

# Grygla Snow and Ice Service Level for Low-Volume Highways

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The level of winter maintenance on a low-volume trunk highway in northern Minnesota was reduced during the winter of 1984–1985. Sand or salt was used only at hazardous locations and plowing coverage was limited to 8 hr a day. The roadway conditions were assessed periodically on this section of highway as well as on two control sections, one a county road and the other a trunk highway where the normal level of winter maintenance was provided. Questionnaires were used to obtain public reaction. Primary findings from the study were that farmers are more tolerant of a lower level of service than nonfarmers, two-thirds of the respondents were satisfied with the lower level of service, road users expect a higher level of service on trunk highways than on county roads, and an annual cost savings of \$140 per roadway mile (approximately 40 percent) was realized by the reduced service.

In recent years, the Minnesota Department of Transportation (Mn/DOT) has conducted several research studies to determine the level of winter maintenance desired and required by the road users. These studies have been limited almost exclusively to higher-volume roads; the service level for low-volume roads has not been adequately addressed.

Three factors indicate that the level of winter maintenance on low-volume trunk highways could be reduced. These are

1. A general acceptance by road users in some parts of the state of a much lower level of service on county roads that often have higher traffic volumes than on low-volume trunk highways in the area,
2. Occasional complaints of excessive sand or salt use on low-volume trunk highways, and
3. Growing public awareness of the need to fully evaluate cost-effective maintenance operations in order to keep public funding needs in perspective.

## SCOPE

In order to examine the effects of reduced service, the winter maintenance level was reduced on sections of low-volume (secondary) trunk highway in northwestern Minnesota. The level of service on these roadway sections was measured subjectively by a panel and compared with similar information from a nearby, parallel county road. In addition, an adjoining section of secondary low-volume trunk highway was maintained at the normal level and evaluated for condition and cost. The study can also be considered another effort to reduce the amount of salt use, as directed by the state legislature some years ago.

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## LOCATION

The roadway sections involved in the reduced level of service included T.H.-89 from Grygla to the south junction of Roseau County Road 2 and T.H.-219 from T.H.-1 to T.H.-89. The county roads used as comparison sections were Pennington County Road 28, Marshall County Road 54, and Roseau County Road 9. The trunk highways maintained at the normal level and used as comparison sections were T.H.-89 from Grygla south to the Red Lake River and T.H.-1 from the west Beltrami County line east to the junction of T.H.-89 (Figure 1). The average annual snowfall in this area is 37.5 in.

## USER BACKGROUND

The local roadway user population in the area of the study was split into two categories: those employed in farming and those not employed in farming. The population was divided in this manner to differentiate between those who do not have to travel to get to work and those who do. From 1980 census data provided by the Northwest Regional Development Commission, the farm-employed group made up 30.4 percent of the working population, and the non-farm-employed group made up the remaining 69.6 percent.

## METHOD OF EVALUATION

The evaluation stage consisted of two phases: (a) the comparison of the level of service (actual roadway surface condition) on the trunk highway sections with the level of service on the county road sections and (b) the determination of whether the level of service on the trunk highway sections met the needs and desires of the road users.

The evaluation of Phase 1 was based on the subjective opinion of a rater who observed the surface condition and reported it on evaluation forms provided by the Project Coordinator. Type and rate of precipitation, temperature, and wind velocity were also noted. Raters tried to evaluate the test sections and the control sections after each significant snowfall event on the roadways. Phase 2 data were obtained through use of a questionnaire, which was distributed to all post office box holders along the affected routes. The questionnaire addressed such items as occupation, road usage, and maintenance rating.

## LEVEL OF SERVICE PROVIDED

The local counties were contacted to determine their procedures and standards. These criteria were then used to target levels of service for the trunk highway sections. The reduced

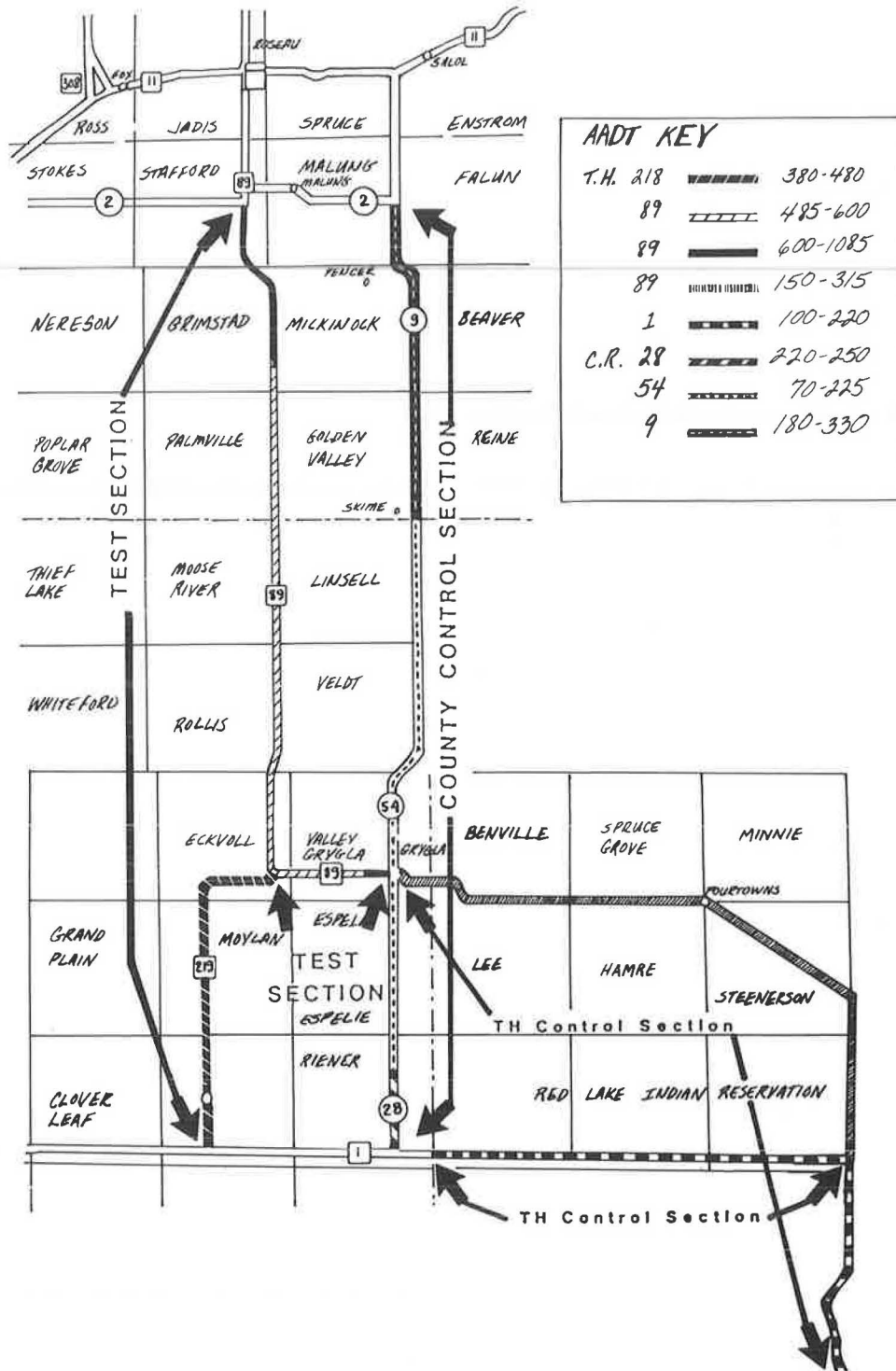


FIGURE 1 Location of test sections and control sections.

level of maintenance used in this test was to limit straight plowing with sanding (10 percent salt) to curves and unsafe locations. No overtime was accumulated and because the truck route was quite long, only one cycle (round trip) per day was run. Trouble spots were provided for in the 8-hr work day; however, no weekend or holiday coverage was provided. It should be noted that during the study period, requests from law enforcement officials were acknowledged and acted on as necessary. Table 1 compares the different levels of service. The

established criteria were deviated from temporarily in late December to remove thick ice and compacted snow caused by an unusual rain and snowfall event.

**RESULTS OF SNOW AND ICE EVENTS: ROAD CONDITIONS**

Table 2 is a summary of the data collected from condition ratings of the driving surfaces after approximately 6 months of

TABLE 1 COMPARISON OF SERVICE LEVELS

	Mn/DOT Standards for Secondary Routes	County Policy	Proposed Study Standards
Lane miles/unit	95	200-250	120+
Coverage time (hr)	12	Varies, <12	8
Cycle time (hr)	5	Varies, 12-24	1/day
Chemical or sand application	Intermittent bare wheel path	Min. (8%) salt/sand mixture applied to extremely hazardous areas only	10 percent salt/sand to hazardous areas only

TABLE 2 SNOW AND ICE EVENTS AND CORRESPONDING CONDITIONS

Event No. and Date	Weather	Section Condition, Duration After Event, and Remarks			
		Trunk Highway		County Control Section	Duration and Remarks
		Test Section	Control Section		
First Mailing: November 15, 1984, to December 19, 1984					
1, 11/01	Freezing rain				No data collected
2, 11/15	Light snow	95% bare	100% bare	75% bare	
3, 11/27	Freezing rain	60% ice glaze	100% bare	60% ice glaze	All sections bare within 7 days
4, 12/16	Heavy freezing rain with 4-in. snow temperature drop to <0°F	100% compacted snow and ice	100% compacted snow and ice	100% compacted snow and ice	Continuous
Second Mailing: December 20, 1984, to January 1, 1985					
5, 12/21	Light snow	100% compacted snow and ice	100% snow covered	100% compacted snow and ice	Relatively continuous
6, 12/28	Light rain with light snow	5% bare	10% bare	25% bare	Maintenance changed to apply sand and salt on test section
12/31	-30°F	60% bare	40% bare	30% bare	Too cold to do anything with ice
1/02	Trace of snow, no rain, -20°F, wind 5-10 mph, no plows out				Heavy application of salt
1/03					Heavy application of salt
Third Mailing: January 2, 1985, to February 13, 1985					
7, 1/04	No snow, 30°F, wind 10-25 mph, plows out sanding	100% bare	100% bare	40% bare, 20% ice-glaze, 40% compacted snow and ice	
8, 1/07	Trace of snow, no rain, 16°F, wind 0-5 mph, no plows out				
9, 1/14	Trace of snow, no rain, -6°F, wind 10-15 mph, plows out				
10, 1/18	Trace of snow, no rain, -22°F, wind 5-10 mph, plows out				
11, 1/21	10-20°F, wind 10-25 mph, plows out	100% bare	90% bare, 10% compacted snow and ice	100% bare	Small drifts on road, wind from NW
12, 1/22	Trace of snow, no rain, 8°F, wind 5-10 mph, plows out spot sanding				
13, 1/25	1 in. snow, no rain, -5°F, wind 5-10 mph, plows out				
14, 1/28	0.5 in. snow, -9°F, wind 0-5 mph, plows out	100% bare	98% bare, 2% compacted snow and ice	100% bare	Sanded in Grygla
1/29	Trace of snow, no rain, 13°F, wind 0-5 mph, no plows out				
15, 2/05	No snow, no rain, -10°F, wind 0-5 mph, plows out sanding				
2/06	1 in. snow, no rain, -1°F, wind 5-20 mph, plows out				
2/07	No snow, -10°F	100% bare	99% bare, 1% compacted snow and ice	100% bare	Sanded in Grygla

TABLE 2 continued

Event No. and Date	Weather	Section Condition, Duration After Event, and Remarks			
		Trunk Highway		County Control Section	Duration and Remarks
		Test Section	Control Section		
16 2/09	6-8 in. snow, no rain, 12°F, wind 5-10 mph, plows out sanding				
2/11	5 in. snow, dry, 0°F, wind 10 mph	98% bare, 2% ice-glaze	95% bare, 5% ice-glaze	95% bare, 5% ice-glaze	T.H.-89 and 219 snow-packed and sanded; county roads and trunk highways bare with very little snow packed in sheltered areas; towns and intersections sanded; research area in excellent winter driving condition
17, 2/13	1 in. snow, no rain, 12°F, wind 0-5 mph, plows out				
Fourth Mailing: February 14, 1985, to March 14, 1985					
18 2/25	No snow, 1 in. rain, 36°F, wind 0-5 mph, no plows out				
2/26	Light snow, dry, 6°F, wind 5-10 mph, plows out	90% bare, 10% compacted snow and ice	80% bare, 20% compacted snow and ice	80% bare, 20% compacted snow and ice	Compacted snow in sheltered areas; bare and dry in Grygla; some compacted snow in Wannaska and Goodridge
19, 3/01	No data	100% bare	100% bare	100% bare	
20 3/04	2-3 in. snow, no rain, 16°F, wind 15-20 mph, plows out				
3/05	Heavy snow, 10°F, wind 5-10 mph, plows out	85% bare, 15% compacted snow and ice	71% bare, 11% compacted snow and ice, 18% uncompactd snow > 2 in.	50% bare, 50% compacted snow and ice	Approx. 20 mi of northern Co. Rd. 9 was not plowed; snow was 2 ft deep in some areas, with one trail to follow
21, 3/07	Blowing snow, 11°F, wind 25+ mph, plows out	95% bare, 5% compacted snow and ice	45% bare, 65% compacted snow and ice	15% bare, 85% compacted snow and ice	On T.H. 89 and 219 majority of compacted snow was melted or melting; by 11:00 roads were getting wet; T.H.s were very wet but clean; county roads were bad because the day before was windy and probably caused blowing snow to stick to roadway
22, 3/13	1 in. snow, 28°F, wind 0-5 mph, plows out	70% bare, 30% compacted snow and ice	100% bare	100% bare	Less than 1 in. compacted snow and ice; melting
23, 3/22	No snow, some rain, 42°F, wind 5-10 mph, no plows out				
24, 3/25	No snow, some rain, 36°F, wind 0-5 mph, no plows out				
25, 3/27	No snow, some rain, 34°F, wind 5-10 mph, no plows out				
26, 3/29	5-6 in. snow, some rain, 22°F, wind 5-10 mph, plows out sanding				

monitoring. Ratings were conducted on the dates indicated in the table; the weather events similarly correspond to the given dates.

#### USER QUESTIONNAIRE

The user questionnaires were distributed by general delivery to all box holders along the affected routes and were handed out at

information meetings. In addition, a supply was made available at the Roseau post office, the general store in Wannaska, and the Grygla elevator. A total of 1,962 forms were distributed through four separate mailings (mailings 2-4 were to previous respondents), of which 774 were returned (some of these were from fourth-time participants). A brief summary of the data collected is shown in Table 3, in which the four time frames given represent the four mailings from the date they went out until just before the next mailing.

TABLE 3 USER QUESTIONNAIRE DATA SUMMARY

Date	No. of Responses		Median Ratings			
			T.H. Test Section		County Control Section	
	Farmers	Nonfarmers	Farmers	Nonfarmers	Farmers	Nonfarmers
11/15/84 to 12/19/84	167	235	3.55	3.34	3.55	3.34
12/20/84 to 1/01/85	19	53	1.68	1.60	1.94	1.90
1/02/85 to 2/13/85	49	116	3.22	3.09	2.66	2.79
2/14/85 to 3/14/85	48	83	3.72	3.66	3.61	3.57

NOTE: Median response rating values were as follows: 1 = poor; 2 = fair; 3 = satisfactory; 4 = good; 5 = excellent. "Farmers" = farming as sole occupation; nonfarmers = all others.

The summary was divided into two groups of data to show the attitude of a group who depend on the highways to get to work daily versus one whose occupation is not geared to daily highway use. The median rating represents a split in response values at the point where about half the responses are less than and the other half greater than the median value.

### SUMMARY AND DISCUSSION

A total of 26 weather-related events were recorded during the 1984-1985 winter. Total snowfall for the winter recorded by the state climatologist's office was 35.8 in. as opposed to an average annual snowfall of 37.4 in. The snowplows were out plowing or sanding for all of these events, and in only one case during the winter was there an extremely negative reaction from the public. During this event a temporary suspension of the study was required and a sand and chemical mixture was applied to clear the roads. This ice storm, which occurred on December 16, was, according to the subarea foreman, one of the two worst ice storms he could recall in his 20 years of experience. A description of that event follows.

Before the December 16 ice storm, 28 percent of the questionnaire responses requested an increase in maintenance level on the trunk highway test section. This proportion increased to 86 percent of the responses after the December 16 storm. The 2-week period following that particular ice storm produced numerous calls and letters, including ones from the Roseau law enforcement agency and the Roseau school superintendent. All were very critical of the condition of the trunk highway test section, which became very slippery (as the compacted snow eroded away, it left a surface of polished ice). Travel on the northerly 10 to 15 mi had been reported as limited to 20 to 25 mph. Most of the more vocal criticism appeared to be centered around school transportation. Buses were running up to 1 hr late, and mothers expressed deep concern for the safety of their children. Of course, much of the bus time is on county roads, but people seem to expect county roads to be slippery.

In reality, the conditions between December 16, 1984, and January 4, 1985, were anything but normal. When the storm hit, temperatures were above freezing, but they quickly dropped, which caused freezing rain (4 in. was reported at Roseau). The rain eventually changed to snow, which stuck to the wet highway and became compacted by the traffic. This all occurred late in the afternoon, and by morning the temperature was below the effective working range of chemicals (above 15°F) and it stayed that way until December 20, which produced poor conditions on all the trunk highways in this area.

On December 20 and 21, temperatures moderated enough to allow some chemical use; however, a number of area routes still remained with significant amounts of compacted snow and ice because of additional snowfall coupled with blowing snow. Following this, another cold wave (0 to -20°F) persisted until December 28, when a warming trend brought another snow and ice storm followed immediately by subzero temperatures. In other words, from December 16 until January 3, 1985, conditions were next to impossible for maintaining highways. On December 31, 1984, a news release was sent out stating that the study would be temporarily postponed to remove the thick, compacted ice and snow, after which the reduced service level set up for the study would return. As stated, heavy application of chemical on January 2 and 3, 1985, produced bare, wet pavement by January 4, 1985.

Responses to the third mailing indicated that 58 percent of the public was again satisfied with the level of service, and the fourth mailing indicated that 90 percent of the public was satisfied with the level of service on the test section. At the same time, the regularly maintained county control section roads were rated, respectively, at a 48 and 88 percent satisfactory or better level of service.

### COST COMPARISONS

The total cost of snow removal for the trunk highway test section, including equipment, labor, and materials, was \$187.70 per roadway mile, and the trunk highway control section snow removal cost \$327.70 per roadway mile. This comes to a \$140.00/mi cost savings on the test section (Figure 2). However, it should be noted that the trunk highway control section includes more miles of sheltered (wooded) areas, which could have contributed to the higher maintenance cost. The maintenance cost for Marshall County Road 54 was \$96.47/mi, as provided by the Marshall County Engineer.

The trunk highway test section would have experienced a further cost reduction of at least \$14/mi if emergency salt and sand had not been needed during the severe ice event in December. Even with the reduced level of service on the trunk highway section, the cost per mile is still nearly twice that of the county control section.

### Man and Truck Hours

#### 1984-1985

There is an obvious reduction in man and truck hours between the trunk highway test and control sections, with the test

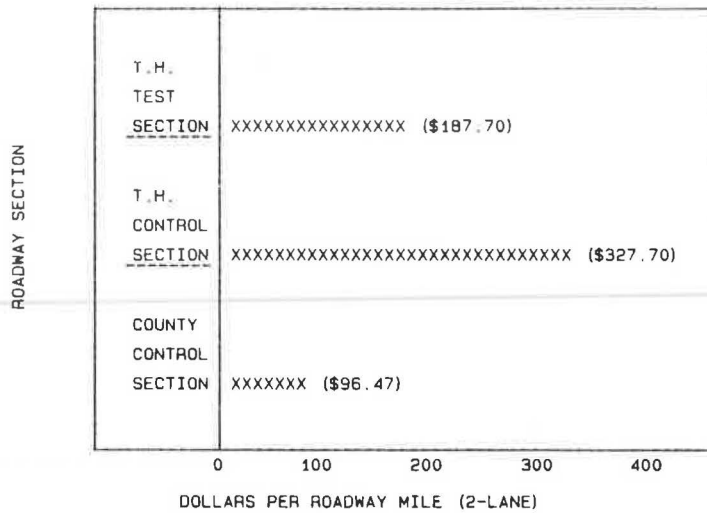


FIGURE 2 Summary of total cost per mile.

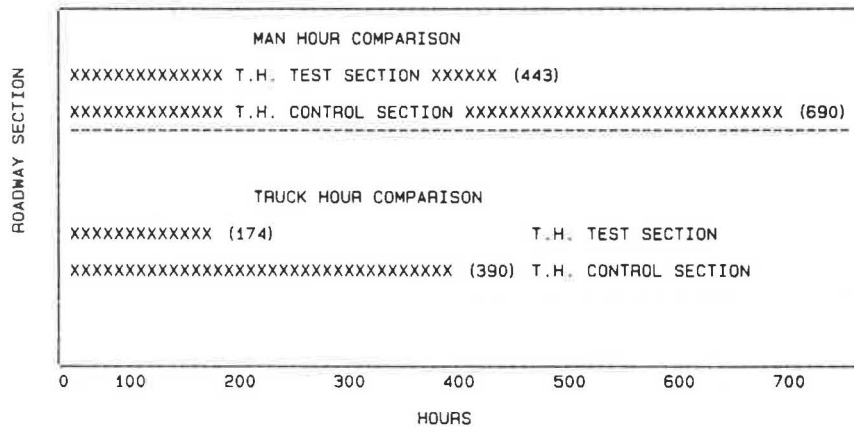


FIGURE 3 Summary of 1984-1985 man and truck hours.

section realizing about half the hours of the control section. This resulted in a savings of \$6,239.80 on the trunk highway test section, or \$115.21/mi (Figure 3). Again, a further cost reduction would have been experienced on the trunk highway test section if emergency man and truck hours had not been needed during the December ice storm.

1983-1984

The following information is provided as a yardstick for comparing section differences and winter severity. Compared with man and truck hours for the winter of 1983-1984 (Figure 4), the 1984-1985 study period realized nearly the same hourly levels, with the exception of the trunk highway test section. This would be attributable to the lower level of service on the test section. This comparison indicates that service levels on the trunk highway control section were at near-normal winter maintenance levels and that the study period experienced near-normal winter weather conditions (excluding the December ice storm). It should be remembered that the winter of 1983-1984 was not in the study season.

Salt and Sand Application

Application of salt and sand on the trunk highway test section was about half that used on the trunk highway control section. This reduction amounted to a cost savings of \$1,841.87, or \$34/mi. During the December ice storm, a sand-salt mixture of 1.5:1 was needed on the test section to remove the thick ice. This additional application added \$14 more to the test section's total cost per mile. Subtracting the emergency salt and sand cost results in a \$48/mi cost savings for the test section over the control section. Figure 5 compares total salt and sand quantities used during the study period.

FINDINGS AND CONCLUSIONS

The following findings and conclusions resulted from this study:

1. It became obvious through the course of this study that any future studies or any new policy should provide for the emergency treatment of severe ice conditions such as those that occurred during December 1984.

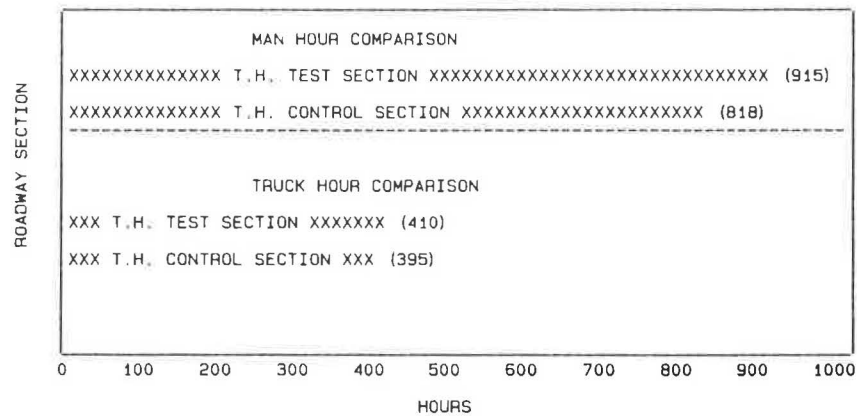


FIGURE 4 Summary of 1983-1984 man and truck hours.

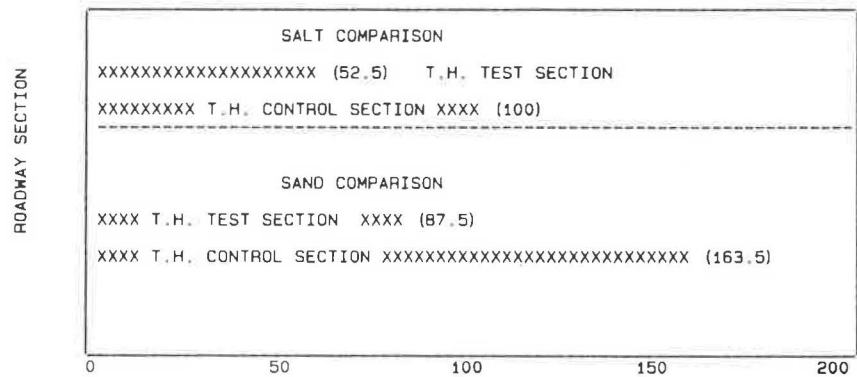


FIGURE 5 Summary of sand and salt comparison.

2. It appears that a distinct difference in user attitudes regarding the level of service is based on occupation. The farm-employed user group in this study was much more tolerant of a lower level of service than the non-farm-employed users. This could be due in part to the farmer's less frequent use of the roads during the winter months as opposed to the nonfarmer, who commutes on a daily basis and therefore desires a higher level of service.

3. Overall, two-thirds of all the respondents were satisfied with the lower level of service. This indicates that, except in times of extreme conditions, service levels on low-volume trunk highways with these characteristics may be reduced and still provide acceptable transportation for the majority of the users. However, the key question may very well be what group's service level should be targeted.

4. On the basis of user interviews, a large portion were tolerant of the county roads' lower level of service. It appears that this lower level of service is tolerated because the users believe that they can use the trunk highways, which they expect to be maintained at a higher level. However, suggestions have been made that approximately 40 percent of Minnesota's trunk highway system—primarily those having traffic volumes less than 1,000 average daily traffic—be turned over to the counties. If this were to happen, the level of service on these roads would most likely be reduced to that of the current county system.

5. Economically, a cost savings of \$140 per roadway mile on the trunk highway test section was realized as a result of the reduced service level compared with that on the control trunk highway section.

## RECOMMENDATIONS

1. The study should be repeated at one or two other locations in the state to determine whether results are similar to those obtained in the Grygla study. These studies should be coordinated with the local media and regional leaders so that the objectives of the study are fully understood.

2. All Mn/DOT districts should consider using the level of service developed in this study on some of its low-volume roads.

3. In selecting roads for a reduced level of service, factors such as expected amount of drifting, direction and intensity of wind, and amount of shelter need to be considered.

4. Future studies with reduced level of service need to provide for treating unusually severe conditions, such as ice storms.

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