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# Clarifying the Quadrennial Needs Study Process

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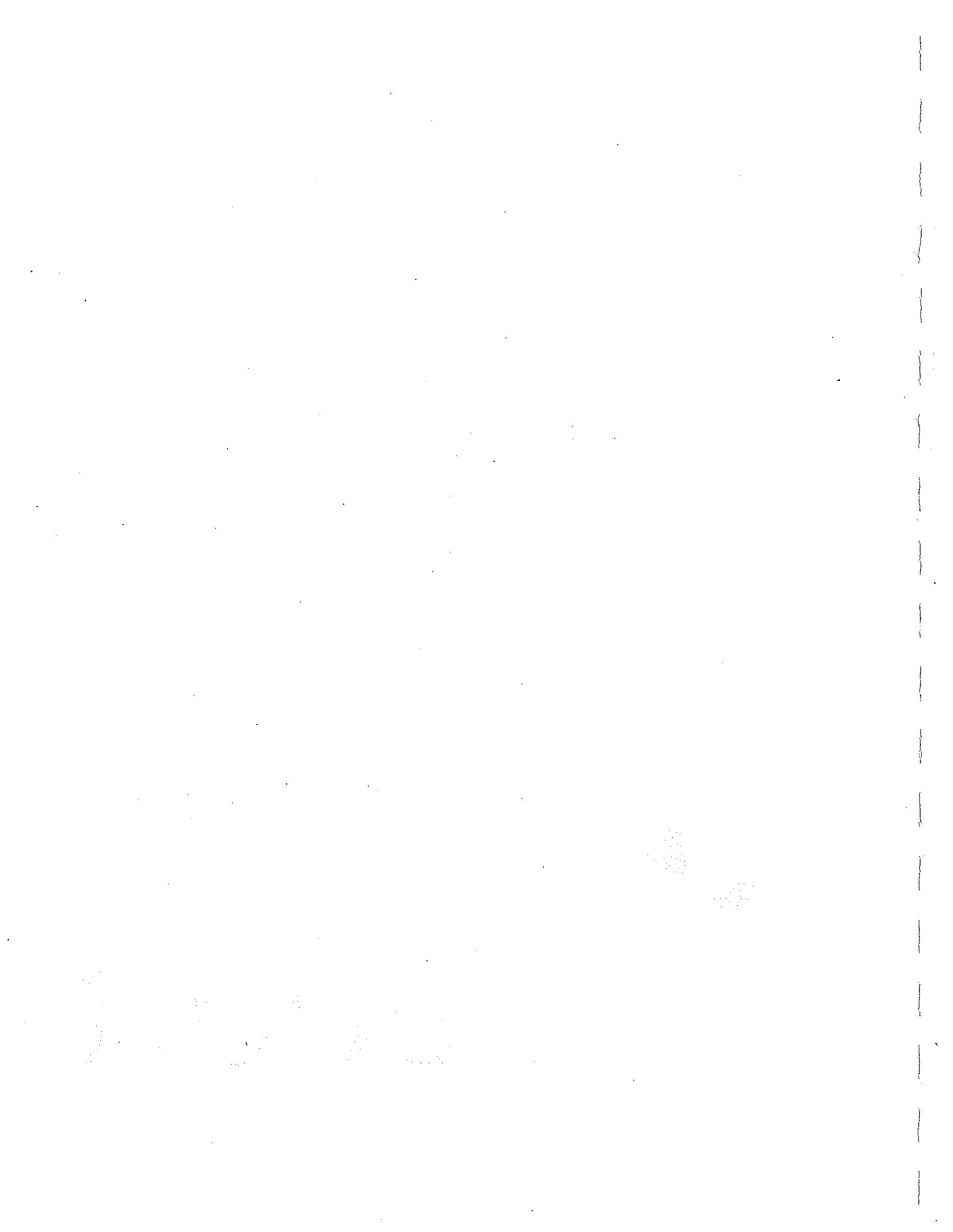
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CLARIFYING THE QUADRENNIAL NEEDS STUDY PROCESS

By

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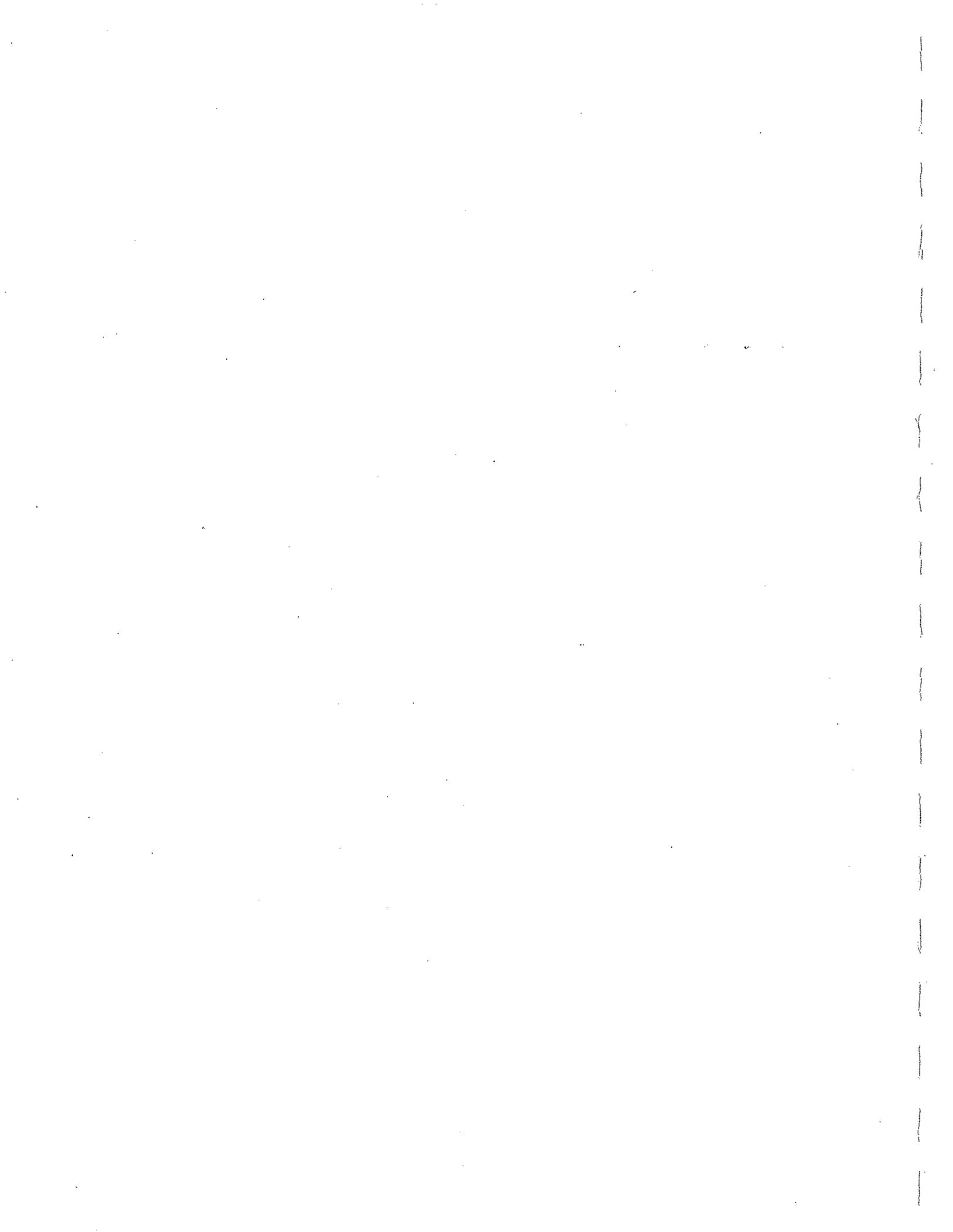
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## ABSTRACT

The Quadrennial Needs Study was developed to assist in the identification of highway needs and the distribution of road funds in Iowa among the various highway entities. During the period 1978 to 1990, the process has seen large shifts in needs and associated funding distribution in individual counties with no apparent reasons. This study investigated the reasons for such shifts.

The study identified program inputs that can result in major shifts in needs either up or down from minor changes in the input values. The areas of concern were identified as the condition ratings for roads and structures, traffic volume and mix counts, and the assignment of construction cost areas. Eight counties exhibiting the large shifts (greater than 30%) in needs over time were used to test the sensitivity of the variables. A ninth county was used as the base line for the study.

Recommendations are identified for improvements in the process of data collection in the areas of road and structure condition rating, traffic, and in the assignment of construction cost areas. Advice is also offered in how to account for changes in jurisdiction between successive studies. Maintenance cost area assignment and levels of maintenance service are identified as requiring additional detailed research.

## ACKNOWLEDGEMENTS

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# CLARIFYING THE QUADRENNIAL NEEDS STUDY PROCESS

## CHAPTER 1

### INTRODUCTION

The Quadrennial Needs Study has been used in Iowa since the early 1960s as the means for measuring the relative 20 year road construction, administration and maintenance needs for each of the 99 counties. The study uses road condition surveys and historical construction, maintenance and administration costs to establish the input for the computer program. County Engineers and Iowa Department of Transportation (DOT) staff have used the computer program output to compare the relative needs and determine the distribution of State Road Use Tax funds between the counties for each four year period.

Quadrennial Needs Studies conducted between 1978 and 1990 resulted in large changes (increases and decreases in excess of 30%) in the needs and associated distribution factors for several counties. In a time of decreasing revenues this caused concern among many counties as to the credibility of the study results for distribution of tax monies.

This study was designed to answer some of the questions posed by members of the Iowa County Engineers Association regarding the sensitivity of the key variables used in developing the quadrennial needs. The association was interested in identifying some or all of the reasons for the large shifts in needs between studies in adjacent counties without visible reasons.

The legislature has also looked at the impact of some of these

shifts in funding and implemented "Hold Harmless" legislation, in July 1991, to protect various counties from large losses in revenue until more permanent solutions could be found. A legislative committee also studied the road use tax distribution formula and looked at various combinations of the factors including relative population, needs, road mileage, and area. The "Hold Harmless" legislation was aimed at reducing the impact of the changes in distribution systems between consecutive studies. The legislation also required the distribution of county funds to be based 70% on relative needs (previously 60%) and 30% on relative area (previously 40%) and take effect with the results of the 1994 Quadrennial Needs Study. The "Hold Harmless" portion of the 1990 legislation was terminated in June 1993.

These legislative actions, combined with the current needs study preparations have caused the County Engineers Association membership to reexamine the needs study process and elements for possible answers to the shifts in needs.

## CHAPTER 2

### STUDY OBJECTIVES

Three objectives were identified to assist in obtaining answers to the shifts in quadrennial needs. They include the following:

1. Identification of sample counties which experienced large needs shifts in the 1978 to 1990 studies and a control county that exhibited minimal changes in needs.

2. Analysis of the sample and control counties 1990 needs under controlled conditions to determine the sensitivity of selected process input variables.
3. Conduct a sensitivity analysis for selected need study input variables. Formulate recommendations for improvements in the needs study process to reduce, or understand the reasons for, shifts in the relative magnitude of individual county needs between studies.

### CHAPTER 3

#### PREVIOUS STUDIES

The Quadrennial Needs Study has its origin in Iowa with the early needs studies being done manually. They were designed to assist in the distribution of the county portion of the Road Use Tax Fund in the late 1950s. The study was closely associated with the development of the state and federal functional classification systems in Iowa. The state of Iowa functional classification system is used to determine the farm to market portion of the needs from the classifications of trunk and trunk collector. All state classifications are used to determine the local secondary needs and associated distribution factors for each county. The intent of both the classification system and the needs study is the distribution of funds in proportion to the needs of an orderly planned highway system.

Needs are computed by comparing the existing condition and

traffic using a structure or section of road to established design guides for the designated road functional classification. Needs are summed over a 20 year planning period for construction, maintenance and administration of each county system. The previously noted road use tax distribution formula is used to relate the relative needs and land area to the total statewide county needs. The resulting ratios for each county are used to divide the available funds in each year between studies.

Each time the Quadrennial Needs Study was performed there were changes in the relative needs of each county and this caused the distribution factors for each county to change. The introduction of computers allowed this process to shift from a manual method to a mechanical process with input on design guides and unit costs supplied by the Iowa County Engineers Association members and the Iowa DOT staff.

In 1982 the study analysis process was changed from the Iowa computer program system to that of one developed by the Federal Highway Administration and patterned after the Iowa process. The FHWA program is available to all states and is used by various states for limited purposes. The total package consists of two software programs. HWYNEEDS is the needs study analysis program patterned after the Iowa manual and computer methods of the 1960's. HIAP is a investment package that allows the agency to look at various funding alternatives and their association with fulfilling the needs identified in HWYNEEDS.

The FHWA also uses a larger program dealing with the subject

of the Highway Performance Monitoring System (HPMS) for all roads in the nation. The objective of this effort is to provide Congress with information on the condition of the transportation system in the USA at any given time through use of a sampling of highways in each state. The needs study program package provides the needs analysis tool module for this purpose and a separate module for projecting revenue need scenarios.

A HPMS users group was formed and met on September 18-19, 1990, in Denver Colorado, to discuss the use and future directions for this type of either the HPMS or HWYNEEDS/HIAP software in the management of state and local highway budgets. Those states attending and making comments on the use of the program included Alaska, Arizona, Colorado, Idaho, Indiana, Kansas, Maine, Michigan, Missouri, Montana, Nebraska, North Dakota, Oregon, South Carolina, Texas, Utah, Virginia, Washington, and Wyoming. A review of the conference reports indicate that only Idaho and Utah are involved in using the FHWA HWYNEEDS program for anything other than state highway analysis. In these two states the legislature and local government officials are working with state government and universities to develop the details of tax distributions using the needs study process results.

The state of Idaho uses the routine HWYNEEDS to develop a listing and map of needs for each state highway district. They also develop a listing of the needs for the paved portion of the local roads for informational purposes. The analysis process utilizes input from a condition survey, and criteria developed from

the 1985 Highway Capacity Manual and the 1986 AASHTO Guide for pavements. Local road funds are distributed currently on the basis of relative miles of road and population. The legislature has asked the university and State DOT to look at ways to use the needs study results in the distribution process.

Colorado has used the HPMS program primarily for the analysis of state highways. They are beginning to use it to analyze potential ways of improving the distribution system for local road agencies. Local highway agencies receive 25% of the state road use taxes currently. Funds are distributed to counties and cities on the basis of relative mileage, population and area.

It appears that Iowa is a leader in both the use of the program software and the distribution process. The other states provided no assistance on the sensitivity analysis, but do identify the need for more knowledge concerning the system operation.

## **CHAPTER 4**

### **RESEARCH APPROACH**

Five areas of effort were identified in the development of the research results. These included test county and study criteria selection, data development, data analysis, analysis, documentation, and recommendations.

#### **Test County Selection**

An advisory committee made up of representatives from the Iowa County Engineers' Association and Iowa DOT Planning Division was

selected by respective group leaders to assist in the study. A list of those representatives is included in the Appendix. The group was charged with assisting the research staff in the selection of the test counties, identification of analysis criteria and review of the results.

The advisory committee was provided with information on a statewide basis for economic factors that could be influencing the changes in needs. Economic development statistics included the changes in population, vehicle registrations, numbers of retail businesses and sales tax receipts over the period of 1980-1990. Information regarding the traffic counting program schedule and facility condition survey schedules were also provided. Information from the previous needs study reports included the cost area assignments made for each county between 1960 and 1990 and the resulting tax distribution factors for each county in the same study years. Study cost area designations for the years 1982-1990 were identified on maps. The 1990 needs study design guides were also provided for use in the selection of counties for detailed analysis. A list of the input variables for roads, structures, and railroad crossing analysis was also provided for consideration.

The advisory committee recommended detailed studies be conducted in eight sample counties exhibiting fluctuations in needs (increases or decreases in excess of 30%) of concern to the association in the distribution of funds. Sample counties were chosen for several reasons. The counties represent a geographical distribution across the state, rural and urban locations, and

counties that have experienced large increases or decreases or combined increases and decreases over the 1960-1990 period in calculated needs distribution factors. The list of counties was designed to provide an adequate distribution of data to represent the state and upon which to base recommendations. The list was also limited to provide some control over the size of the data analysis process.

Black Hawk and Webster Counties were identified as two counties for study that have indicated increasing relative needs factors over time. Counties chosen because of decreasing needs factors included Adams, Iowa and Scott. Des Moines, Jones, and O'Brien counties were chosen because they exhibit large fluctuations in needs over time.

The committee also selected Butler County to represent the base line or a county whose needs factors have remained relatively constant over time.

**Table 1 Test county secondary road mileage by functional classification**

County	Total miles	Freeway miles	Expressway miles	Trunk miles	Trunk Collector miles	Area Service miles
Adams	713.08			82.65	103.10	527.33
Black Hawk	779.55	0.39	3.24	104.44	161.86	509.62
Butler	1003.28			146.30	182.08	674.90
Des Moines	623.03			109.47	130.09	383.47
Iowa	940.24		8.51	176.04	174.22	581.47
Jones	846.41			128.62	188.82	528.97
O'Brien	1023.37			131.32	188.26	703.79
Scott	561.13			100.29	108.59	352.25
Webster	1173.14			163.98	229.81	779.35

The relative centerline miles of secondary roadway by functional class in each county is shown in Table 1. The mileages for each county indicate a balance in mileage between the various functional classes in each county. It also illustrates the potential problem that can occur when freeway and expressway mileage are under the jurisdiction of local government. The program can develop large needs for a small mileage of such a highway. It is important that changes in classification follow changes in jurisdiction to place needs under the appropriate jurisdiction. Failure to make the jurisdiction change, can upset the balance of needs between counties.

#### **Test County Analysis Criteria Selection**

The advisory committee considered several potential factors as criteria for the analysis of the individual needs. The primary study variables of concern are shown below.

1. Condition rating values for roads and bridges
2. Assignment of cost area factors for construction,  
maintenance and administration
3. Cost area component selection
4. Traffic data collection and assignment methods
5. Functional classification assignment
6. Jurisdictional transfer impacts
7. Software analysis period selection

Each of these factors are important to the results of the study, but not all can be addressed in one study. The existing

data allow the study of several of the variables. Condition ratings for roads and bridges are included. Due to the relatively small amount of needs associated with railroad crossings, they were omitted from further study. The assignment of cost area factors for construction unit cost development was retained and is of importance to all counties. Administrative cost area selection was deleted because each county is treated equally in this area. More definitive criteria would be required in the need study software to refine and use this factor to any degree in future studies.

Maintenance cost area factors are of concern, but the advisory committee indicated that a more in depth study is required to address this issue. Reported costs in this area are currently driven more by available funding than identified need. Actual maintenance levels of service are driven by forces such as surface type, functional classification, actual traffic use and mix, and public travel desire lines. It is recommended that this issue be part of a future study into the development of levels of maintenance service for state and local highways.

The effect of traffic counting methods and the use of the data in the needs study are of interest and included in this analysis. In connection with this analysis, the emphasis is on the effect of large shifts in traffic that is not reflected in the current counting procedures and included in the needs study input.

Functional classification of roads and streets can be a concern and was included in the study for analysis. The impact of

this can be identified in two ways. First, changes in classification that are not entered in the needs records, can under or over estimate actual needs. Secondly, jurisdictional transfers that result from classification changes often include provisions for some type of rehabilitation work or exchange of funds to complete the transaction. It is important that the transfer of jurisdiction be accounted for in the condition rating and computation of the remaining needs for a given county.

### **Data Development**

Data for this study was only available at the Iowa DOT and the Office of Advance Planning. Due to Iowa DOT record retention policies, only the written reports were available for the years of 1978, 1982, and 1986. These reports contained the basic cost area information individual county needs and resulting Road Use Tax Fund distribution factors for needs and area. They were used to develop the background information used in the selection of test counties and study criteria.

The 1990 Quadrennial Needs Study computer tapes were retained and served as the basis for all computer analysis. These tapes retained the input values necessary for the analysis.

Several other items of information were used to develop the basis for the analysis. The Manual of Instruction for Rural Secondary Road Inventory was used to analyze the methods of condition survey data collection. Various economic reports from the Iowa Office of Economic Development were used to develop

background information for consideration in test county selection. Discussions were conducted with representatives of the Office of Transportation Inventory to understand the traffic counting and condition survey process and limitations.

### **Data Analysis**

The analysis was carried out primarily through the use of various computer runs to test the effect of changes in the variables. This work was done to simulate what might be happening in regard to the data collection or data entry portion of the process. In this way the research team could identify the sensitivity of each variable or a combination of the variables to anticipated changes.

Several alternatives were modeled through the computer runs.

1. The effect of changes in traffic or ADT (average daily traffic) volumes on individual functional classes and total system in an individual county. The 1990 traffic value was reduced by half and increased by a factor of two to identify this trend.
2. The effect of road condition rating changes by functional class and total system in each county. The 1990 condition ratings for each pavement section were increased or decreased by increments of one from minus two to plus two to measure the sensitivity of the process to differences in raters, climatic conditions and rating knowledge.

3. The effect of combined changes in traffic volume (ADT) and conditions ratings for road sections. This analysis is directed to identifying the results of overestimating road condition and traffic volumes.
4. The effect of changes in the assignment of cost area factors for development of construction unit costs. This analysis is used to determine the sensitivity of changing cost area factors for individual counties between successive study years.
5. The effect of changes in condition ratings for structures. In this analysis the impact of the rating process and changes in rater or rating knowledge can be quantified.

The previously mentioned criteria of condition values, traffic volumes, and cost area assignment were varied from the original 1990 to simulate the effect of field differences in the input data. In each case the adjusted 1990 input data for a county was processed individually and the resulting listing was compared to the output listing for the 1990 study. It is also important to note that the changes in a selected variable are applied evenly across each functional classification. In this way it overstates what might be actually happening in an existing system or gives the most conservative answer. In reality some roads in each classification may be surveyed in a manner that provides a mixed set of answers relative to the 1990 values. It is also true that the survey team develops a "calibrated" view of the field conditions and tends to rate high or low in the required areas on

a uniform basis during their time for surveying a given county.

The research staff was also asked to look at the relationships between the needs for the farm to market and local or area service roads in the study. The computer analysis separates the needs by functional classification and therefore the relationships can be made directly in the output values or viewed graphically or in tabular form. Generally the sensitivity of changes in the individual variables effected the total needs proportionately across the classifications. In a time of decreasing revenues, it may be wise to consider the amount of effort spent in data collection on each classification in proportion to the amount of total needs being developed for that portion of the system.

## CHAPTER 5

### RESEARCH RESULTS

The results of this work were developed in three ways. Output in the form of graphs, tables and listings were developed. To meet the objectives of this study, the results of the tests are presented here in the form of summary tables to illustrate the percentage change from the 1990 study due to changes in a selected input variable. Graphs were constructed for each roadway functional classification and a total of all classes. The graphs associated with the ADT, road and structure condition, and cost area assignment for each county are included in the Appendix of this report.

**Table 2 Percent change in needs due to changes in ADT**

County	Freeway		Expressway		Trunk		Trunk Collector		Area Service		Total	
	0.5	2.0	0.5	2.0	0.5	2.0	0.5	2.0	0.5	2.0	0.5	2.0
ADT change (multiple)												
Adams					0	275	-39	52	-8	38	-18	63
Black Hawk	-5	132	-29	22	-25	58	-25	39	-22	45	-23	45
Butler					-18	72	-32	38	-18	50	-20	55
Des Moines					-33	36	-29	61	-22	70	-28	58
Iowa			-10	42	-18	76	-27	35	-15	40	-20	46
Jones					-8	23	-23	46	-19	46	-17	39
O'Brien					-10	27	-21	42	-9	52	-13	46
Scott					-25	130	-24	125	-25	90	-22	110
Webster					-19	28	-15	45	-12	47	15	42

Information presented in Table 2 represents the effect of changes in the traffic or ADT (average daily traffic) on the total needs of a county. The analysis varies the amount of traffic from the 1990 value (assumed as unity) to values of one half the base value to double the base value. This analysis is based on the following assumptions relative to county roads:

1. Traffic surveys are completed on a four year cycle at optimum on paved roads and at a lesser rate on granular and earth surfaced routes.
2. Individual routes may experience large changes in traffic in a four year period due to economic development or changes in traffic patterns due to improvements or disruptions in other parts of the county and state road system in the general area of the route.

3. Traffic increases or decreases uniformly across the county system.

Traffic changes can be very dramatically effect the needs as shown in Scott County where increasing traffic 50% from 1990 results in a 100% increase in needs for each of the functional classifications. Large changes in needs are noted in Black Hawk County for the freeway and expressway classified mileages. Relatively low traffic volumes on these segments is allowing the classification to control the need rather than the traffic at that level. Low traffic volumes also reduce the overall increase on the system needs for the county.

The values in Table 3 represent the result of varying the condition of the road components in increments of one from minus two to plus two for each of the components (foundation, surface, drainage, shoulder) simultaneously. This analysis assumes the following:

1. Overall pavement condition deteriorates uniformly between components.
2. Rating is accomplished by use of the SHRP manual reference system and the Iowa DOT manual guidelines.
3. Process replicates the variability in raters and survey time and site conditions.

Graphical representations of the data shown in Table 3 indicate that changing the condition rating factors for all counties causes dramatic impacts on each of the highway classification needs. A reduction in condition on the trunk

**Table 3 Percent change in needs from changes in road condition ratings**

County	Freeway		Expressway		Trunk		Trunk Collector		Area Service		Total	
	-2	2	-2	2	-2	2	-2	2	-2	2	-2	2
Condition value change												
Adams					480	-10	35	-25	55	-5	95	-10
Black Hawk	55	-30	400	-25	150	-70	18	-57	14	-30	49	-50
Butler					125	-55	115	-30	42	-30	85	-35
Des Moines					102	-20	33	-15	40	-18	55	-18
Iowa			650	-50	280	0	32	-15	33	-15	92	-10
Jones					55	-65	11	-15	4	-30	22	-38
O'Brien					510	-50	138	-15	55	-20	150	-20
Scott					450	-50	82	-20	45	-3	150	-20
Webster					175	-50	35	-45	35	-20	70	-35

roads causes the needs to increase very sharply. An increase in condition rating for the same classification causes large negative changes in the needs. Similar but less dramatic changes are shown in the trunk collector and area service classifications. This difference in change is attributed to the functional classification, construction guides, and assigned unit construction costs associated with a given classification. A limited number of improvements can be made to an area service road while the computer considers a greater number of alternatives for the trunk road. Thus with more alternatives as available in the trunk classification, there will be a larger change.

A two point increase in the condition factors often indicates a perfect condition score and directs the computer to simulate no

need for a pavement improvement.

In several instances a two point decrease had less of an impact than did the one point decrease. It was determined by reviewing the deficiency and improvement section of the output that the original rating values were low enough that additional decreases in condition cannot increase the amount of needs. In many cases this would indicate that reconstruction is being called for in the base case and lowering the rating cannot change the outcome. In comparing changes made to the individual condition ratings for the control county, Butler, it was noticed that an increase in the condition rating, which would lead one to think there would be a decrease in need, caused a greater need than originally. This change occurred because the increased condition no longer controlled the deficiency module of the program. A deficiency which had a larger cost of improvement now became the controlling condition thus causing an increase in the need.

Table 4 indicates the results of making combined changes in condition and traffic simultaneously. This alternative was examined to simulate the situation where traffic is over estimated and the pavement condition was over estimated in the field surveys. To accomplish this, the traffic was reduced by one half of the 1990 value and the condition was varied between minus two and plus two points from the 1990 values.

This analysis resulted in similar needs trends to those obtained from one variable. The magnitude of the changes was reduced approximately 10% due to the combination of variables.

**Table 4 Percent change in needs from changes in pavement condition and traffic**

County	Freeway	Expressway	Trunk	Trunk Collector	Area Service	Total
	%Needs change per point increase in condition and reduction in traffic by 0.5					
Adams			-17	-44	-11	-21
Black Hawk	-35	-56	-70	-66	-43	-58
Butler			-49	-41	-35	-41
Des Moines			-54	-33	-35	-39
Iowa		-44	-29	-34	-27	-29
Jones			-73	-30	-41	-49
O'Brien			-55	-29	-21	-28
Scott			-56	-38	-27	-37
Webster			-61	-47	-26	-41

The needs study also identifies large needs associated with the construction and maintenance of structures such as bridges and culverts. Table 5 illustrates the results of varying the condition ratings for each structure in the county. The condition ratings for structures include ratings for substructure, superstructure, deck and channel for bridges and culvert and retaining wall condition for culverts. The following assumptions were used in the study analysis:

1. The items of substructure, superstructure and deck ratings for bridges and culvert ratings were considered in the analysis. Channel and retaining wall elements were omitted from this analysis due to their small impact on the results.

**Table 5 Percent change in needs from changes in structure condition ratings**

County	Freeway		Expressway		Trunk		Trunk Collector		Area Service		Total	
	-2	2	-2	2	-2	2	-2	2	-2	2	-2	2
Condition value change												
Adams					16	-47	15	-57	27	-16	21	-33
Black Hawk			0	-75	34	-38	38	-25	22	-12	30	-24
Butler					50	-28	12	-25	40	-12	35	-21
Des Moines					9	-45	46	-23	48	-1	30	-25
Iowa			5	-82	18	-37	18	-38	16	-5	18	-23
Jones					23	-42	25	-45	63	1	38	-28
O'Brien					85	-65	38	-42	18	-16	35	-30
Scott					22	-55	19	-50	59	-27	33	-45
Webster					30	-40	82	-25	16	-7	35	-25

2. All parts of the structure deteriorate at the same rate.
3. Bridge load ratings were held constant. Ratings would be reduced as the structure deteriorates, but this would not be decided by the needs study survey process.
4. All components were increased or decreased in increments of one simultaneously in a range of minus 2 to plus 2.

The results shown in Table 5 indicate the sensitivity of the total needs for a county to changes in condition of all structures in a county. Changes of 30-50% in needs can be obtained by changes of one point in the condition ratings. This could account for some of the major shifts in needs in counties which have large numbers of bridges versus those with few bridges. The data indicates that the changes are moderated outside the minus or plus

one values due to the step functions associated with rehabilitation of structures. Rehabilitation procedures considered in the cost functions move from inexpensive maintenance operations to total reconstruction of a portion or all of the structure due to a small change in the condition ratings.

**Table 6 Percent change in needs from changes in construction cost area assignment**

County	Freeway		Expressway		Trunk		Trunk Collector		Area Service		Total	
	17	23	17	23	17	23	17	23	17	23	17	23
County Cost Area ( )												
Adams (4)					-10	55	-17	33	-10	59	-12	50
Black Hawk (18)	-20	27	-23	28	-8	30	-7	35	-19	33	-12	34
Butler (16)					-7	35	-8	44	-5	62	-8	50
Des Moines (10)					-24	15	-25	15	-28	20	-27	17
Iowa (11)			-18	32	-22	30	-20	25	-22	32	-22	30
Jones (10)					-24	12	-17	13	-28	17	-27	15
O'Brien (17)					0	62	0	62	0	81	0	75
Scott (23)					-38	0	-37	0	-41	0	-40	
Webster (18)					-11	28	-11	35	-22	32	-16	33

Table 6 represents the analysis of changes in the cost area factors assigned to each county in the needs study analysis. Cost area factors are assigned based on the representative unit costs for construction, maintenance, and administration in each county. Input data is requested for various types of construction and maintenance to establish the unit costs. Cost areas are currently

assigned from comparing unit costs for construction and maintenance provided by each county in preparation for the study. The Office of Advance Planning staff compares the data provided and attempts to develop data for those missing areas.

The analysis considered the following assumptions:

1. The current analysis allows for some 23 separate cost areas to be assigned to the 99 counties.
2. The 1990 study assigned the highest unit costs to area 23 and the lowest unit costs to area 17.
3. Needs were calculated using the 1990 cost area assignment and comparing those values with the extreme values obtained from using cost areas 23 and 17 for each county. Where the test county cost area number was less than 17, tests were conducted at a cost area value of one higher and one value lower than the test county assignment. For example Des Moines county was assigned a cost area of 10. It was tested at cost area 9 and cost area 11. Changes in cost area assignments have resulted from the study of unit costs in several of the recent studies.

The results of this analysis indicate that the assignment of cost area factors can have a dramatic effect on the results of the study. Cost area factors can be the reason for the large differences in needs. It is important that changes in cost area assignment only be made when specific documented information warrants such changes.

A noted concern of the advisory committee was the accuracy of the traffic count. To accommodate this into the study the ADT and percentage of trucks were adjusted and tested. The ADT was factored by 0.5 and 2. It is realized that a traffic change of this nature may not occur frequently, but it was used to determine the sensitivity of the program in shifting roads into a different highway class. The changes from the actual study by factoring the ADT were as expected, but to a larger percentage.

The percentage of truck traffic was increased by 5 and 10 percent. Although this caused no change in the study, further study may be necessary to fully determine the impact of trucks on the program process. The program uses the percentage of trucks to determine deterioration rates that are used to calculate deficiencies. It was felt that if the percentage was higher the deficiency rates would be higher thus leading to the need for more of an improvement. Additional effort may be required to relate the percentage trucks to an appropriate deterioration rate for the road and bridge surfaces.

The research staff reviewed the January 1, 1993, "Manual of Instruction for Rural Secondary Road Inventory" [1] that is provided to each of the field staff involved in the annual study of portions of the state and local system of roads. This manual provides instruction on the conduct of the study by a crew of three persons that is given limited training prior to conducting the study in their area. The review pointed out certain items of information that are excluded that can have an effect on the

outcome of the survey and the overall statewide results.

Advances in the evaluation of pavement surfaces have resulted from various federal initiatives such as the Strategic Highway Research Program (SHRP). These efforts have identified the importance of consistent survey measurements and developed new survey methods to provide more consistent field pavement condition surveys.

The Iowa manual does provide a very good overall set of instructions for conducting the pavement survey. It also lacks some of the details that could improve the quality of the data being collected. The following observations were made regarding such improvements that should be considered.

The General Inventory Procedures (page 2), does ask the survey crew to identify the direction of travel on the route being surveyed. It does not include information on the time of day, location of the sun relative to the survey vehicle and the general visibility of the pavement surface. Most of the Iowa surveys are conducted during the winter months. Pavement surfaces may be partially covered with snow and defects such as cracking are very difficult to identify under these conditions. The location and intensity of the sun relative to the observer can also cause large variations in the resulting condition rating assigned to the surface condition. Surveys conducted in the spring months (March, April, May) would indicate the most severe condition ratings and reflect the same conditions being monitored for structural capacity by the Department of Transportation. The key to any

survey time is the collection quality pavement condition data at the same time each year and similar enviromental conditions that allow the rater to see all defects.

Sight Distance Measurement (pages 9-12) considerations provide an opportunity for large variations in the mileage recorded by individuals. This may be an area that is more accurately measured on as built construction plans or by the use of the photolog type van with grade and distance measuring equipment.

Foundation, Surface, Drainage, and Shoulder Condition Ratings (pages 13-16), provide the surveyor the opportunity to select values between 0 and 10. This type of rating system was adequate when the needs study process was initiated and the process was aimed at developing a paved system of county roads. The system is now in place and the emphasis is on evaluation of existing pavement condition. The rating system must be revised to reflect the distress type that is apparent in foundation, surface, drainage and shoulder and the extent and severity of each. The 10 point system can be retained with greater details provided for the selection of the appropriate value. The strategic highway research program pavement evaluation manual and the rating system developed by Iowa State University for Local Road and Street Pavement Management are examples of evaluation systems that could assist in this effort. The Iowa DOT staff has indicated that the SHRP manual is being utilized in the process, but it could be used to greater degree in the detailed analysis of the pavement and foundation ratings.

Analysis of the frequency of condition ratings for pavements indicates another area of concern. County road condition surveys (needs study surveys) are conducted on a 10 year recurrence interval. This allows for the same set of condition data to be used in as many as three consecutive needs study reports. Based on deterioration rates for Iowa pavements on the state system, this amount of time will allow the pavement to change approximately 10-20% in condition. This is not adequately accounted for in the current process.

Currently traffic is sampled on the major or paved routes in each county once in each four years. This appears to be adequate for those routes. This may be adequate in the rural counties, but may not be extensive enough in the urban areas to represent rapid changes in development areas. Minimal counts are performed on the granular and earth surfaced roads. This appears to be adequate for the majority of roads in this category, but additional counts should be considered for those granular surfaced routes exhibiting excessive travel and maintenance requirements.

## CHAPTER 6

### CONCLUSIONS

The results of the data analysis clearly point out the sensitivity to changes in traffic, road and bridge condition ratings and construction cost area assignment. The county Engineers' Association was interested in understanding the major reasons for large shifts in the needs in consecutive studies. The

data indicates that shifts in needs exceeding 30% can occur when one of more of the following conditions is present in a county:

1. Changes in traffic reduced by one half or doubled from the 1990 values.
2. Changes in road condition ratings between plus and minus two points of the 1990 ratings.
3. Changes in combinations of the road condition ratings and traffic factors.
4. Changes in structure condition ratings between plus and minus two points of the 1990 ratings.
5. Changes in the construction cost area assignment between consecutive needs studies.

## **CHAPTER 7**

### **RECOMMENDATIONS**

This study was designed to evaluate the sensitivity of various input items to the Quadrennial Needs Study process and make recommendations on ways that the process could be improved. The research staff recommends the following changes in the process to improve the equality between counties relative to their identified needs in any given study year.

1. Road Condition Surveys. The goal of these changes is to improve the continuity of the survey results, survey for items pertaining to the rehabilitation and improvement needs of the roadway and pavement and provide sufficient and factual data for compliance with

federal requirements of the Intermodal Surface Transportation Act (ISTEA). The process can be improved in at least three areas. First, the method of data collection should be reviewed for possible changes. The following alternatives represent some of the possible ways of improving the survey:

- a. Utilize an automated survey vehicle with forward and down looking cameras and automated pavement data reduction to assist in the analysis. This can be the same type of vehicle being considered by the Iowa DOT as a pavement management vehicle, the existing photolog van, or a rent/lease arrangement with private vendors. The Vehicle could be used on one half of the state each year to evaluate all of the paved system. This correlates well with the current requirements for data for the National Highway System designated for the ISTEA fulfillment. If all paved miles are included, it would include some additional mileage in each county and city.

A team composed of an Iowa DOT District Transportation Planner (or DOT Transportation Center representative), a representative from the county, and the regional transportation planning agency will sample (10%) the granular and earth surfaced roadways using the Corps of Engineers

survey methods and convert the data to the ten point scale for the needs study process. A composite value will be used to separately represent all granular and earth surfaced roads in the county. The studies will be conducted in the counties which are being surveyed by the automated survey vehicle.

- b. Survey all paved mileage in each county visually by an Iowa DOT District Planner (or DOT Transportation Center representative), a representative of the county, and regional transportation planning agency, on a biennial basis. The team will use the SHRP Pavement Distress Manual to evaluate the type, severity, and extent of each distress present. The total distress will be converted into the ten point scale required for the needs study program using the Iowa DOT specified pavement management program.

The same team will sample (10%) the granular and earth surfaced roadways using the Corps of Engineers survey methods and convert the data to the ten point scale for the needs study process. A composite value will be used to separately represent all granular and earth surfaced roads in the county.

c. Utilize the existing study team process, but increase the rate of surveys to two year interval. Train the survey crews to use the SHRP Pavement Distress Manual to evaluate the type, severity and extent of each distress present. The total distress will be converted into the ten point scale required for the needs study program using the Iowa DOT specified pavement management program.

The team will sample (10%) the granular and earth surfaced roadways using the Corps of Engineers survey methods and convert the data to the ten point scale for the needs study process. A composite value will be used to separately represent all granular and earth surfaced roads in the county.

Regardless of which method of survey is employed, surveys should be scheduled to provide needs study data that is obtained no longer than two years prior to the study analysis input data set being formed. The process should strive to utilize the same trained raters in successive studies in a given DOT district and regional planning area. The SHRP process also indicates the need for consistency in the time of survey, direction and lighting conditions. This suggests that the surveys be done in the same direction, time of year and same lighting conditions each survey across the county and regional planning area. The surveys should

be considered for spring (March - May) when the pavements are clear and distresses are readily visible.

This portion of the recommendations should be implemented between 1993 and 1996 to provide improved data for the 1998 need study process. The method of data collection may be phased in over two consecutive needs studies to move from the current method to an improved manual data collection to automated data collection and analysis of condition for roads. Testing of automated methods is recommended for 1994-1996 to determine the proper equipment to purchase or lease for this purpose. During the same period the Department of Transportation staff and the Iowa County Engineers Needs Study Committee should agree on the distresses to be measured and the methods to be used to input the field data into the needs study software. Automated field survey equipment for the paved portions of the Iowa state, county and city systems should be considered for implementation as early as 1998.

It is recommended that funding for any of the survey methods identified be obtained from existing survey funding and other planning monies identified in ISTEA for monitoring of the National Highway System.

2. Structural Condition Surveys. The goal of these changes is to bring about continuity of condition ratings from survey to survey and with the requirements of ISTEA. The Iowa Department of Transportation is currently implementing the PONTIS bridge management system. As part of this effort and the continuing efforts to the

Federal Highway Administration and its National Bridge Inspection program, detailed inspections are being carried out on each bridge on the federal aid system on a predetermined schedule. It is recommended that the PONTIS system of inspections be conducted on all bridges with reduced amounts of information being considered on local, area service road bridges. Information gained in those surveys should be converted to the values necessary for the needs study program to utilize. This eliminates duplicate inspections and provides uniform data for all levels of government to use in funding requests.

This portion of the recommendations can be implemented between 1993 and 1998 to provide PONTIS quality input values for structural condition on each structure for the 1998 needs study. It will require coordination between the Iowa DOT Office of Maintenance, Office of Local Systems, Office of Advance Planning and the Iowa County Engineers Needs Study Committee to determine and implement both the changes in the inspection procedures and the development of the input items for the 1998 needs study analysis.

3. Cost Area Assignment. Changes are aimed at strengthening the basis for area assignment and providing continuity over time and consecutive studies.

a. Utilize the data gathered by the Iowa DOT, from each county, for the 1990 and 1994 studies as a basis for assignment of the future cost areas.

Consider expansion of the existing number of cost areas to properly identify individual problems in each county. This may require up to 99 separate cost areas. Utilize the Iowa County Engineers Needs Study Committee, and representatives of the Office of Advance Planning and Local Systems to develop the cost area assignments.

- b. Future changes in individual cost area assignment could only be made in one of two ways. First all counties in a given cost area could receive an increase or decrease in unit cost factors. Secondly a county could petition the Iowa DOT for a shift to another cost area. In either case the decision would be made jointly by representatives of the Iowa DOT Offices of Advance Planning, Local Systems and the Iowa County Engineers Needs Study Committee based on information provided by one of the parties or individual counties.

This portion of the recommendations can best be implemented for the 1998 needs study based on local government cost information gathered for the 1994 and 1998 studies. Care should be exercised in the 1994 study to retain the 1990 cost area assignments where possible to reduce the potential for shifts due to cost area assignment.

4. Traffic Counts. Traffic volume counts appear to be adequate for the local roads in terms of frequency (4

years) and amount of information gathered. Current counts for paved roadways should be supplemented with additional traffic volume and vehicle distribution counts to provide details on the use of that system for planning purposes and the needs study program. Such counts should be made no longer than two years prior to each need study and on a two year cycle on each segment of the paved system representing a significant change in traffic volume or mix.

Support for this type of count process will require increased work effort. It is recommended that the regional planning agencies be trained and provided equipment to obtain the raw data and the analysis be done by trained Iowa DOT personnel to provide economy of effort and funding. Funding for this activity should be obtained from the same ISTEA planning monies as used for the condition surveys and could be implemented prior to the data collection for the 1998 needs study.

5. Functional Classification Changes and Jurisdictional Transfers. Functional classification changes made at the county level must be forwarded to the Iowa DOT Offices of Advance Planning and Transportation Inventory prior to the year of the needs study analysis to be considered in the study analysis. Jurisdictional transfer agreements that include transfer of funds for the improvement of the condition of an existing roadway or structure must be considered

in the individual county needs. It is recommended that the amount of funds transferred be manually deducted from the total county calculated needs if the records indicate that the work has not been accomplished at the time of the latest condition survey and prior to the needs study analysis.

This activity requires implementation through good communications between each of the parties involved in jurisdictional transfers and functional classification changes to provide manual adjustments to the needs study analysis. Accurate records of classification changes, jurisdictional transfers and transfer of funds should reduce the chance for problems in this area.

6. Maintenance Costs and Factors. Future research is recommended to determine the level of service required for each functional classification on the county system of roads and structures. The research should address what level of effort and costs are required for a given classification and public perception as compared to available funding levels.

## REFERENCES

1. Manual of Instruction for Rural Secondary Road Inventory, Iowa Department of Transportation, January 1993.
2. Quadrennial Need Study Report on Highways, Roads, and Streets, Iowa Department of Transportation, 1978, 1982, 1986, 1990.