OPTIMIZATION OF WINTER MAINTENANCE IN THE MINNEAPOLIS-St. PAUL METROPOLITAN AREA USING PERFORMANCE TARGETS

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Abstract

Optimization of Winter maintenance in the Minneapolis-St. Paul Metropolitan Area Using Performance Targets

The Minneapolis- St. Paul metropolitan area is subject to winter conditions which may range from freezing rain to heavy wet snow at moderate temperatures to blowing dry snow at very cold temperatures. With average daily traffic of up to 300,000 vehicles per day on some area roadways, it is imperative that a high level of winter road maintenance be provided to road users at all times. Widely differing levels of resource consumption, primarily sodium chloride and sand were noted in the 19 metro subareas prior to the 1999-2000 season. A comprehensive system was not in place to identify and accurately evaluate the wide differences in salt and sand use which may have been caused by differing environmental conditions during the storm events or even differing operational philosophies among the various subarea supervisors.

After several years of development on a statewide basis, maintenance business planning techniques were put in effect for the 1999-2000 winter season. These techniques included the concept of loss of bare pavement during a storm event and bare pavement regain time after a storm event. This concept of bare pavement regain time (bare pavement is when pavement is 95 % free of ice or snow) was defined with the help of road users who participated in surveys and or focus groups. Performance target values for bare pavement by road class were developed for the entire state recognizing different traffic conditions and storm duration and severity around the state. Target range values were determined from past performance results, field supervisor and worker experience, market research conducted in 1994 and 1996, environmental factors and other considerations. The capture of resource consumption data and comparison of actual plow route and subarea performance versus the established performance target values during the 1999-2000 winter season greatly assisted Mn/DOT's Metro Division in making accurate evaluations of overall winter maintenance performance for the 19 subareas.

Introduction

Winter maintenance is one of the most important maintenance activities in the Minneapolis-St. Paul metropolitan area. This metropolitan area with a population of approximately 2.8 million is located in east central Minnesota which is located in the colder, snow and ice prone area of the upper midwestern part of the United States. A map showing the metropolitan area is shown in figure 1.

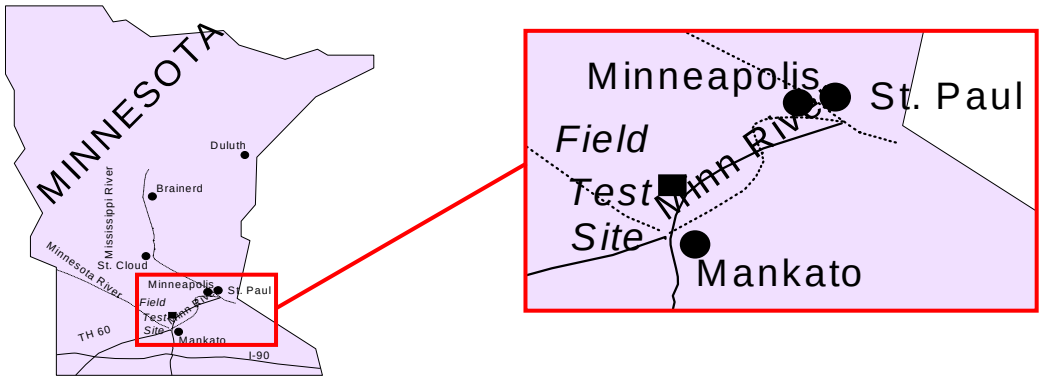


Figure 1. Minnesota

The Minnesota Department of Transportation, Metropolitan Division maintains a total of about 6500 lane kilometers. Providing the same or better level of winter maintenance in the metro area presents an ever-increasing challenge. Metro area road traffic has increased roughly 59 percent over the past 9 years. Congestion has increased to the point where it consumes about 38 hours per year. The metro area is the second fastest growing area in terms of congestion in the U.S. and now ranks as the 15th most congested area nationwide. Winter road maintenance is becoming increasingly difficult and more costly as a result of this congestion. Adding to these winter maintenance problems are the static labor and financial resources that are available. Maintenance personnel levels, mainly snow plow operators, have declined about 15 percent over the past 8 years. The maintenance budget has remained relatively static over the last five years except for minor budget increases to implement in innovations such as prewetting and anti-icing techniques in the metro area. In times of heavy snow and ice years, increased salt costs, overtime expenses, etc. consume a larger portion of the budget leaving less for spring pothole repairs and summer road maintenance. Thus, hard choices have to be made by the Metro Division. Do they fund winter maintenance at a level to meet public road user expectations or do they invest more in maintaining a deteriorating road infrastructure?

Provision of limited funding for implementing new technique such as pre wetting and anti-icing has helped to improve the level of winter service. Several metro area truck stations have been outfitted with new brine mixing storage and dispensing systems. The use of alternative deicing chemicals has also aided winter maintenance efforts. And, most recently, the completion of a fixed automated deicer spray system on the I-35W Mississippi River crossing at Minneapolis will help relieve a traffic accident problem and congestion in this immediate area.

Still other factors have affected winter maintenance performance. It is increasingly difficult to hire qualified operators due to competition from better paying private and public competitors. Attempts to increase the work force through entry level work force diversity programs have helped but require expensive training programs.

A Maintenance Business Approach

Under the former operating scheme, quantities of salt and sand used and related costs were tabulated on a monthly basis. This data would indicate for some months that any one truck station's resource consumption was high in comparison to others. For other months, it would be a different truck station. Although this data, with its varying implications was available, there was no coherent way to measure the real costs of winter maintenance of one or more metro area snow and ice removal routes versus others. Nor was there any good way to measure the value of winter maintenance service to the customer. Given these prevailing issues and the need to maintain an acceptable level of service, the Metro Division decided to get fully involved in a state wide maintenance business planning approach that was currently being developed and implemented.

Maintenance Business Planning

What is "Maintenance Business Planning"? It is simply the application of a private industry "business" perspective to public service maintenance work. Maintenance Business Planning further implies that the only justification for any organization's existence and efforts is the value it provides to its customers. In order to better assess MN/DOT's value of services to its customers, seven core products and services were identified as shown below.

Clear roadways
Smooth and reliable pavement
Available bridges
Attractive roadsides
Safety features
Highway permits/regulations
Motorist Services

Of interest in this paper is "Clear Roadways" which includes the function of keeping roadways clear of ice and snow. Market research conducted by the Minnesota Department of Transportation in 1994 and 1996 showed that the top five road maintenance issues of importance to the public user were;

Stop lights/signs visible and working
Roads clear of snow and ice
Highway signs readable
Road stripes and markings visible
Roads clear of debris

This market research showing winter road maintenance as the second most important issue to the road used was repeated in 2000 with the same results.

Measurement of Winter Maintenance Performance

From the market research conducted in 1994, 1996 and 2000, Mn/DOT has learned that one important value of winter maintenance to the customer is how quickly an adequate level of service is obtained after a storm event. Thus, was born the concept of "bare pavement regain time." Bare pavement was initially determined to be when 95 % of the roadway was clear of ice and snow. However, subsequent market research indicated a high level of public satisfaction at a somewhat lesser level of service. Thus, the bare pavement or bare lane was redefined as 90 percent bare lane. The 10% snow and ice cover can be any combination of the following possible road conditions:

10 – 50 foot spots per mile
2 – 250 for spot per mile
2– mile per 20 miles
2 – ½ mile per 10 miles
8 – ¼ mile spots per 20 miles

After a short study of possible road surface conditions, it is expected that the snowplow operator become quickly trained in estimating when 90% bare pavement/lane is achieved. This is important as the operator is charged with the event times and road surface conditions needed to calculate the bare pavement regain time. The derivation of bare pavement regain time is shown if Figure 2.

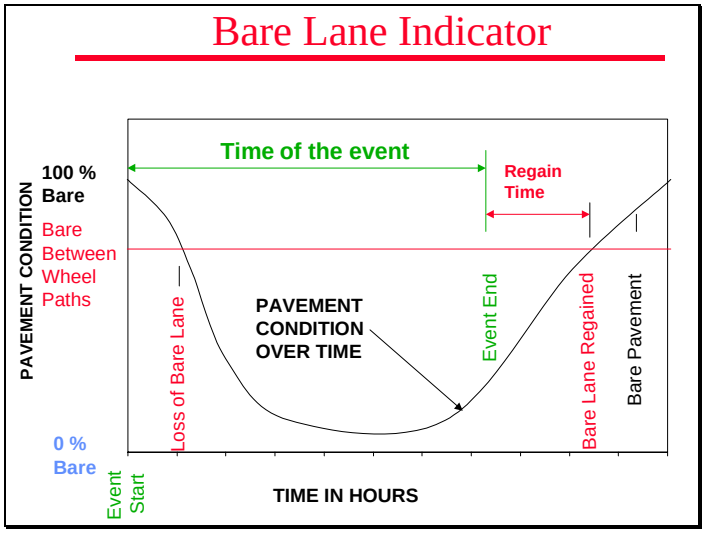
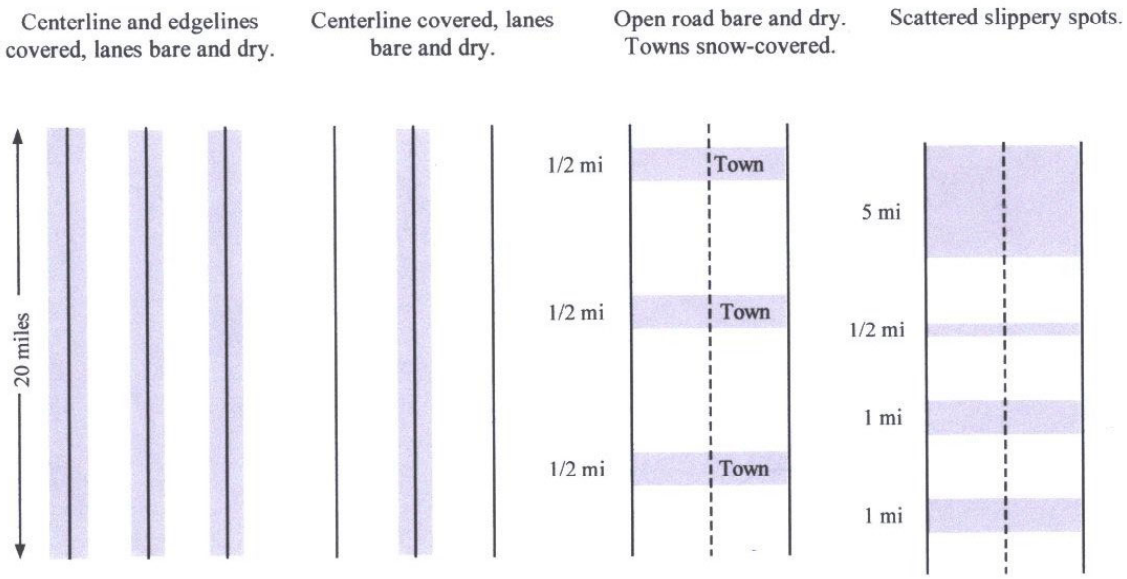


Figure 2. Derivation of Bare Pavement Regain Time (2)

Examples of lost bare pavement and not lost bare pavement are shown in Figure 3.

Examples of lost bare pavement are shown below:



Examples of no lost bare pavement are shown below:

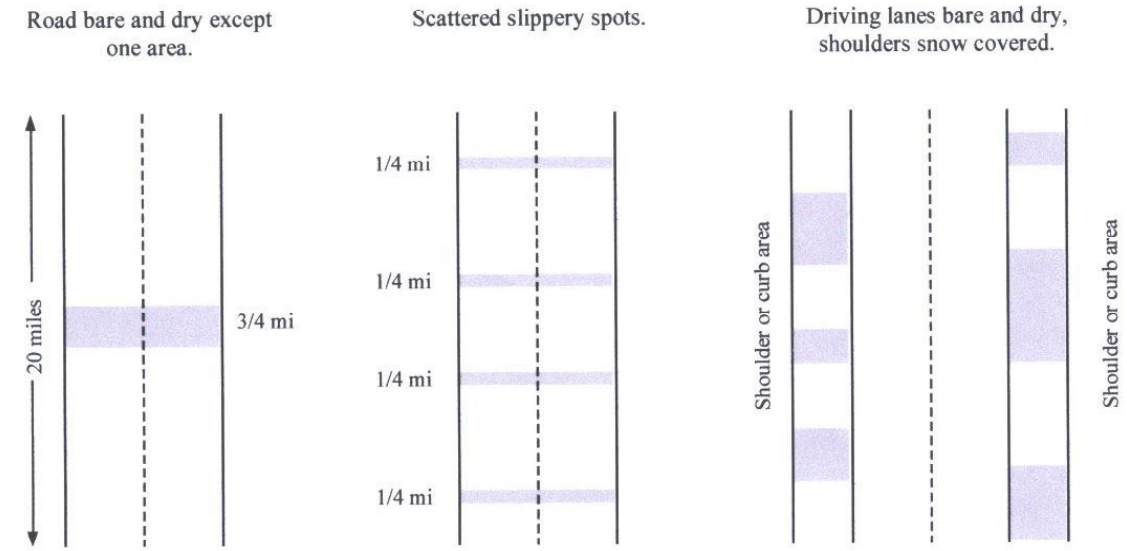


Figure 3. Examples of lost and not lost bare pavement

Bare Pavement Collection Data

Bare pavement data is collected at each truck station usually by a designated maintenance worker or in a few cases, office support staff. Data on route number, even

begin and end times, bare pavement lost and regained times are recorded by the route operator.

Statewide Target Ranges for Bare Pavement Regain Time

Several factors went in to the development of target values for bare pavement regain time. Past performance in each of Mn/DOT's districts was considered. This performance reflects some differences in management philosophy between districts and past district performance with given amounts of resources. Market research was conducted with established focus groups to measure the public road users acceptance of bare pavement regain time in relation to a given set of storm and road surface conditions. Operator experience is an increasingly important factor as up to 40 percent of the maintenance work force is expected to retire within the next 5 years. Performance differences can be attributed to the climate differences around the state. Freezing rain in the southern part of the state, blowing snow in the open western area and heavy dry snow in the north will impact use of resources and bare pavement regain time. Statewide target indicator ranges for the range of road classes are given below.

Road Class		Statewide Range (hrs.)
Super Commuter	(>30,000 AADT)	SC1 to SC 10
- Urban Commuter	(10,000-30,000)	U1 to U10
Rural Commuter	(2,000-10,000)	R1 to R 10
Primary	(800-2,000)	P1 to P10
Secondary	(<800)	S1 to S10

Target values for bare pavement regain time (indicator) for the Minneapolis – St. Paul metro area are as follows:

Road Class	Bare Pavement Indicator
Super Commuter	1.5 to 2 hours
Urban Commuter	2 to 3 hours
Rural Commuter	4 hours

Use of Bare pavement Data for Winter Road Management

Bare pavement data will be of use to all levels of winter road management in MN/Dot's Metro Division and to the Central Maintenance Office. A report of storm event conditions, resource consumption and bare pavement regain times will give state maintenance managers a quick statewide overview of winter maintenance performance of a just passed storm event. The end of year report will provide a more detailed look at material, labor and equipment resources used statewide and provide background for future budgets. As an example, statewide results for time in hours to bare lane are as follows:

Super Commuter	2.7	Primary	7.5
Urban Commuter	3.9	Secondary	32.9
Rural Commuter	11.2	All classes	10.5

District maintenance management staff will use the two-day and end of year reports in a similar manner but also will have a means to evaluate performance by a sub-area. A monthly report will also provide a near real time report of performance throughout the winter season. Frontline supervisors and workers at the truck stations will be particularly interested in the two-day after event report as it will provide a route by route comparison of performance during the storm event. A report sheet of interest to all levels of Metro Division maintenance management is shown in Figure 4 below.

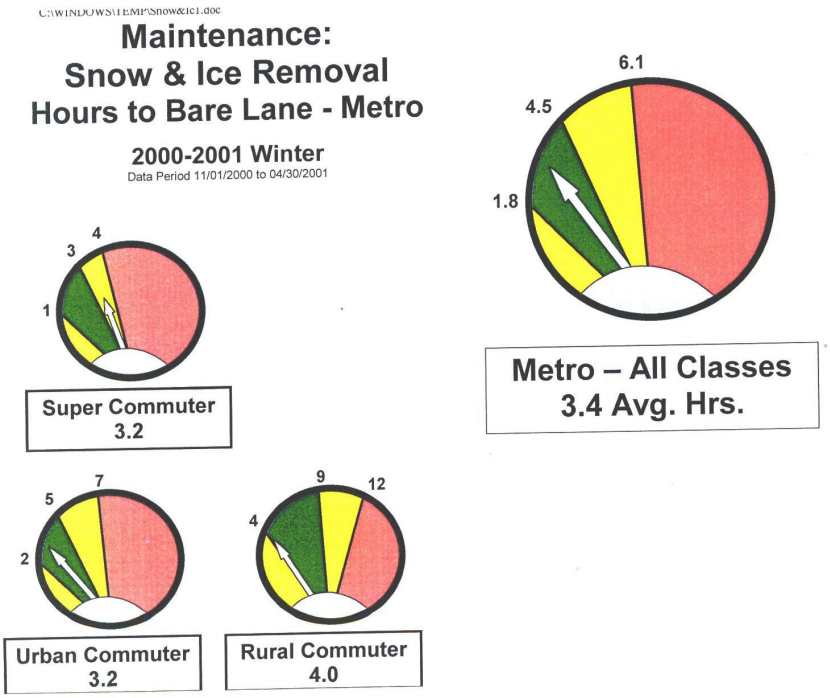


Figure 4. Hours to Bare Lane – Metro Division (3)

A detailed route-by-route comparison of bare pavement lost and regain time is shown in Figure 5.

Dates: 10/15/1998 to 04/15/1999

OPERATIONS MANAGEMENT SYSTEM

BARE PAVEMENT COMBINED LIST

Friday, May 21, 1999

Metro Division

Class : SC Super Commuter

Plow Route : MTCM225 I94 - TH55 to Henn/Ramsey Co Line

Mostly	Begin Date	Begin Time	End Date	End Time	Event Hours	Lost Date	Lost Time	Regain Date	Regain Time	Lost Hours	Recov. Hours	Comments
snow	12/16/1998	01:00 PM	12/16/1998	04:00 PM	3	12/16/1998	05:00 PM	12/16/1998	09:00 PM	4	5	REFREEZING
snow	12/20/1998	04:00 AM	12/20/1998	03:00 PM	11	12/20/1998	01:00 PM	12/20/1998	02:30 PM	2	0	
snow	12/26/1998	08:00 PM	12/27/1998	00:01 AM	4	12/26/1998	08:00 PM	12/27/1998	00:01 AM	4	0	
snow	01/01/1999	06:00 PM	01/03/1999	05:00 PM	47	01/01/1999	07:00 PM	01/03/1999	05:00 PM	46	0	
snow	01/08/1999	02:00 AM	01/10/1999	07:30 AM	54	01/08/1999	02:00 AM	01/10/1999	01:00 PM	59	6	
snow	01/11/1999	01:30 AM	01/11/1999	02:00 PM	13	01/11/1999	02:00 AM	01/11/1999	03:00 PM	13	1	
snow	01/12/1999	04:00 AM	01/13/1999	10:00 AM	30	01/12/1999	04:30 AM	01/13/1999	12:00 PM	32	2	
snow	01/13/1999	10:00 PM	01/14/1999	10:00 AM	12	01/14/1999	01:00 AM	01/14/1999	03:00 PM	14	5	
snow	01/17/1999	05:00 PM	01/18/1999	05:00 AM	12	01/17/1999	06:00 PM	01/18/1999	10:00 AM	16	5	
both	01/22/1999	11:00 AM	01/22/1999	10:00 PM	11	01/22/1999	11:00 AM	01/22/1999	11:59 PM	13	2	
snow	01/26/1999	05:30 PM	01/26/1999	10:00 PM	5	01/26/1999	08:45 PM	01/27/1999	10:00 AM	13	12	
					201					215	37	

Figure 5 Bare Pavement Combined list – Metro Division

A Global Management Perspective

How does the collection of bare pavement data fit into an overall maintenance management plan? Alone, this data is helpful but when combined with other information it is much more useful. Along with bare pavement regain time, the Metro Maintenance Manager will collect the following:

- RWIS information
- Salt and Sand use
- Costs per lane mile (lane – kilometer)
- Best practices 48 hours after a storm event

Collection of RWIS data such as precipitation type and amount and storm tracking, actual salt and sand use, and labor and equipment costs provides a good data base for analyzing winter maintenance performance for a snow or freezing rain event. Large amounts of salt and sand use can now be correlated with an actual precipitation event. This is most useful as freezing rain events will account for sharp spikes in salt and sand use. Collection and comparison of the above data also enables the maintenance manager to analyze route or area performance differences in terms of different storm track and precipitation amounts, varying temperatures during the storm event, etc.

Much information can be gleaned from the two-day after storm reports. The maintenance manager or supervisor can form a comparison of similar storm and performance data, look for unexplained differences in field performance and seek corrective action.

List of Figures

References

1 Mark Wikelius, Minnesota Department of Transportation, Office of Maintenance, 1997

2 Minnesota Department of Transportation Maintenance Manual, Revised Feb. 21, 2001

3 Steve Rocky Haider, Minnesota Department of Transportation, Office of Maintenance, 2001

4 Norman Ashfeld, Minnesota Department of Transportation, Metro Division

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