GUIDELINES FOR CONSOLIDATING TOWNSHIP ROADS

A CASE STUDY SHOWING BENEFIT/COST ANALYSIS FOR CLOSING TOWNSHIP ROADS IN NORTH DAKOTA

Kiel Ova
Jill Hough

Upper Great Plains Transportation Institute
North Dakota State University
Fargo, North Dakota

May 1999

Acknowledgments

This report has been prepared with funds provided by the U.S. Department of Transportation to the Mountain-Plains Consortium (MPC). The MPC member universities include North Dakota State University, Colorado State University, University of Wyoming, and Utah State University.

The authors would like to thank Keith Berndt, Cass County Engineer, for his help identifying the case study township; Susan Schlecht, Enderlin School District, for supplying school bus routes; David Nudell, Treasurer of Clifton Township, for his assistance in providing financial data to help in the case study. Also, thanks is extended to Clifton Township Residents who participated in the telephone questionnaire, and to John Bitzan for his assistance throughout the study.

Disclaimer

TABLE OF CONTENTS

INTRODUCTION 1
Objective of the Study 2
Report Organization 3

LITERATURE REVIEW 5

RESEARCH METHOD 7
Case Study Selection 7
Data Collection 7

CASE STUDY ANALYSIS & RESULTS 9
Description of Township 9
General Methodology 10
Scenarios 14
Benefit/Cost Analysis 18
Vehicle Operating Costs 18
Opportunity Cost 20
Township Road Maintenance Cost 20
Summary of Costs 21
Results 22
Scenario 1 23
Scenario 2 23
Scenario 3 24

SUMMARY AND CONCLUSION 25
Need for Further Study 26

REFERENCES 27

List of Tables

Table 4.1. Benefit/Cost Analysis 23

Table 4.2. Comparison of Benefit/Cost Analysis Between Lamberton and Ova & Hough Studies 24

List of Figures

Figure 1. Clifton Township Location 9

Figure 2. Clifton Township Road Type and Resident Origin and Destinations 11

Figure 3. Steps to Take When Conducting a Benefit Cost Analysis to Evaluate Reducing a Township Road Network. 13

Figure 4. Weekly Traffic Counts Based on Telephone Origin Destination Survey of Clifton Township 15

Figure 5. Clifton Township Road Consolidation, Scenario 1 16

Figure 6. Clifton Township Road Consolidation, Scenario 2 16

Figure 7. Clifton Township Road Consolidation, Scenario 3 17

CHAPTER 1

INTRODUCTION

Transportation planning is becoming a higher priority for local governments and road officials. It is apparent that maintenance and planning decisions cannot continue on immediate demand basis; short and long term planning must exist to develop and maintain a reliable infrastructure for the future. Local governments establish and maintain local roads while faced with declining tax bases, increasing traffic surrounding immediate urban areas and decreased traffic in extreme rural areas, increased vehicle loading, funding targeted at higher priority roads such as interstates or arterial roads, and lack of resources to provide future improvements and adequate maintenance. Investigating alternative maintenance strategies will help townships and local governments maintain their infrastructure. One solution may be the elimination of unnecessary roads that provide duplicate service yet provide reasonable service to users, while increasing funds to help improve the remaining infrastructure.

Most townships already face the increasing pressure from lower tax-bases due to a decreasing population and have problems maintaining the existing road infrastructure. For example, the township used as a case study for this report has experienced nearly a 60 percent decline in population since 1960. In comparison, the network has reduced a maximum of eight percent in the same period of time.

In addition, changes in the agricultural industry and increased commuter traffic are redistributing traffic in several counties, thus contributing to the problem of road maintenance for township governments. Townships surrounding cities such as Fargo, N.D., are experiencing increasing traffic from commuters in small developments or communities, whereas townships located further from urban areas continually decline in population with the removal of farms from bankruptcies and retired families moving to urban areas. This trend indirectly contributes to another difficulty for townships — the advent of the corporate farm.

The inception of the large or corporate farm has resulted in an increase of equipment size. The corporate farm corresponds to larger fields in a section of land or the same owner for an entire section therefore reducing the need for multiple field accesses. The local road infrastructure was built more than 60 years ago when equipment and vehicles were one-half to one-third the size and weight of vehicles today. Infrastructure must be wider and stronger to handle larger and heavier equipment. Prioritization and elimination of unnecessary township roads will allow more money to be spent on improving road conditions for increased travel and heavier loads.

Funding also is a problem for townships. In addition to a decreasing tax base, townships receive little monetary help from state or federal agencies. County governments are reluctant to help townships by taking jurisdictional control of roads because they are pressured with decreased funding from the state and often look to turn control of some roads over to townships. Increased costs of infrastructure repair also are impairing townships. For example, one township in Cass County spent 15 percent of it's total budget on one culvert replacement. In addition, increased gravel costs have decreased the townships ability to budget for improvements.

Objective of the Study

The objective of this report is to provide guidance for townships that are considering reducing their road network. A methodology was developed to show a level of township roads that provides adequate service to its users while increasing township resources. Specifically, the objectives in this study are:

1. Select a case study township.

2. Collect relevant data.
3. Analyze the case study network.
4. Propose alternative networks based on traffic levels.
5. Apply benefit/cost analysis to demonstrate best case scenario.

Report Organization

The remainder of this report includes four chapters. Chapter 2 provides a review of other studies conducted on decreasing networks for townships or counties. Chapter 3 contains a description of research methods used for this study, including data collection and benefit cost analysis. Chapter 4 is a description of the case study and results. Chapter 5 contains a summary and conclusions of this research.

CHAPTER 2

LITERATURE REVIEW

Several studies have been conducted on the reduction or addition of roads to county and state networks, however few have been conducted on the local township level. For example, Bitzan and Tolliver examined the benefits and costs of converting paved roads to gravel roads due to low traffic counts on some paved roads. The study also aims to research this method to reduce road maintenance costs for the counties. In addition, studies concerning the reduction or addition of roads to a network provide a methodology for the means, but lack a simplified guide for local or township officials to follow for possible closure implementation. None have included the application of Geographical Information System (GIS) for network analysis.

Baumel (1986) conducted a case study analysis of three counties in Iowa to evaluate reducing the road network. The results in this report include comprehensive analysis of the alternative networks and the impact to travel costs. Baumel included various tables calculating costs associated with travel on gravel and pavement, which was referenced by Lamberton. The major conclusions from the study are:

1. Major sources of vehicle miles on county roads are automobiles used for household purposes and pickup truck travel for farm purposes.
2. Farm related travel represents a small percent of total travel, but a high percent of total travel costs.
3. In areas with large non-farm population, only a small number of roads can be abandoned.
4. In areas with small rural population and a large percent of gravel roads, a small number of roads with no property access can be abandoned.

5. In areas with a small rural population and a high percent of paved roads, many miles of county roads with no property access can be abandoned.

6. Dead-end roads with property access can be converted to private drives.

Lamberton (1992) conducted a study to evaluate road reductions for a township in South Dakota. Four alternative networks were considered for reducing their network. The analysis applied to removing roads from the network were based on minimizing travel distance to identified origins and destinations. The alternative networks considered were:

1. removing township roads with no farm access, but maintaining school and postal routes,

2. removing township and county roads with no farm access while changing school and postal routes,

3. removing only those roads that did not provide access to farmsteads, and

4. removing only those roads with the annual cost of rerouting the traffic less than $500.

The results for the four alternatives showed net changes of $1,700, -$2,600, -$2,600, and $5,100 respectively. The report did not include details on calculation of vehicle operating costs, opportunity costs, or determination of origin and destination data.

CHAPTER 3

RESEARCH METHOD

The methodology presented in this study uses a Geographical Information System (GIS) for the case study network and data collected from residents of the case study township. Simply stated, GIS is the inclusion of specific information or attributes of a geographical feature or entity, such as highways, rivers, or boundaries, and is based on a coordinate system. Specific information pertaining to each township was needed for the case study selection. This information included accurate route information and budget information. Once the case study was selected, traveler information data were obtained through a telephone survey. Finally, the information was applied to the methodology and a benefit/cost analysis was applied to investigate the feasibility of closing low volume, non-essential township roads.

Case Study Selection

Several townships were identified as possible case studies and provided a diverse representation of Cass County and North Dakota. Clifton township was selected. It represents an ideal case study for examining potential benefits of closing or reducing maintenance of low volume township roads for several reasons: a very limited tax base, a continually decreasing tax base as residents continue to migrate to more urban areas, and a large number of fully maintained roads with the inclusion of some county paved roads, suggesting that significant maintenance savings could be realized through selective road closing or designation as minimum maintenance.

Data Collection

Several types of data were collected for this study, including origin-destination data, budget information, and road centerline data. Origin-destination data were collected through a telephone survey of the Clifton Township residents. Residents were asked about the nature of their trips during a normal week. Frequency and destination of the trips were then determined for all residents of the household. The occupations of the residents, number of school children, and seasonal trips also were investigated. Of the 30 resident locations in the township, 13 responses were obtained. The locations with no responses were estimated by taking a weighted average of the nearest neighbors origin-destination data. Annual budget information was obtained from the township representatives.

The application of a GIS was used for case study analysis. Attributes attached to each road segment for this study included speed, length, vehicle operating costs per mile by surface type, opportunity costs per minute, and total travel time. The GIS transportation software, TransCAD3.1, was used to calculate the shortest path for the origin-destination routes based on minimizing travel time.

Preparation of the network consisted of obtaining the road centerline from TIGER/LINE® 1995 files[1], selecting the specific road types, and designating them with the above attributes. On-site inspections and official county maps were then used to pinpoint the locations of all residences and businesses in the township and outside any city limits in the township. Actual road conditions were obtained from the on-site inspections.

---

[1]TIGER/Line® stands for Topographically Integrated Geographic Encoding and Referencing System developed by the Bureau of the Census. At the start of this report, TIGER/Line® files were the only centerline data available. Concerns have been raised about the accuracy of TIGER/Line® centerline. After comparison with Cass County centerline data obtained from the North Dakota Department of Transportation, it was determined the TIGER/Line® centerline contains the correct length, however is shifted approximately one-tenth of a mile south. This does not affect the accuracy of the results presented in this report.

CHAPTER 4

CASE STUDY ANALYSIS & RESULTS

This chapter contains a description of the case study township, the general methodology used to examine the feasibility of closing or reducing maintenance of low volume road segments, a description of three scenarios for reducing the road network, a description of costs involved to conduct the benefit cost analysis, and results of the benefit cost analysis for the scenarios.

Description of Township

Clifton Township is on the western border of Cass County, N.D., approximately seven miles south of I-94. Figure 1 illustrates the location of Clifton Township in North Dakota.

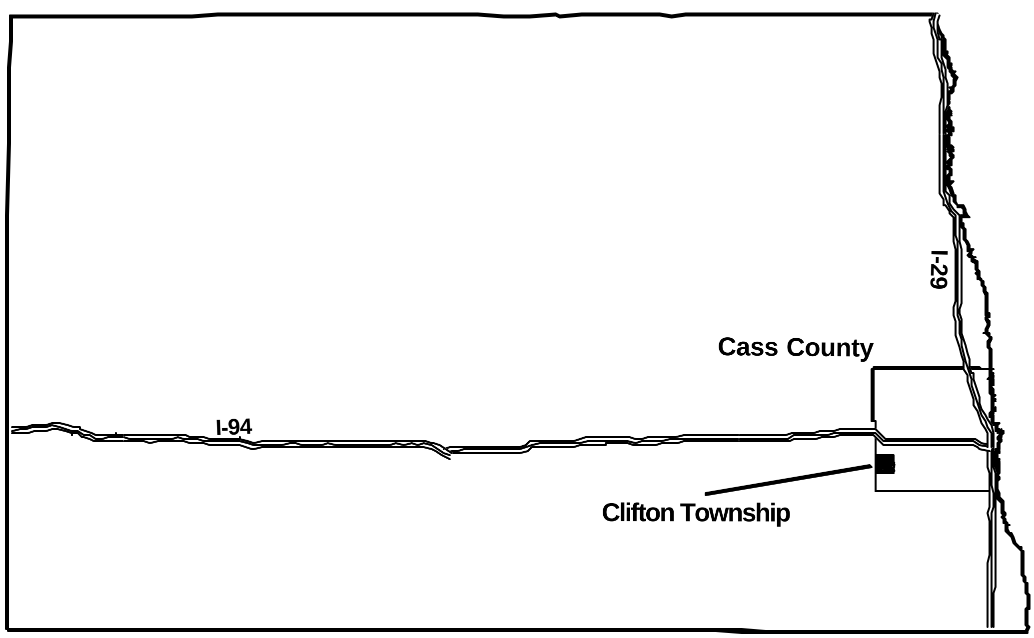


Figure 1. Clifton Township Location.

According to the 1990 Census data, Clifton Township had a population of 78. The 1960, 1970, and 1980 Census data showed Clifton Township with a population of 188, 146, and 113 respectively. This represents approximately a 59 percent decline in population over 30 years. This trend of population decline is predicted to continue due to the out-migration of people in this area to urban areas (Rathge, 1993). With a decreasing population, a smaller tax base will be available for the upkeep of the road network. This poses a common problem in most, if not all, townships in North Dakota except those townships immediately adjacent to urban areas.

Clifton has a road network that consists of approximately 75 miles, with eight bridges crossing the Maple River. All these bridges were built between 1950 and 1960, except for one built in 1979. The road network consists of 12 miles of paved county roads, 50 miles of graveled roads (including six miles of county gravel roads), eight and one-half miles of un-graveled roads, and approximately six miles of designated minimum maintenance roads. The paved roads consist of Cass County 38 on the eastern boundary of Clifton township, and Cass County 6 dividing the township into equal north and south regions (Figure 2). Cass County 1 is a gravel road on the western boundary of Clifton Township. Figure 2 illustrates the road types, resident locations, and destination locations.

General Methodology

The methodology presented in this section provides an evaluation process used to examine the feasibility of closing or reducing maintenance of low volume road segments of a township network. Road segments are defined as sections of the township network that represent a direct path from one point to another without an intersection, usually from section corner to section corner or driveway access to driveway access, etc.

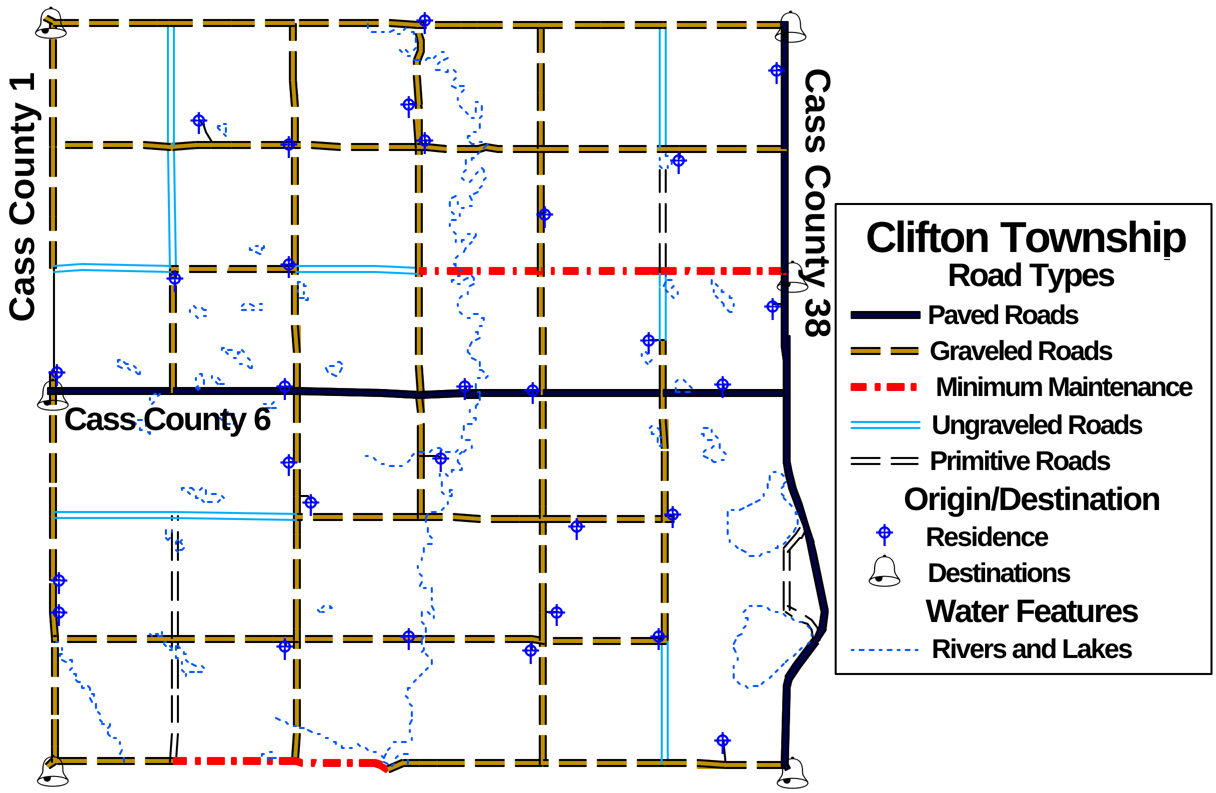


Figure 2. Clifton Township Road Type and Resident Origin and Destinations.

The methodology compares reduction in road maintenance costs (the benefit) to increase in user costs[2] (the cost) from closing low volume road segments. The methodology is really a three-step process. The first step determines the number of vehicle trips occurring on the various road segments in a given amount of time under the present road configuration. This is done by: 1) making an assessment of the origin, destination, and frequency of trips originating or terminating in the township, 2) evaluating the time

---

[2]User costs, or vehicle operating costs and opportunity costs will be discussed in detail in the benefit/cost analysis later in this chapter.

necessary to make each trip for all possible routes, 3) choosing the least time route for each trip, and 4) tabulating the number of trips traveled on each segment when least time routes are chosen. The second step decides which segments to eliminate from the township network for a benefit cost comparison. This determination primarily is based on the number of trips realized on each road segment by evaluating the network collectively and determining a level that differentiates low and high volumes. The last step compares the change in road maintenance cost to opportunity and vehicle operating cost changes given the proposed segment closings.

Figure 3 shows the specific steps of the methodology:

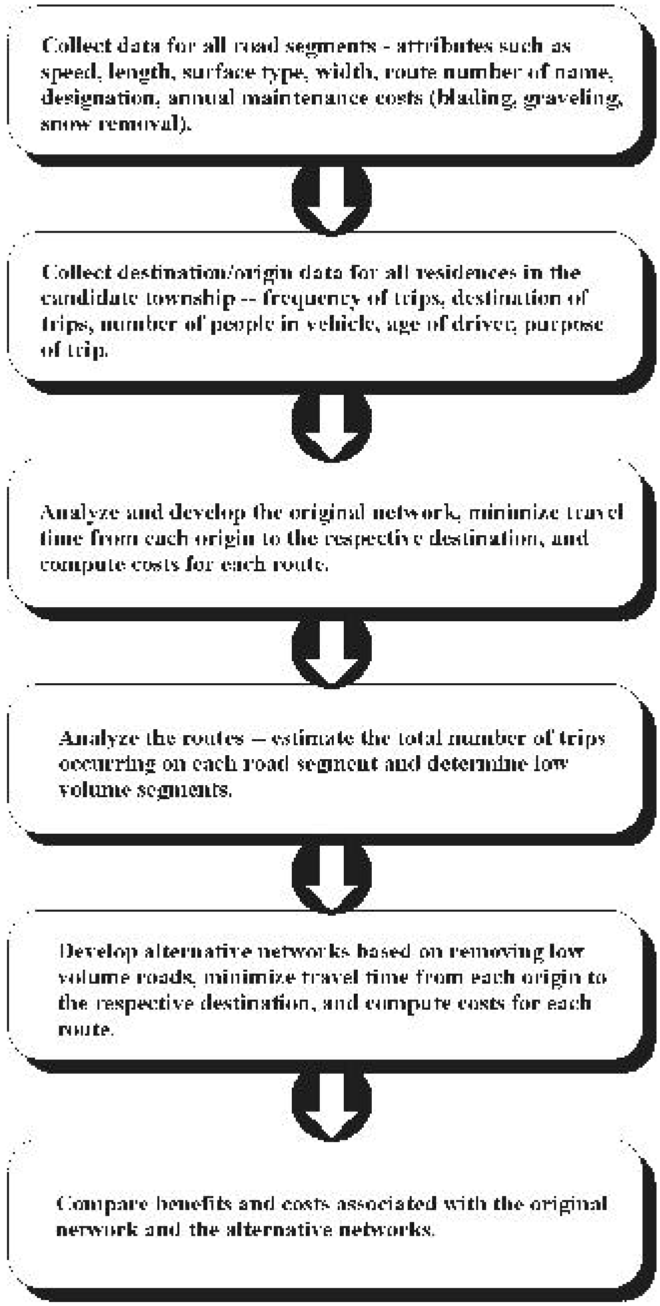


Figure 3. Steps to Take When Conducting a Benefit Cost Analysis to Evaluate Reducing a Township Road Network.

It is imperative to understand that the results found in this study are specific to Clifton Township, but represent many townships in North Dakota and the Midwest, where township roads are built on the section grid system.While the methodology used to determine segments of a network to be eliminated from the network is specifically defined, it could be modified for any township in question. Each township poses a unique topography or layout of the network — may include bridges or county roads, has different users, or more critical user routes.

Scenarios

The origin/destination data based on the telephone survey were used to determine the shortest-path of travel time routes from the location of residences to their typical destination points in Clifton township. These destination points are the four corners of the township, the intersection of Cass County 1 and Cass County 6, and the intersection of Cass County 38 and Cass County 6. The calculated routes revealed the road segments not used for any trips and segments with less than 10 trips (Figure 4). These natural breaks provided the basis for determining alternative networks.

Three scenarios were developed to compare the benefit and cost of removing roads from a network. The first scenario is based on removing segments that have no regular local travel. This resulted in the removal of 16 miles from the network (Figure 5). The second scenario network is based on removing all segments that have less than 10 weekly trips; resulting in the removal of 25 miles from the network (Figure 6). The third scenario uses the same criteria as the second, but takes into consideration the connectivity of the township network, the conditions of the roadways, and most importantly, the general shift of traffic due to other road segment closures (Figure 7). After reviewing the second scenario, one segment was determined to cause a significant increase in user costs by limiting east/west travel for the northern end of the township. These trips were forced to travel up to three miles south to Cass County 6 to reach the east end of the township and then travel Cass County 38 to go north. This resulted in a substantial increase to user miles traveled.

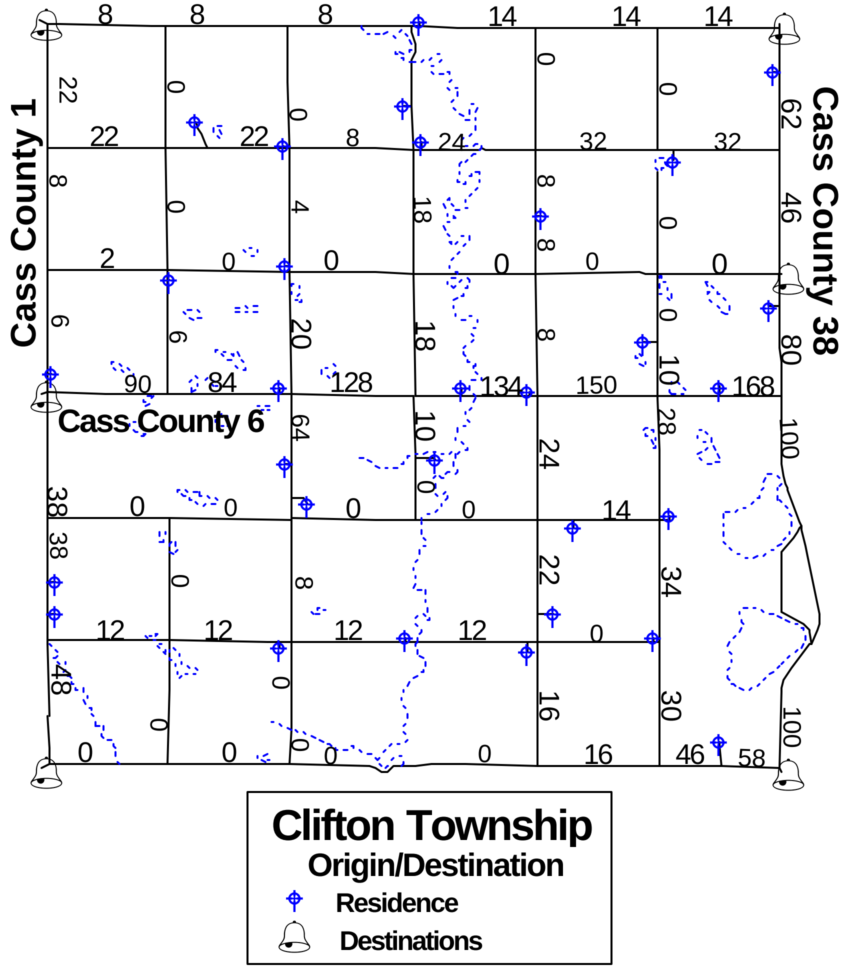
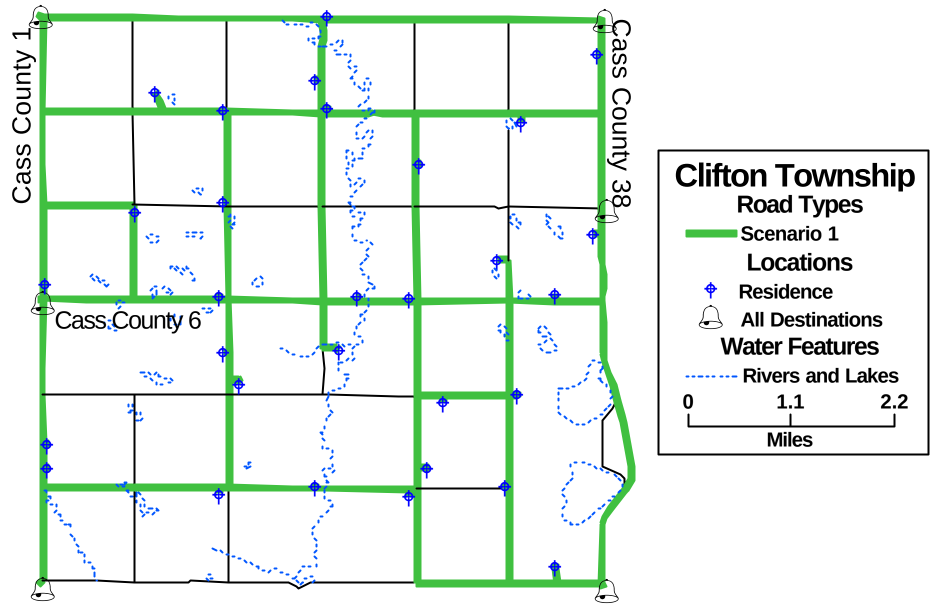


Figure 4. Weekly Traffic Counts based on Telephone Origin Destination Survey of Clifton Township



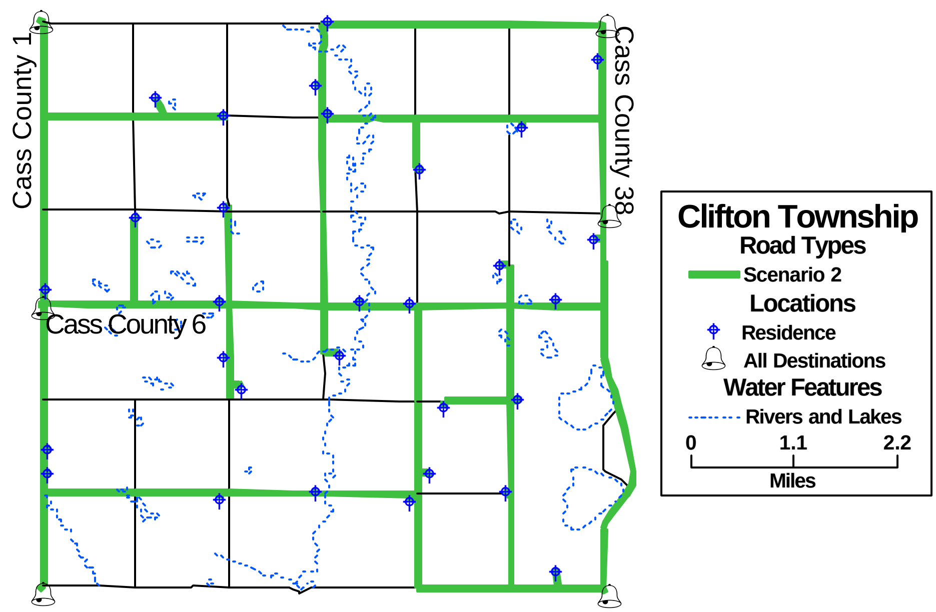


Figure 6 Clifton Township Road Consolidation, Scenario 2.

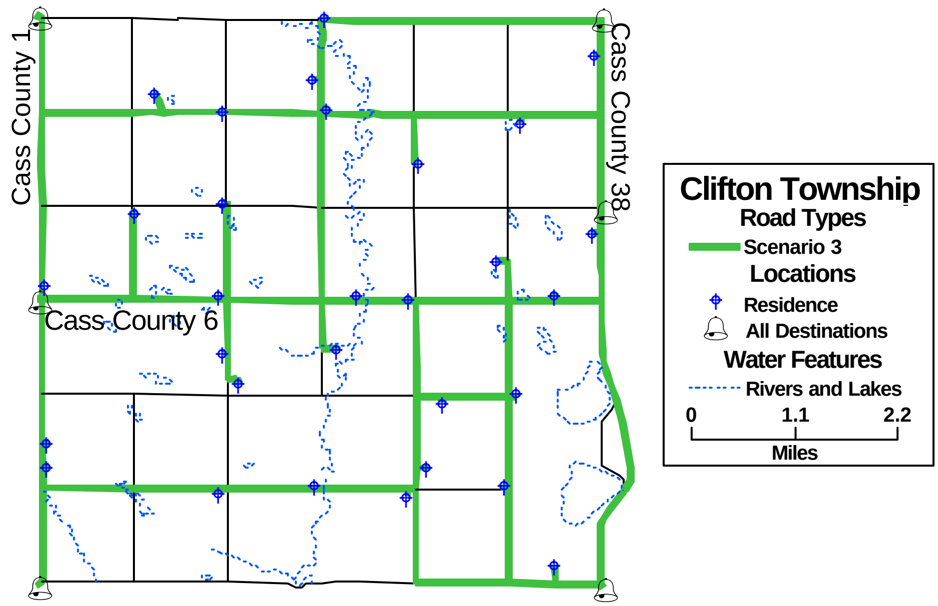


Figure 7 Clifton Township Road Consolidation, Scenario 3.

For this case study, school bus routes and mail carrier routes were included in the determination of user costs, but were not included in determination of removing routes from the network. This was determined to be more effective in analysis of the case study because some of the school and mail routes were on roads that provided duplicate service to a residence. These systems are adjustable from year to year due to students graduating and residents moving to urban areas, therefore limiting the criteria for removing a road from the network based on school bus or mail carriers did not seem advantageous to analysis of the network. When comparing alternative networks, there were minimal increases in the number of miles traveled by either service.

Tangible factors may be taken into consideration for removal of segments such as bridge conditions, existing surface conditions, and connectivity to corresponding township networks. By visual inspection and familiarity of the township, routes that have less gravel, experience seasonal travel, or are unsafe could be considered for closure or minimum maintenance designation.[3] In the next section, benefit/cost analysis will be applied to the three scenarios to illustrate net savings to the users.

Benefit/Cost Analysis

Feasibility of the three scenario networks was determined by comparing the increase in user cost verses the decrease in maintenance cost. Closing a road segment increases vehicle miles traveled and therefore increases vehicle operating costs and opportunity costs, but decreases total maintenance costs. By decreasing maintenance costs, there will be more money available for other improvements, such as gravel stabilization and road widening, thus decreasing the vehicle operating cost; in return increasing benefits by reducing the vehicle operating costs on gravel.

This report focuses mainly on initial benefits for the three scenarios and does not take into consideration the added long term benefits from possible future improvements. However, an attempt is made to illustrate additional costs associated with converting un-graveled segments to graveled segments. The scenarios assume the network contains all graveled roads, therefore if un-graveled roads remained in the scenario an additional cost was added. This cost represents the difference in maintenance costs between un-graveled and graveled segments; it also assumes the conversion to gravel is distributed through the annual cost. The next section examines costs and benefits used in the methodology.

---

[3]For a more detailed description of the procedures to follow to declare a minimum maintenance road or to close a road, see Welte, Peter, Jill Hough, and Ayman Smadi. *Legal Implications to Closing or Reducing Maintenance on Low Volume Roads in North Dakota.* MPC Report 97-69. Mountain Plains Consortium, North Dakota State University, Fargo, 1997.

Vehicle Operating Costs

Vehicle operating costs (VOC) include cost of fuel, fuel taxes, maintenance, financing, registration/taxes, insurance and repairs, and use-related depreciation (FHA, 1995). Vehicle operating costs reflect additional wear and tear on a vehicle due to operations on deteriorating pavements. This analysis uses the same principle, but compares the vehicle operating costs of operating on different road segments and surfaces.

Road user costs will typically be higher on gravel roads than paved roads for several reasons. First, paved roads will permit greater vehicle speeds to be achieved with higher levels of safety and comfort than gravel roads. Second, the increased smoothness of paved roads produces less damage on vehicles and requires less fuel consumption. This results in decreased vehicle operating costs incurred on paved roads compared to costs incurred on gravel roads. Thus, the vehicle operating costs and opportunity cost incurred on gravel roads will be greater than those incurred on paved roads (Bitzan et. al., 1992).

The vehicle operating costs for township residents and the postal route were estimated to be $.45 per mile for gravel surfaces and $.395 per mile for pavement surfaces. The value for gravel was based on adjusting the national pavement vehicle operating cost by a factor of 1.14[4]. The value for pavement was obtained from the Federal Highway Administration estimates based on 1994 editions of *The Complete Small Truck Guide and The Complete Car Cost Guide*, from Intellichoice, Inc., and sales figures from Automotive News. The vehicle operating cost per mile for the school bus route was

[4] This factor was obtained by taking a comparison of the 1992 VOC for gravel and VOC for pavement, as reported in Bitzan et. al. These values were based on the Highway Performance Monitoring System, Version 2.0, January 1986, issued by the Federal Highway Administration, where a formula is used to determine effect of the pavement condition on the VOC. The formula relates the cost at a PSR of 4.5 (good pavement condition) to a PSR of 2.0 (condition equivalent to gravel). The formula is:

$$VOC = 0.9818182 + (5.0 - PSR)/(20.0 + (5.0 \times (PSR - 3.0)))$$

It is assumed the adjustment factor is the same for 1997.

calculated to be $1.30, based on an interview with Dietrich and Son's Inc., a distributor of school buses in North Dakota. This value is based on private contractors' prices for operating a bus per mile, therefore it includes profit for the company and reflects an opportunity cost for the driver. The VOC for the school bus route on gravel is adjusted by the 1.14 factor mentioned above.

Opportunity Cost

Opportunity cost is the cost associated with additional travel time. This cost represents cost of additional time the road user spends on the alternative route instead of productive events such as employment. This is true for individuals who can substitute time for money, such as dentists, sales professionals, or farmers; where they have discretionary work schedules and can expect that their earnings will decline in proportion to time off. Retirees, students, or the unemployed do not exchange time for money, therefore it may overstate the time valuation (McKean et. al., 1995). Nonetheless, since the case study is in a rural, farming area and the telephone survey resulted in few retirees, substituting money for time is assumed valid.

To correctly represent opportunity cost on average, per capita income was divided by 2,000 working hours in a year and by 60 minutes in an hour to yield an average wage per minute. This was used as a proxy for opportunity cost. The opportunity cost of $.1633 per minute was determined based on Cass County per capita income of $19,596 in 1996 (Bureau of Census, 1996). Based on travel speeds of 40 mph and 55 mph on gravel and paved surfaces respectively, opportunity costs are estimated at $0.245 per mile for travel on gravel and $0.178 per mile for travel on pavement. It is assumed that the average vehicle occupancy for this study is 1.0, based on results of the telephone survey. This is considerably lower than the national average vehicle occupancy of 1.6 for all trips (USDOT, *Our Nations Travel*, 1995). The opportunity cost for the postal route is not calculated because the postal worker is earning an income during the time they are driving on the roads delivering mail. The opportunity cost for the school bus route is included in the VOC.

Township Road Maintenance Cost

The township road maintenance costs were derived from a five-year average of blading, snow removal, and gravel costs. Since the network is fairly homogeneous, it was assumed the costs could be distributed over the entire system for the two types of road surfaces, even though certain segments of the network received more maintenance than other segments. The five-year average budget was $20,769.80. This included the years of 1992-1994 and 1996-1997, with a range of $12,725 to $28,250.

Maintenance costs per mile were calculated by taking the five-year average budget and dividing by total miles of the original network. This was done for both the un-graveled roads and the graveled roads to best represent costs associated with both types of road surfaces. In this manner, blading expenses were distributed over the total distance of un-graveled roads, whereas blading expenses, gravel expenses, and snow removal expenses were distributed over the total distance of the graveled roads. The Clifton township had annual maintenance costs of approximately $156 per mile on un-graveled roads and $435 per mile on graveled roads.

Costs associated with the maintenance of signs and bridges were not included in the budget calculation. Cass County is responsible for the upkeep of bridges, but the township is responsible for signs not crossing a county route. Furthermore, additional costs due to flooding were not included in the maintenance costs because they were paid by Federal Emergency Management Association funds. Funds and costs associated with bridge maintenance were kept separate from the calculation for the maintenance cost per mile because they were not direct expenses of the residents in the township.

Summary of Costs

Clifton Township has county paved surfaces on the eastern border and through the middle going east and west. These paved county roads are influential in calculation of the routes because they provide higher travel speeds than gravel, lower operating costs than gravel, and are the financial and maintenance responsibility of the county.

User costs, or VOC and opportunity costs combined, were calculated for the origin/destination trips based on survey results. It was assumed that results of the survey represent actual trips on the township network in one week. Thus, user costs were multiplied by 52 (weeks in a year) to get the annual costs.

The total cost of a particular trip from a residence to destination can be formulated as the vehicle costs plus opportunity costs. This is represented by the equation:

$$TC = VOC + OC$$

where:

TC	=	total cost per mile
VOC	=	vehicle operating cost per mile
OC	=	opportunity cost per mile

Therefore, the total cost per mile is \$0.695 (\$0.45 + \$0.245) on a gravel road and is \$0.573 (\$0.395 + \$0.178) on a paved road.

The benefits of network reductions are the product of maintenance costs per mile and total miles eliminated from the network. This is represented by the equation:

$$TB = MC * (E_m - P_m)$$

where:

TB	=	total benefits
MC	=	annual maintenance costs per mile
E_m	=	existing network miles
P_m	=	proposed network miles

Results

Using the cost information described above, a benefit-cost analysis was conducted on the three scenario road networks to identify cost savings for Clifton Township. It is important to note that in the benefit cost analysis, no bridge costs were included in the analysis because Cass County absorbs the bridge expense incurred by Clifton Township. Other townships conducting a similar type of analysis may need to include bridge expenses. To conduct this benefit-cost analysis of closing or designating a minimum maintenance road segment from a network, all figures were converted to 1997 dollars using the Consumer Price Index. Findings of the three scenarios follow.

Scenario 1

In Scenario 1 the township road network was reduced by 16 miles. This mileage reduction was based on removing segments that have no regular local travel. There is essentially no annual resident impact cost in this scenario. Rerouting costs for postal and school bus routes are minimal at $381 and $636, respectively (Table 4.1). The annual reduction in maintenance costs for the township are $5,245. The annual net benefit for Scenario 1 equals $3,681 (Table 4.1). This results in an savings of 18 percent of the average annual budget.

Table 4.1 Benefit/Cost Analysis

	Reduction in Miles of Township Road	Annual Resident Impact Cost	Annual Postal Route Impact Cost	Annual School Bus Route Impact Cost	Annual Reduction in Maintenance Cost (Benefit)	Annual Increase in Maintenance Cost	Annual Net Benefit
Scenario 1	16	$0	$381	$636	$5,245	$547	$3,681
Scenario 2	25	$5226	$1354	$257	$8,772	$279	$1,656
Scenario 3	24	$1247	$627	$641	$8,284	$279	$5,490

Scenario 2

In Scenario 2, the road segments with less than 10 weekly trips were removed. This resulted in reducing the township road network by 25 miles. The annual resident impact costs are high ($5,226) due to rerouting of traffic. The postal service costs would increase by $1,354 while the school bus route impact costs equal $257, which is lower than in Scenario 1. Annual maintenance costs would be reduced by $8,772, which is a substantial benefit over Scenario 1. However, due to the high impact costs on users, the annual net benefit is only $1,656 (Table 4.1).

Scenario 3

In Scenario 3, the township road network was reduced by 24 miles, which is only one mile less than Scenario 2. Interestingly, this small change saved $3,979 in user costs and increased the annual net benefit by $4,834. It is critical for township officials to realize that small changes in the road network can result in significant cost savings. Road closures should be well planned to determine how traffic levels shift due to the closure. A general guideline to consider when closing or reducing maintenance of roads is to remove road segments with the lowest percentage of daily traffic in the township, given the segment is not the only access.

These findings are comparable to the findings of Lamberton (1992). Table 4.2 illustrates the comparison between the two studies after adjusting Lamberton's net benefits into 1997 dollars. Interestingly, when Lamberton removed only those roads with the annual cost of rerouting the traffic being less than $500, the annual net benefits were the largest at $5,834. However, this current study did not focus upon keeping the cost of re-routing traffic to a specific number, rather, the focus was placed upon removing segments based on number of trips. The addition of one segment to Scenario 3 of the current study illustrates the importance of maintaining a through route for the re-routed traffic. This is comparable to Scenario 4 in the Lamberton study.

Table 4.2. Comparison of Benefit/Cost Analysis Between Lamberton and Ova & Hough Studies

	Lamberton		Ova & Hough	
Scenario*	**Miles of Road**	**Net Benefit ($)**	**Miles of Road**	**Net Benefit ($)**
1	11	1,944	16	3,681
2	15	(2,974)	25	1,656
3	21	(2,974)	24	5,490

4	15	5,834		

* See Chapter 2 Literature Review for a description of Lamberton Scenarios.

CHAPTER 5

SUMMARY AND CONCLUSION

This report shows a methodology to determine the level of township roads needed to provide adequate service and reduce road expenditures for maintenance. Through the use of GIS and transportation software, three scenarios for a case study revealed annual savings or benefits from $1,656 to $5,490. It also shows that some closures in a township result in substantial user costs and lowers the marginal benefits. For this case study, Scenario 3, the removal of a select 24 miles of road is the solution with the most benefits and low user costs. While political or accessibility factors may override the actual decision to close or reduce maintenance of a township road, this report still shows that the elimination of unnecessary roads can result in lower road expenses for townships.

Proper implementation of this methodology requires detailed investigation of the township network and education of residents affected by any changes. Although it is politically unpopular even to propose removing a segment from maintenance, the feasibility of this action based on economics should not be ignored. This analysis was developed from specific data from the case study location; while it may represent many townships in North Dakota and the surrounding areas, it is important to note that each township is unique and some consequential issues may exist in other townships not specifically defined in this report. For example, perennial winter conditions or flooding concerns must be evaluated when applying this methodology to the township in question. In addition, analysis should be based on sound calculations to avoid eliminating segments that result in dramatic increases in travel length and time, as illustrated by Scenario 3.

Need for Further Study

This study includes a case study township with a simple road network. The township network is part of a more complex network of roads. The travel and road costs used in this study do not include any effect upon the traffic levels and routes in adjacent townships. A more in-depth analysis of several townships to evaluate changes in the larger road network would be beneficial for a more complex road system.

Although the analysis becomes more complicated, removal or replacement of bridges in a future analysis would be insightful. For example, when reducing a road network or to re-route traffic, increasing traffic levels on alternative routes may require making bridge improvements to handle higher levels of traffic in addition to heavier weight limits.

Finally, educating the public about removal of specific roads would be necessary to ease possible hostile emotions. However, once citizens realize the underpinnings of shrinking resources, they may become more understanding of difficult choices that road officials and decision makers must devise.

REFERENCES

Baumel, Phillip C., Hamlett, Cathy A., and Pautsch, Gregory R. *The Economics of Reducing the County Road System: Three Case Studies in Iowa.* DOT/OST/P-34/86/035, U.S. Department of Transportation, 1986.

Bitzan, John D., Denver D. Tolliver, and Daniel L. Zink. *Rural Road Financing Strategies Two New models Applied to N.D. Counties.* Mountain-Plains Consortium Report No. 92-13, North Dakota State University, Fargo, N.D., 1992.

Bureau of the Census. *Number of Inhabitants, North Dakota, 1980 Census of Population.* U.S. Department of Commerce. PC80-1-A36.

Bureau of the Census. *USA Counties 1996.* U.S. Department of Commerce.

Hough, Jill, Ayman Smadi, and Lance Shultz. *Gravel Shortage Options.* Mountain-Plains Consortium Report No. 96-65, North Dakota State University, Fargo N.D., 1996.

Lamberton, Charles E. *Alternative Road Networks for a South Dakota Township.* Economics Research Report 92-5, Economics Department, South Dakota State University, Brookings, South Dakota. June, 1992

McKean, John R., Donn M. Johnson, and Richard G.Walsh. "Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation." *Land Economics.* 71(1): 96-105, 1995.

Rathge, Richard, and Shannon Terry. *North Dakota Population Projections By Age And Gender, 1995-2010.* North Dakota Census Data Center Report #21, North Dakota State University, Fargo, N.D., 1993.

United States Department of Transportation. Federal Highway Administration. *Our Nations's Highways.* Publication No. FHWA-PL-95-028, Washington, D.C., 1995.

United States Department of Transportation. Federal Highway Administration. *Our Nation's Travel: 1995 Nationwide Personal Transportation Survey.* Washington, D.C., 1995.

Welte, Peter, Jill Hough, and Ayman Smadi. *Legal Implications to Closing or Reducing Maintenance on Low Volume Roads in North Dakota.* MPC Report 97-69. Mountain Plains Consortium, North Dakota State University, Fargo, 1997.