703	35 12	1546.474
12		123.1268			
13	293	270.3792	22.62076	7.72	1686 119
14		229.7645			
15	86	86.49394	-0 4939451	0.57	1770.916
16		104 014			
17	138	146.0713	-8 071297	5.85	1757 118
18		164 478			
19	25	72 15934	-47 15934	188.64	1436.618
20		55.43563			
21	259	204.2808	54 71922	21.13	1289.642
22		202.688			
23	60				
24		83.30848			
25	330	358.776	-28.77598	8.72	1590.823
26		259.2301			
27	137	116.7559	20.24411	14 78	1708.672
28		144.6287			
29	70	107.9204	-37 92036	54.17	1491 296
30		52.17467			
31	29	78 53027	-49.53027	170 79	1402.755
32		58.6211			

Multiple Regression Report

Database	C:\MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	smsa=>0
Dependent	nbridmean

Regression Diagnostics Section

Row	Studentized Residual	Rstudent	Hat Diagonal	Cook's D	Dffits	Covratio
1						
2			0 236762			
3	1.057525	1.065435	0 166670	0 055919	0.476482	1 130550
4			0 192756			
5	-0 512141	-0.490045	0 583139	0 091727	-0.579597	3 413809
6			2 000284			
8			0 341566			
9	0 520575	0 498364	0 739242	0 192068	0 839113	5 435762
10			1 171242			
11	1.068083	1 077608	0 168728	0 057889	0 485493	1 120495
12			0 182255			
13	0.656601	0 634431	0 246025	0 035169	0.362406	1 745735
14			0 220303			
15	-0.013638	-0 012858	0 166686	0 000009	-0.005751	1 922053
16			0 170509			
17	-0.265155	-0 250972	0 411382	0.012284	-0 209813	2 637259
18			0 384772			
19	-1.303493	-1 364474	0 168497	0 086077	-0.614227	0.834226
20			0 176229			
21	1.563977	1 727917	0 222385	0 174881	0 924046	0 579288
22			0 222982			
23						
24			0 166704			
25	-0.956777	-0.951759	0 425375	0 169414	-0 818881	1 815035
26			0 235410			
27	0.562592	0 539997	0 177461	0 017072	0.250822	1.687567
28			0 204915			
29	-1 192148	-1 224829	0 357268	0 197499	-0.913182	1.253164
30			0 527024			
31	-1.367913	-1 449088	0 167143	0.093880	-0 649163	0 757075
32			0 174289			

Multicollinearity Section

Independent Variable	Variance Inflation	R-Squared Vs Other X's	Tolerance	Diagonal of X'X Inverse
rdtype	2 314421	0 567927	0 432073	0 7163686
mean	2 655835	0 623471	0 376529	6 860547E-06
rdXsmsaXmed	1 436316	0 303775	0 696225	1 241167E-05

Multiple Regression Report

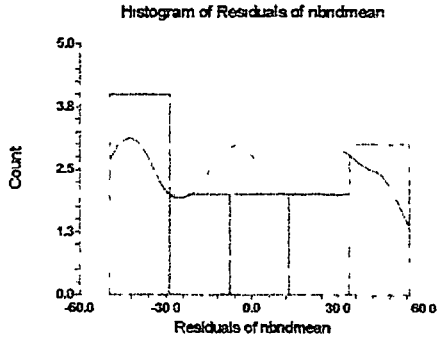
Database	C \MY DOCUMENTS\TDOT ADT\ADTTN2 S0
Filter	smsa=>0
Dependent	nbndmean

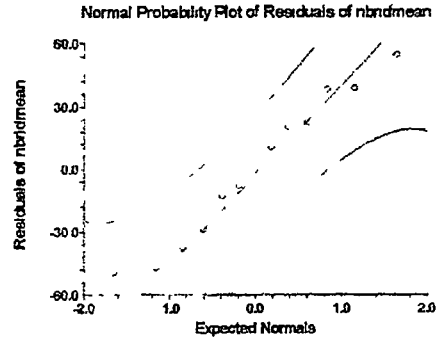
Eigenvalues of Centered Correlations

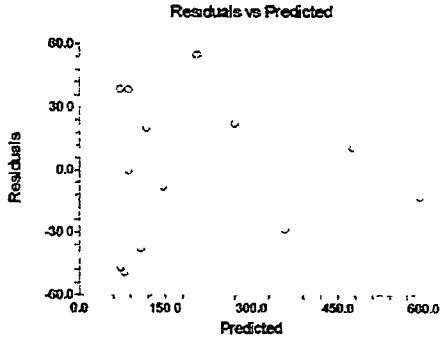
No.	Eigenvalue	Incremental Percent	Cumulative Percent	Condition Number
1	2 174522	72 48	72.48	1.00
2	0 590336	19 68	92 16	3.68
3	0.235142	7.84	100.00	9 25

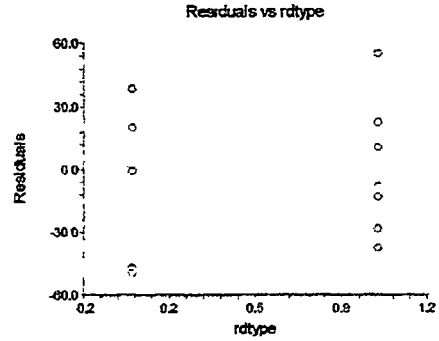
All Condition Numbers less than 100. Multicollineanty is NOT a problem

Plots Section









APPENDIX F

PROGRAMMING USED IN THE MICROSOFT EXCEL SPREADSHEET

```
Module 1
Option Base 1

Sub Analyze()
'
' Analyze Macro
' Macro recorded 1/5/2000 by Jason A  Crouch
'
Dim County As String
Dim CtyStrg As String
Dim CtyNo As String
Dim CountyNo As Integer
Dim Year As Integer
Dim YearA As Integer
Dim AnalYear As Integer
Dim YrMove As Integer
AnalYear = Application.InputBox("Please enter the Year of data to process ", "Input Year", 1997, 300,
150, , , 1)
If AnalYear < 1997 Then End
Let Year = AnalYear - 1994
Let YrMove = (4 * AnalYear) - 7988
Let YearA = 1
   Sheets("Paved") Select
   Range("A4") Select
   ActiveCell Offset(0, YearA) Select
   Sheets("Unpaved") Select
   Range("A4") Select
   ActiveCell.Offset(0, YearA).Select
   Sheets("Temp1") Select
   Range("A1").Select
   Sheets("Temp2") Select
   Range("A1") Select
   Sheets("Input").Select
   Range("A3") Select
20  If ActiveCell Value = "" Then GoTo 100
Let County = ActiveCell Value
25  If ActiveCell Value = "" Then GoTo 100
   If ActiveCell Offset(0, Year) > 0 Then
         GoTo 30
      ElseIf ActiveCell Offset(0, Year) = "" Then
         ActiveCell Offset(1, 0).Select
         GoTo 25
      Else
         GoTo 20
      End If
30  Let County = ActiveCell Value
   Let CtyStrg = ActiveCell Offset(0, 1).Value
   Let CtyNo = Left(CtyStrg, 2)
   Let CountyNo = Val(CtyNo)
   If ActiveCell Offset(0, 2) Value = "U" Then
      ActiveCell Offset(0, Year) Select
      Selection.Copy
      ActiveCell Offset(0, -Year) Select
```

```
      Sheets("Temp2") Select
      ActiveSheet.Paste
      Application.CutCopyMode = False
      ActiveCell.Offset(1, 0) Select
      Sheets("Input") Select
      ActiveCell Offset(1, 0).Select
    ElseIf ActiveCell Offset(0, 2) Value = "" Then
      ActiveCell Offset(0, Year) Select
      Selection.Copy
      ActiveCell.Offset(0, -Year) Select
      Sheets("Temp1") Select
      ActiveSheet Paste
      Application.CutCopyMode = False
      ActiveCell Offset(1, 0).Select
      Sheets("Input") Select
      ActiveCell.Offset(1, 0).Select
    Else
      ActiveCell Offset(1, 0) Select
    End If
    If ActiveCell.Value = County Then
      GoTo 30
    Else
'Copy Mean and Median Info to the Paved Sheet
      Sheets("Temp1") Select
      Range("A300") Select
      Selection.Copy
      Sheets("Paved").Select
        ActiveCell Offset(CountyNo, YrMove).Select
      Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
      Application.CutCopyMode = False
      ActiveCell Offset(0, 1) Select
      Sheets("Temp1") Select
      Range("A301") Select
      Selection Copy
      Sheets("Paved") Select
      Selection PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
      Application.CutCopyMode = False
      ActiveCell Offset(-CountyNo, -YrMove - 1).Select
      Sheets("Temp1") Select
      Range("A1.A299") Select
      Selection.ClearContents
      Range("A1") Select
'     Copy Mean and Median Info to the Unpaved Sheet
      Sheets("Temp2") Select
      Range("A300") Select
      Selection.Copy
      Sheets("Unpaved") Select
        ActiveCell Offset(CountyNo, YrMove) Select
      Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, SkipBlanks:= _
        False, Transpose:=False
      Application.CutCopyMode = False
```

```
    ActiveCell.Offset(0, 1) Select
    Sheets("Temp2") Select
    Range("A301") Select
    Selection.Copy
    Sheets("Unpaved").Select
    Selection.PasteSpecial Paste:=xlValues, Operation.=xlNone, SkipBlanks:= _
      False, Transpose:=False
    Application.CutCopyMode = False
    ActiveCell.Offset(-CountyNo, -YrMove - 1) Select
    Sheets("Temp2").Select
    Range("A1.A299").Select
    Selection.ClearContents
    Range("A1") Select
    Sheets("Input").Select
    GoTo 20
  End If
100 Sheets("Tools") Select
End Sub
```

Module 2

```
Sub Printing()
'
' Printing Macro
' Macro recorded 1/8/2000 by Jason A  Crouch
  Dim YrReport As Integer
  Dim Yr As Integer
  Sheets("Results Report") Select
  Range("A4").Select
  YrReport = Application InputBox("Please enter the Year of data to print.", "Input Print Year", 1997,
300, 150, , , 1)
  If YrReport < 1997 Then End
  Yr = (4 * YrReport) - 7986
  ActiveCell Offset(1, Yr).Range("A1 D48").Select
  Selection.Copy
  Range("H147") Select
  Selection.PasteSpecial Paste:=xlValues, Operation =xlNone, SkipBlanks = _
    False, Transpose =False
  Range("A4").Select
  ActiveCell.Offset(1, Yr) Range("A1 D48") Select
  Selection.Copy
  Range("H147") Select
  Selection.PasteSpecial Paste:=xlFormats, Operation:=xlNone, SkipBlanks = _
    False, Transpose =False
  Range("A4").Select
  ActiveCell Offset(49, Yr).Range("A1 D48").Select
  Application.CutCopyMode = False
  Selection.Copy
  Range("N147") Select
  Selection PasteSpecial Paste =xlValues, Operation =xlNone, SkipBlanks = _
    False, Transpose:=False
  Range("A4") Select
```

```
    ActiveCell.Offset(49, Yr) Range("A1:D48") Select
    Application.CutCopyMode = False
    Selection.Copy
    Range("N147") Select
    Selection.PasteSpecial Paste:=xlFormats, Operation =xlNone, SkipBlanks:= _
      False, Transpose =False
    Application CutCopyMode = False
    Range("I144") Select
    ActiveCell Value = YrReport
    Range("O144") Select
    ActiveCell Value = YrReport
    Range("G144 Q194") Select
    ActiveSheet.PageSetup PrintArea = "$G$144:$Q$194"
    ActiveWindow.SelectedSheets PrintOut Copies =1, Collate =True
    Range("A4").Select
  Sheets("Tools").Select
End Sub
```

Module 3

```
Sub Estimate()
'
' Estimate Macro
' Macro recorded 1/8/2000 by Jason A. Crouch
'
    Dim Cty As String
    Dim YearE As Integer
    Dim YearF As Integer
    Dim YY As Integer
    YearE = Application.InputBox("Please enter the Year of data to review ", "Input Year", 1997, 300, 150,
, , 1)
    If YearE < 1997 Then End
    YearF = (4 * YearE) - 7988
    Cty = Application.InputBox("Please enter the County you wish to estimate ", "Input County", "", 300,
150, , , 2)
    If Cty = "" Then End
    Growth = Application.InputBox("Please enter a growth factor for data estimation.", "Input Growth
Factor", 0, 300, 150, , , 1)
    GF = Growth + 1
    GF1 = 1 - Growth
    YY = (4 * YearE) - 7986
    Sheets("Paved") Select
    Range("B4") Select
    Sheets("Unpaved") Select
    Range("B4") Select
    Sheets("Results Report") Select
    Range("A4") Select
    Sheets("Paved") Select
    ActiveCell Offset(1, YearF) Select
    For X = 1 To 95
    If ActiveCell Offset(0, -(YearF + 1)) Value <> Cty Then
      ActiveCell Offset(1, 0) Select
```

```
    GoTo 10
  Else
    If ActiveCell Value = "" Then
      If YearE = 1997 Then
        If ActiveCell.Offset(0, 4).Value = "" Then
          ActiveCell.Offset(1, 0).Select
          GoTo 10
        End If
        ActiveCell Value = Int(ActiveCell Offset(0, 4) Value * GF1)
        Selection.Font.Bold = True
        ActiveCell Offset(0, 1) Range("A1", "C1") Select
        Selection.Font.Bold = True
        ActiveCell Offset(0, -1) Select
        'Bold the corresponding county on Results Report sheet
          Sheets("Results Report") Select
          ActiveCell Offset(X, YY) Range("A1", "D1") Select
          Selection.Font Bold = True
          Range("A4") Select
          Sheets("Paved") Select
        ActiveCell Offset(1, 0) Select
      Else
        If ActiveCell Offset(0, -4) Value = "" Then
          ActiveCell.Offset(1, 0) Select
          GoTo 10
        End If
        ActiveCell.Value = Int(ActiveCell Offset(0, -4) Value * GF)
        Selection.Font.Bold = True
        ActiveCell Offset(0, 1) Range("A1", "C1") Select
        Selection.Font.Bold = True
        ActiveCell.Offset(0, -1).Select
        'Bold the corresponding county on Results Report sheet
          Sheets("Results Report") Select
          ActiveCell.Offset(X, YY) Range("A1", "D1") Select
          Selection Font.Bold = True
          Range("A4") Select
          Sheets("Paved").Select
        ActiveCell.Offset(1, 0) Select
      End If
    End If
  End If
10 Next X
  Range("B4") Select
  ActiveCell.Offset(1, YearF + 1) Select
  For Y = 1 To 95
  If ActiveCell Offset(0, -(YearF + 2)) Value <> Cty Then
    ActiveCell Offset(1, 0) Select
    GoTo 30
  Else
    If ActiveCell Value = "" Then
      If YearE = 1997 Then
        If ActiveCell Offset(0, 4) Value = "" Then
          ActiveCell Offset(1, 0).Select
          GoTo 30
```

```
            End If
            ActiveCell Value = Int(ActiveCell Offset(0, 4) Value * GF1)
            ActiveCell Offset(1, 0) Select
          Else
            If ActiveCell Offset(0, -4) Value = "" Then
              ActiveCell.Offset(1, 0).Select
              GoTo 30
            End If
            ActiveCell Value = Int(ActiveCell Offset(0, -4) Value * GF)
            ActiveCell Offset(1, 0) Select
          End If
        End If
      End If
30  Next Y
    Range("A5").Select
    Range("A4") Select
    Sheets("Unpaved") Select
    ActiveCell.Offset(1, YearF) Select
    For A = 1 To 95
    If ActiveCell Offset(0, -(YearF + 1)).Value <> Cty Then
      ActiveCell Offset(1, 0).Select
      GoTo 60
    Else
      If ActiveCell Value = "" Then
        If YearE = 1997 Then
          If ActiveCell.Offset(0, 4) Value = "" Then
            ActiveCell.Offset(1, 0) Select
            GoTo 60
          End If
          ActiveCell Value = Int(ActiveCell Offset(0, 4) Value * GF1)
          Selection.Font.Bold = True
          ActiveCell Offset(0, 1) Range("A1", "C1") Select
          Selection.Font.Bold = True
          ActiveCell.Offset(0, -1) Select
          ActiveCell.Offset(1, 0) Select
        Else
          If ActiveCell Offset(0, -4).Value = "" Then
            ActiveCell.Offset(1, 0) Select
            GoTo 60
          End If
          ActiveCell.Value = Int(ActiveCell.Offset(0, -4) Value * GF)
          Selection.Font.Bold = True
          ActiveCell.Offset(0, 1) Range("A1", "C1") Select
          Selection.Font.Bold = True
          ActiveCell.Offset(0, -1) Select
          ActiveCell Offset(1, 0) Select
        End If
      End If
    End If
60  Next A
    Range("B4") Select
    ActiveCell Offset(1, YearF + 1) Select
    For Z = 1 To 95
```

```
  If ActiveCell Offset(0, -(YearF + 2)) Value <> Cty Then
    ActiveCell.Offset(1, 0) Select
    GoTo 90
  Else
    If ActiveCell Value = "" Then
      If YearE = 1997 Then
        If ActiveCell Offset(0, 4) Value = "" Then
          ActiveCell Offset(1, 0) Select
          GoTo 90
        End If
        ActiveCell.Value = Int(ActiveCell Offset(0, 4) Value * GF1)
        ActiveCell Offset(1, 0).Select
      Else
        If ActiveCell Offset(0, -4) Value = "" Then
          ActiveCell.Offset(1, 0) Select
          GoTo 90
        End If
        ActiveCell Value = Int(ActiveCell.Offset(0, -4) Value * GF)
        ActiveCell Offset(1, 0) Select
      End If
    End If
  End If
90  Next Z
  Range("A5") Select
  Range("A4") Select
 Sheets("Tools") Select
End Sub
```

VITA

Jason Allen Crouch was born in Johnson City, Tennessee on August 23, 1973. He attended public school in the Washington County, Tennessee system until graduation from Daniel Boone High School in Gray, Tennessee on May 25, 1991. He then entered the University of Tennessee, Knoxville in August 1991 and completed a Bachelor of Science degree in Agricultural Engineering in December 1995. After a year of graduate school in Agricultural Engineering, he accepted a position with John Deere Company of Atlanta, Georgia. In June 1998, he returned to the University of Tennessee, Knoxville and enrolled in the Master's program in Civil Engineering with a concentration in Transportation Engineering. While pursuing his Master's degree, he worked as a research associate with the University of Tennessee Transportation Center's Tennessee Transportation Assistance Program (TTAP). In this role he assisted local governments in Tennessee with technical problems related to their transportation systems. The Master of Science degree was received in August 2000. He is currently working in the area of transportation and traffic studies for SITE, Incorporated, located in Knoxville, Tennessee and is a member of the Institute of Transportation Engineers and an Engineer-in-Training.