MRI REPORT

CRITERIA FOR THE EVALUATION AND DISPOSITION OF LOW-TRAFFIC-COUNT SECONDARY ROADS

FINAL REPORT
February 7, 1969

MRI Project No. 3205-P

Iowa Highway Research Board
Project HR-139

For

Iowa State Highway Commission
Ames, Iowa

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MIDWEST RESEARCH INSTITUTE 425 VOLKER BOULEVARD, KANSAS CITY, MISSOURI 64110 • AREA 816 561-0202

PREFACE

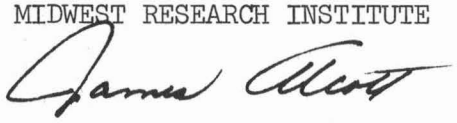
This report presents the findings of our analysis of Iowa secondary roads. The principal focus of the research was on the formulation of criteria and systematic procedures for identifying and evaluating low-traffic-count roads for consideration for vacating action. For purposes of demonstration, the procedures were applied to 3,421 roads in 10 sample counties, and the results of the demonstration have been provided to the Iowa State Highway Commission and to the respective sample counties. The report also includes our findings and conclusions relating to road closure or vacation, along with our recommendations regarding implementation of the road evaluation procedures.

Many members of the Institute staff participated in this research program. Principal contributors include Walter R. Benson, Richard L. Salmon, Lawrence L. Carter, Bruce W. Macy, Jeanne Robertson, Sharon Starks, Linda Crosswhite, and Patricia Quinlan. Judge John L. McKinney of Ames, Iowa, acted as legal consultant.

The excellent cooperation and assistance we received from state and county officials and employees is gratefully acknowledged. We are especially indebted to Mr. Stephen Roberts, Research Engineer, Iowa State Highway Commission; Mr. Robert Anderson and Mr. Harry Budd of the Needs Study Group; and Mr. Phillip Spangler, Iowa Department of Public Safety. In citing these individuals, we recognize that many others contributed valuable information, suggestions, insights, and constructive criticism for which we are extremely grateful.

Approved for:

MIDWEST RESEARCH INSTITUTE



James Alcott, Director
Economics and Management Science Division

February 7, 1969

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I. THE SECONDARY ROAD PROBLEM

The State of Iowa has too many roads. Although ranking thirty-fourth in population, twenty-fifth in area, and twentieth in motor vehicle registration, it ranks seventh in the nation in miles of rural roads. In 1920 when Iowa's rural population was 1,528,000, there were 97,440 miles of secondary roads. In 1960 with rural population down 56 percent to 662,000, there were 91,000 miles of secondary roads--a 7 percent decrease. The question has been asked: "Who are these 'service roads' serving?"

This excess mileage tends to dissipate road funds at a critical time of increasing public demand for better and safer roads.

A. Historical Background

The excessive secondary road network is typical of several mid-western states and is a relic of an earlier American era. When the nation's population was largely rural, small family farms were the rule and the people were close to the land. Even into the Twentieth Century the mid-western economy and demography necessitated the sectional grid road network. The revolutionary advances in agriculture coupled with the mass migration to the cities during and after World War II dramatically altered the agrarian picture.

Tne extensive secondary road network no longer serves the large number of farm families resident on their quarter sections. Farmland ownership patterns have changed. Farms have become larger. Perhaps more important, the de facto farm, that is, the entirety of lands farmed by one individual or enterprise via owning, leasing, renting, or share-cropping arrangements, has greatly increased in size. The result is that many secondary roads have over many years become only marginally useful. They once carried farm produce to market and made the economic, social, and cultural advantages of the towns and cities available to the rural population. Now many of these roads serve few people and are of such marginal value that a serious question arises as to whether these are "public" roads in the functional sense. Legally of course they remain "on the books" and are a responsibility and drain on the county.

Events and trends of the last several years have made it imperative to reexamine the need for the great number of secondary roads in the state. Of major concern is a large disparity between projected road maintenance costs and available road funds. Public opinion, and the federal government, are bringing increasing pressure for safer roads, and the passage of the 1965 and 1967 Torts Claims Acts opened the state and county

governments to civil suits for liability damages due to unsafe road conditions, among other things. Thus the continued existence of roads of marginal utility must be called into question. Obviously many should be vacated.

Road vacating in Iowa (with a few notable exceptions) has been a county responsibility approached with great apprehension. The County Board of Supervisors is an elective body quite vulnerable to political pressures. There is often a lack of legal and administrative support for a Board when they represent the general public against a narrower interest in such actions. There is also an incomplete understanding of the legal implications of vacating actions. Often, raising the "bogey-man" of a civil suit is sufficient to cause vacating action to cease forthwith.

If Iowa road mileage is to be reduced to manageable proportions, the counties must have legislative, administrative, legal, and technical assistance including a sound, structured, and defensible procedure for selecting and vacating roads. This study report presents such procedures, means of employing them, and supporting research findings.

B. Study Objectives

The objectives of this research study were to describe the conditions which warrant closure or vacating of county roads, and to suggest legislation that would facilitate such action. These objectives were achieved with full consideration for: the continuity or network effects of the county road system, possible increased user cost and inconvenience to the traveling public, cost of maintenance of roads at current level, possible future costs of upgrading roads to higher safety standards, use and value of land released from public road use, legal rights and possible claims from property owners, and legal rights of utility companies.

C. Method of Analysis

The first step of the analysis was to research the literature and gather data on the experience of other states and of counties within Iowa. A listing of significant references is presented in Appendix A. A survey questionnaire was mailed to 47 states (all mainland states except Iowa), of which 32 responded. (See Appendix B for a summary of responses.) This survey covered a broad spectrum of the elements bearing on the problem. Results indicate that no one has concentrated on this problem heretofore.

Seven fact-finding trips were made by the authors to discuss secondary road problems and inspect typical roads with county and state highway engineers and officers.

A statistical sample of 10 Iowa counties was selected. (See Appendix C.) A Road Evaluation Model (see Section III and Appendix E) was formulated, and road data on low-traffic-count roads were derived from plat books and highway and traffic maps. Computer programs were developed and used to analyze these road data.

The elements of road costs--maintenance, improvements, and liability risk--were assessed from Needs Study Files and from records at the Iowa Department of Public Safety, Des Moines. These aspects are discussed in detail under III-B and III-C below and in Appendices F and G.

Legal research on tortuous liability of Iowa counties, power to vacate secondary roads, compensation of damage, legal rights of utilities with respect to vacating roads, and possible legislation to facilitate vacating actions was performed at MRI's Washington, D. C., office and in Iowa. The findings are given in Appendix H.

II. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

It was the objective of this study to address two aspects of this problem of excessive road mileage--the determination of legal impediments and the development of criteria with which roads could be evaluated for disposition.

An implied objection was a systematic plan of action for evaluating and disposing of low traffic-count roads.[1/]

Major results of this study are--road value criteria and a model for their application. A concise, systematic plan is laid out under II-C "Recommendations."

A. Findings and Conclusions

There are no impediments in law to secondary road vacating action, although there is a need for legislation that will either define a "public road" functionally or empower some authority to do so.

There is nothing in the Iowa Code that establishes the functional characteristics or benefits that must attach to a road to justify its retention and attendant costs to the general public.

The measurement of the relative value of a road can be based on objective, physical facts. The Road Value Index developed in this study provides a realistic basis for measuring the relative value of any road.

The only possibility of reducing the controversy that is inherent to this problem will lie in (a) basing the measurement of road value on physical facts such as number of abutting ownership tracts, average daily traffic count, etc., and (b) uniform, objective, and accurate application of the evaluation system statewide. This points toward a central, computer-supported clerical facility which might be furnished by the Iowa State Highway Commission.

Road maintenance and improvement costs account for by far the greatest portion of total costs associated with any road.

Road maintenance and improvement costs historically incurred by most Iowa counties are less than those required to bring roads up to adequate

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1/ For this study, "low-traffic-count" is defined as Average Daily Traffic count less than 30. A road, road segment, or road link is defined as that portion of a road between two junctions, or from a junction to a terminus.

safety standards. Very significant future costs may be avoided by abandonment of low-value roads.

Liability risk is not a significant factor in vacating decisions.

We find that the direct liability risk (accident damage) costs associated with the secondary road system are not great. The real, out-of-pocket costs for this risk are some portion of the county comprehensive liability insurance premium. It is very doubtful that vacating even a large number of roads would affect this premium. This conclusion is supported by detailed analysis of highway accidents occurring on secondary roads.

However, the indirect cost of accident damage and fatalities is considerable. This indirect cost derives from the public demand for better and safer roads. The implied higher safety standards result in much higher road costs.

Roads with an ADT greater than 30 are relatively valuable and significant elements of the secondary road network.

In our evaluation and screening process, roads with ADT greater than 30 are first eliminated from consideration. These roads generally have attributes that make them relatively valuable links in the county network.

A measure of road value can be developed for determining the value of a road relative to all other roads.

This measure of road value, the Road Value Index, is based on known facts about the road use and access requirement features of the road. Procedures for constructing the RVI can be applied uniformly to all low-traffic-count roads, using readily available data.

Roads with a Road Value Index of less than 50 are of marginal utility.

Roads with a Road Value Index of less than 50[1/] characteristically serve only a few farm units and thus represent good candidates for vacating action. We estimate, based on a careful analysis of 3,421 roads in 10 counties, that there are more than 3,000 miles of roads in the state with a Road Value Index equal to or less than 50. Roads in the below 50 RVI category are characterized by the following:

1/ Any change in the factors on weights used to construct the RVI might alter this cut-off index value of 50.

Average length	= 0.53 mile
Average number of occupied residences	= 0.31
Average daily traffic count	= 11.7
Surface type	= 41% dirt 59% gravel

Figure 1 shows the estimated cumulative distribution of secondary road miles as a function of the Road Value Index. Ultimately, most of these roads could and should be vacated, but the political and administrative impact on some counties would be too great to attempt at one time. Therefore, a priority ordering is necessary.

The efficiency or cost-effectiveness of a road may be judged by the ratio of anticipated future costs to the value or benefits provided.

Since all the roads with RVI less than 50 are candidates, the list of roads in descending Cost/Value sequence constitutes a priority list. This gives priority for vacating action to those roads which cost most for benefits yielded.

Using the Road Value Index as a measure of value or benefit of a given road, we derive the Cost/Value ratio as a measure of the relative cost to the road agency of providing that value or benefit. For example, a road that provides one access to a farm land tract is assigned a value of 5 points; if this is the only benefit provided by the road and it will cost $2,000 to maintain and improve this road for the next 20 years, we compute a $400 Cost/Value ratio. Figure 2 shows the estimated cumulative distribution of miles of low-traffic-count roads as a function of this Cost/Value ratio. It is evident that the costs of many of these roads are out of proportion to the benefits they provide.

Generally, roads which are serious candidates for vacating contribute very little to the county road network.

Analysis of county road networks discloses that through traffic is very little inconvenienced by vacation of the low-value roads.

Political and administrative considerations have inhibited the vacating of roads.

In practice, the road vacating process is not being fully utilized. A few counties have undertaken an effort to find and eliminate those roads that they feel do not justify the expenditures of public funds. However, for the most part, roads are considered for vacating by the county only

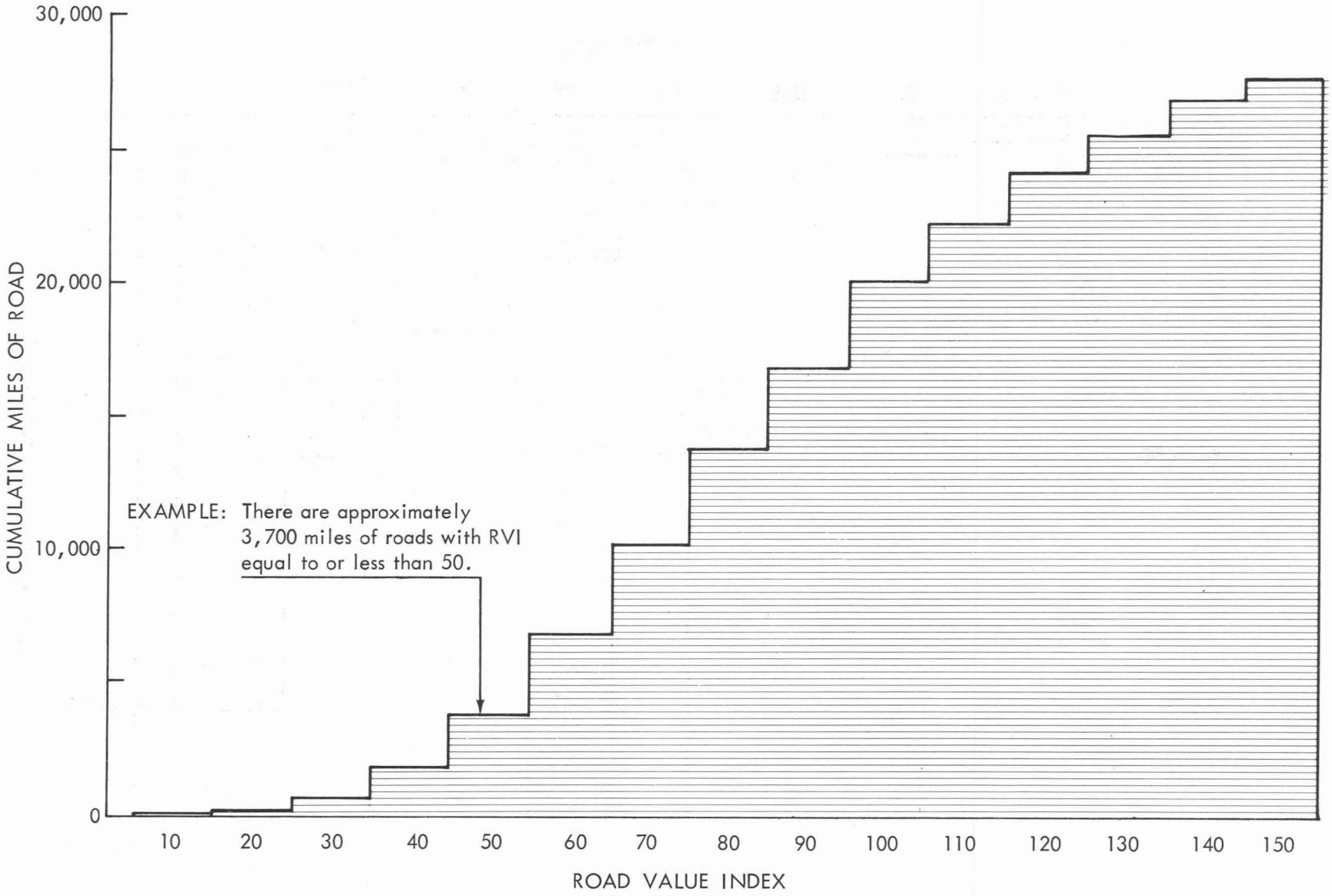


Figure 1 - Cumulative Distribution of Iowa Secondary Roads by Road Value Index
(Estimated from 10-County Sample)

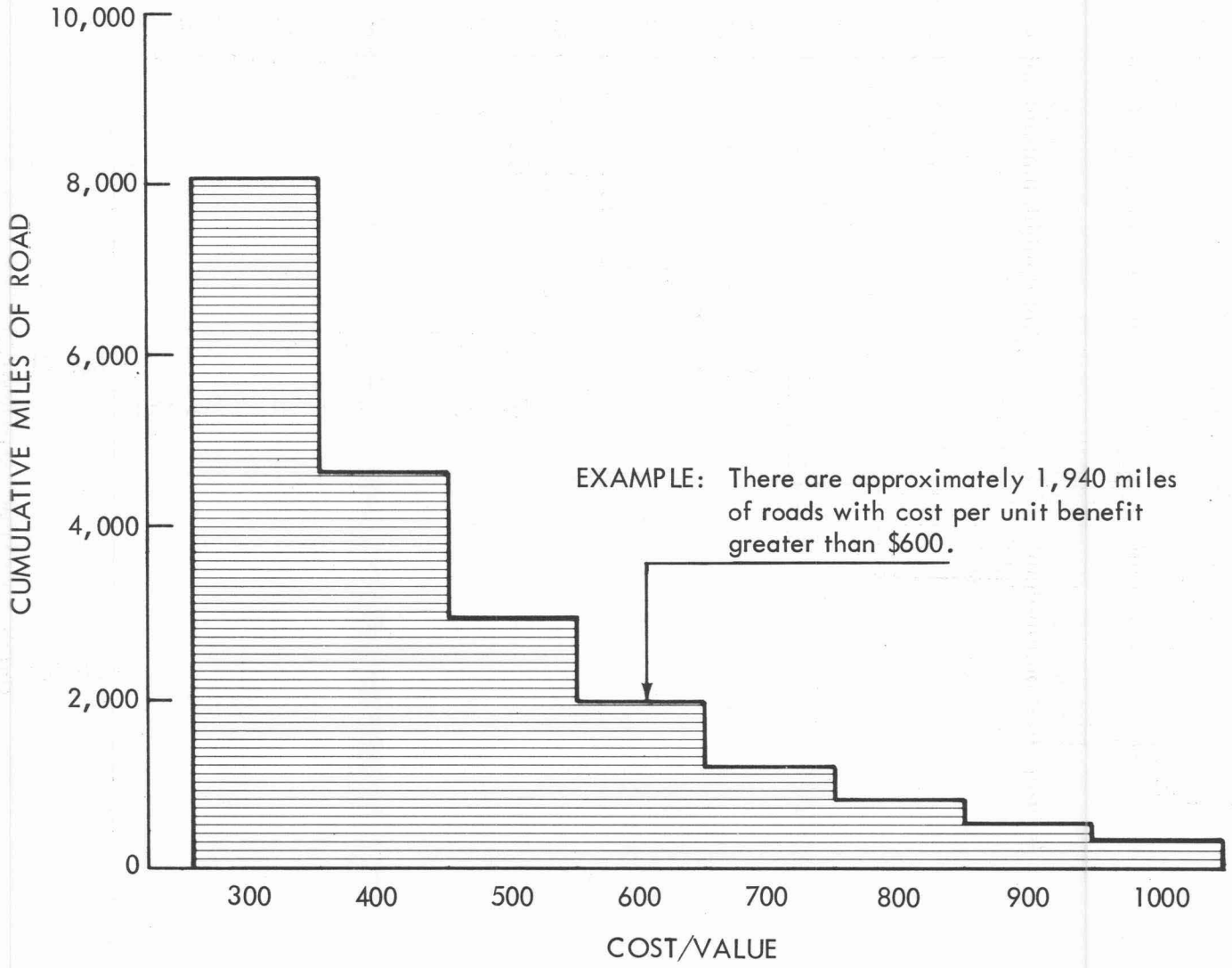


Figure 2 - Cumulative Distribution of Iowa Secondary Roads by Cost/Value Ratio
(Estimated from 10-County Sample)

when the landowners along the roads request the action of the county. This rather passive action on the part of the counties results in only a few miles of road vacation each year for the entire state.

The public has little understanding of the legal authority, basis of claims, or implications of vacating roads.

There is little public appreciation for the cost implications of the improved road standards.

Road vacating procedures impose an administrative burden on the county.

The long-term trends in population and land ownership patterns in rural Iowa affect traffic patterns and hence the value of secondary roads.

These trends result from population migration to the cities, from consolidation of farm lands, from more efficient farming methods, and from increasing farm mechanization.

B. Recommendations

On the basis of these findings and conclusions we make the following recommendations:

Amend Chapter 306 of the Code to create an Authority which would be empowered to establish criteria and procedures for adjudging the functional value of secondary roads. Further, that such Authority would periodically evaluate secondary roads, and such roads determined not to be of sufficient value would be vacated unless good and sufficient reason be shown to the contrary. The judgment of "sufficient value" would be a function of the Authority but would be based on uniform criteria, universally applied.

The recommended legislation would provide a structure and basis in law to facilitate the objective, equitable, and expeditious evaluation of all low-traffic-count secondary roads and would give the county governments the incentive and framework required to pursue the abandonment of those roads that are nonessential. The "Authority" recommended should be a professional body or have professional members who can appreciate the impact on the various counties, the available road funds, and the potential cost avoidance inherent in road vacating actions. Their judgment of "sufficient value" can be an assignment of a "cut-off" point for the Cost/Value ratio.

All low-traffic-count secondary roads should be evaluated under legally based criteria at intervals set by the Authority mentioned above. A tabulation of this evaluation should be furnished each county.

Procedures for selecting vacating candidates should be as follows:

a. Low-traffic-count roads should be defined as those roads that have an average daily traffic of less than 30.

b. Attention should be focused on roads with a Road Value Index of less than 50.

c. The Cost/Value ratio should be computed for each road. The Authority mentioned above should set a cut-off value. All roads with ratios above this value should be scheduled for final screening and vacating action.

d. County Engineers should perform a final screening for accuracy of data. County Engineers should eliminate candidates from vacating consideration where there are cogent technical reasons.

The low-traffic-count roads with a Road Value Index of less than 50 offer the greatest opportunities for vacation. The evaluation should focus on these roads.

A significant aspect of this evaluation is the assignment of road costs. To be effective, this cost assignment must be done objectively and uniformly. The Needs Study File represents one obvious source of uniform data.

As a final step in the screening process, the County Engineer's office should carefully examine data on the affected roads for accuracy. Network effects should now be carefully considered. These are discussed in detail in Section III-D below. Any road segments whose closure would create significant network problems or for which other cogent technical reasons exist should be removed from consideration. An example of the latter would be a low-value road which will play an important role in a planned future realignment of the road network. Details on all such roads removed from consideration should be communicated to the Authority.

Under proposed legislation, roads adjudged not of sufficient value to be functionally classified as "public roads" and with no technical reason for retention would be mandatorily considered for vacation. Existing legal procedures would be followed, and interested parties would be given an opportunity to show cause why the road should not be vacated.

Each landowner has a right in law to free and convenient access to the general system of roads from his land. However, this is not to be interpreted as a right to have a public road abutting his property. He merely has a legal basis for condemnation of an accessway.

By functionally defining what constitutes a "public road," there would be a basis for vacating roads which now exist only because of historical precedent. This action would not deny rights mentioned above since affected owners have due process to just compensation. Further, making implementation of these procedures mandatory does not abrogate the authority of the County Board of Supervisors since they continue to make the final, binding decisions. This mandatory consideration will, however, cause many low-value roads to be vacated that otherwise would remain in the road system.

The State Highway Commission should assemble and make available to requesting counties a team of administrative, legal, and technical specialists to assist in the vacating actions.

This assistance rendered by the state might include a discussion and explanation of the road evaluation process, an explanation and forecast of the outlook on road maintenance, standards, and costs, and a legal briefing just prior to the hearings. Because public support is essential, some form of public education or publicity is recommended.

Reevaluation of roads should be accomplished in the year following the periodic traffic count.

After the initial evaluation, reevaluation should be made every five years, with one-fifth of the counties being evaluated each year. ADT (Average Daily Traffic count) is an important criterion, and is taken every five years. The evaluation and subsequent vacating actions should be based on the latest available ADT data. Property ownership patterns, also an important criterion, vary little from year to year, but five years is likely to bring significant changes. Concentrating on one-fifth of the counties each year would spread the work load of the state support team.

C. Recapitulation

The following table (Table I) is a recapitulation of the conclusions and recommendations. In addition, the recommendations column is a concise, step-by-step recommended course of action.

TABLE I

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Area of Investigation	Findings and Conclusions	Recommendations
1. Legislative Action	1. There are no impediments in law to secondary road vacating action, although there is a need for legislation that will either define a "public road" functionally or empower some authority to do so.	1. Amend Chapter 306 of the Code to create an authority which would be empowered to establish criteria and procedures for adjudging the functional value of secondary roads. Further, that such authority would periodically evaluate secondary roads; and such roads determined not to be of sufficient value would be vacated unless good and sufficient reason be shown to the contrary. The judgment of "sufficient value" would be a function of the authority but would be based on uniform criteria, universally applied.
2. Road Evaluation Criteria		2. All low-traffic-count secondary roads should be evaluated under legally based criteria at intervals set by the Authority mentioned above. A tabulation of this evaluation should be furnished each county.
a. Road Value	2.a. The measurement of the relative value of a road can be based on physical facts. The "Road Value Index" developed in this study provides a realistic basis for measuring the relative value of any road.	
b. Road Costs	b. Road maintenance and improvement costs historically incurred by most Iowa counties are less than those required to bring roads up to adequate safety standards. Liability risk cost is not a significant factor in vacating decisions.	
3. Selection of Vacating Candidates		3. Procedures for selecting vacating candidates should be as follows:
a. ADT	3.a. Roads with an ADT greater than 30 are nearly always valuable and significant elements of the secondary road network.	a. Low-traffic-count roads should be defined as those roads that have an average daily traffic of less than 30.
b. Road Value	b. Roads with Road Value Index less than 50 are of marginal utility.	b. Attention should be focused on roads with a Road Value Index of less than 50.
c. Cost/Value	c. The efficiency or cost/effectiveness of a road may be judged by the ratio of anticipated future costs to the value or benefits provided.	c. The Cost/Value ratio should be computed for each road. The authority mentioned above should set a cut-off value. All roads with ratios above this value should be scheduled for final screening and vacating action.

TABLE I (Concluded)

Area of Investigation	Findings and Conclusions	Recommendations
3. Selection of Vacating Candidates (Concluded)		
d. Network Effects and User Inconvenience	d. Generally, roads which are serious candidates for vacating contribute very little to the county road network. Through traffic is very little inconvenienced by removal of these segments.	d. County engineers should perform a final screening for accuracy of data. County engineers may eliminate candidates from vacating consideration for technical reasons, such as those described in Section III-D.
4. Vacating Action	4. Political and administrative considerations have inhibited the vacating of roads.	4. Under proposed legislation, roads adjudged not of sufficient value to be functionally classified as "public roads" and with no technical reason for retention would be mandatorily considered for vacating. Current legal proceedings would be followed and interested parties given an opportunity to show cause why the road should not be vacated.
5. Vacating Assistance		
a. Legal	5.a. Many county supervisors as well as the general public have little understanding of the legal authority, basis of claims, or implications of vacating roads.	5. The State Highway Commission should prepare and make available to requesting counties a team of administrative, legal, and technical specialists to assist in the vacating actions. Publicity should educate the public whose support is mandatory.
b. Technical	b. There is little public appreciation for the cost implications of the improved road standards.	
c. Administrative	c. An extensive road vacating program would impose an administrative burden on the county.	
6. Periodic Reevaluation of Roads	6. There has been a gradual, long-term shifting of population and land ownership patterns in rural Iowa. This secular trend affects traffic patterns and, hence, the value of secondary roads. These trends will continue.	6. Reevaluation of roads should be accomplished in the year following the periodic traffic count.

III. THE ROAD EVALUATION MODEL

A. Measuring Road Value

Much effort was devoted to the question of how to determine the value of any given segment of road. A review of the literature revealed that very little had been done on this problem, particularly as it relates to the kinds of roads that were dealt with in this study. The highway departments of other states were contacted in an effort to determine how they have handled this problem. We found that a systematic approach is rarely employed. However, discussions with highway commission personnel and with officials at the county level provided information on current practices. These discussions, supplemented by a survey of Iowa County Engineers, also revealed that a number of different factors had to be taken into account in trying to assess the value of a road.

After experimenting with a number of different concepts, we concluded that the value of any given road segment is a function of two things--road use and access requirements.[1/] Each of these, in turn, is determined by a combination of other factors.

For example, road use can be measured in terms of volume of traffic. ADT (Average Daily Traffic count) provides a good measure of traffic volume. But traffic volume alone is not an adequate measure of road use, particularly on the low-traffic-count roads. Number and types of users also should be taken into account. Therefore, measures were developed to reflect different types of users, such as the farm family living on the road, the farm operator farming land abutting on the road, the individuals using the road to get to a church, cemetery, park, or other type of public facility.

One of the most important functions of a road, particularly the low-traffic-count road, is to provide access--access to farm residences, access to fields, and access to other types of facilities. Thus, the extent to which a road is required for access purposes is also an important factor determining the value of that particular road.

Specific indicators were chosen that would best measure the relative importance of the road with respect to road use and access requirements. The following factors were selected for use as measures of road use:

1/ Other factors such as maintenance costs, costs of bringing roads up to standards, risk, and other considerations are extremely important and are introduced at a later stage.

traffic count, number of abutting owners, number of residences, type of road (through road or dead end), school bus and mail routes, and other public or private nonfarm uses. These factors reflect the extent of road use and road users for any segment of road.

For determining road access requirements, the following factors were chosen: property ownership patterns; residences and their location; bridges, streams and other potential barriers; and other nonfarm public and private uses.

A survey of the Iowa County Engineers was made to validate the factors we had chosen.[1] Each engineer was sent a questionnaire indicating possible factors affecting road use and access, and was asked to indicate the relative importance of each of the factors and to suggest others. The results of this survey support and substantiate the selection of factors and weighting procedures.

All of the data needed to develop the Road Value Index can be obtained from published or readily available sources. For example, information regarding land ownership patterns is available from county plat books. Information regarding residences, rivers and streams, and bridges can be obtained from the Iowa Highway Commission's general highway transportation maps. The traffic-count data are presented on the motor vehicle traffic flow maps of the Highway Commission.

Some of the information is quite routine in nature--traffic count, number of residences, etc. Other types of information, particularly relating to land ownership patterns, are not so straightforward and require clarification. Definitions of some of these factors are presented in Table II, while Figure 3 illustrates the different types of ownership tracts.

The distinction between different types of ownership tracts is important in our analysis. For example, an owner of exterior property--one whose property abuts on two adjacent roads--is less likely to be inconvenienced by vacating one of the roads than is the owner who has access from only one road. Hence, this distinction is made in the initial coding so that appropriate weights can be applied to different ownership patterns at a later stage.[2]

Weights are applied to each road use and access requirements indicator. The weighted indicators are then combined into a single measure of road value. The resulting value measure--the Road Value Index--indicates the relative value of any given road with respect to other roads. Thus, the index makes it possible to rank roads according to their value.

1/ See Appendix D for a discussion of the survey results.

2/ For an explanation of the coding and data collection procedures, see Appendix E.

TABLE II

DEFINITION OF TERMS

Road segment: A separate stretch of road which is bound by either two intersections or by one intersection and a dead end.

Ownership tract: All contiguous land owned by one person, family corporation, partnership, estate, etc. As a special case, land which lies on both sides of a river or a road or some natural barrier is defined as contiguous.

Exterior ownership tract (EOT): An ownership tract which abuts on the road segment under consideration and on at least one of the intersections of the segment.

Dual access interior ownership tract (DA-IOT): An ownership tract abutting on the road segment under consideration and also on some other road segment which does not abut on any intersection of the road under analysis.

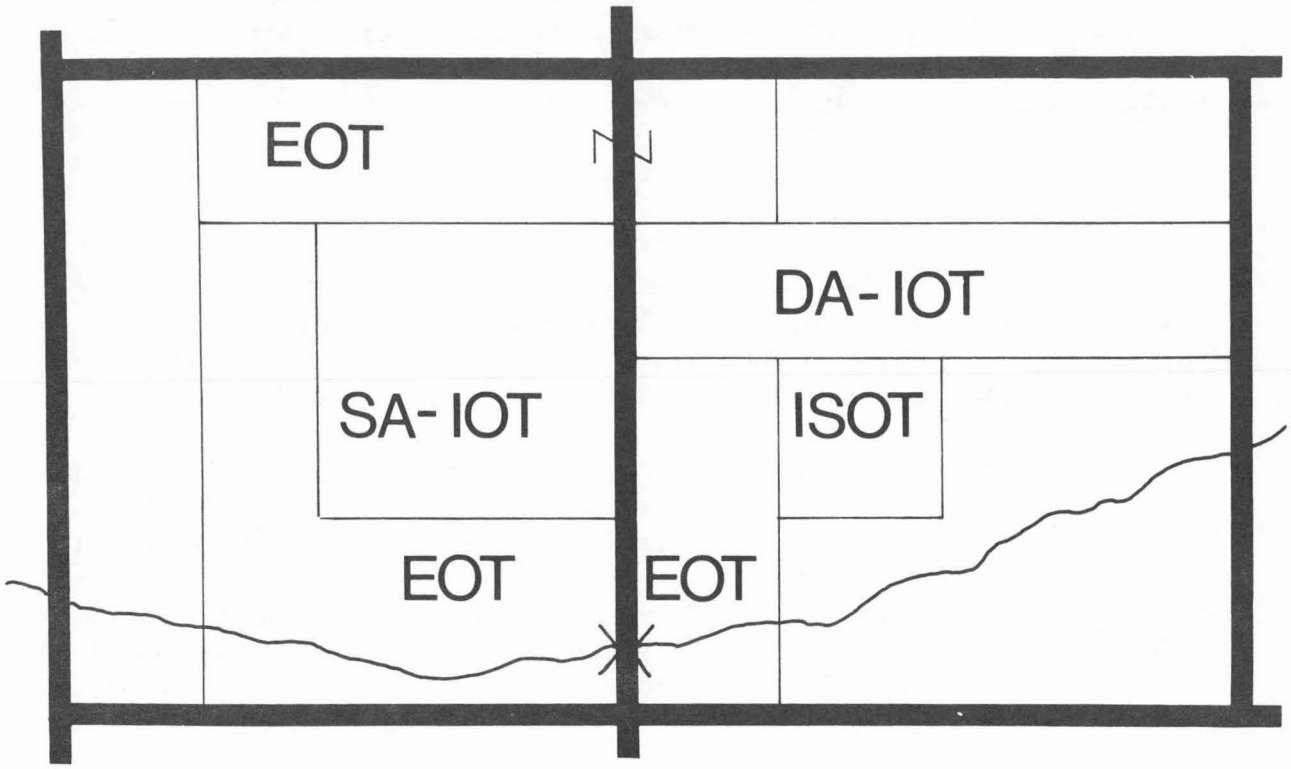
Single access interior ownership tract (SA-IOT): An ownership tract abutting on the road under consideration which does not abut on any of its intersections nor on any other road segment.

Isolated ownership tract (IS-IOT): An ownership tract which does not abut on any road segment but, because of its position in relation to roads in the area, appears to have access through one of the owners abutting the road segment of interest.

Ownership tracts bisected by a river or stream: Those tracts bisected by a river or stream or intermittent stream which requires a bridge on the road segments that it intersects. Secondly, the river or stream bisects the tract in such a way that if the road were vacated, the owner would have restricted access to part of his land unless he constructed a bridge.

Residence: It is assumed that where the Iowa Highway Commission-general highway and transportation map indicates a farm unit in use, a residence is also in use. Where this map indicates a farm unit not in use, it is assumed that the residence also is not in use and consequently is not counted as a residence.

Types of ownership tracts



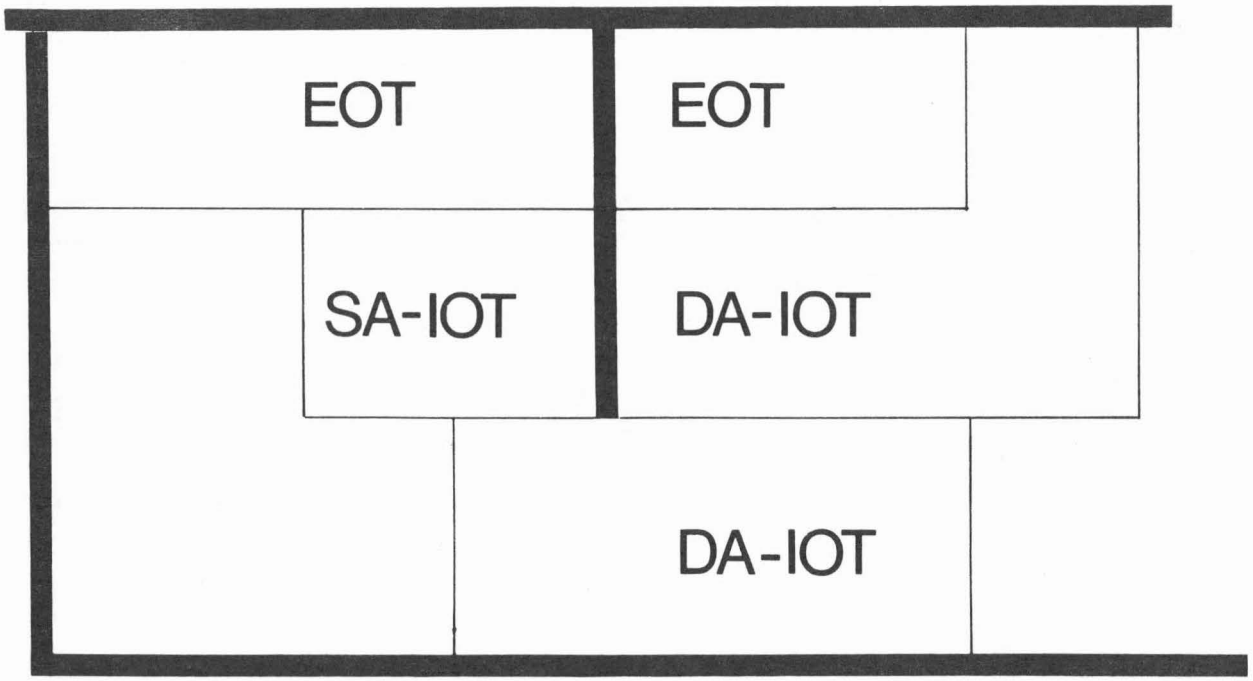


Figure 3

The procedures used to construct the Road Value Index are fairly simple and straightforward and can be performed either at the state level or by the individual county. The information required can be obtained from readily available sources.

B. Road Costs

The road value model presented above provides a means of assigning an index of value to a road segment based upon the physical, observable facts of its use and the access it provides. This rating system provides a measure of each road segment's utility to the public at large.

The roads found to be of low value must be further evaluated on a cost basis. The cost to the general public for the benefits derived from these roads are the costs incurred by the highway agencies required to maintain and improve the roads to adequate standards throughout a future period of time. However, the costs required to retain a road are not a complete measure of the costs to be avoided by vacating the road, since expenditures are required in order to vacate a road. Thus, each of the alternatives--retention or vacation of a low-value road segment--will incur costs to the highway agency.

The true measure of cost to be avoided by vacating a road is the difference between the cost of retention and the cost of vacating. The cost analysis of a road segment requires determination of these costs. The essential elements of retention costs are: (1) routine maintenance costs, (2) capital improvements costs, and (3) liability risk costs. Vacating costs consist of (1) damage claims of affected parties and (2) procedural costs.

To compute a road retention cost, a period of retention must be specified. We recommend a period of 20 years to coincide with the Needs Study Group's planning period.

The individual elements to be assessed in the cost analysis are retention costs and vacating costs. Retention costs are composed of routine maintenance, capital improvements, and liability risk costs.

Routine maintenance costs are the costs required to maintain the roadway surface and shoulders irrespective of any capital improvements. Also included are mowing and snow-plowing costs and costs of maintaining signs.

Capital improvement costs are the costs incurred throughout a future time period for improvements of structures, for major resurfacing, and for any reconstruction of the elements of a given road segment. These costs for a given road segment depend on the schedule of improvements deemed necessary for the road. The future needs for the entire road system, used in conjunction with anticipated revenues and a priority basis for scheduling improvements, provide a basis for determining the costs for a particular road segment.

Liability risk costs are those costs incurred by the highway agency due to claims for damages resulting from a negligent, wrongful act or omission of any employee of the agency. This cost will include not only damages due to traffic accidents which may be attributed to inadequate operation or maintenance of the road, but also incidental damages due to negligence of the agency in maintenance or construction operations on the road. The latter will include, for example, crop damage because of weed spray, or flood damage resulting from inadequate maintenance of drainage structures.

Vacating costs are composed of damage claims costs and procedural costs. Damage claims costs are those damages to be paid to affected landowners who incur an economic loss due to vacation of a road segment. A court of law would determine the validity and amount of damage claims for each affected landowner on a vacated road segment. Only abutting landowners have recourse under the law; the amount of damages would be based on the reduction in the fair market value of the affected property. See Appendix H for detailed discussion of the legal aspects of damage claims.

Procedural costs are the expenditures required to carry out the necessary legal procedures of closing a road. Example procedures are preparing and serving notices to affected parties or retaining legal and real-estate consultants for assessing damage cases.

C. Cost/Benefit Analysis

Neither the road value nor the retention cost should be the sole basis for selecting candidate roads for elimination. Rather, the final selection procedure should reflect the retention cost as compared to the benefits.

The evaluation posed in these terms leads naturally to a cost/benefit type analysis. The measure of the benefit for a given road segment is taken as the Road Value Index. The cost is the net retention cost (the difference between the cost of retention of the road and the cost of vacation). With these values we can form a Cost/Benefit Ratio, defined as follows:

$$\text{Cost/Benefit Ratio} = \frac{\text{Retention Cost-Vacation Cost}}{\text{Road Value Index}}$$

The Cost/Benefit Ratio is a direct measure of the cost to the highway agency--and, hence, to the public at large--for each of the benefits derived from a road of marginal utility. It is obvious then that those road segments found to give higher values for this ratio should be first considered for vacation.

D. Road Vacating--Impact on County Road Network

In computing the Road Value Index, full consideration is given the local user. However, it is also necessary to consider the value of the road to the general user. We may determine this by evaluating the impact of vacating a particular road on the secondary road network. We found this impact to be of little consequence since roads that are serious candidates for vacating contribute very little to the general system of roads. They have a low average daily traffic count. They often are dead end stubs. They are all dirt or gravel surfaced. Alternative through routes are nearly always available.

Initially, we considered the network effect to be a significant problem and developed a computerized road-network-analysis algorithm to assess this effect. This algorithm is called the "Shortest Route Algorithm"[1/] and is described in Appendix M. It measures travel time from any given origin (we used county seats) to all road junctions in the county. Figure 4 illustrates the results of application to Clayton County, Iowa. The contours or isochrons represent average distances from Elkader that may be driven in the given number of minutes.

Figure 5 illustrates the impact on the general road network resulting from the removal of approximately 20 miles of roads (the top vacating candidates). The shaded area shows affected regions and degree of impact. That is, the constant time contour has moved inward (toward Elkader) in some places, indicating that in those areas the traveler will not have traveled so far from Elkader in the given time because of some circuity of travel. However, it may be noted that even here (shaded regions) the impact is not great--possibly two to three minutes increased travel time; further, only the shaded areas are affected; travelers to and from points more remote would not have chosen that route as a part of the "shortest path," and hence are totally unaffected. Even the minor impact may sometimes be mitigated:

1/ Shortest in the sense of time, i.e., quickest.

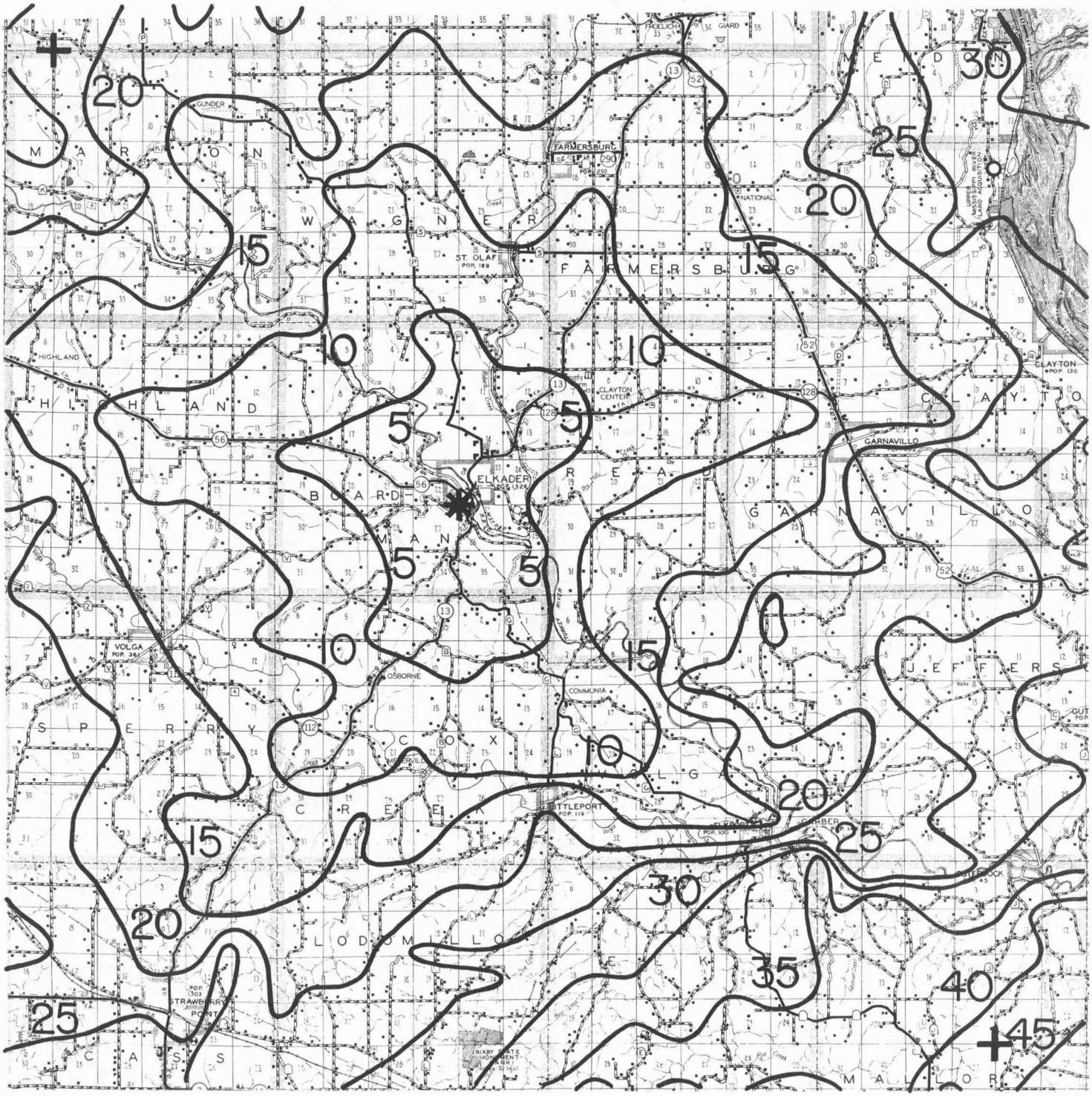


Figure 4 - Time Contours Indicating Average Distance
Traveled from Elkader
(Time in Minutes)

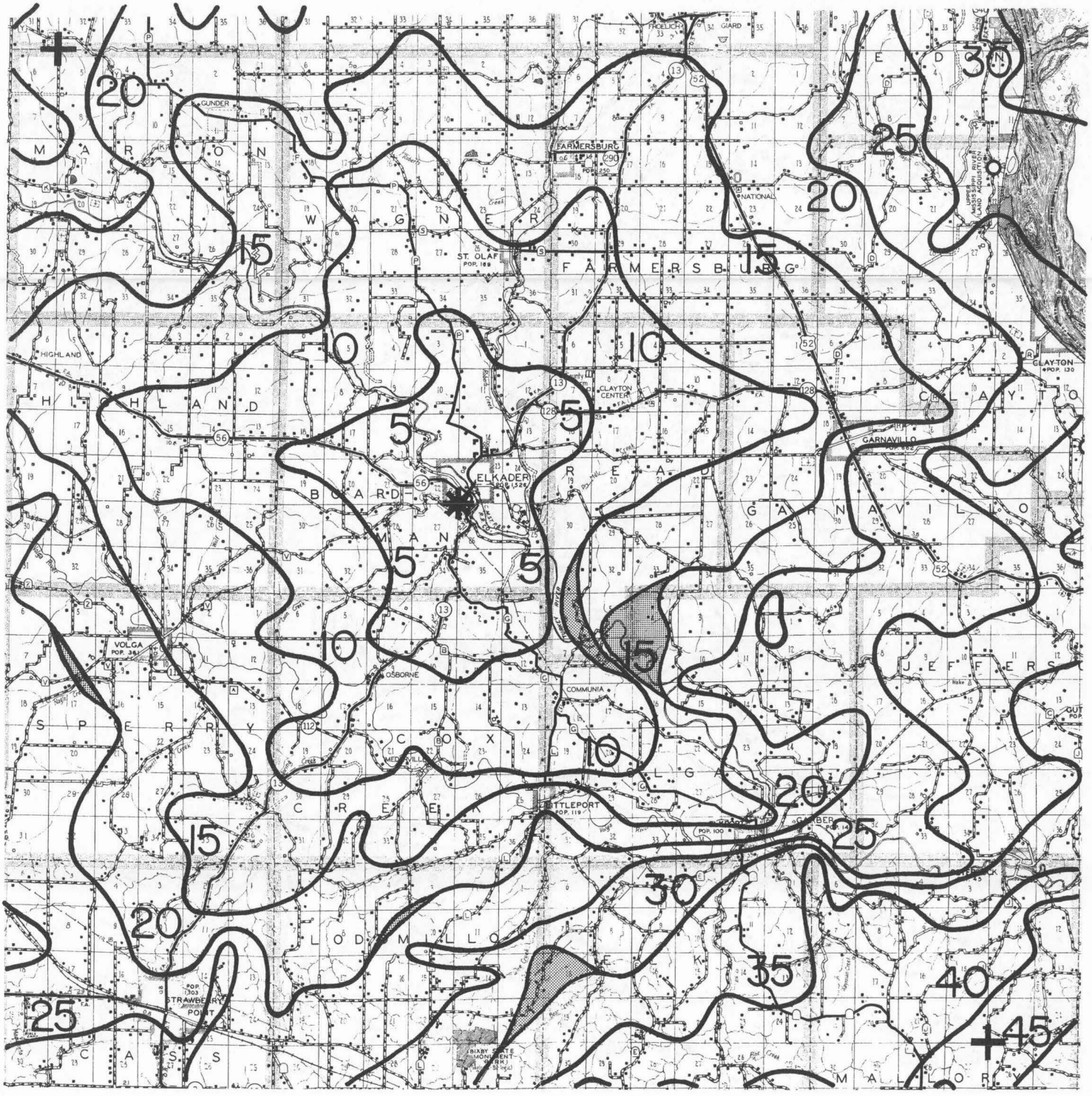


Figure 5 - Time Contours after Removal of 20 Miles of Low-Value Roads

A review of the Clayton County road map revealed that there are two key roads in the sense that vacating these two roads would have as much impact as all the others combined. These two roads were inter-regional or inter-network linkages. They were restored and travel time computed again with the result shown in Figure 6.

There is one other anomaly that should be carefully analyzed. Contiguous or parallel road segments should not be considered for simultaneous vacating action. The reason for this is that the Road Value Index is computed for a road with the assumption that other roads in the immediate vicinity remain intact. For example, a given road is not so valuable to an abutting ownership tract if access to that tract may also be gained from another (parallel or adjoining) road. But when one of these roads is vacated, the other becomes much more valuable. This increase in value cannot be anticipated in one evaluation.

One final note on the network analysis: Although the computer algorithm is fast, accurate, and very comprehensive, it possibly is more than is needed. Good engineering judgment can provide approximately the same results.

Based on the above analysis we recommend the following detailed procedure and guidance for the application of engineering judgment to network analysis:

Road segments should not be vacated:

1. When they are in the path of future land and/or road development projects. Obviously there is no point in giving up right-of-way that will have to be condemned back for a new primary route, etc.

2. When candidate segments are parallel or adjoining--one should be removed from candidacy. This condition is easily detected from a county road map plot.

3. When vacating causes an increase in travel time (to or from the nearest town or attraction center) of more than 20 percent of the original travel time.[1/]

1/ These are some of the cogent technical reasons mentioned above.

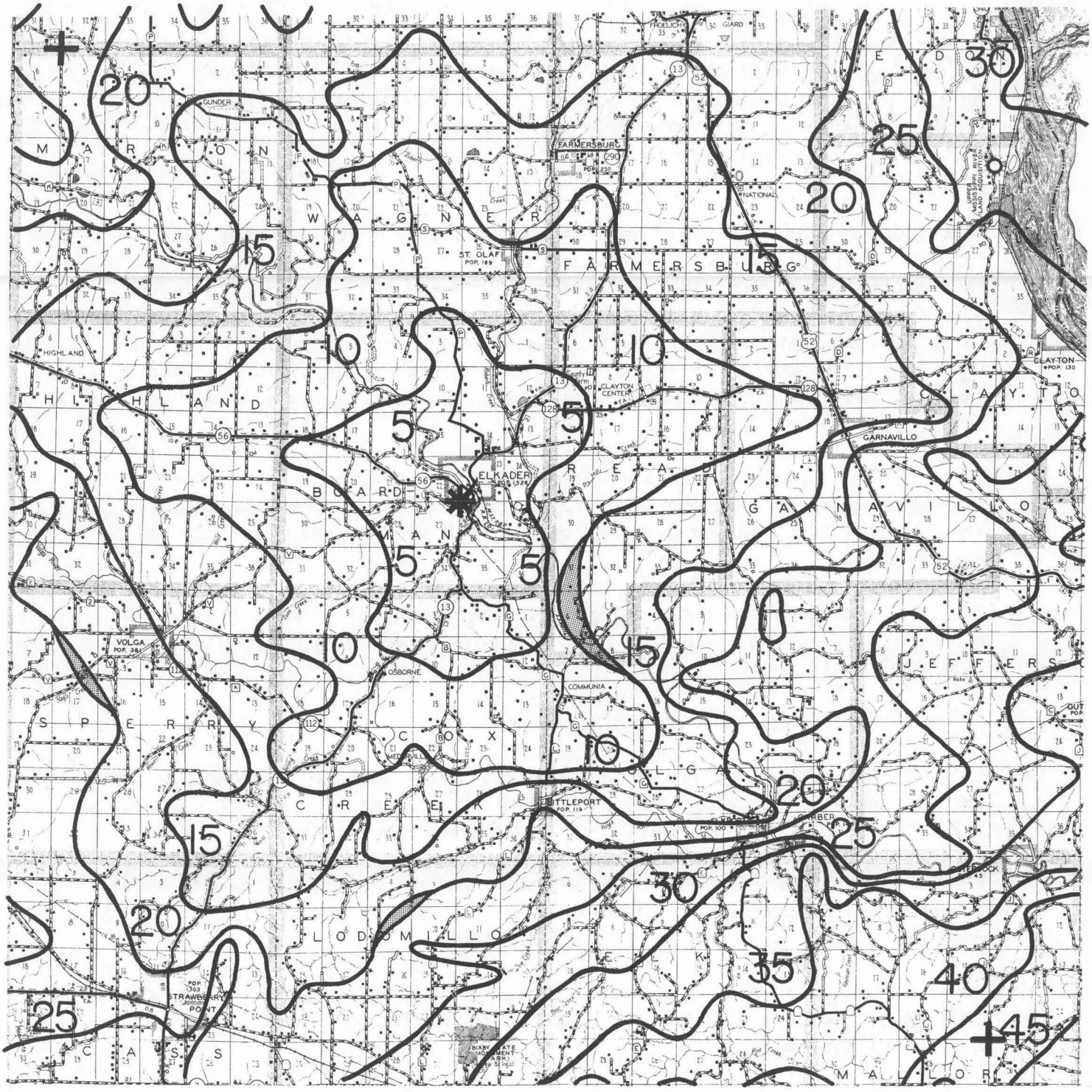


Figure 6 - Time Contours after Two Key Roads Replaced

We believe, for example, that it would be acceptable to the general public if travel time for a few users increased from, say, 10 to 12 minutes. Roads of the type we are concerned with are not characteristically used for longer trips. This increased travel time may be easily estimated using a county road map and estimating one minute per mile on hard-surfaced roads, two minutes per mile on gravel or rock, and three minutes per mile on dirt roads. The measurement should be from the nearest attraction center to the remote road junction of the given road segment--with the segment in the system and then with it out of the system. An indicated 20 percent or more increase in travel time should be justification for retaining the road.

If these final technical screening procedures are followed uniformly, the entire process will be defensible as an objective, equitable, realistic, and effective method of reducing secondary road mileage.

IV. APPLICATION OF THE ROAD EVALUATION SYSTEM

For purposes of testing and demonstrating the road evaluation system we selected a sample of 10 Iowa counties: Black Hawk, Calhoun, Clay, Clayton, Franklin, Fremont, Poweshiek, Ringgold, Van Buren, and Warren. (See Figure 7.) Our objective was to obtain a sample which would reflect differences in the various physical, demographic, and economic conditions throughout the state which might have a bearing on the problem of vacating roads. The specific criteria used in selecting the sample are discussed in Appendix C.

A. Construction of the Road Value Index

The procedures for determining the relative value of a road, which were described in Section III, were applied to each of the 3,421 low-traffic-count roads in the 10-county sample.

Road value is a function of road use and access requirements, each of which, in turn, is measured by a combination of different factors. The procedures we used for quantifying each factor (along with appropriate weights) were as shown in the listing on p. 28.

The sum of these weighted factors provides a Road Value Index. Under this system, a road with a high Road Value Index is considered to be of substantial value and therefore should be low on the list of abandonment candidates. Conversely, a road with a low Road Value Index represents a road of limited value and represents a good candidate for abandonment.

The manner in which these various factors were combined to form the Road Value Index is illustrated in the following formulae:

(1) ADT + (AOT's x 5) +(RES x 10) + (PUB x 25) +(PVT x 10) + (ML x 10) + (BS x 10) + (UT x 10) - (DE x 10) = Road Use Value

(2) (EOT's x 5) + (DA-IOT's x 5) + (SA-IOT's x 10) + (IS-IOT's x 10) + (AOT's/S x 5) + (EOT RES x 5) +(IOT RES x 10) - (RES within 1/8 mi x 5) + (PUB x 25) + (PVG x 10) = Access Requirement Value

(3) Road Use Value + Access Requirement Value = Road Value Index

A more detailed description of procedures and a discussion of steps taken to check the reliability and sensitivity of our value measures are presented in Appendix E.

Sample Counties

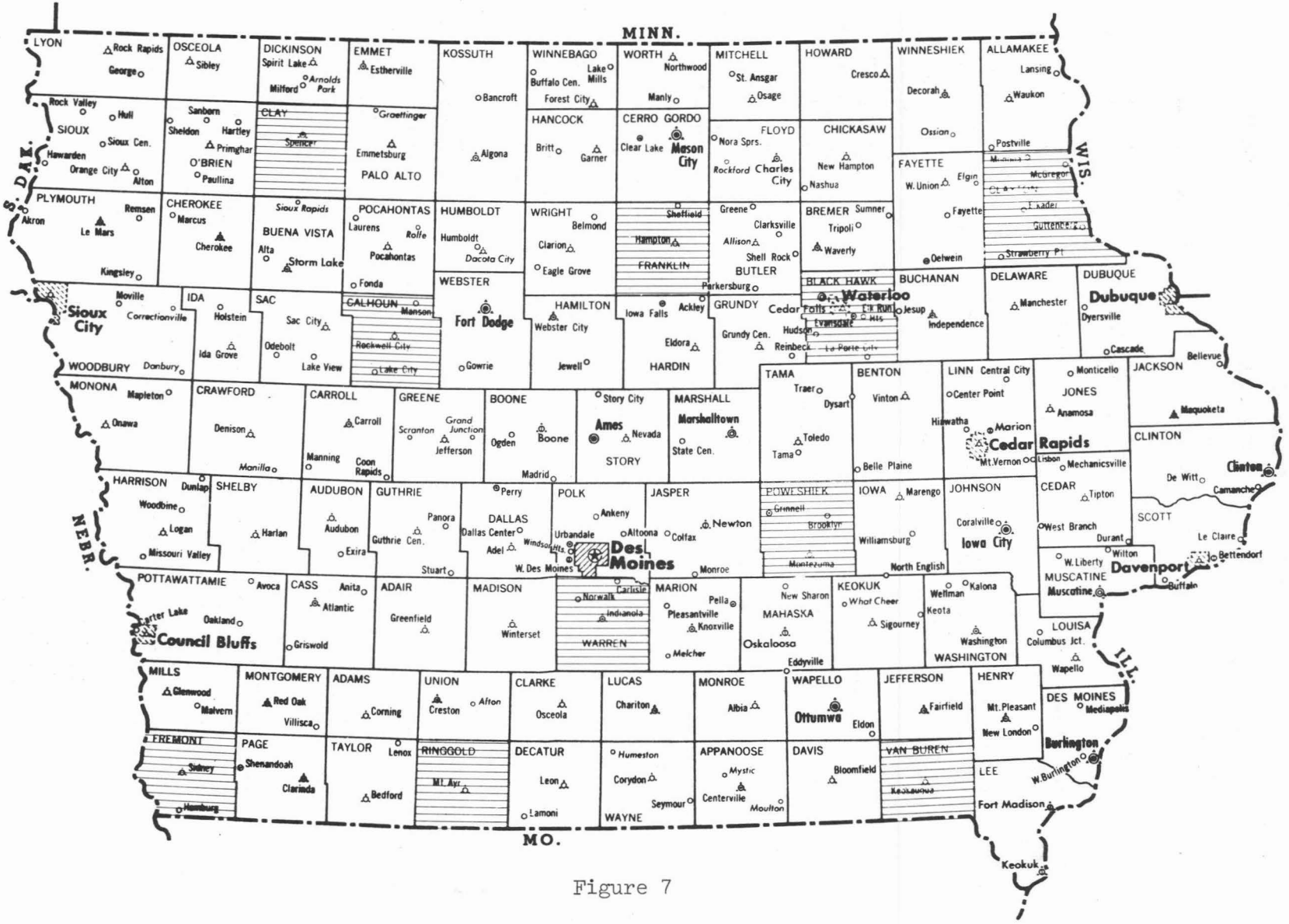


Figure 7

ROAD VALUE FACTORS

Factor	Measure Used	Purpose
Road Use		
Traffic count	Actual ADT	Reflects volume of traffic
Number of users	Number of ownership tracts abutting on the road x 5	On low-count road this should reflect number of users
Number of resident users	Number of residences on road x 10	Provides additional weight for residential users
Other users	Number of public uses x 25 and other private nonfarm uses x 10[1/]	Provides additional weight for important nonfarm uses
Dead end	Deduct 10 if the road is a dead end	The dead-end road reduces potential for through traffic thereby restricting potential use
Mail route	If road is used as mail route add 10	Provides additional weight for special uses of roads
School bus route	If road is used as bus route add 10	Provides additional weight for special uses of roads
Utility route	If road is used as utility route, add 10	Provides additional weight for special uses of roads
Access		
Land ownership patterns	(No. of EOT's x 5) + (No. of DA-IOT's x 5) + (No. of SA-IOT's x 10) + (No. of IS-IOT's x 10)[2/]	Reflects the access requirements for different types of ownership tracts abutting on the road segment
Access barriers	(No. of EOT's and IOT's bisected by a stream x 5)[3/]	Reflects additional access problems created by vacation of the road segment
Residence access	(No. of EOT's with residences x 5) + (No. of IOT's with residences x 10)	Provides additional weight for those ownership tracts with a residence
Residence access	If all residences are within 1/8 mile from another road segment deduct 5 x the number of residences	Tends to reduce the residential access requirement for those residences with potential alternative access
Other uses	(No. of public uses x 25) + (No. of other private uses x 10)	Reflects access requirements for non-farm uses

1/ The Needs Study Tape or field observation are major sources of information on private nonfarm uses. Our demonstration data include largely public uses (schools, churches, cemeteries, etc.) identified from inspection of Highway Commission maps.

2/ Definitions are as follows:

ADT = Average Daily Traffic
AOT = Abutting Ownership Tracts
AOT/S = Abutting Ownership Tracts Bisected with Stream
RES = Number of Residences
PUB = Public Uses
PVT = Private Uses
DE = Dead End
ML = Mail Route
UT = Utility Route
BS = School Bus Route
EOT = External Ownership Tract--abutting on two adjacent roads.
DA-IOT = Dual Access Interior Ownership Tract--abutting on two roads which are not adjacent.
SA-IOT = Single Access Interior Ownership Tract--abutting only on one road.
IS-IOT = Isolated Interior Ownership Tract--not abutting on any road but with likely private access to the road in question.

3/ Data on rail and/or interstate highway barriers were not included in demonstration. This information can be obtained from the maps.

This approach was used in examining each of the 3,421 low-traffic-count roads in the 10 sample counties. The result is a Road Value Index number assigned to each road segment. The range in Road Value Index numbers was quite large--0 to 340 for the 10-county sample. Moreover, the range within each county was sufficiently large to be sensitive to differences in road value characteristics. (See Table III for a listing of the ranges and median values for all the sample counties.)

TABLE III

ROAD VALUE INDEX RANGES AND MEDIANS

Counties	Number of Low-Traffic-Count Roads	Road Value Index Range	Median[1/] Road Value
Ringgold	497	10 - 219	68
Poweshiek	424	12 - 228	76
Warren	404	0 - 265	73
Fremont	352	0 - 340	79.5
Van Buren	341	10 - 279	72
Calhoun	323	13 - 281	83
Clay	323	10 - 190	77
Franklin	313	14 - 259	71
Clayton	301	0 - 304	80
Black Hawk	143	28 - 176	86

1/ Median refers to that number above and below which there are an equal number of values.

Although there was a large spread in Road Value Index range among the counties--for example, the range in Black Hawk County was from 28 to 176, while the range in Fremont was 0 to 340--the median Road Value Index was about the same in every county. This suggests that even though the system was designed to evaluate roads within any given county, it can also be used to compare roads throughout the state regardless of the county in which the road is located.

B. Estimating Road Costs

Estimates of future routine maintenance costs, capital improvement costs, liability risk costs, and vacating costs were derived as follows.

The Needs Study File, which now has a 20 percent sample of Iowa secondary roads, was used to develop averages. We computed an average cost per mile for routine maintenance and capital improvements as a function of three factors: maintenance cost area, surface type, and average daily traffic count. Average bridge costs were computed as a function of two factors: surface type and average daily traffic. Details of the analysis and results are given in Appendix G.

An upper-limit estimate for the anticipated cost of liability risk was obtained from an analysis of many aspects of the problem, including an assessment of liability of the counties under current law, a study of relevant traffic accident statistics on the system of secondary roads, and an evaluation of incidental damage claims experienced by the ISHC on the state's system of roads. Details of the liability risk analysis are given in Appendix F.

Estimates of anticipated road vacating costs have been obtained through analysis of the pertinent legal aspects and procedural requirements of road vacating. Details of the analysis and the resulting cost estimates are given in Appendix G.

C. Rank Ordering the Candidates

Each of the 3,421 roads in the 10-county sample was analyzed using the criteria described above. The resulting road data were encoded on key punch sheets and a tabulating card was punched for each road. These road data were then analyzed by a computerized road evaluation system. Road cost data and criteria weighting factors were entered separately (the particular values used are listed in A above and in Appendix E).

Three reports were generated for each of the study counties. These reports are illustrated in Figures 8, 9, and 10. The individual roads listed in these three figures were selected at random from project records; consequently the figures are illustrative of the type of reports which may be prepared for all counties, but are not descriptive of any particular county.

Briefly, the first report (Figure 8) is an inventory or listing of all low-traffic-count secondary roads in the county. They are listed in road segment identification order for easy reference.

														COLUMN																		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ROAD		SEGMENT		IDENT		RD		SF	NO	INT			IOT	IOT	IOT	BIS	BIS	EOT	IOT	TOT	RES	DEAD	U	M	B	S	RETENTN	VACATG	RETENTN	RD VAL
CO	TWP	RG	SECT	S2	RD	LG	ADT	TY	BR	STR	AOT	EOT	-DA	-SA	-IS	EOT	IOT	RES	RES	RES	1/8	END	T	L	S	U	TOT CST	TOT CST	NET CST	INDEX
A	10	11	2	0	2	0.25	8	2	0	0	2	2	0	0	0	0	0	1	0	1	0	1	0	0	0	0	3118.	1000.	2118.	33
A	11	12	6	1	2	0.38	0	1	1	0	3	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	10454.	0.	10454.	20
A	12	13	7	0	2	0.38	8	2	0	0	2	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	4739.	0.	4739.	18
A	13	14	11	0	2	0.50	9	1	0	0	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7545.	0.	7545.	39
A	14	15	13	0	1	0.25	0	2	0	0	2	2	0	0	0	0	0	1	0	1	0	1	0	0	0	0	3118.	1000.	2118.	25
A	15	16	13	0	2	0.13	7	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1621.	0.	1621.	17
A	16	17	14	0	1	1.00	18	2	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12330.	0.	12330.	48
A	17	18	14	0	2	0.50	8	2	0	0	3	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	6235.	1000.	5235.	33
A	18	19	15	0	1	0.25	13	2	0	0	2	2	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3368.	1000.	2368.	48
A	19	20	16	0	1	0.25	21	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3388.	0.	3388.	31

Figure 8 - Road Inventory and Value Analysis

COLUMN																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ROAD		SEGMENT		IDENT			RD	CUM	TWENTY YEAR RETENTION COST					VACATING	20YR RETENTN	
CO	TWP	RG	SECT	S2	RD	RVI	LG	RDLG	MAINT	IMPV	BRIDGE	RISK	TOTAL	COST	NET COST	COST/VALUE
A	15	16	13	0	2	17	0.13	0.13	1251.	352.	0.	18.	1621.	0.	1621.	95.
A	12	13	7	0	2	18	0.38	0.51	3656.	1030.	0.	53.	4739.	0.	4739.	263.
A	11	12	6	1	2	20	0.38	0.89	1737.	3944.	4720.	53.	10454.	0.	10454.	523.
A	14	15	13	0	1	25	0.25	1.14	2405.	678.	0.	35.	3118.	1000.	2118.	85.
A	19	20	16	0	1	31	0.25	1.39	2555.	758.	0.	75.	3388.	0.	3388.	109.
A	10	11	2	0	2	33	0.25	1.64	2405.	678.	0.	35.	3118.	1000.	2118.	64.
A	17	18	14	0	2	33	0.50	2.14	4810.	1355.	0.	70.	6235.	1000.	5235.	159.
A	13	14	11	0	2	39	0.50	2.64	2285.	5190.	0.	70.	7545.	0.	7545.	193.
A	18	19	15	0	1	48	0.25	2.89	2555.	758.	0.	55.	3368.	1000.	2368.	49.
A	16	17	14	0	1	48	1.00	3.89	12119.	140.	0.	71.	12330.	0.	12330.	258.

Figure 9 - Roads Ranked by Road Value Index with Cost Analysis

COLUMN															
1 2		3 4		5 6		7	8	9	10	11	12	13	14	15	16	17
ROAD		SEGMENT		IDENT			RD	CUM	TWENTY YEAR RETENTION COST					VACATING	20YR RETENTN	
CO	TWP	RG	SECT	S2	RD	RVI	LG	RDLG	MAINT	IMPV	BRIDGE	RISK	TOTAL	COST	NET COST	COST/VALUE
A	11	12	6	1	2	20	0.38	0.38	1737.	3944.	4720.	53.	10454.	0.	10454.	523.
A	12	13	7	0	2	18	0.38	0.76	3656.	1030.	0.	53.	4739.	0.	4739.	263.
A	16	17	14	0	1	48	1.00	1.76	12119.	200.	0.	11.	12330.	0.	12330.	258.
A	13	14	11	0	2	39	0.50	2.26	2285.	5190.	0.	70.	7545.	0.	7545.	193.
A	17	18	14	0	2	33	0.50	2.76	4810.	1355.	0.	70.	6235.	1000.	5235.	159.
A	19	20	16	0	1	31	0.25	3.01	2555.	758.	0.	75.	3388.	0.	3388.	109.
A	15	16	13	0	2	17	0.13	3.14	1251.	352.	0.	18.	1621.	0.	1621.	95.
A	14	15	13	0	1	25	0.25	3.39	2405.	678.	0.	35.	3118.	1000.	2118.	85.
A	10	11	2	0	2	33	0.25	3.64	2405.	678.	0.	35.	3118.	1000.	2118.	64.
A	18	19	15	0	1	48	0.25	3.89	2555.	758.	0.	55.	3368.	1000.	2368.	49.

Figure 10 - Roads Ranked by Cost/Value Ratio

Estimated 20-year road costs (labeled RETENTN TOT CST) were based on:

Col. 1 - Maintenance cost area
Col. 7 - Road length (miles)
Col. 8 - Average daily traffic count
Col. 9 - Surface types (1-dirt, 2-rock)
Col. 10 - Number of bridges

The road value is developed from the application of weights to the criteria shown in columns 12 through 27.

Col. 12 - Number of abutting ownership tracts
Col. 13 - Number of exterior ownership tracts
Col. 14 - Number of interior ownership tracts with dual access
Col. 15 - Number of interior ownership tracts with single access
Col. 16 - Number of isolated interior ownership tracts
Col. 17 - Number of exterior ownership tracts bisected by a barrier (unfordable stream)
Col. 18 - Number of interior ownership tracts bisected by a barrier
Col. 19 - Number of exterior ownership tracts with residence
Col. 20 - Number of interior ownership tracts with residence
Col. 21 - Total number of residences on the road
Col. 22 - If 1 - all residences on road are within 1/8 mile of corner
Col. 23 - If 0 - through road, 1 - dead-end road
Col. 24 - If 1 - utility routes[1/]
Col. 25 - If 1 - mail routes[1/]
Col. 26 - If 1 - school bus routes[1/]
Col. 27 - If special use such as cemetery, church, etc.

"VACATG TOT CST" is an estimate, based on ownership patterns, of legitimate claims that might be brought as a result of vacating action. "RETENTN NET CST" (Col. 30) is simply Col. 28 less Col. 29 or an estimate of the net cost of retaining the road for the next 20 years. Finally, Col. 31 is the Road Value Index or relative value of any given road with respect to other roads.

1/ These criteria were not used in the demonstration since data were not readily available.

The second report (Figure 9) is a cost analysis of the low-traffic-count roads. This report is different from the first in that it is in Road Value sequence-ascending order, i.e., lowest value road first (Col. 7), road mileage is accumulated (Col. 9), the estimated 20-year road retention costs are detailed, none of the value criteria are shown, and a "Cost/Value" ratio is shown (Col. 17). This Cost/Value is a relative measure of the cost-effectiveness, cost/benefit, or efficiency of the road in returning benefits per dollar expended.

The third report (Figure 10) shows the same information as the second. There are two differences in sorting: all roads with Road Value Index greater than 50 have been deleted, and the remainder are rank ordered by the Cost/Value ratio in descending order, i.e., most inefficient first.

In summary, the first report is an inventory of all low-traffic-count roads showing the details of the Road Value Criteria. It is simply a reference list. The second report gives details of road costs. Roads are listed in order of the value, lowest first. This report focuses attention on low-value roads but with no regard to their efficiency. The third report is, in effect, a priority list for vacating roads.

APPENDIX A

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APPENDIX B

SURVEY OF STATE HIGHWAY COMMISSIONS

A survey was conducted to determine the practices and experiences of other states in the problem of road vacation. Highway Commissions in 47 States were contacted. Iowa, Hawaii, and Alaska were omitted from the survey. Comprehensive responses were received from the following 32 states:

Alabama	Kentucky	New Mexico	South Carolina
Arizona	Maine	Nevada	Tennessee
Arkansas	Massachusetts	North Dakota	Texas
Colorado	Minnesota	Ohio	Utah
Delaware	Mississippi	Oklahoma	Virginia
Florida	Missouri	Oregon	West Virginia
Illinois	Nebraska	Pennsylvania	Wisconsin
Indiana	New Jersey	Rhode Island	Wyoming

Are there any common practices in your state regarding the vacation of low-value secondary roads?

Practices	States Responding
Functional classification:	(3)1/ New Jersey, Missouri, Kentucky
Highway director controls:	(2) Alabama, Ohio
Counties control:	(2) Nebraska, Florida
Transfer to local jurisdiction:	(2) Indiana, Oklahoma
Trade local for high count:	(1) Maine
Dictated by replacement:	(1) Arizona
Statutes:	(1) Wisconsin
No method given:	(2) Minnesota, Virginia

Does your state use special methods to identify secondary road use patterns?

Special Methods	States Responding
Functional classification:	(6) West Virginia, New Jersey, North Dakota, Oklahoma, Arizona, Virginia, Missouri
Special report:	(3) Pennsylvania, Oregon, Delaware
Appraisal of character of trip making:	(1) New Mexico
Fed Aid Secondary Road Plan (1954), Amended:	(1) Alabama

1/ Number in parentheses refers to number of responses.

How do you determine what maintenance is necessary to meet the minimum safety standards?

Methods	States Responding
Not responsible or no reply:	(8) Nebraska, Mississippi, New Mexico, Wyoming, New Jersey, Illinois, Tennessee, North Dakota
Visual inspection by engineers usually:	(8) Arizona, Utah, Kentucky, Ohio, West Virginia, Rhode Island, Maine, South Carolina
Accident reports are given high degree of consideration:	(5) Texas, Pennsylvania, Colorado, Indiana, Oregon
Usage dictates:	(4) Arkansas, Oklahoma, Massachusetts, Virginia
Funds available:	(3) Minnesota, Colorado, Wisconsin
Service and needs usually minimum safety:	(2) Missouri, Florida
Sufficiency rating:	(1) Delaware
Meet U.S. BPR standards:	(1) Nevada

What criteria do you use for determining which roads will be raised to safety standards?

Some states cited more than one of the following:

Criteria	States Responding
Functional need and sufficiency standards:	(15) Utah, Oregon, Ohio, Tennessee, Delaware, Nevada, North Dakota, Massachusetts, Oklahoma, Kentucky, Wyoming, Indiana, Wisconsin, Maine, New Mexico
Safety or accident factor:	(12) North Dakota, Tennessee, Texas, Ohio, Maine, Pennsylvania, Arizona, Virginia, Colorado, Indiana, Alabama, Rhode Island

What criteria do you use for determining which roads will be raised to safety standards? (Concluded.)

Criteria	States Responding
Traffic volume:	(9) Tennessee, Delaware, Kentucky, Virginia, Colorado, Minnesota, Nebraska, Indiana, New Mexico
Funds available:	(4) Oklahoma, New Jersey, New Mexico, North Dakota
Engineering judgment:	(2) South Carolina, Colorado
Local officials dictate:	(1) Illinois
AASHO standards:	(1) Ohio

Do you have a cost model or a set of cost factors that you use to determine maintenance costs of a secondary road or to determine the cost of bringing it up to safe standards?

Cost Model Basis	States Responding
Did not clarify:	(4) Ohio, Arkansas, Massachusetts, Tennessee
Past history:	(4) Virginia, New Mexico, Kentucky, Indiana
Needs study:	(1) Illinois
Sufficiency rating:	(1) Nevada
Classification study:	(1) Nebraska
Operations division handles:	(1) Arizona

Has your state established special criteria for determining the value of a secondary road?

Special Criteria Cited	States Responding
No critera given:	(4) Delaware, Maine, Oregon, New Jersey
Functional classification:	(4) Missouri, Arizona, Arkansas, Massachusetts
Previous study:	(2) Alabama, Pennsylvania
For essential access:	(1) New Mexico
Has developed five basic criteria for functional classification: 1. Availability of other highways 2. Service to community center 3. Recreation access 4. Area service 5. Relative traffic volume	(1) Oklahoma

Which of the following criteria do you use for evaluating an established secondary road segment's worth to the immediate community and the total road network? RANK criteria in order of importance for your procedure.

RANK	Criteria
1	Traffic volume
2	Number of those owners which also have access to another road segment
3	Special uses such as bus service, mail delivery, emergency requirements, etc.
4	Traffic type
5	Types of adjacent land use
6	Number of owners, businesses, etc.
7	Future expectations for the area
8	Presence of utility transmission lines or pipes
9	Access for the public to governmental land for recreation

Does low maintenance cost by itself justify retaining a low-traffic-count secondary road?

Response	States Responding
Yes:	(3) Alabama, Minnesota, Pennsylvania
No:	(29) Missouri, Utah, Oregon, West Virginia, North Dakota, Tennessee, Texas, Ohio, Delaware, Nevada, Maine, Mississippi, Arkansas, Massachusetts, Florida, Arizona, Oklahoma, Kentucky, South Carolina, Virginia, Colorado, New Jersey, New Mexico, Illinois, Wyoming, Indiana, Nebraska, Wisconsin, Rhode Island

Is a secondary road's location in a larger network of transportation a strong factor in evaluating its need?

Response	States Responding
No:	(5) Arkansas, Tennessee, Wyoming, South Carolina, New Mexico
Yes:	(26) Rhode Island, Wisconsin, Nebraska, Alabama, Indiana, Minnesota, New Jersey, Colorado, Virginia, Kentucky, Oklahoma, Arizona, Florida, Massachusetts, Mississippi, Maine, Nevada, Pennsylvania, Ohio, North Dakota, West Virginia, Oregon, Utah, Texas, Illinois, Delaware

Do you use a network analysis model such as the Gravity or Frater Model?

Network Analysis Model	States Responding
Only in urban areas:	(8) Maine, Wisconsin, Oregon, Pennsylvania, West Virginia, Rhode Island, Utah, Colorado
Gravity:	(2) Massachusetts, Delaware
On state secondary routes:	(1) Tennessee
Only in county-wide studies:	(1) Illinois

What are the legal aspects of vacating or retaining secondary roads?

Legal Aspects	States Responding
Statute or law:	(7) Missouri, Wisconsin, Minnesota, Kentucky, Virginia, Indiana, Oregon
Highway commission or state board dictates (usually joint action with county involved):	(7) Oklahoma, South Carolina, Rhode Island, Colorado, New Mexico, Arizona, West Virginia
County board dictates:	(6) Alabama, Illinois, Nebraska, Wyoming, Utah, Florida

Has your state conducted recent surveys related to vacating of secondary roads by the state?

Surveys	States Responding
Functional classification study:	(3) Kentucky, Oklahoma, Utah
Continuing studies by field engineers:	(1) Virginia
1966-1985 Guidelines for Progress:[1/]	(1) Indiana
Arterial Transport Systems:[1/]	(1) Pennsylvania
Consultant study:	(1) Nebraska
No information given:	(1) Massachusetts

1/ Titles of recent studies.

Has any legislation been passed by your state to facilitate vacating of low-value roads?

Legislation	States Responding
Statutes:	(5) New Mexico, Alabama, Arizona, Wisconsin, Ohio
Counties new leg. pend.:	(1) Utah
KRS 177.020 (1964):	(1) Kentucky
County has authority (1967):	(1) Illinois
Functional class. statute:	(1) New Jersey
Chp. 161.15 and 164.07:	(1) Minnesota
Chp. 1, Acts 6.2 & 6.3 of Title 33:	(1) Virginia
Acts of Gen.Assn.'33,'35,'49,'57:	(1) Indiana
Act 150 (1961):	(1) Arkansas
Ord 366.290 & Ord 366.300	(1) Oregon

Can your state be sued by individuals for unsafe road conditions?

Response	States Responding
Yes:	(12) Virginia, Nevada, South Carolina, Kentucky, Oklahoma, West Virginia, Oregon, Arizona, Utah, Ohio, Maine, Colorado
No:	(20) Missouri, North Dakota, Tennessee, Delaware, Pennsylvania, Mississippi, Arkansas, Massachusetts, Florida, New Jersey, New Mexico, Illinois, Minnesota, Wyoming, Indiana, Alabama, Nebraska, Wisconsin, Rhode Island, Texas

APPENDIX C

SELECTION OF TEN COUNTY SAMPLE

One of the early tasks in the Secondary Roads Study was to select a sample of ten Iowa counties for detailed analysis. Our goal was to select a sample that would be representative of the various conditions within the state that might have a bearing on the problem of road vacation. Many of the selection criteria were suggested by Iowa Highway Commission officials; other criteria were added by MRI. The resulting sample represents variations in the state's physical features, topography, economic characteristics, and demographic patterns. The counties included in the sample are shown in Figure C-1.

The criteria used in the selection of sample counties are as follows:

1. Recent traffic count: Traffic counts are made for roads in approximately 20 counties each year. Therefore, traffic count data are available for each county every five years. The sample was selected from among those counties having data for 1965, 1966, and 1967.

2. Planning and zoning: An effort was made to select counties with planning or zoning commissions on the assumption that certain types of data might be more readily available for these counties.

3. Topography: Various types of topography are represented in the sample counties--some are level or gently rolling while others are hilly and bisected by numerous streams.

4. Physical features: Counties representing a variety of physical features are included in the sample. We selected counties bordering on the Mississippi and Missouri rivers, counties bisected by rivers or streams, counties containing lakes, and counties bisected by a controlled access highway.

5. Urban-rural population mix: Included in the sample is one county with a large city (over 50,000), counties with medium-sized cities (7,000 to 12,000), and counties with a largely rural population.

6. Population change: We selected counties in which the total population is increasing (more than 5 percent between 1950 and 1960), counties in which the population is relatively stable, and counties in which the population is decreasing (more than 5 percent from 1950 to 1960).

7. Average farm size: Farm size was broken down into three categories--large (over 250 acres), medium (from 200 to 249 acres), and small (under 200 acres). Each farm size category is represented in the sample.

8. Maintenance cost: The sample includes at least one county in each of the four maintenance cost areas designated by the Iowa Highway Commission.

The resulting sample includes all of the desired variations in physical features and socio-economic characteristics. Most of the sample counties have traffic count data for 1966 or 1967, with only three having 1965 traffic count data. Seven of the ten counties have planning commissions. In addition, the counties are well distributed geographically throughout the state. Table C-I shows the various criteria applied to each of the sample counties. Additional data relating to each of the criteria are presented in the accompanying figures (C-2 to C-7).

Several other factors were considered in the selection of the sample. For example, we included counties which had vacated roads in recent years. Polk County was excluded because of its highly urban character, but adjacent Warren County was included to show the possible effects of urban expansion.

In summary, the sample appears to reflect the various conditions within the state that might have a bearing on the problem of road vacation. With the approval of the Iowa Highway Commission, the analysis and demonstration of the road evaluation system focused on the roads in the ten sample counties.

TABLE C-I

Criteria Used in Selecting Sample Counties

	Black Hawk	Calhoun	Clay	Clayton	Franklin	Fremont	Poweshiek	Ringgold	Van Buren	Warren
Traffic Count: 1965						●	●			●
1966			●					●	●	
1967	●	●		●	●					
County Planning or Zoning Commission	●	●	●		●	●	●			●
Topography :										
Hilly, stream dissected				●		●			●	●
Fairly level	●	●	●		●		●	●		
Physical Features :										
Bordering Miss.River				●						
Bordering Mo. River						●				
Bissected by a river	●		●	●		●			●	
Lake area			●							
Bissected by an interstate highway							●			●
Urban-Rural Mix :										
Largely urban	●									
Some urban			●		●		●			●
Largely rural		●		●		●		●	●	
Population change(1950-60) :										
Increase	●									●
Stable			●	●	●		●			
Decline		●				●		●	●	
Farm size										
Large			●			●		●		
Medium		●		●	●		●		●	●
Small	●									
Maintenance										
Region 1						●				
Region 2	●	●	●		●					
Region 3				●						
Region 4							●	●	●	●

Sample Counties

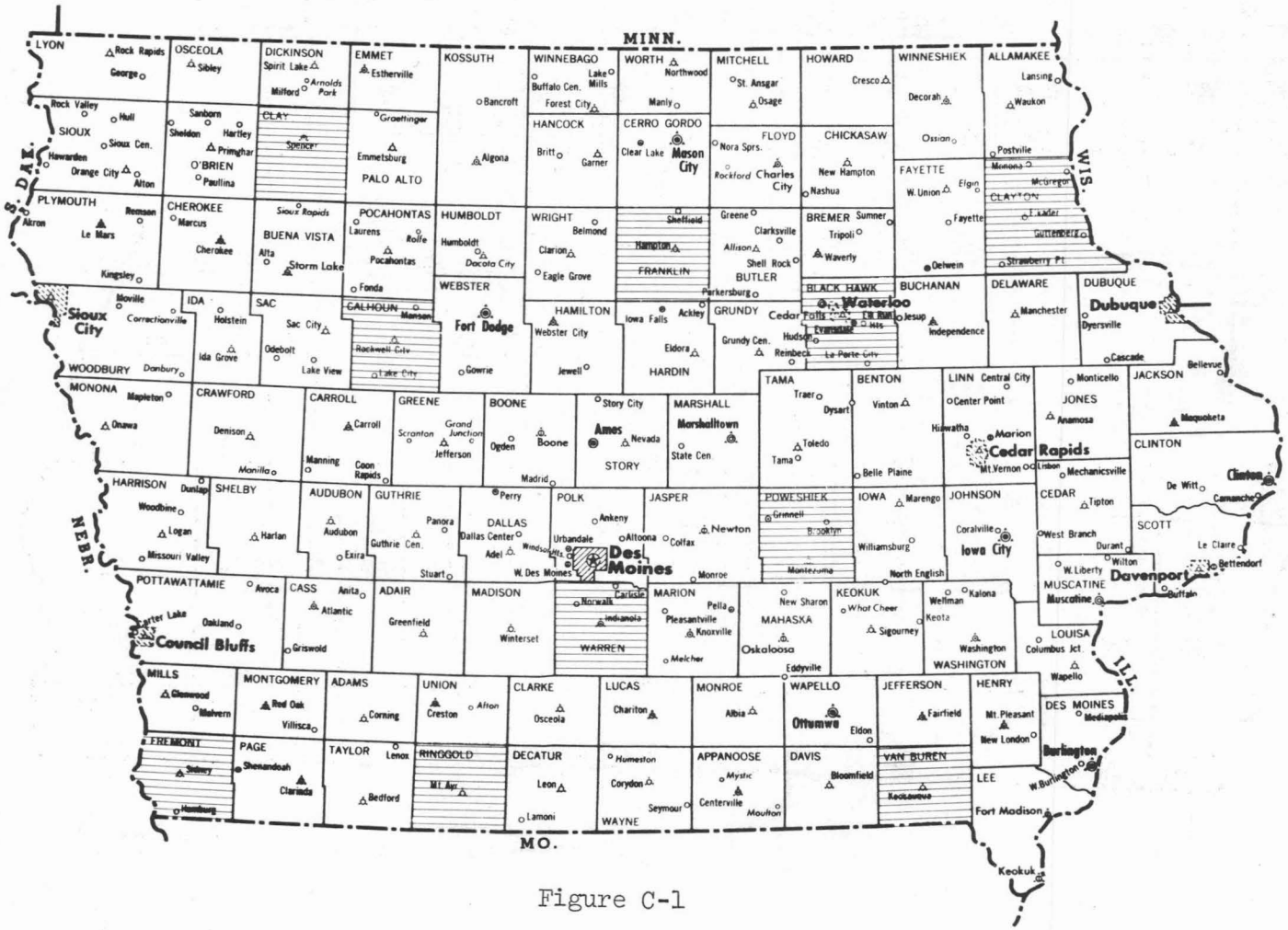


Figure C-1

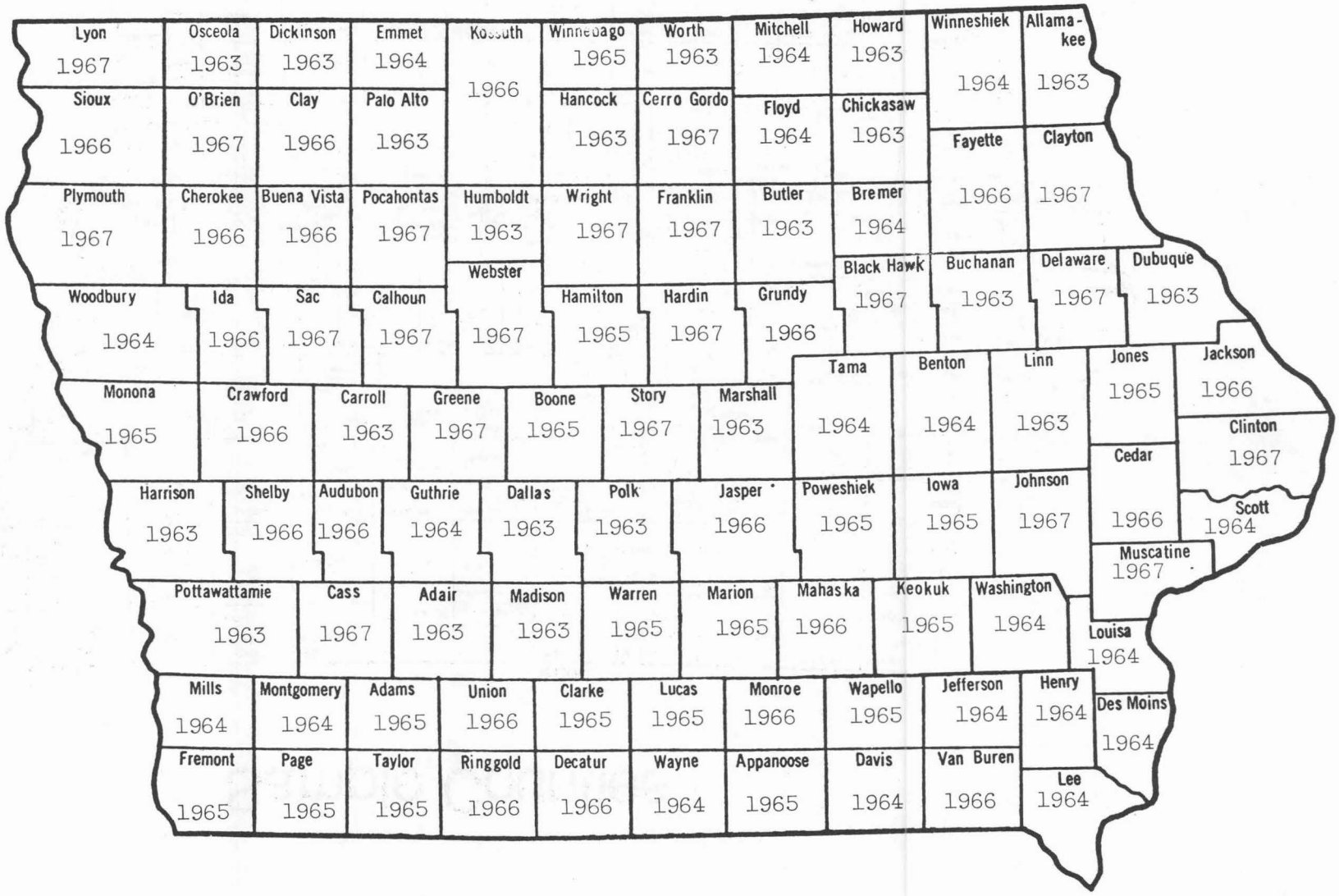


Figure C-2 - Year in Which Latest Road Traffic Survey Was Completed

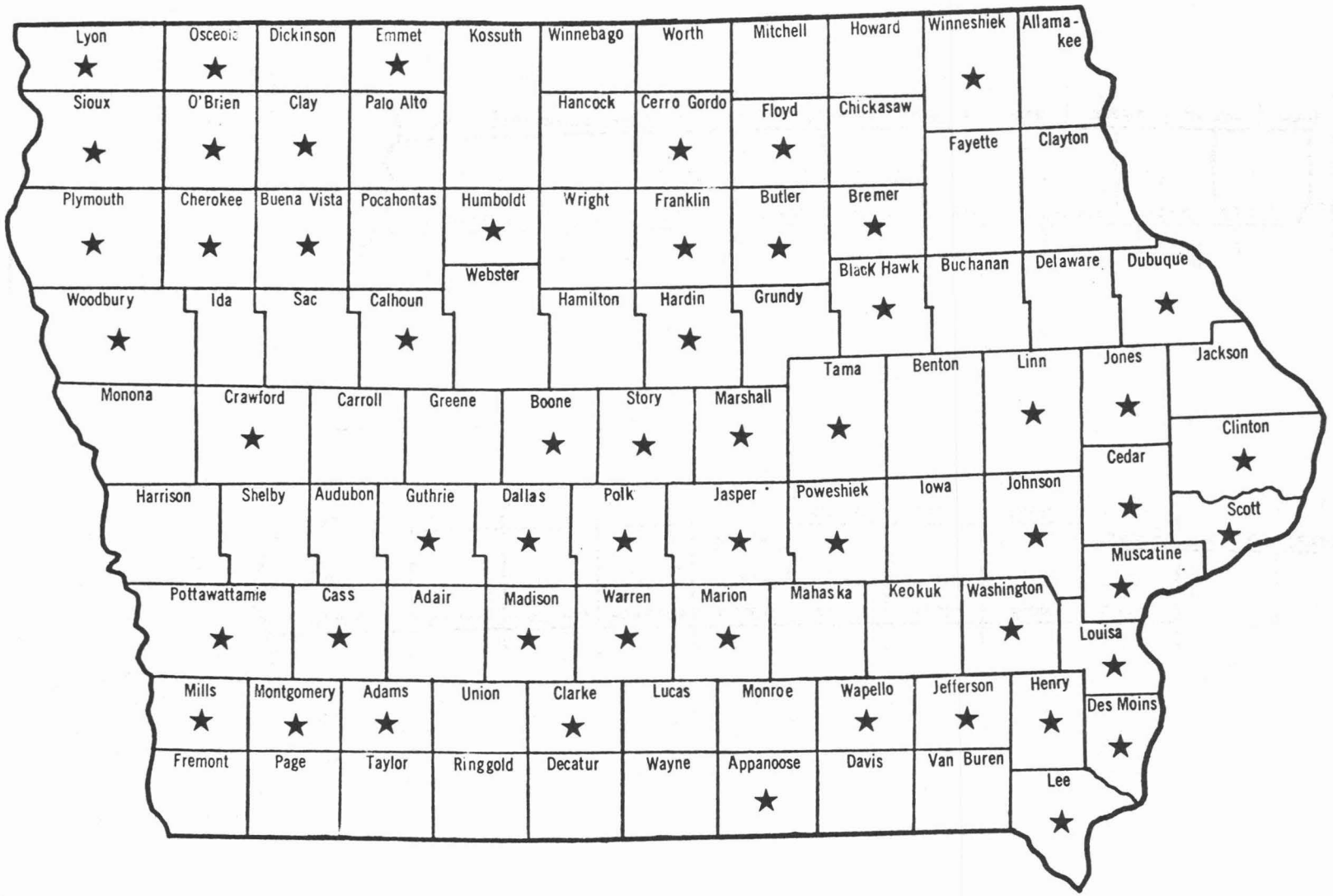


Figure C-3 - Iowa Counties with Planning or Zoning Commissions as of February 1967

Figure C-4 - Major Rivers in Iowa

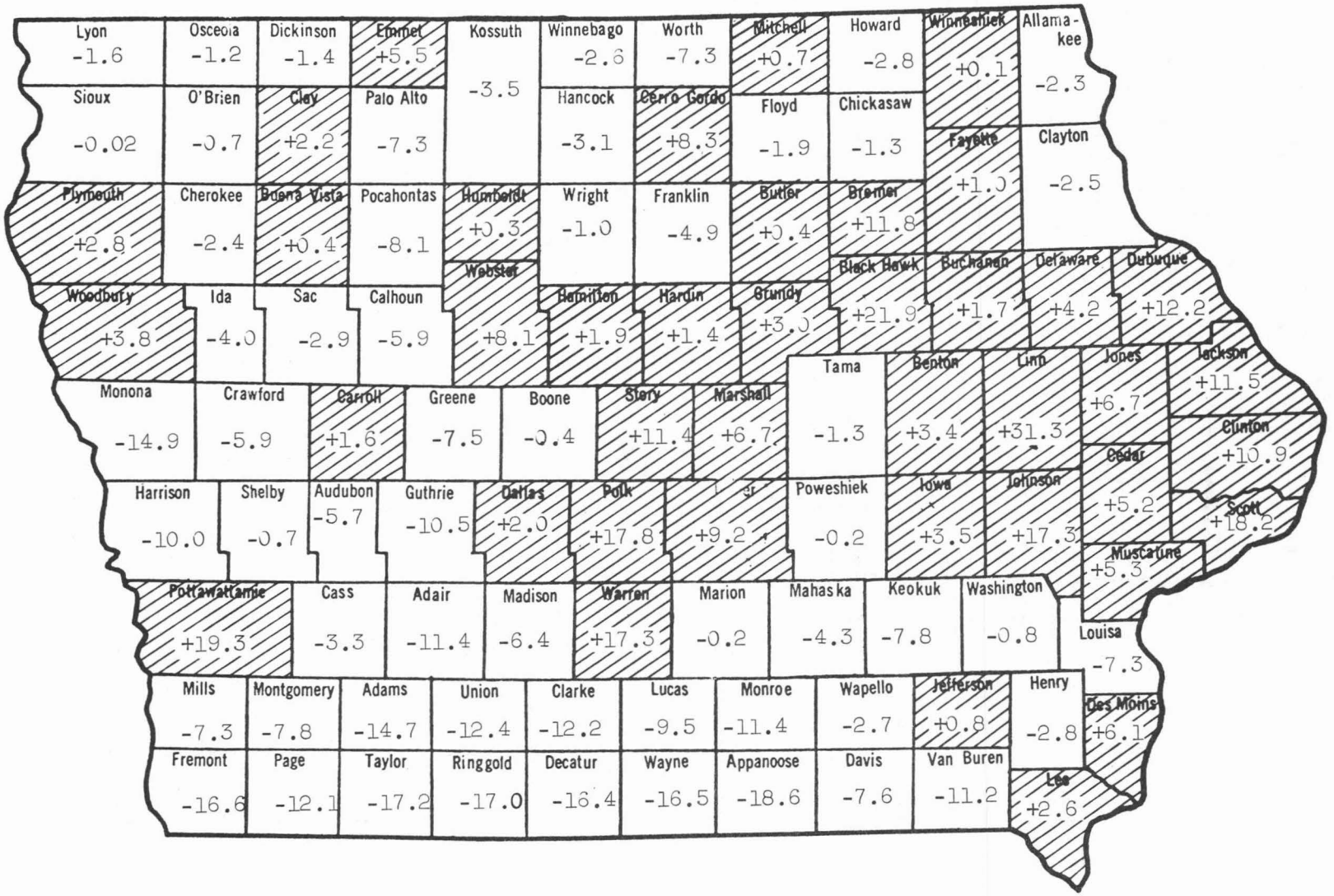


Figure C-5 - Change in County Populations from 1950 to 1960

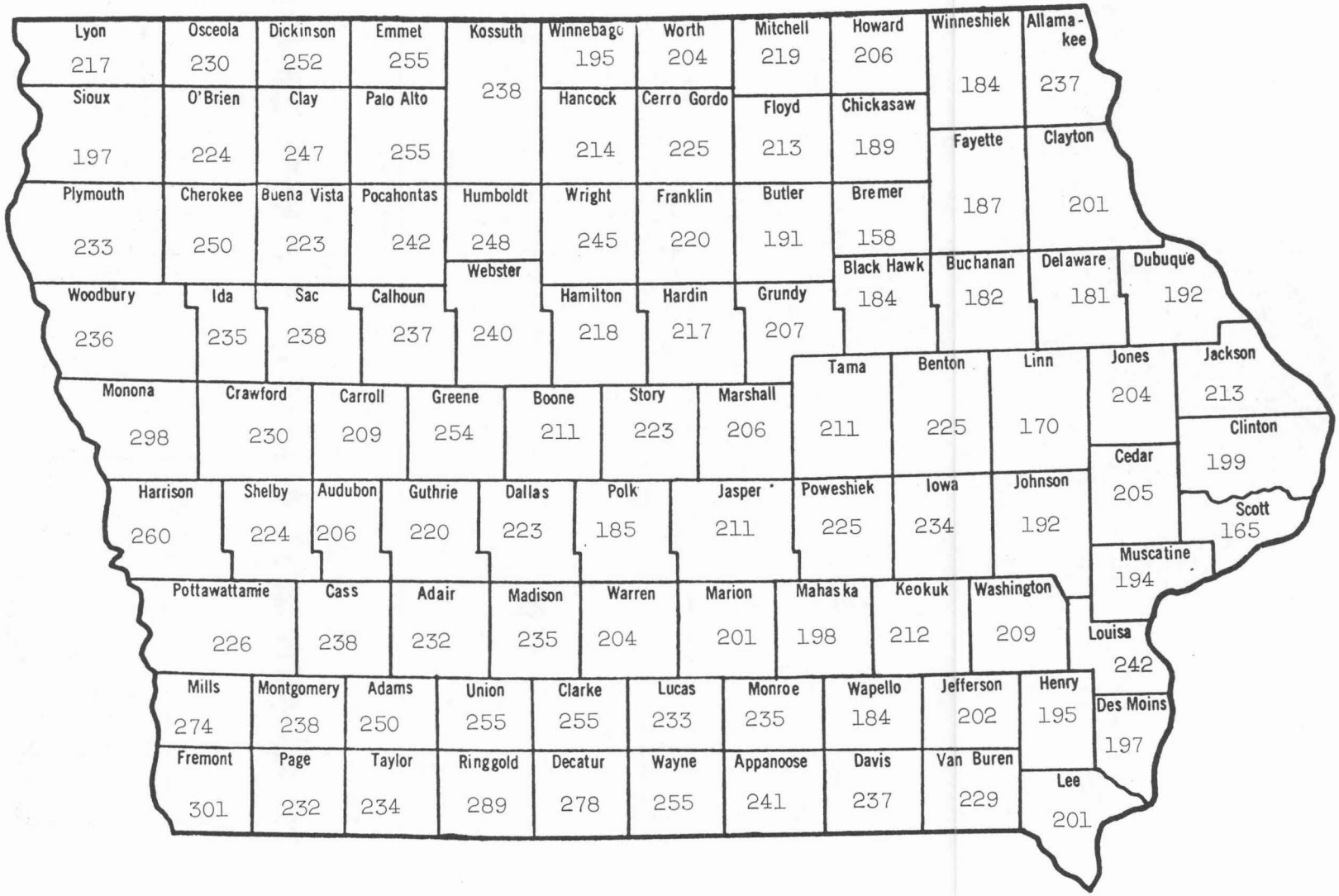


Figure C-6 - Average Size of Iowa Farms by County
1964 State Average = 219 Acres

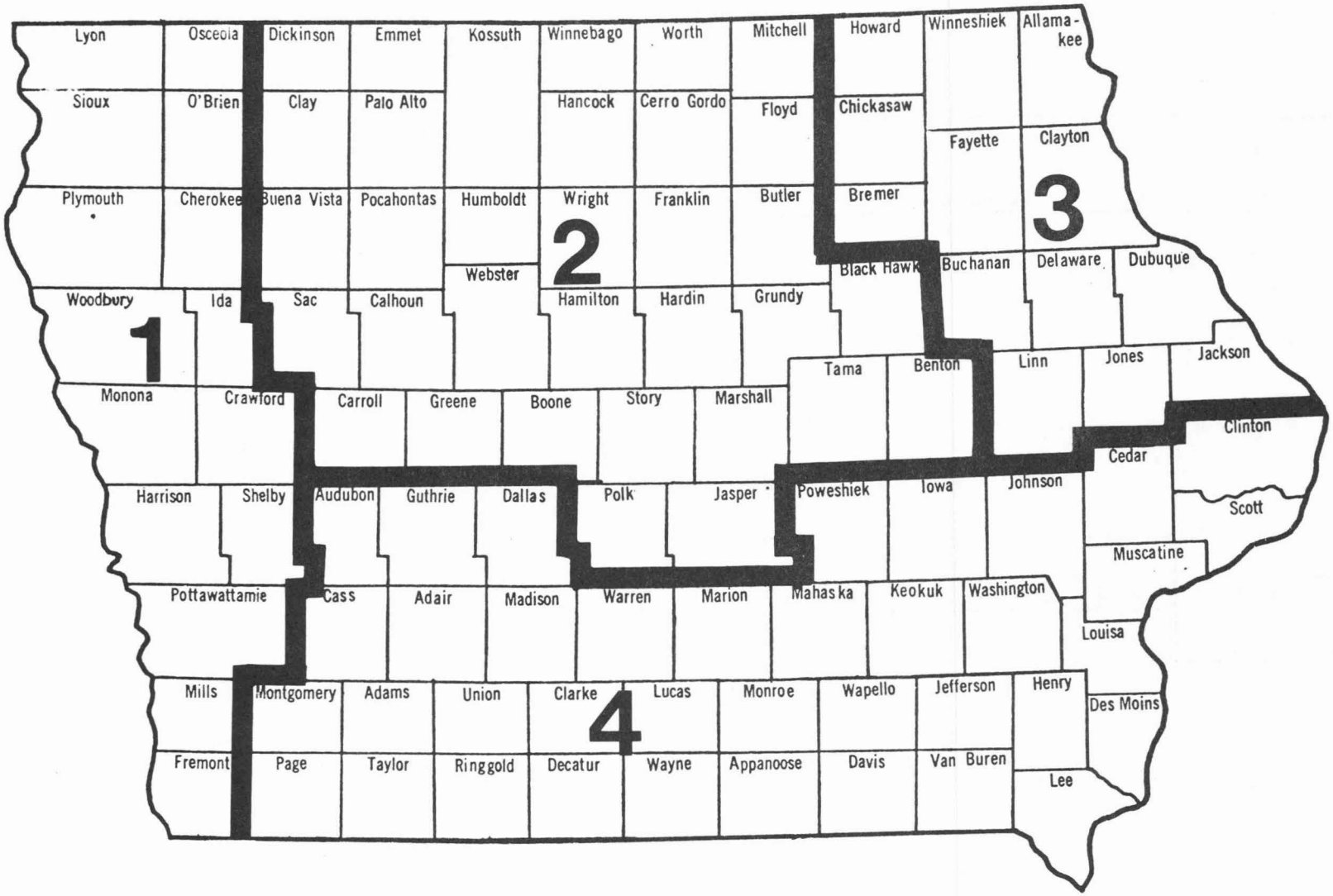


Figure C-7 - Iowa Highway Commission Cost Areas

APPENDIX D

SURVEY OF IOWA COUNTY ENGINEERS

Most of the county engineers in the sample counties were interviewed for the purpose of gaining information regarding practices and problems of road vacation. These discussions yielded useful information and insights into the problem.

In addition to the interviews with county engineers in the sample counties, questionnaires were sent to county engineers in the rest of the state. They were asked to state which factors they felt to be important in determining the value of low-traffic-count secondary roads, and the relative importance of those factors. Of the 89 engineers contacted, 79 responded (89 percent).

The responses are summarized in Tables D-I and D-II. The total weighted value for each factor shown in Table D-I was computed to provide a simple method for ranking the various factors according to their importance as far as the county engineers are concerned. Table D-III indicates other factors mentioned by the county engineers.

The number of residences on the road was considered to be the most important factor determining the value of a low-traffic-count road. This factor was rated of much or extreme importance by over 92 percent of all who responded. The following factors also were rated high in importance: average daily traffic count, abutting land ownership patterns, number and type of structures (bridges, etc.), the condition of structures, and field access to nonadjacent farms. The results of this survey support the selection of criteria and weights used in constructing the Road Value Index.

TABLE D-I

FACTORS DETERMINING THE VALUE OF A LOW-TRAFFIC-COUNT SECONDARY ROAD
Summary of Responses from County Engineers

	Number of Responses					Total Weighted Value[1/]	Rank
	None	Little	Some	Much	Extreme		
Number of residences	2	0	7	41	29	332	1
Average daily traffic count	0	7	16	34	22	308	2
Abutting land ownership pattern	0	5	23	30	21	304	3
Condition of structures	3	8	19	31	18	290	4
Number and type of structures (bridges, etc.)	2	10	18	35	14	276	5
Field access to nonadjacent farms (for the abutting owner who farms land elsewhere)	1	17	33	18	10	256	6
School bus route	8	13	34	18	6	238	7
Mail route	8	20	28	16	7	230	8
Road use by others not owning abutting property	7	32	26	8	5	206	9
Surface type	4	34	33	7	1	204	10
Road length	9	31	28	9	2	201	11
Dead end road	17	24	22	12	4	199	12
Condition of surface	8	35	26	9	0	192	13
Utility lines	19	30	25	5	0	174	14

1/ Weights:
None = 1
Little = 2
Some = 3
Much = 4
Extreme = 5

TABLE D-II

FACTORS DETERMINING THE VALUE OF A LOW-TRAFFIC-COUNT SECONDARY ROAD
Summary of Responses from County Engineers

	Percent of Responses					
	None	Little	Some	Much	Extreme	Rank
Average daily traffic count	0.0	8.9	20.3	43.0	27.8	2
Number of residences	2.5	0.0	8.9	51.9	36.7	1
Surface type	5.1	43.0	41.8	8.9	1.3	10
Condition of surface	10.3	44.9	33.3	11.5	0.0	13
Road length	11.4	39.4	35.4	11.4	2.5	12
Number and type of structures (bridges, etc.)	2.5	12.7	22.8	44.3	17.7	5
Condition of structures	3.8	10.1	24.1	39.2	22.8	4
Mail route	10.1	26.3	35.4	20.2	8.9	9
School bus route	10.1	16.5	43.0	22.9	7.6	7
Abutting land ownership pattern	0.0	6.3	29.0	38.0	26.6	3
Utility lines	24.1	38.0	31.6	6.3	0.0	14
Field access to nonadjacent farms (for the abutting owner who farms land elsewhere)	1.3	21.5	41.8	22.9	12.7	6
Road use by others not owning abutting property	9.0	41.0	33.3	10.3	6.4	8
Dead end road	21.5	20.4	27.8	15.2	5.1	11

TABLE D-III

OTHER FACTORS DETERMINING THE VALUE OF A LOW-TRAFFIC-COUNT SECONDARY ROAD

Factors	Relative Importance[1/]
Properties that would be landlocked	Extreme (1)
Private easement for landowners needing access	Much (1)
Access to recreation areas	Much (1)
Access to town or elevators	Much (1)
Cost of buying landlocked property	Much (1)
Future plans for area	Extreme (2), much, (2)
Continuity of route	Extreme (1), much (4), some (1)
Objections by other property owners, damage claims, and cost of vacating	Extreme (2)
Interstate highway construction	Extreme (1)
Cost of maintaining present highway condition	Much (1)
Availability of alternate routes	Extreme (1)
Size and length of school buses	Much (1)
Terrain	Some (1)
Access to industrial plants	Much (1)
State laws and court decisions	Extreme (1)
Condition of existing road	Much (1)
Rural fire department use	Some (1)

1/ Number in parentheses refers to number of responses.

APPENDIX E

DEVELOPING THE ROAD VALUE INDEX

The value of a given segment of road is considered to be a function of factors reflecting road use and access requirements. The factors which were employed to reflect road use were traffic volume, numbers of users, types of users, and type of road (through road or dead end). Access requirements were measured in terms of different land ownership patterns, potential barriers to access if the road is vacated, residence access requirements, and other public and private access requirements.

The procedures used for quantifying each factor (along with appropriate weights) are as follows:

Factor	Measure Used	Purpose
Road Use		
Traffic count	Actual ADT	Reflects volume of traffic
Number of users	Number of ownership tracts abutting on the road x 5	On low-count road this should reflect number of users
Residential users	Number of residences on road x 10	This provides additional weight for residential users
Other users	Number of public uses x 25 and other private nonfarm uses x 10[1/]	This provides additional weight for important nonfarm uses
Dead End	Deduct 10 if the road is a dead end	The dead end road tends to reduce potential for through traffic, thereby restricting potential use
Mail Route	Add 10	This provides additional weight for special uses
Bus Route	Add 10	This provides additional weight for special uses
Utility Route	Add 10	This provides additional weight for special uses

1/ The needs study tape or field observation is a major source of information on private nonfarm uses. Our demonstration data include largely public uses (schools, churches, cemeteries, etc.) identified from inspection of highway commission maps.

Factor	Measure Used	Purpose
Access		
Land ownership patterns	(No. of EOT's x 5) + (No. of DA-IOT's x 5) + (No. of SA-IOT's x 10) + (No. of IS-IOT's x 10)[1/]	This weighting system reflects the access requirements for different types of ownership tracts abutting on the road segment
Access barriers	(No. of EOT's and IOT's bisected by a stream x 5)[2/]	This reflects additional access problems created by vacation of the road segment
Residence access	(No. of EOT's with residences x 5) + (No. of IOT's with residences x 10)	This provides additional weight for those ownership tracts with a residence
Residence access	If all residences are within 1/8 mile from another road segment deduct 5 x the number of residences	This tends to reduce the residential access requirements for those residences with potential alternative access
Other uses	(No. of public uses x 25) + (No. of other private uses x 10)	This reflects access requirements for nonfarm uses

The sum of the above weighted factors provides a Road Value Index. Under this system, a road with a high Road Value Index is considered to be of substantial value and therefore is probably low on the list of abandonment candidates. Conversely, a road with a low Road Value Index represents a road of limited value and therefore represents a good potential candidate for abandonment.

1/ Definitions are as follows:
EOT = External ownership tract--abutting on two adjacent roads.
DA-IOT = Dual access interior ownership tract--abutting on two roads which are not adjacent.
SA-IOT = Single access interior ownership tract--abutting only on one road.
IS-IOT = Isolated interior ownership tract not abutting on any road but with private access to the road in question.

2/ Data on rail and/or interstate highway barriers were not included in demonstration. This information can be obtained from the maps.

The manner in which these various factors are combined to form the Road Value Index is illustrated in the following formulae:

(1) ADT + (AOT's x 5) + (RES's x 10) + (PUB x 25) + (PVT x 10) + (ML x 10) + (BS x 10) + (UT x 10) - (DE x 10) = Road Use Value

(2) (EOT's x 5) + (DA-IOT's x 5) + (SA-IOT's x 10) + (IS-IOT's x 10) + (AOT's/S x 5) + (EOT RES x 5) + (IOT RES x 10) - (RES within 1/8 mi x 5) + (PUB x 25) + (PVT x 10) = Access Requirement Value

(3) Road Use Value + Access Requirement Value = Road Value Index

Figure E-1 illustrates the different types of ownership tracts. Definitions are presented in Table E-I.

A description of each factor, the sources of data, the weights applied, and their rationale will help to explain the procedures and the construction of the Road Value Index.

Traffic volume (ADT) is employed as one measure of road use. ADT was obtained from the traffic count maps published by the Iowa State Highway Commission.

The number of road users is another factor of importance. Users are categorized into different types--people owning property abutting on the road, people living in residences located on the road, and uses of other facilities located on the road.

The number of ownership tracts abutting on the road is determined from county plat books. Then, the number is weighted by a factor of 5.

For every residence on the road, determined by examination of highway commission maps, a factor of 10 is applied. It is our opinion that the residential user warrants the additional weight.

It is also important to recognize other users, and two alternative types of weights are applied depending upon the type of user. For example, a road serving public facilities, such as churches, parks, and the like, has a weight of 25 applied. The rationale is that a road serving the general public rather than a few selected individuals warrants a higher weight. Other nonfarm private uses, such as a private business, have a weight of 10 applied. Private nonfarm use should carry about the same weight as the private farm use.

The Road Value Index formula also takes into account whether a road is a through road or a dead end. If the road is a dead end road, 10 points are deducted. The rationale for this type of negative weight is that the dead end road tends to reduce potential through traffic, thereby restricting the number of potential users.

The sum of the weights for each of the different factors represents the value of that road from the standpoint of road use. By way of illustration, assume a road has an ADT of 16, four ownership tracts, one residence, no other public or private facilities on the road, and is a through road. The resulting value measure assigned to that road for road use would be 46.

The same type of procedure is used to develop a measure of the value of the road in satisfying access requirements. Here, land ownership patterns--distinguishing between the different types of ownership tracts abutting on the road segment--are taken into account. Potential barriers to access if the road were vacated are also considered. For example, vacating a road may present certain access problems if a tract of land abutting on the road is cut by a stream or a railroad track or some other barrier.

Residence access requirements are also taken into account, with additional weight being provided for those ownership tracts with an occupied residence. The type of ownership tract on which the residence is located is also taken into account, as are the access requirements for other private and public nonfarm uses. These different types of ownership tracts combine to form many different land ownership patterns along any given stretch of road, and these different ownership patterns present different access requirements and also present different problems when it comes to vacating roads. Thus, it is important to distinguish between different types of ownership patterns.

Continuing with the construction of our Road Value Index, a weight of 5 is applied to each exterior ownership tract and to each dual access interior ownership tract. These are tracts of land having access from other roads. To the single access interior ownership tract and the isolated interior ownership tracts, a weight of 10 is applied. This weighting system reflects the access requirements for different types of ownership tracts abutting on the road segment in question.

In some cases, streams or other barriers present additional access problems. An additional weight of 5 is applied to each exterior ownership tract and to each dual access interior ownership tract bisected by a stream in such a way that vacation of the road would deny access to a portion of the tract.[1/]

1/ This same approach could be followed for railroad tracks, interstate highways, and other similar barriers.

Since access to farm residences is a major function of the rural road system, additional weights are provided for those ownership tracts with a residence. A weight of 5 is applied to each exterior ownership tract with a residence, and a weight of 10 is given each interior ownership tract with a residence.

In those instances where all residences on a given road are located within 1/8 mile from another road segment, we deduct 5 times the number of residences. This reduces the weight for residential access requirements for those residences with potential alternative access.

Access to public facilities is given a relatively high weight of 25. Other nonfarm uses receive a weight of 10. This is to reflect the access requirements for the nonfarm uses.

The sum of these access requirements factors represents that portion of the total Road Value Index attributed to access requirements.

The access requirement value, added to the road use value, yields our total Road Value Index figure for that particular road segment.

When this system is applied to all roads in a county, the resulting series of road index values allows us to determine the relative value of any given road segment compared with the value of other road segments.

Reference to Figure E-2 will help to show how the Road Value Index value was developed. This map shows a portion of Lone Tree Township in Clay County. The roads, property ownership lines, structures, and other physical features and road characteristics are plotted on the map. This information represents the basic data used in construction of the Road Value Index.

Consider the road that runs north and south between Section 20 and Section 21. This road has an average daily traffic count of 12. There are six ownership tracts abutting on this road so, according to the weighting procedure of 5 points per ownership tract, 30 points are added. One residence abutting on the road provides another 10 points. There are no apparent nonfarm facilities on the road.

Looking at the access requirements, there are four exterior ownership tracts, adding a total of 20 points. There are no dual access interior ownership tracts, but there are two single access interior ownership tracts adding 20 more points. There is one residence on an interior ownership tract and no other residences. This adds 10 additional points. There are no isolated interior ownership tracts, nor are any of the tracts bisected by a stream which might present access problems.

Adding all this together then gives a total Road Value Index for this particular road of 102. The Road Value Index figures in Clay County ranged from 10 to 190, with median value of 77. Thus, the index value for this road is higher than the average for this county.

Another example is the road that runs east and west between Sections 20 and 29. The recorded traffic count is 21. There are four ownership tracts abutting on that road (20 points). There is one residence, adding 10 points. Four of these ownership tracts are exterior ownership tracts (20 points). The residence is on an exterior ownership tract, which yields another 5 points. There are no other items to increase the score, so the total Road Value Index for this particular road is 76.

A railroad track runs diagonally across Sections 20 and 29. This was not taken into account in the demonstration of the system, although this type of potential barrier could be easily introduced. For example, the railroad presents a potential barrier to access to the land in the northwest corner of Section 29. If this had been a stream instead of railroad track, 5 points would have been added. By way of comparison, the situation in Section 20 does not impair access.

A low-traffic-count road was defined as any road with an ADT of 30 or less. This definition of cutoff point was based on several considerations. First, a review of the literature was conducted in an effort to find some basis for defining a low-traffic-count road. Little of use was uncovered. Through numerous discussions with the Highway Commission staff and with county engineers it was concluded that 30 ADT represented a reasonable upper limit, at least for experimental purposes. However, in order to test this decision a sample of higher traffic count roads--roads with 30 to 75 ADT--was selected and the system applied to these roads. The resulting Road Value Index for these roads fell in the upper quartile for the respective county in about 75 percent of the cases. Virtually all of the rest of the high-count roads fell in the second quartile. This means that roads with traffic counts higher than 30 ADT tend to rank high in road value. This usually means that there are more ownership tracts on the road, usually more single access properties, and more residences. It also means that these high-traffic-count roads usually are more difficult to vacate and, consequently, do not represent good candidates for closure.

Once the Road Value Index had been developed, it was important to determine how sensitive the final results were to a change in the weights. In other words, if someone decided that more weight should be given a particular factor, what would be the effect of the overall value ranking of the roads?

To determine the effect of changing the coefficients or weights, a series of experiments was conducted. In each experiment, one coefficient was doubled and all the others were left unchanged. This change increased some road values more than others and changed the relative ranking of the road segments. The amount and frequency of these shifts were determined by calculating the average absolute deviation in the rank order. The results of these tests are shown in Figure E-3.

Certain factors were more sensitive than others to changes in the coefficients. For example, the rank order of each road value is not significantly changed (less than 1 percent on the average) when the coefficient for road segments with ownership tracts bisected by a stream is doubled. However, when the weight for ADT is doubled, the rank order is significantly changed (5 percent shift on the average).

This suggests that the Road Value Index is highly sensitive to any changes in the weights given to such factors as ADT, number of residences, and ownership patterns.

These same factors are also among those the county engineers consider to be most important. The county engineers were asked to indicate which factors they felt were most important in determining the value of a low-traffic-count road. They were also asked to indicate how important they felt each factor was. The responses were then tabulated, using a simple weighting technique to reflect differences in importance. Number of residences, ADT, and ownership patterns were found to be most important according to the county engineers. These results tend to support the selection of factors and weights which were used in constructing the Road Value Index numbers. (See Figure E-4 and Appendix D.)

In summary, the objective of this portion of the analysis was to develop a system for determining the relative value of any given road segment. The procedures developed accomplish this objective. The Road Value Index can be used alone in evaluating roads in a county, or it can be used in conjunction with other data such as road cost data. The methods used to construct the Road Value Index are fairly simple and straightforward and can be performed either at the state level or by the individual county. The information required can be obtained from readily available sources.

TABLE E-I

DEFINITIONS

Road segment: A separate stretch of road that is bounded by either two intersections or by one intersection and a dead end.

Ownership tract (AOT): All contiguous land owned by one person, family, corporation, partnership, estate, etc. As a special case, land that lies on both sides of a river or a road or some natural barrier is defined as contiguous.

Exterior ownership tract (EOT): An ownership tract that abuts on the road segment under consideration and on at least one of the intersections of the segment.

Dual access interior ownership tract (DA-IOT): An ownership tract abutting on the road segment under consideration and also on some other road segment but that does not abut on any intersection of the road under analysis.

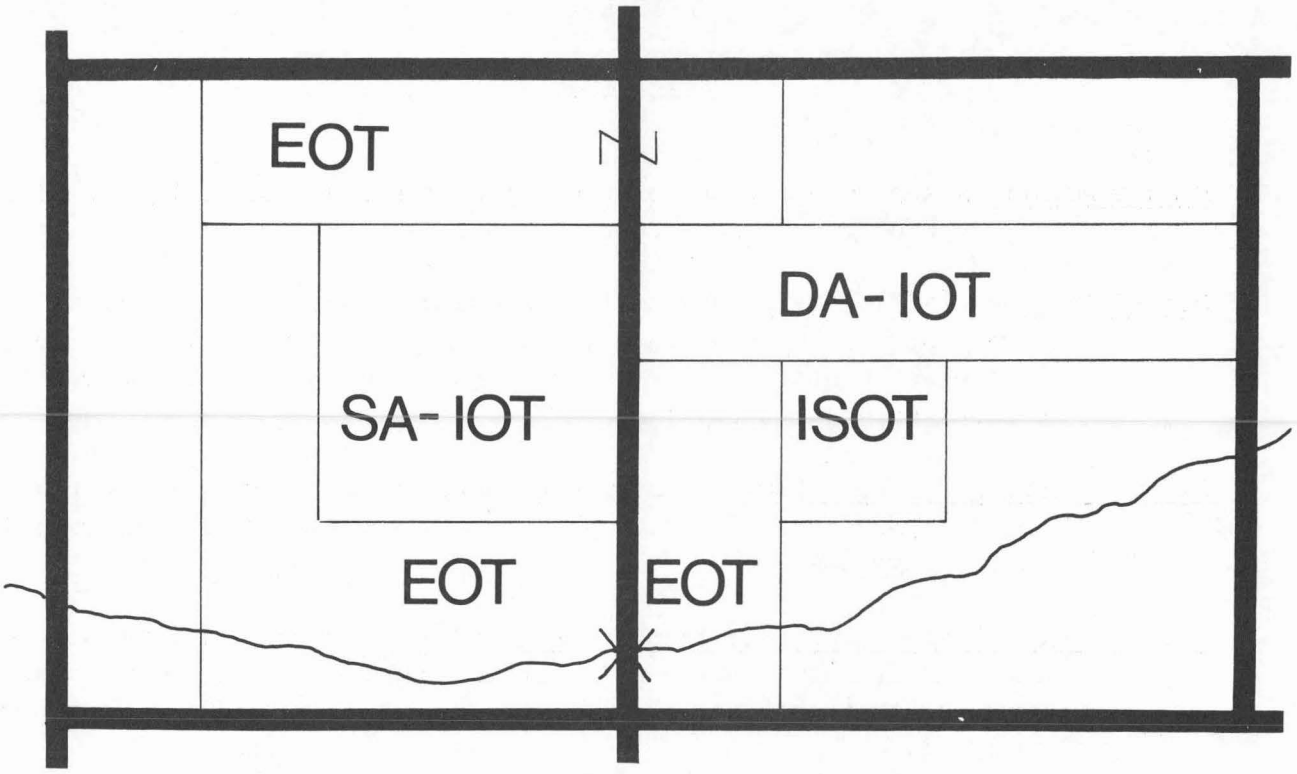
Single access interior ownership tract (SA-IOT): An ownership tract abutting on the road under consideration that does not abut on any of its intersections nor on any other road segment.

Isolated ownership tract (IS-IOT): An ownership tract that does not abut on any road segment but which, because of its position in relation to roads in the area, appears to have access through one of the owners abutting the road segment under consideration.

Ownership tracts bisected by a river or stream: Those tracts bisected by a river or stream (or intermittent stream) that requires a bridge on the road segment that it intersects. Secondly, the river or stream bisects the tract in such a way that if the road were vacated, the owner would be restricted access to part of his land unless he constructed a bridge.

Residence: It was assumed that where the Iowa State Highway Commission--General Highway and Transportation Map indicated a farm unit in use, a residence was also in use. Where this map indicated a farm unit not in use, it was assumed that the residence also was not in use and consequently was not counted as a residence.

Types of ownership tracts



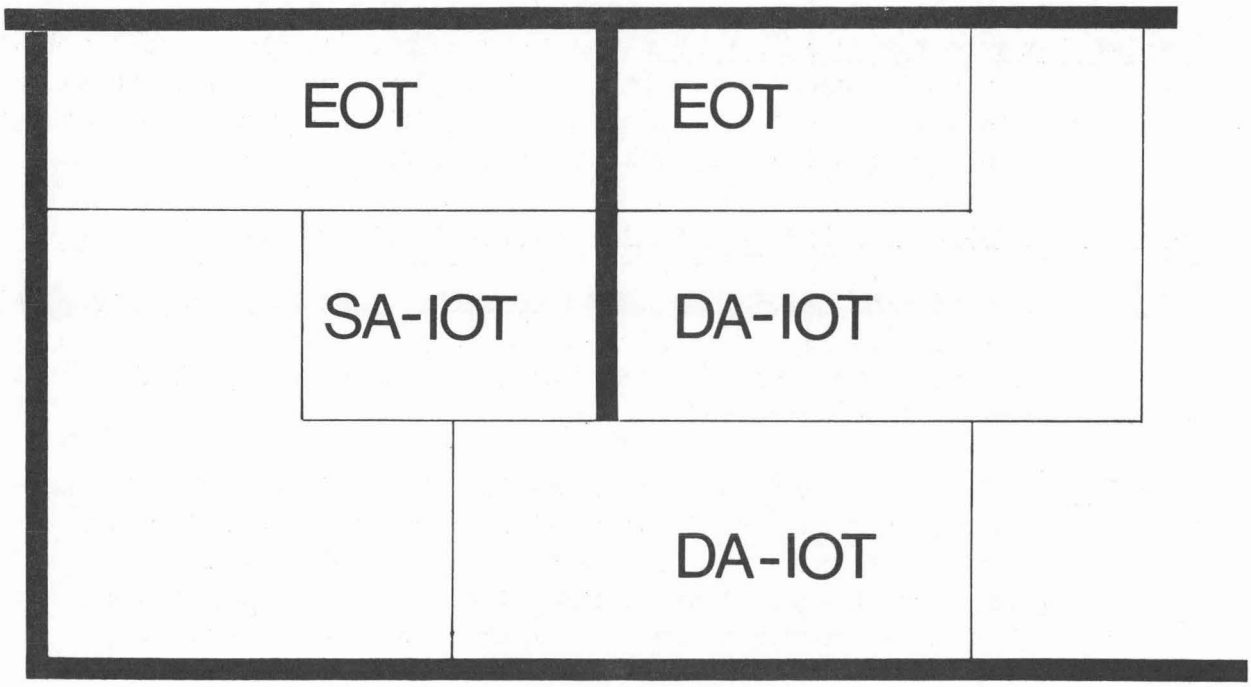


Figure E-1

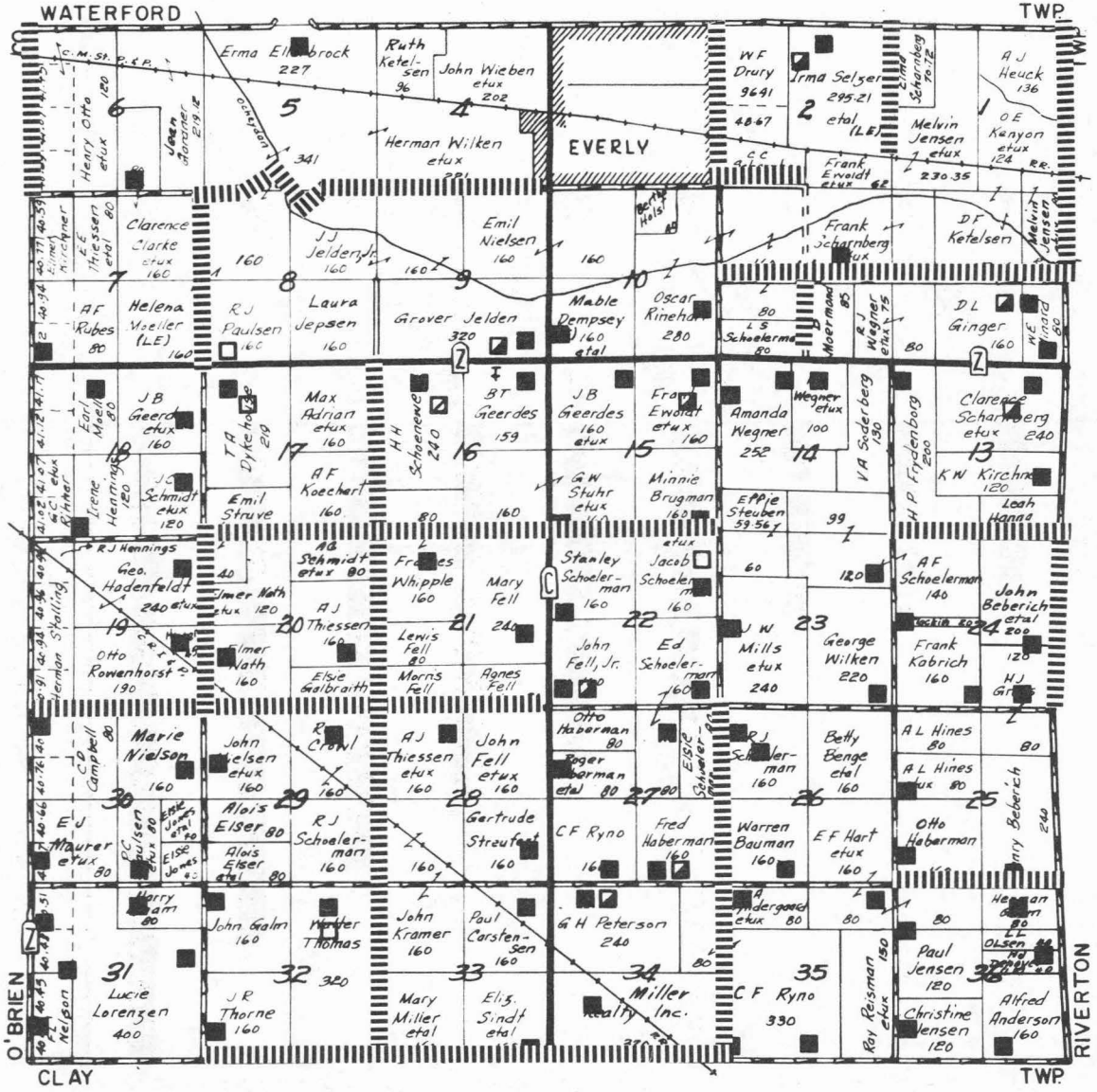


Figure E-2 - Illustrative Road Network

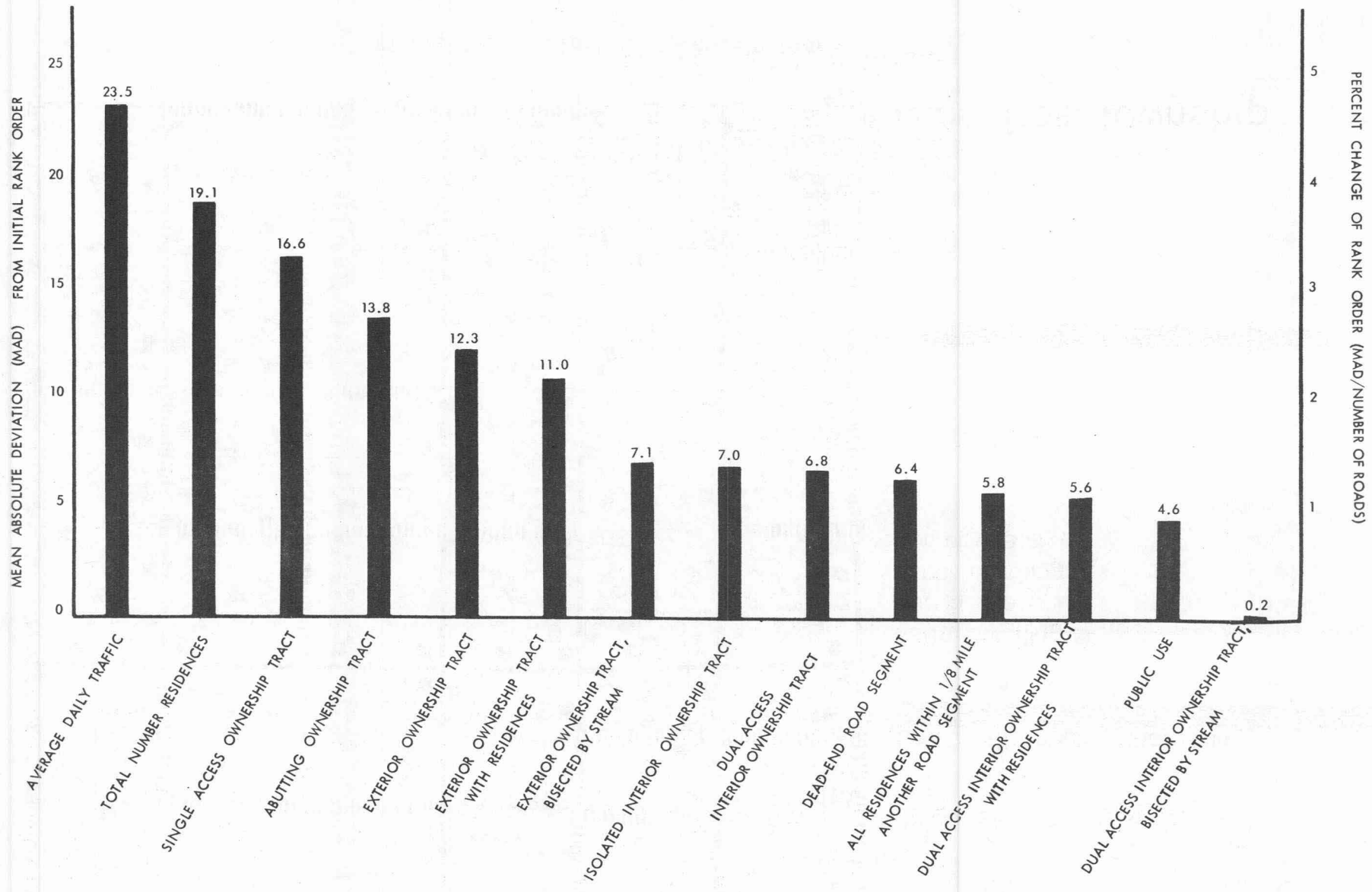


Figure E-3 - Sensitivity Analysis of Road Value Rank Order

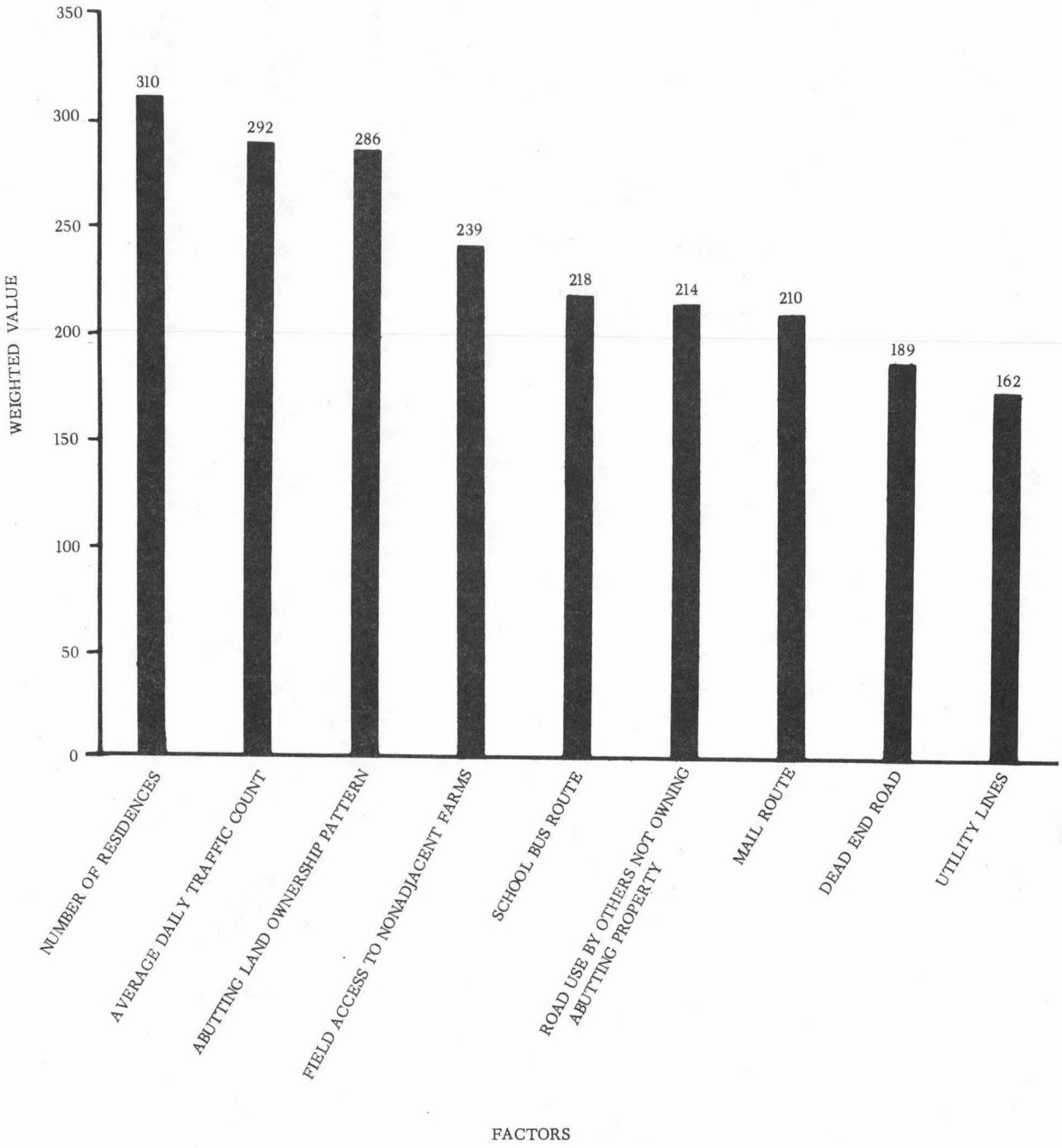


Figure E-4 - Factors Determining Road Value by Response of Iowa County Engineers

APPENDIX F

EVALUATION OF LIABILITY RISK COST

Liability risk costs are those costs incurred by the highway agency due to claims for damages resulting from a negligent, wrongful act or omission of any employee of the agency. This cost includes damages due to traffic accidents that may be attributed to inadequate operation or maintenance of the roadway surface and incidental damages resulting from negligence of the agency pertaining to maintenance and construction operations on the road segment. Because the agencies responsible for the system of secondary roads--the county governments--have been liable for such claims only since 1967, a history of such claims from which to deduce a cost does not exist. Thus, these costs, for the present, must be estimated. The evidence presented below will show this cost to be small for the low-value roads that can be considered for vacation.

An estimate of the anticipated cost of incidental damage claims was obtained by analysis of the history of such damage claims paid by the ISHC for their system of roads. For the most part, the kinds of incidental damage claims arising will be independent of the type or level of service of a road, e.g., flood damage resulting from inadequate drainage structures. A small portion of such claims may be expected to occur more frequently on the system of better-maintained roads, e.g., private property damage occurring during maintenance operations. For this reason, use of the ISHC records of claims to deduce an estimated average cost per mile of road gives a conservative or upper-limit estimate for the anticipated claims on the system of secondary roads.

The present annual rate of incidental damage claims filed with the ISHC is illustrated in Figure F-1. General descriptions of conditions resulting in the claims are indicated in the figure.

Only a portion of the claims filed will be paid. To obtain an estimate of the percentage of claims which are paid, we have analyzed the recent history of such claims filed. The results are indicated in Figure F-2. This figure clearly illustrates the rapid expansion of damage claims filed subsequent to passage of the 1965 legislative act removing state sovereignty. The records of the 1963-1964 reporting period indicate the percentage of damage claims paid to be about 45 percent. The 1965-1966 records, though incomplete, appear to be tending to that percentage also. Thus, of the amount in the 1967-1968 reporting period, some 45 percent may be expected to be paid.

Applying the 45 percent figure to the total present annual rate of incidental claims experienced by the state and prorating this cost over the state's system of rural roads, an estimated annual incidental liability risk cost of $3.00 per mile is found. This figure is assumed to be the maximum anticipated average cost for the system of secondary roads.

Estimating the liability risk cost arising from traffic accidents occuring on the system of secondary roads is the next task. Of those states which responded to the questionnaire, 12 are presently liable as is the State of Iowa. The State of Arizona indicated they too were concerned about the question of liability risk. Because of this concern they had compiled an extensive report containing case histories of successful accident claims filed against the State of New York. This report contains descriptions of many conditions leading to a claim being awarded by the court. These findings parallel our findings in our legal research of the problem. (A discussion of the pertinent findings is included in Appendix G.) The essential features of the findings have been used to estimate what portion of traffic accidents can possibly result in a claim against the highway agency. To do this, we have performed an extensive analysis of the accident records for the system of secondary roads for the State of Iowa.

The Department of Public Safety in Des Moines maintains accident records in a computer record format suitable for analysis. Each accident report filed by the reporting officer includes a description of any roadway and surface conditions or defects which may have contributed to the cause of the accident.

Unfortunately, the accident records on the local rural roads cannot be pinpointed in many cases to a specific road segment. Thus, it was impractical to deduce accident costs for each particular road segment. Instead, an estimated average annual risk cost for local secondary roads was deduced.

The 1967 road-attributable accident costs on the system of secondary roads is shown in Figure F-3. These costs were obtained using average accident costs recommended by the Department of Public Safety, and estimated by the National Safety Council for the State of Iowa. Figure F-3 illustrates that the majority of the road-attributable accident costs occur on the FAS-system of roads rather than on the non-FAS system. That is, the majority of costs occur on the system of trunks and feeders rather than on the system of local roads with which we are concerned. Figure F-4 illustrates this point further. It is evident that the accident rates are nearly equal for the two road systems. It is interesting to note that the road-attributable accident rate is greatest on the FAS-system of roads.

We have recognized the possibility that the reporting officer may, in some cases, be reluctant to indicate a specific road defect in his report now that the county may be held liable for such cases. Figure F-5 illustrates that this may have occurred since 1965 when state sovereignty was eliminated and the possibility of county governments being included was still in

question. To offset this trend and possible bias, the 1965 rate of 13.2 percent was applied to the total number of accidents for 1967 to obtain a better estimate of the present number of road-attributable accidents. Using the average accident cost data for Iowa recommended by the Department of Public Safety, the estimated road-attributable accident costs occurring on the system of non-FAS roads--essentially the system of local roads--was then allocated to the individual road segments on a per-vehicle-mile basis. For the low-ADT roads under consideration, the estimated accident risk costs are given in Figure F-6.

The incidental liability costs are also included in Figure F-6 to indicate the total estimated annual liability risk cost. The costs shown in this figure clearly indicate that for the roads being considered for vacation, the liability risk cost is not large. Indeed, it is small compared with annual maintenance costs.

These estimates for liability risk cost are conservative; they are probably an upper limit for the anticipated costs. The present cost of liability insurance for the highway agencies is much less than the conservative cost estimate derived here. Thus, the real cost of liability risk, that of insurance, bears out the contention that liability risk costs are small.

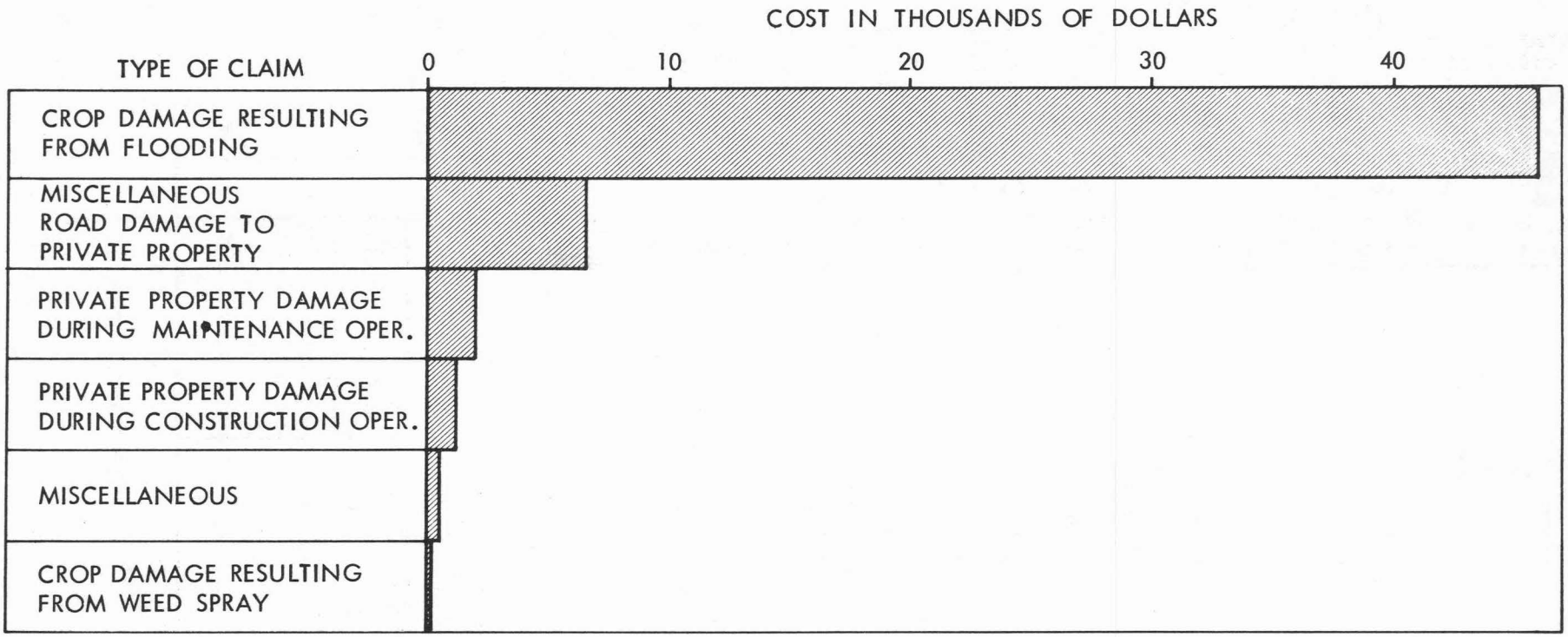


Figure F-1 - Present Annual Rate of Incidental Damage Claims Filed with Iowa State Highway Commission

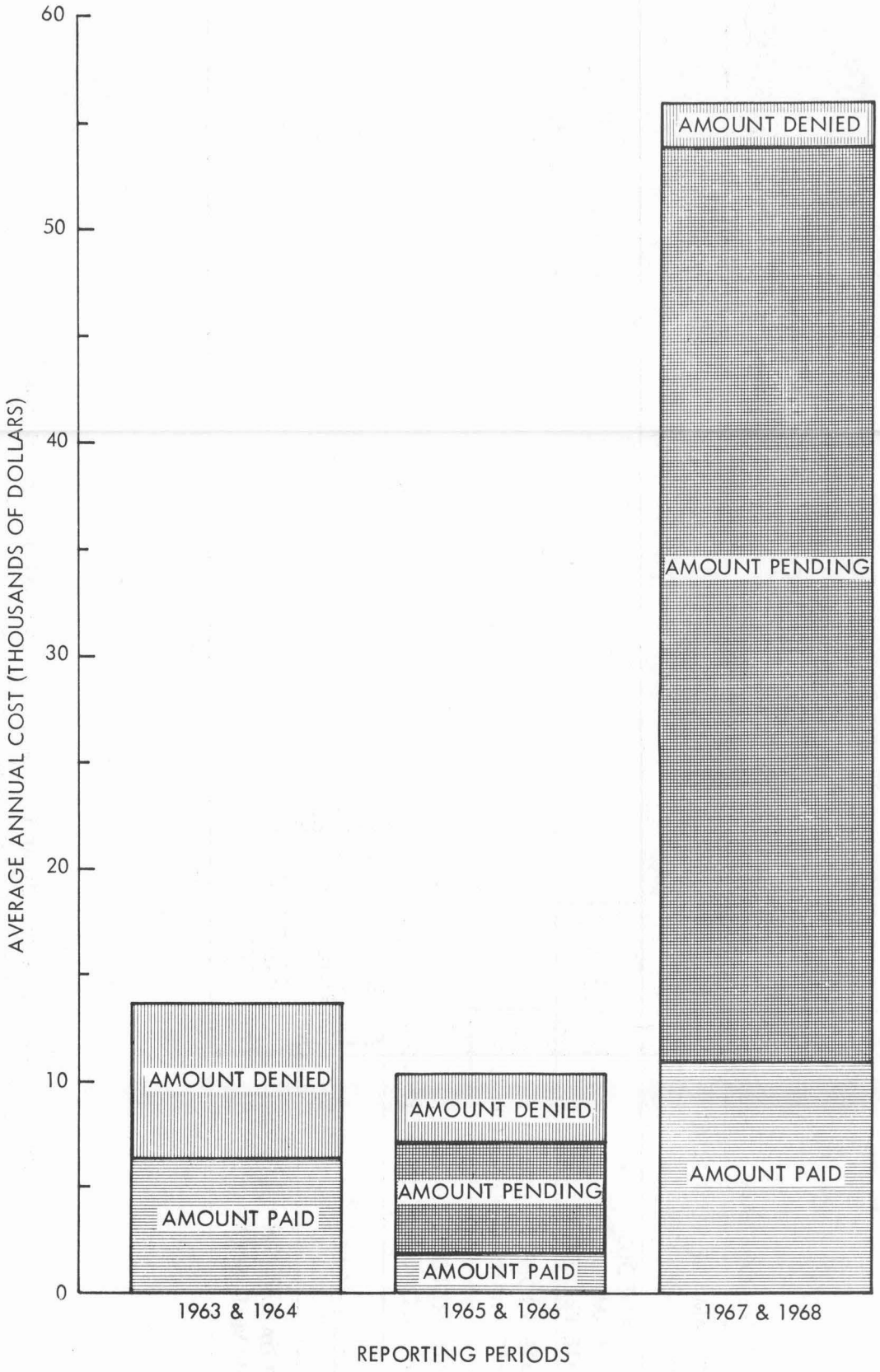


Figure F-2 - History of Incidental Damage Claims Costs

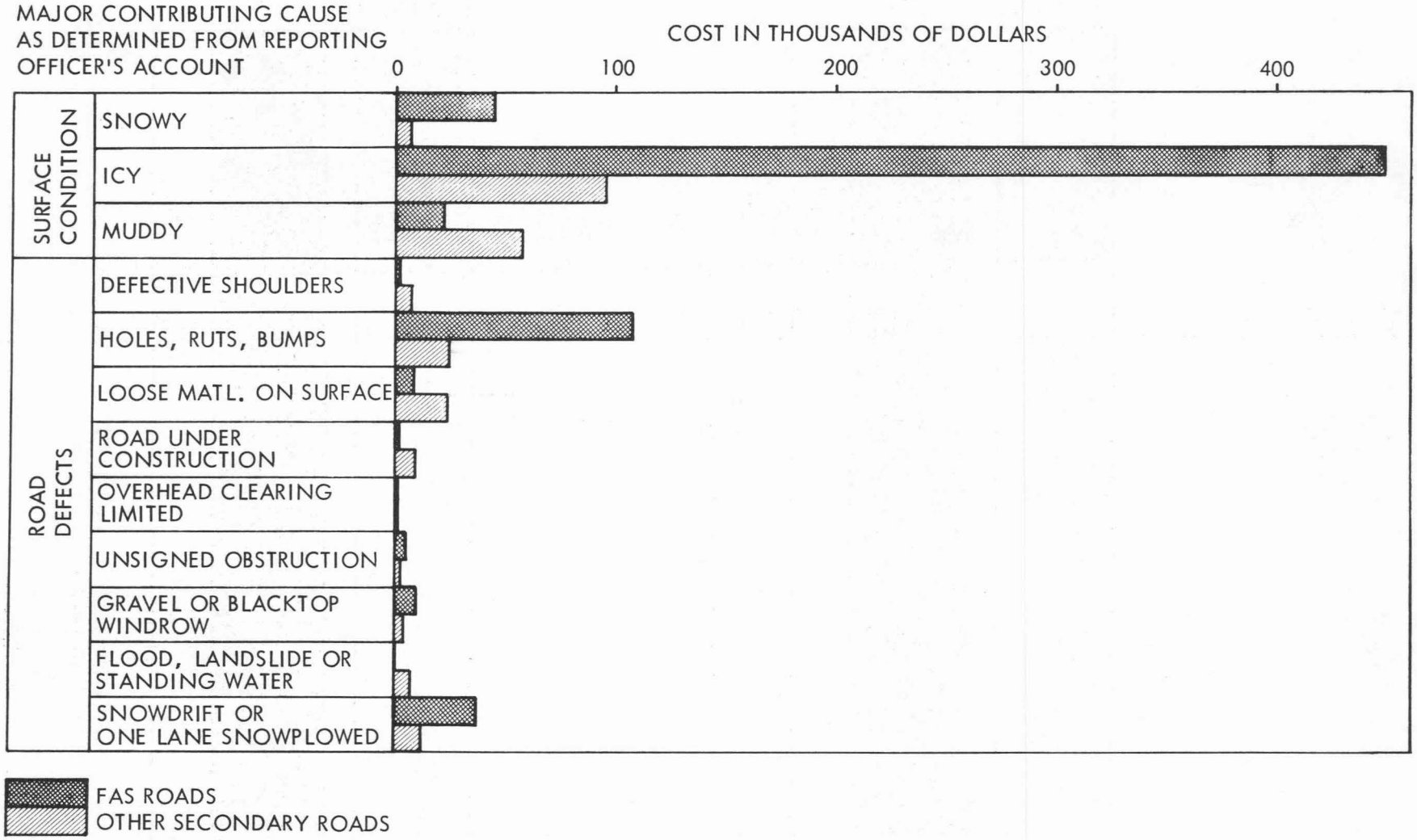


Figure F-3 - Road-Attributable Accident Costs for 1967 on Iowa Secondary Road System

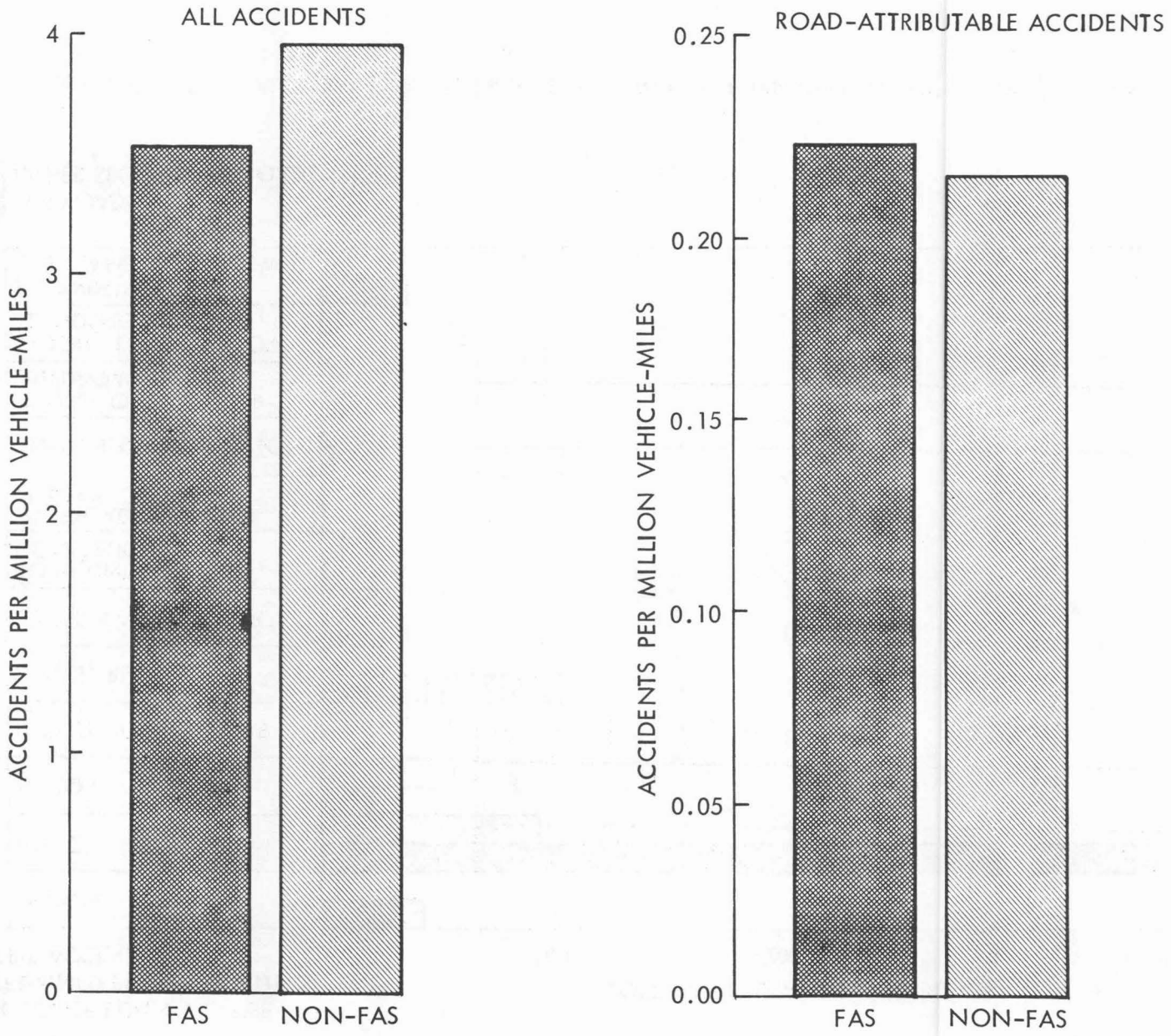


Figure F-4 - Iowa Secondary Road System Accident Rates for 1967

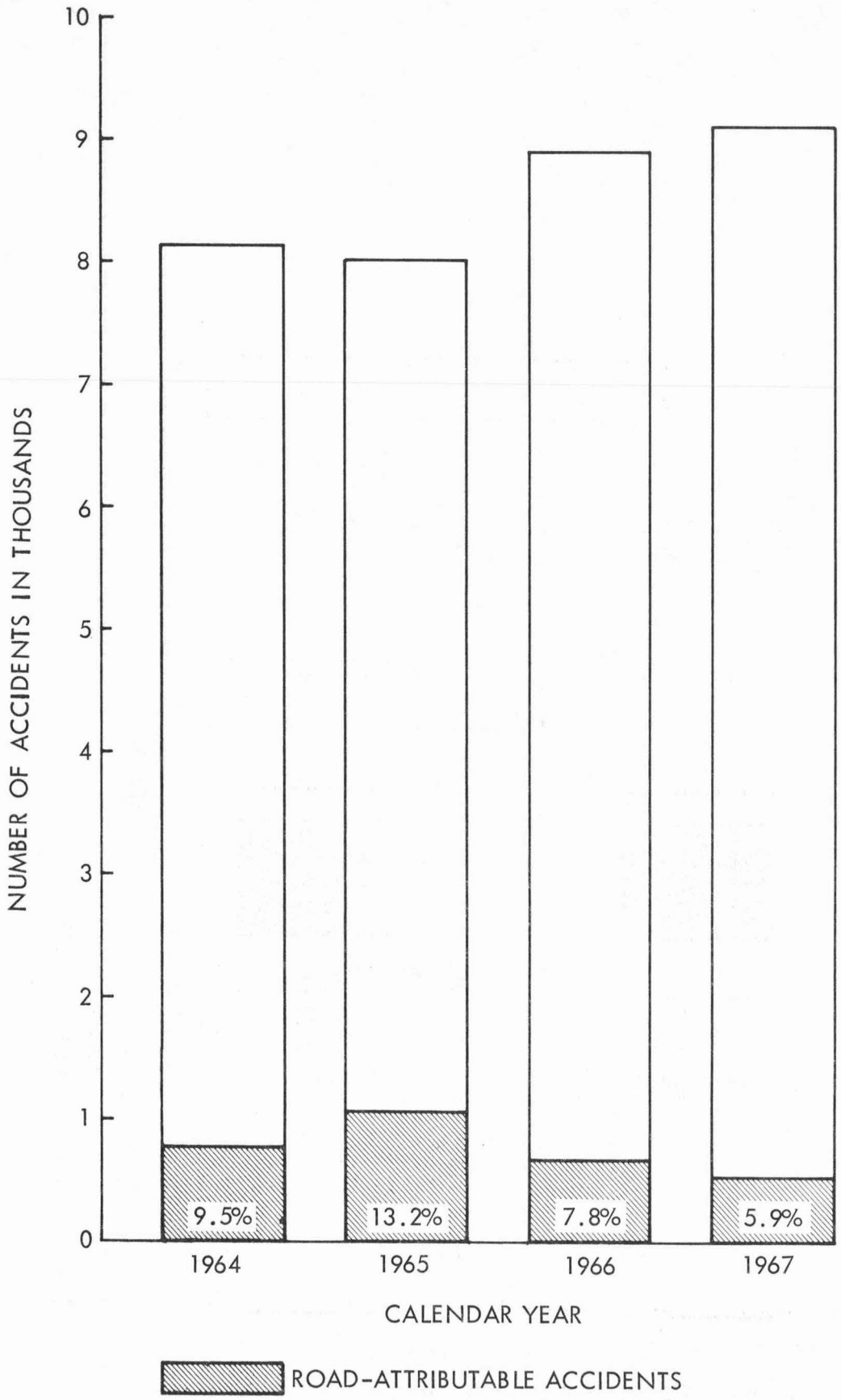


Figure F-5 - Accidents on Iowa's System of Secondary Roads

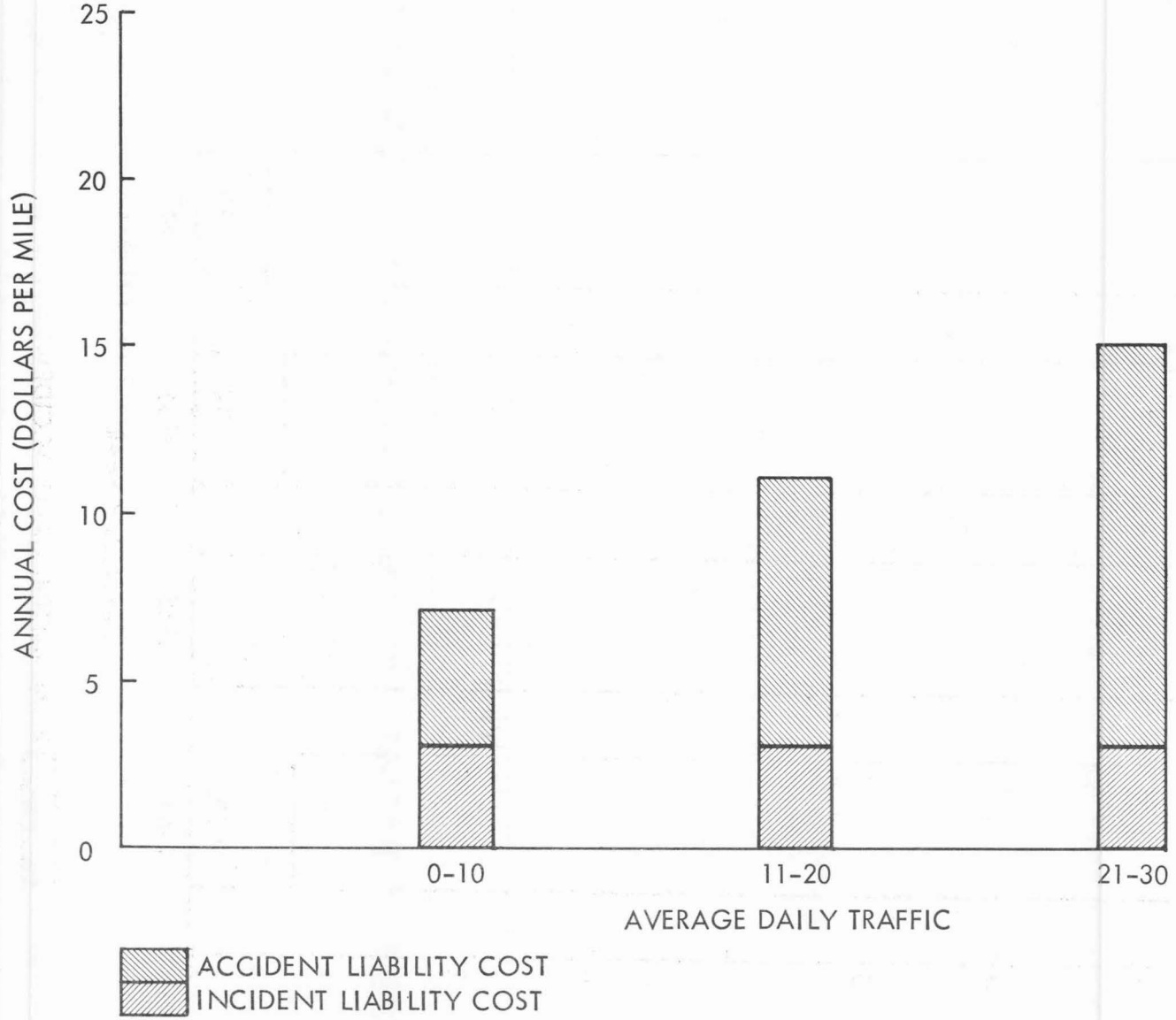


Figure F-6 - Annual Liability Cost

APPENDIX G

ROAD COST ELEMENTS USED IN THE DEMONSTRATION

The cost analysis presented in Sections III-B and III-C requires determination of the cost of retention and the cost of vacating for each road segment considered. The essential elements of retention costs are: (1) routine maintenance costs, (2) capital improvement costs, and (3) liability risk costs. Vacating costs are (1) damage claims to affected properties and (2) procedural costs.

Estimates for each of the above cost elements were derived for purposes of the application described in Section IV. A decision period of 20 years was chosen in keeping with the time period selected by the Iowa State Highway Commission (ISHC) for their Continuing Needs Study. The major cost elements--maintenance and capital improvements--were based on the extensive needs analysis of the ISHC. A thorough analysis was performed to estimate the expected cost of liability risk. Estimates of anticipated road vacating costs were obtained through analysis of the pertinent legal aspects and procedural requirements. The details of the analysis used to obtain values for each of the cost elements for the study demonstration are described below.

The cost of capital improvements depends upon the schedule of improvements deemed necessary for each particular road segment. Improvements resulting in roadway surface type changes will also affect future maintenance requirements. Any schedule of improvements and attendant costs for a particular road segment is a function of three important factors: (1) the standards selected as a basis for determining the extent of improvements necessary, (2) availability of funds to meet the total needs, and (3) the basis for allocating priorities among the system of roads. Obviously, a cost-analysis accounting for all these factors requires a complete inventory and analysis of the entire system of roads--a major undertaking. An extensive analysis is now being undertaken for the secondary roads system by the ISHC as part of the Continuing Needs Study. We have utilized their results to estimate the capital improvements and maintenance costs throughout the future 20-year period for the study demonstration.

The ISHC, in conjunction with the County Engineers Association, has selected a set of design standards which, together with an inventory of existing conditions of a road and a method of scheduling improvements to adequately meet the standards, determines the capital improvements and maintenance costs required for a given road. The Continuing Needs Study will, when all roads have been adequately inventoried, provide the improvements schedule and attendant cost estimates for a future period for each segment. At present, however, these data are available only for a sample of

the secondary roads system. This sample includes about 20 percent of the low-value roads considered to be candidates for vacating. Thus, needs study cost estimates for specific road segments were not available at this time. For purposes of the study demonstration, it was necessary to use the sample cost data to deduce average costs of capital improvements and maintenance on road segments having similar present conditions.

Another factor limiting the detail in assessing these costs is the lack of information on existing road conditions in a form readily available for computerized analysis. For the most part, information we have used to assess present conditions on the system of secondary roads has been limited to recent maps. Those existing roadway characteristics influencing capital improvements and maintenance costs which could be determined were present surface type, average daily traffic, roadway length, and number of bridges. Because costs anticipated for a given road segment had to be deduced from this information alone, the breakdown of cost estimates determined from the needs study data was limited to these present roadway characteristics. Costs were also broken down into the four cost areas of the state. The resulting costs deduced for capital improvements and maintenance are given in Table G-I. These costs are average costs per mile required to improve the indicated types of roads throughout the next 20-year period. This set of average costs was applied to those road segments considered in the study demonstration.

The assumptions made by the ISHC in determining the costs from which Table G-I was derived should be made clear. Most importantly, it was assumed that all roads would be brought up to the accepted standards within the next 10 years. It was further assumed that they would be maintained at a prescribed adequacy level throughout the remaining 10-year period. Although these assumptions are not compatible with forecasts of available road funds, the costs do provide a meaningful indication of the inadequacy of each road segment in terms of the cost expenditures required to make each meet the standards. In reality, the amount of cost avoidance calculated using these figures is a measure of the reduction in the road-funds deficit that can be facilitated by road vacation.

Estimated liability risk costs were used in the demonstration. The details of the analysis are presented in Appendix F. Briefly, the analysis included an assessment of liability of the counties under current law, a study of relevant traffic accident statistics on the secondary roads system in Iowa, and an evaluation of incidental damage claims experienced by the ISHC on the state's road system. The resulting cost estimates, believed to be upper-bound estimates, are given in Figure F-6. A comparison of these costs with the capital improvements and maintenance costs shows the liability risk cost to be relatively small.

In order to determine both the basis for and the anticipated amounts of damage claims costs expected to be paid to parties affected by road vacating, we have undertaken extensive research of conditions existing under current Iowa law. We have employed legal council resident in Iowa to interpret and evaluate our findings. The complete details of the study are presented in Appendix H.

The essential features of the findings are that a special or compensatory damage arises from the vacation of a road segment when an abutting owner's ingress and egress from his land to the general system of roads are substantially impaired. The amount of the claim is the amount of reduction in the fair market value of the affected property. A recent decision by the courts has indicated that special damages may occur to abutting properties bisected by a natural stream where the road serves as access to the separate parts of the property. The court has otherwise held that no damages occur to a party who suffers the loss of a direct or a convenient route of travel due to the vacating of the road.

In applying the above findings to the study demonstration we have found it necessary to use estimates or average anticipated claims for typical situations which occur on a given road segment. The amounts of damage claims used represent an estimate of the decrease in fair market value of the property in each case. The estimated costs used are as follows:

--Each abutting (interior) ownerhip tract that would become land-locked after road vacation was estimated to incur a sum of $1,000 as a measure of damages suffered in the form of costs of condemnation procedures required to gain new access to the property.

--Each abutting (exterior or interior) ownership tract that contains a residence on the road was estimated to have incurred a loss of $1,000 in the form of costs required to maintain a private lane in a condition adequate for daily ingress and egress. Those tracts with residences less than 1/8 mile from the end of the road segment were not included on the basis that they either represent residences with existing or easily attainable access to other roads, or that the road segment may be vacated only beyond the affected residences resulting in no damages to that property.

--Each abutting (exterior or interior) ownership tract bisected by a river or stream (barrier to internal access) was estimated to incur a loss of $1,000 as a measure of the special damages occurring to them.

An illustration of the estimated damage claims incurred by affected parties is given in Figure G-1.

Procedural costs of road vacating have been neglected in the study demonstration. Procedural matters, such as preparing and serving notices to affected parties or retaining legal and real-estate consultation, are for the most part those which the county highway agencies can carry out with their own personnel or with assistance from other agencies of the county governments.

TABLE G-I

TWENTY-YEAR MAINTENANCE AND CAPITAL IMPROVEMENTS COSTS

ROADWAY MAINTENANCE AND CAPITAL IMPROVEMENTS COSTS (DOLLARS PER MILE):

COST AREA	1				2			
PRESENT SURFACE TYPE	DIRT		GRAVEL		DIRT		GRAVEL	
AVERAGE DAILY TRAFFIC	0-9	10-30	0-9	10-30	0-9	10-30	0-9	10-30
MAINTENANCE	4740	9430	9010	10130	4630	8230	9720	10250
CAPITAL IMPROVEMENTS	12510	22300	3420	9220	5610	12190	1000	200

ROADWAY MAINTENANCE AND CAPITAL IMPROVEMENTS COSTS (DOLLARS PER MILE):

COST AREA	3				4			
PRESENT SURFACE TYPE	DIRT		GRAVEL		DIRT		GRAVEL	
AVERAGE DAILY TRAFFIC	0-9	10-30	0-9	10-30	0-9	10-30	0-9	10-30
MAINTENANCE	4570	8610	9620	10220	4760	9300	9500	10150
CAPITAL IMPROVEMENTS	10380	23490	2710	3030	10240	23520	2500	3030

BRIDGE CAPITAL IMPROVEMENTS COSTS (DOLLARS PER STRUCTURE)

PRESENT SURFACE TYPE	DIRT		GRAVEL	
AVERAGE DAILY TRAFFIC	0-9	10-30	0-9	10-30
CAPITAL IMPROVEMENTS	4720	24930	1230	21050

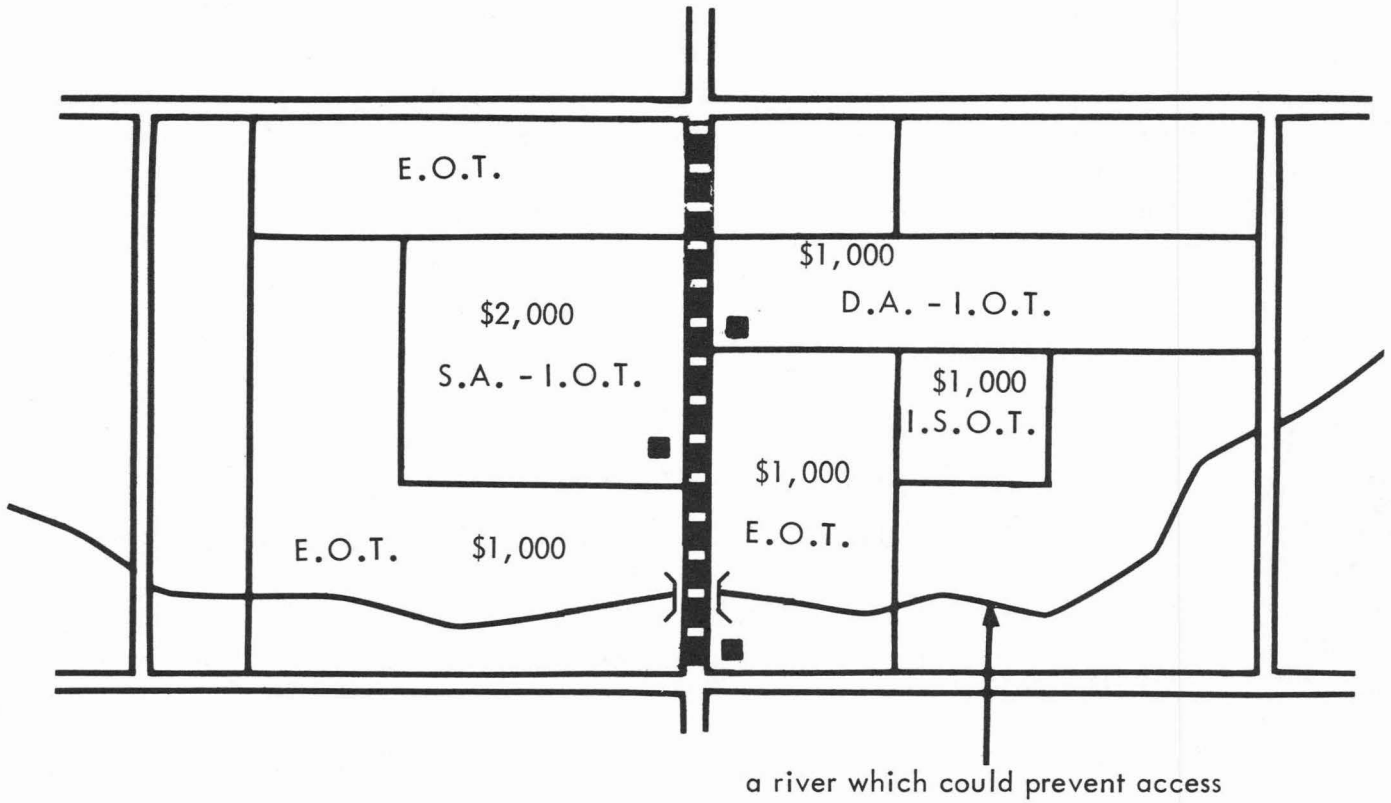


Figure G-1 - Illustration of Estimated Damage Claims

APPENDIX H

LEGAL ASPECTS OF SECONDARY ROAD DISPOSITION

This appendix is a general summary of the legal aspects of disposition of secondary roads in the State of Iowa. The three major areas of concern are: (1) tortious liability on the part of the counties arising from inadequate maintenance of secondary roads; (2) power to vacate secondary roads; and (3) compensating damages to affected parties arising as a result of road vacation. The general principles are presented so that specific problems encountered during vacation of a road segment can be properly evaluated.

Prior to the recent Tort Claims Act passed by the Iowa Legislature, Iowa followed the common law doctrine of sovereign immunity, usually referred to as governmental immunity. In effect, this meant that the State of Iowa could not be sued without its consent. Statutory consent up until 1965 had been given in only two sections of the Iowa Code. The rule of governmental immunity was applicable also to subdivisions of the state such as counties. The county, since it was an involuntary subdivision of the state, was not held liable for any tortious liability growing out of governmental or proprietory functions. There are many cases on this in Iowa; for reference, see Liability of Public Bodies, Officers, and Employees, 11 Drake Law Review 79.

In 1965 the Iowa legislature passed the Tort Claims Act. This is now Chapter 25A of the Iowa Code. This act had the effect of waiving governmental immunity with respect to the State of Iowa, and any state agency, including executive departments, agencies, boards, bureaus, and commissions. This act was challenged in the Court in a declaratory judgment action in the case of Graham v. Worthington, Iowa, 146 NW 2d 626, and the Iowa Court upheld the constitutionality of the act. As far as the county government is concerned, the Court in the Graham case held that counties were not agencies of the state or instrumentalities of the state, but must be considered separately as distinct political subdivisions. The Court held that Chapter 25A did not apply to county governments, school boards, cities and towns, and similar political subdivisions. To fill this gap, the 1967 legislature passed Chapter 613A of the Iowa Code. This act dealt specifically with political subdivisions and waived governmental immunity for the negligent acts on the part of such bodies whether the function was proprietory or governmental and, in effect, wiped out the common law rule of governmental immunity. In summary this means that a county can be sued for money damages for its tortious acts; that is, acts of negligence on the part of the county itself and its employees acting in the scope of their employment.

This responsibility for liability now imposed under Chapter 613A covers a wide spectrum. Almost any negligent act that one can think of, with the exception of the four that are excepted by the statute, is covered, and if proven, the political subdivision is liable for damages. Specifically with respect to secondary roads, cases can arise from bad repair of the roads, from failure to keep the roads free from nuisances and in repair, from damage arising from negligence in removal of snow and ice, from damages

resulting from a known defect in the road, from improperly marking or signing a road, or from failure to post adequate warnings on roads. The various occasions that could occur that would lead to liability on the part of a county with respect to the road systems are limited only by one's imagination. It would be impossible to outline each and every possible situation that might arise. It is not difficult to see that there are many such situations, and that the responsibility of the county in this regard is substantial.

The county is solely responsible for any damages growing out of its negligence in maintaining the secondary roads system. Chapter 306 gives the county through its Board of Supervisors the exclusive control over the secondary roads. The counties themselves obtain their funds through their own separate levies of taxation and are not responsible to the state in this respect. Therefore, the State of Iowa would have no liability with respect to secondary road liability. This is the import of the Graham case cited above. The only increase in financial burden that might occur with respect to the state would be the increase in secondary road budgets for increased maintenance of the secondary road systems to keep them up to standards. There would, however, be no direct liability on the part of the state from any damages arising out of the negligence in the maintenance of a secondary road.

Chapter 306 of the Iowa Code sets forth the process for the establishment, alteration, or vacation of highways. The various specific procedures required in the vacating of a secondary road are given therein. Section 306.3 of Chapter 306 clearly establishes in the county Board of Supervisors the jurisdiction and control of secondary roads in the respective counties. Section 306.4 delegates to the Board of Supervisors the power to establish, alter, or close secondary roads upon their own motion so long as the board follows the procedures outlined in Chapter 306. The power to establish, alter, and vacate is absolute so long as there is no showing of any fraud or bad faith on the part of the Board of Supervisors. If the board is acting in good faith and not arbitrarily or capriciously, their judgment in this area is not challengable in the courts. See Cresman v. Brandes, 137 Iowa 441, 112 NW 836.

A special or compensatory damage arises from the closing of a secondary road or part thereof when an abutting owner's ingress or egress from his land to the general system of roads is substantially impaired. This general rule has been tested in the Iowa courts on numerous occasions. The landmark case in this field up until the Braden case, which will be discussed later, is Warren v. The Iowa Highway Commission, 250 Iowa 473, 93 NW 2d 60. This case contains a review of all prior cases arising in Iowa dealing with this point and concisely sets down the rule with respect to whether or not the abutting or adjacent owner has a compensable damage. The Iowa Court states on page 67 of the Northwestern Report:

"The principle evolving from the foregoing authority is that one whose property abuts upon a highway, a part of which is closed or vacated has no special damage if his lands do not abut upon the closed or vacated portion so that his right of ingress and egress is not affected. If he has the access to the general highway system as before, his injury is the same in kind as of that suffered by the general public and is not compensable. It is damnum absque injuria. In the case before us the plaintiff's right of access to the secondary road is not affected. She has the same means of ingress and egress as she had prior to the closing. The traveling public generally who have occasion to use the secondary road will find it much less convenient on many occasions. Some persons living along the roadway, or those who may wish to visit their lands lying along it, will be compelled to travel additional miles. Some will be shut off from their formerly direct route to the nearest city or town. They will be considerably inconvenienced in visiting these places for shopping purposes, or in taking their livestock or grain to market. Persons in the city or town desiring to visit farms along the road for business or social purposes must go farther and on other roads to reach their destinations which may lie on the other side of U.S. Highway No. 35. But they have no recourse in damages.

This is a common injury, inevitable in the building of highways, or in handling the traffic upon them."
(Emphasis supplied)

In the Warren case the person appealing the refusal of damages owned two tracts of land that were farmed as a single unit. She had used a secondary road to get between the two tracts, and, upon the building of the Interstate Highway, this secondary road was closed where it abutted up against the highway. This meant that to get from one tract to the other the owner had to go about three miles. In the Warren case the court held there was no compensable damage, since the owner could still get onto the secondary road system as she had before, and the access to and from her land was not substantially affected or impaired. It was quite clear that the Court said in the Warren case that so long as abutting owners can get onto the road as before, the fact that the road is closed farther on, even though it abuts along a person's property, does not give rise to a special damage so long as the abutting owner can then use the general system of roads. This view was reaffirmed in the case of Christianson v. Board of Supervisors of Woodbury County, 253 Iowa 978, 114 NW 2d 897. The principle was also affirmed in the case of Hinricks

v. The Iowa State Highway Commission, Iowa, 152 NW 2d 248. The Hinricks case is interesting also on the question of private highways. The court is of the opinion in the case that a road is either a public highway or it is not a highway. Either the proper governmental body has jurisdiction and control over it or it is a private lane under the control of the person owning the private lane. This case again bolsters the idea that highways, being creatures of the law, may be altered, vacated, or closed at any time, and said alternation, vacation, or closing cannot be prevented by anyone upon the basis of a vested right to keep the road open.

The rule clarified by the Warren case was followed by a number of decisions sometimes directly on the point of special damages and sometimes with collateral issues dealing with access to property. However, in 1968, the case of Braden v. The Board of Supervisors, Iowa, 157 NW 2d 123, weakened the Warren thinking. Braden was a consolidation of two different cases in which the landowners had single unit farms that were cut or severed by a creek or a small river. A county road ran between these two separate farms and there was a bridge over the creek. It was the custom of the owners in using their individual single units to use the county road for access from one part of the unit to the other. It was the evidence in that case that they could not ford the creek with their equipment internally; or at least had not up to that time. The bridge was washed out by heavy floods in 1960 and had not been replaced. In 1966, some six years later, the board officially closed that section of the road between the creek banks and the property owners claimed damages. The question is, what did the owners do in farming their property for the six years prior to the offical closing? But, in any event, the owners brought the consolidated cases to the Supreme Court of Iowa and the Supreme Court said that this was a special damage and that they had a cause of action: this case goes against the Warren reasoning in that the owners in Braden had access to the road the same as before, had access to the general road system the same as before, and were merely inconvenienced in getting from one portion of their farm to the other. However, the reasoning in Braden is similar to that in Ferguson v. Woodbury County, 212 Iowa 814, 237 NW 214, where a portion of an owner's property was rendered inaccessible by the removal of a bridge. The Court in Braden seems to be saying that where the convenient access to any part of an owner's land is impaired by the closing of a portion of an abutting secondary road, then a special compensatory damage arises.

Warren was not mentioned in the Braden decision as being specifically overruled nor was the Christianson case overruled. They can be distinguished from Braden by reason of the unit rule. That is, in Braden and Ferguson one unit of land was involved; whereas in Warren and Christianson, two units were involved. The question is: Has the Supreme Court changed its thinking relative to what is a special damage, so as to open the door to

situations such as Warren? We cannot be sure. If the Court has changed its thinking in this area, then the factor of special damages becomes quite important in deciding whether low-count secondary roads should be closed. Hopefully, this is a special situation type of case and the doctrine of Braden will not be expanded, but this we do not know. Of course, any time that a secondary road closing landlocks a property, denies access to the property, or substantially interferes with ingress and egress to the property, then a special damage arises, and the Board of Supervisors is responsible for it. This has always been the law and is not controverted. The amount of the special damage would, of course, vary with each individual case. The reduction in the fair market value of the farm would be the amount of the damages.

There are a number of chapters of the Iowa Code that deal with the disposition of public utility lines affected by the vacation of secondary roads. The tenor of these sections of the code is that obstructions in the roads, such as telephone lines, electric transmission lines, and the like, are there at the leave of the county or state, and that if the road is closed or changed, these companies will have to move their lines upon written notice from the county or state. There would be no costs to the county for the removal. It is unlikely that the utility lines would be removed from many of the secondary roads after vacation. The land would revert to the farmer, who would likely wish to continue having the service. In some cases, a utility company might have acquired its own easement over the land; their easement is still good after vacation of the road and the county is affected in no way. The power is with the Board of Supervisors to establish, alter, or vacate roads, and if they exercise that power, then the utilities that are in the right-of-way could be forced to move, but there would be no cost to the county for such movement.

Appendices I, J, and K Will Be Bound
as Separate Documents

APPENDIX L

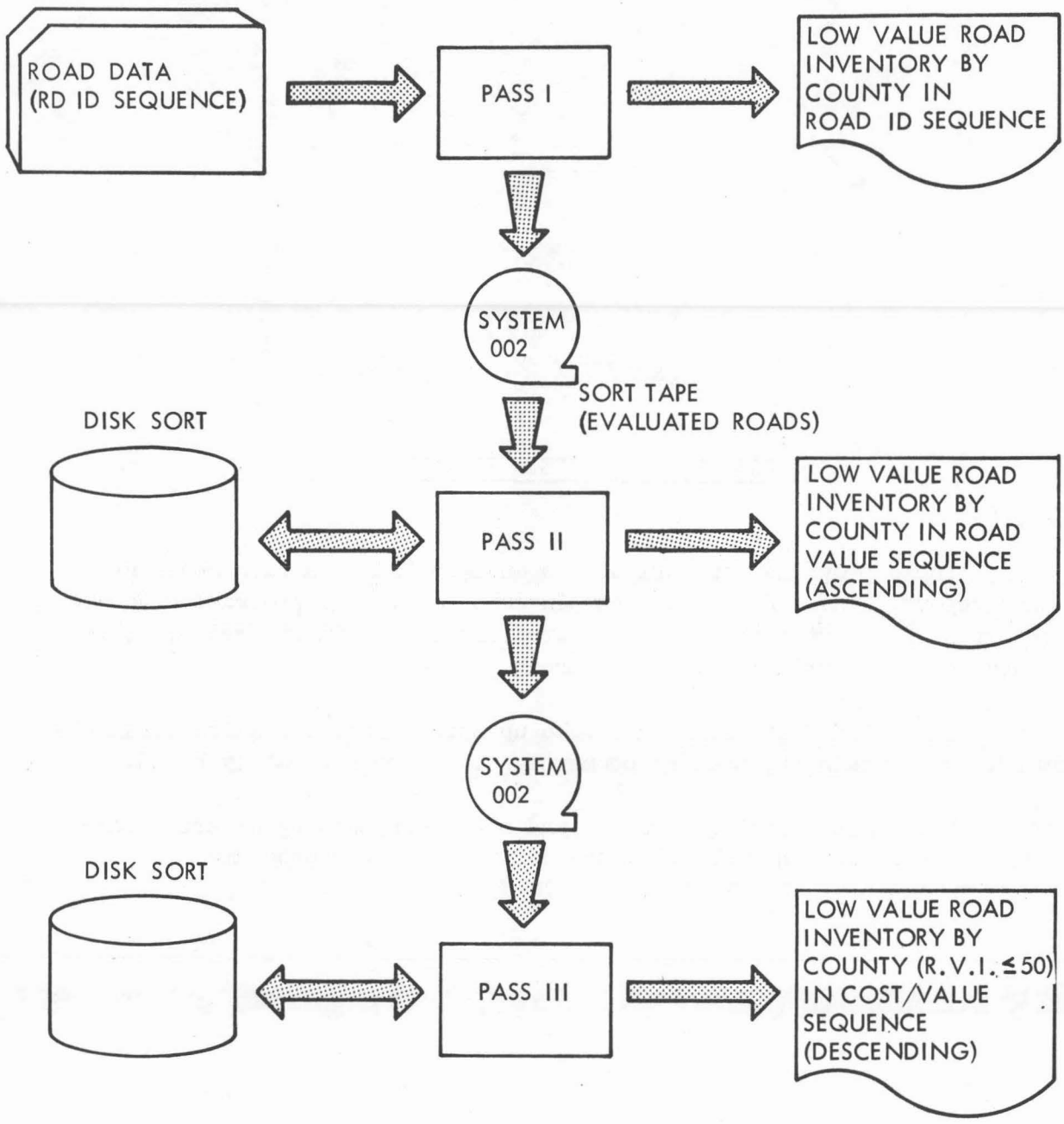
ROAD VALUE ANALYZER SYSTEM

These programs were written to analyze the road data mentioned in this report. These data are input in card form. The programs generate three types of reports; these reports are illustrated in Figures 8, 9, and 10. Headings are further described herein.

The FORTRAN programs that make up this system are quite straightforward, and contain explanatory comments. They are separately bound.

The tables, lists, figures, and other explanatory material following are meant for the technical user of the computer programs.

(See p. 113.)



MINIMUM REQUIRED MACHINE CONFIGURATION:

IBM 360/30 DOS W/FORTRAN IV G Level 32K Bytes Core
3 Tape Drives
1 - 2311 Disk Pack Drive

Figure L-1 - Operational Flowchart

INPUT DATA DECK SETUP

00
Last Card

Road Data Deck
County N

Road Data Deck
County 1 Format - (See Table L-I)

Bridge Costs Per 20 Yr.
Format 16 F 5.0
Bridge Cost (1) = (See Maint. Cost)

Improvements Costs Per Mile Per
20 Yr. Format 16 F 5.0
Improvement Cost (1) = (See Maint. Cost)

Maintenance Costs Per Mile
Per 20 Yr. Format 16 F 5.0

Risk Rates Per Mile
Per 20 Yr. Format 3 F 5.0
Rate (1) Used Where ADT < 10, Rate(2) for ADT = 11-20,
Rate (3), ADT > 20

Run Number and Weights To Be Applied
To Road Value Criteria Format I2, 18 F 3.0

WT	Road Attribute Applied to
1	Ave. Daily Traffic Count
2	No. of Abutting Ownership Tracts
3	Total No. of Residences
4.	No. of Public Uses
5	No. of Private Uses
6	Mail Route
7	Bus Route
8	Utility Route
9	Dead End
10	Exterior Ownership Tract
11	Interior Ownership Tract - Dual Access
12	Interior Ownership Tract - Single Access
13	Interior Ownership Tract - Isolated
14	Bisected Ext. Ownership Tract
15	Bisected Int. Ownership Tract
16	Residences on Exterior Ownership Tracts
17	Residences on Interior Ownership Tracts
18	All Residences Within 1/8 Mile of Intersection

Figure L-2 - Input Data Deck Setup

TABLE L-I

INPUT DATA VARIABLE NAMES, DESCRIPTION, AND FORMAT

	Variable Name	Description	Code	Format	Card Column
1.	ICNTY	County number	01-99	I2	1-2
2.	ITWP	Township (containing major part of road segment, 00 for 100)	00-67	I2	3-4
3.	IRG	Range (major part of road segment)	1 W 01 2 W 02 . . . 49 W 49 1 E 51 2 E 52 . . . 7 E 57	I2	5-6
4.	ISECT	Section number (major part of road segment)	01-36	I2	7-8
5.	ISECT2	Section number of second part of road segment if it is contained in more than one section	01-36	I2	9-10
6.	IRD	Road number: If the road segment is on a section line, the section number will always be the section below or to the right. The road number indicates the segment's position in the section.	E-W 1 N-S 2	I1	11
		Not used		19X	12-30
7.	RDLG	Road length of segment (actual length to hundredth of mile)	X.XX	F4.2	31-34
8.	IDEAD	Code identifying through or dead end road	Through 1 Dead End 2	I1	35

TABLE L-I (Continued)

	Variable Name	Description	Code		Format	Card Column
9.	IYEAR	Year of latest traffic count	1963	3	I1	36
			1964	4		
			1965	5		
			1966	6		
			1967	7		
10.	IADT	Average daily traffic count (if more than one for the segment, use the highest)	00-99		I2	37-38
11.	ITCI	Traffic count interval	00-19 ADT	1	I1	39
			11-20 ADT	2		
			21-30 ADT	3		
12.	ISFTY	Surface type	Dirt	1	I1	40
			Rock	2		
			Dirt and rock	3		
			Hard surface	4		
13.	INOBR	Number of bridges	X		I1	41
14.	INTSTR	If no bridge, does an intermittent stream cross segment?	Yes	1	I1	42
			No	0		
		Not used			9X	43-51
15.	IAOT	Number of abutting ownership tracts	XX		I2	52-53
16.	IOTEX	Number of exterior ownership tracts	X		I1	54
17.	IOTDA	Number of interior ownership tracts, dual access	X		I1	55
18.	IOTSA	Number of interior ownership tracts, single access	X		I1	56
19.	IOTIS	Number of interior ownership tracts, isolated	X		I1	57

TABLE L-I (Concluded)

	Variable Name	Description	Code		Format	Card Column
20.	ISEOT	Number of exterior ownership tracts, bisected by a stream such that access would be impaired if segment is closed	X		I1	58
21.	ISIOT	Number of interior ownership tracts, bisected by a stream such that access would be impaired if segment is closed	X		I1	59
22.	IREOT	Number of exterior ownership tracts with residences on segment	X		I1	60
23.	IRIOT	Number of interior ownership tracts with residences on segment	X		I1	61
24.	ITOTRS	Total number of residences on segment	X		I1	62
25.	IRES8	Indicator that all residences are within 1/8 mile from another road segment	Yes No	1 0	I1	63
26.	IBSNES	Indicator other than residences along road segment	Yes No	1 0	I1	64
27.	ITP	Code identifying other type	Cemetery Church School Recreation area Coal mine Airstrip County farm Seasonal dwelling Church and cemetery	1 2 3 4 5 6 7 8 9	I1	65
28.	IUTIL	Indicator - utility route (1 - if yes, 0 - no)	1		I1	66
29.	IMAIL	Indicator - mail route (1 - if yes, 0 - no)	1		I1	67
30	IBUS	Indicator - bus route (1 - if yes, 0 - no)	1		I1	68

TABLE L-II

OUTPUT DATA, VARIABLE NAMES, AND DESCRIPTION

Variable Name	Description
TRC	Total retention cost
TMAINT	Total maintenance cost
TIMPRV	Total improvement cost
CSTMNT	Maintenance cost per mile per 20 years
CSTIMP	Improvement cost per mile per 20 years
CBRIDG	Bridge cost per 20 years
TCBRG	Total bridge cost
RISK	Total risk cost
TVC	Total vacating cost
TNRC	Net retention cost
IRVI	Road value index
CSTPV	Net retention cost per road value

REPORTS - EXPLANATION

Inventory of low-traffic-count roads. This report is generated line by line as input road data cards are read. It is in road identification number sequence. Input cards have been sorted into ascending road identification sequence.

Explanation of Headings

Road Segment Indent

CO -- County number

TWP -- Township number

RG -- Range number

SECT -- Section number

S2 -- Section number of road segment in second section

RD -- Road number with section

RDLG -- Road length in miles

ADT -- Average daily traffic count

SF TY -- Surface type

NO BR -- Number of bridges

INT STR -- Intermittent stream

AOT -- Number of abutting ownership tracts

EOT -- Number of exterior ownership tracts

IOT -DA -- Number of interior ownership tracts with dual access

IOT -SA -- Number of interior ownership tracts with single access

IOT-IS -- Number of interior ownership tracts isolated

BIS EOT -- Number of exterior ownership tracts bisected by stream

BIS IOT -- Number of interior ownership tracts bisected by stream

EOT RES -- Number of exterior ownership tracts with residence

IOT RES -- Number of interior ownership tracts with residence

TOT RES -- Number of occupied residences

RES 1/8 -- If 1 - all residences within 1/8 mile of intersection;
0 - not all within 1/8 mile

DEAD END -- If 1 - road is dead end; 0 - through road

UT -- If 1 - road has a utility easement

ML -- If 1 - road used as a mail route

BS -- If 1 - road used as a school bus route

SU -- Special use -- See Table L-I

RETENTN TOT COST -- Total 20-year road retention cost in dollars computed from 20-year maintenance + Improvements + Liability risk + Bridge costs

Evaluated Roads - RVI Sequence. This report is generated by evaluating the inventory of low-traffic-count roads. Roads are listed in RVI (Road Value Index) sequence, lowest to highest.

Explanation of Headings

Road Segment Indent

RVI -- Road Value Index

RDLG -- Road length in miles

CUM RDLG -- Cumulative road length - Length of this plus a previously listed road in the county

20-YEAR RETENTION COST

MAINT ---Estimated 20-year cost of maintaining this road including maintenance of probable improvements

IMPV -- Estimated cost of improvements made in next 20 years

BRIDGE -- Estimated bridge improvement or replacement cost

RISK -- Estimate of maximum road risk cost prorated to the road on an ADT and per-mile basis

TOTAL -- Total of preceding four costs

VACATING COST -- Estimate of amount of legitimate claims precipitated by vacating this road

20-YEAR RETENTN NET COST -- Total retention cost less vacating costs

COST/VALUE -- The Cost/Benefit ratio computed by dividing 20-YEAR RETENTION NET COST by RVI. A measure of the cost-effectiveness of the road

Evaluated Roads - Cost/Value Sequence. This report is the same as the one described above except roads with RVI greater than 50 have been deleted and the remainder are ranked by the Cost/Value ratio in descending order.

APPENDIX M

NETWORK ANALYSIS PROGRAM

The purpose of this program is to determine whether the elimination of given road segments will increase the minimum travel time to any destination. This program uses a shortest route algorithm reported by Pollock and Wiebenson[1] and attributed to Minty. The algorithm determines the shortest time for a vehicle to travel from a specified origin to a set of destinations. The network has 625 nodes consisting of 25 rows (east-west road segments) and 25 columns (north-south road segments). Each node is numbered sequentially starting with the northwest corner.

The program[2] computes a shortest time matrix for all roads. Asterisks or -1's in the output report indicate an isolated node; that is, a node not accessible from any direction. Selected roads are eliminated and the program generates a second shortest time network matrix. A third, "difference" matrix, is then computed; this matrix shows the increased time required to reach any node. A zero for any node indicates the eliminated roads did not effect the minimum time to travel from the origin to that node.

The network analysis is designed for batch processing by county. A data deck consisting of the following input cards is required for each county:

1. County identification
2. Node linkage time data
3. Header card to specify number of roads to be eliminated
4. Road elimination cards to specify node number and direction
5. Origin node number
6. End card: "99" in columns 1 and 2

There are 2,448 links in this 625-node network. The program yields results with acceptable accuracy if a one-mile grid is assumed. This corresponds to section lines and generally follows most county roads. The linkage time matrix (LT) is created from 50 node linkage time data input cards which must be arranged in a specific order. The first card contains values for the east links of the first row of nodes. The second card contains values for the south links, also for the first row of nodes. The third card contains east link data and the fourth card, south link data (for the second row of nodes). This exact sequence is followed for all 25 rows of nodes.

1/ Pollock and Wiebenson, "Solutions of the Shortest-Route Problem - A Review." Operations Research, Vol. 8, No. 2, 1960, pp. 224-230.

2/ The FORTRAN listing of this program is separately bound as an attachment.

Each node linkage time card contains 25 values, one for each node in a row. The time value for each link is coded as an integer from 1 to 8. When two nodes are not connected, the link is coded as a "9." This is converted within the computer program to 99,999 so that this link would never be used as the shortest path.

Judgment is frequently required to code the road segments into an idealized 25 x 25 matrix. The following rules should be followed.

-- When more than one road links two nodes, code the link with the fastest travel time.

-- When a road segment does not pass directly through two nodes (and if there is a free set of nodes), "move" the road segment in the appropriate direction.

The 25th eastern link for each row is always coded as a "9" to indicate the end of the matrix. Also, the 25th row of nodes does not have southern links so this card is coded with all "9's."

A data input card is used to specify the node number and the direction of the road which is to be eliminated from the network. The following code is used to specify the road direction:

West = 1
North = 2
East = 3
South = 4

To eliminate selected roads from the original network, the computer program changes the linkage data for the eliminated roads to a very large number. A header card is used to specify the number of roads to be eliminated. The series of input cards to eliminate given road segments can be in sequential order, after the header card.

TABLE M-I

INPUT DATA DECK

Card	Description	Variable Code	Field	Format
1	County Name	ICNTYX	7-26	5A4
2,4,6,...,24	West to East Node[1]	IROW	7-32	I1
3,5,7,...,25	North to South Node	ICLMN	7-32	I1
26	Number of roads to be eliminated	NRUN	9-10	I2
As many as necessary	Specify eliminated roads[2]			
	Node number	INODE	7-9	I3
	Direction road segment	IDRCT	10	I1
	Original time to travel road segment	ITME	11	I1
Last data card	Origin node			
	Origin node number	NORG	1-3	I3
	Origin name	IORIGN	11-30	5A4
End card	"99" in columns 1 and 2		1-2	I2

1/ To determine node number, start at the northwest corner, count from left to right across each row. Row 1 has nodes from 1 to 25, and row 2 from 26 to 50, etc.

2/ One input card for each road segment to be eliminated.

26	28	30	32	33	31	30	28	26	24	22	17	15	13	16	19	21	23	25	26	28	29	31	33	-1
25	27	29	33	31	29	29	26	24	22	20	17	14	12	14	17	19	21	24	24	-1	27	31	34	36
24	27	30	31	29	27	-1	24	22	21	18	16	14	11	13	16	19	20	22	22	24	25	28	-1	-1
23	25	27	29	27	25	24	22	20	18	16	14	12	10	11	16	17	18	19	20	23	23	25	27	-1
22	24	26	27	25	23	24	23	20	17	15	13	11	9	11	14	16	18	20	21	23	21	23	26	28
21	24	26	25	23	21	21	21	19	18	18	13	11	8	10	12	14	16	18	20	21	19	21	24	26
20	22	24	23	21	19	18	20	17	16	15	13	10	7	10	13	15	17	20	20	20	17	20	22	24
19	21	23	23	20	17	15	13	15	14	13	11	8	6	9	11	13	15	17	18	18	16	19	21	23
18	20	22	21	19	17	15	12	10	12	11	9	7	5	7	9	11	13	15	16	17	15	18	21	23
17	19	21	19	17	15	13	11	9	11	12	10	7	4	7	10	12	13	16	14	16	14	16	19	21
16	18	19	22	15	17	13	10	8	10	10	8	6	3	6	8	10	11	13	12	15	13	-1	17	19
15	16	16	15	13	13	11	9	7	9	7	6	4	2	4	6	8	9	11	10	12	12	14	15	16
14	14	14	12	11	11	9	9	6	6	5	3	2	1	3	4	6	6	8	8	9	11	10	12	13
13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	12
14	16	13	14	11	14	-1	8	-1	6	4	4	2	2	3	4	7	6	7	8	9	10	12	13	14
15	19	15	-1	13	15	17	11	9	7	5	7	5	3	5	6	10	8	10	10	12	12	14	15	16
16	18	17	10	15	16	14	12	10	8	6	8	7	4	7	8	10	10	12	12	14	14	16	17	18
17	20	22	20	17	20	15	13	11	9	7	9	7	5	7	9	12	12	14	14	16	16	18	19	20
18	20	22	21	19	19	17	15	12	10	8	10	8	6	8	10	15	14	16	16	18	18	20	22	22
19	21	23	22	19	17	17	15	14	11	9	11	10	7	9	11	13	15	17	18	20	20	22	24	26
20	22	24	23	21	15	14	13	12	11	10	12	11	9	11	-1	15	23	20	20	22	22	24	26	-1
22	24	26	23	21	19	17	15	15	14	12	14	13	11	14	19	17	20	22	22	24	24	26	28	30
24	26	-1	25	22	22	19	17	17	17	14	16	15	13	15	17	19	21	23	24	26	26	28	30	32
26	28	28	25	23	25	21	20	19	22	25	-1	-1	15	-1	20	21	-1	-1	26	-1	-1	30	32	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

IJT219I

Figure M-1 - Output of Network Analysis Program. Numbers are estimated minutes of travel time to nodes formed by section grids. Example is Ringgold County; 0 point is Mt. Ayr, -1's or *'s indicate the node is inaccessible.