

Adopting Network Level Preventative Maintenance in Saskatchewan

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ABSTRACT

Adopting Network Level Preventative Maintenance in Saskatchewan

This paper discusses the Saskatchewan experience of implementing large scale change in direction for maintenance management on our high-speed, high-volume pavement network. In 2011, the Ministry recognized that the overwhelming majority of the high-speed, high-volume network in the province was now in good condition. Adopting a preventative maintenance approach for this network would have significant benefit by keeping these good roads good as long as possible. However, the Ministry would need to evolve the existing maintenance management system to include development and implementation of network level preventative maintenance strategies.

This paper discusses the process of putting the tools in place to enable the Saskatchewan Ministry of Highways to deliver preventative maintenance strategies across a network. These include:

- Creating a process to identify and collect the pavement defect and condition information that trigger preventative maintenance
- Creating network level information of the amount, type and cost of needed preventative maintenance work
- Adapting the current maintenance budgeting process to include options for preventative maintenance strategies
- Creating processes for tracking and reporting the needed, planned, and delivered preventative maintenance work
- Implementing a process for finding and adapting best practice for preventative maintenance work activities
- Implementing pilots to try out new preventative maintenance work activities including:
 - High Quality Centerline Crack Repairs
 - Preventative Fog Seals
 - Restorative Fog Seals
 - Joint Sealant
 - High Quality Deep Patch
 - High Quality Mill Fill Spot Repair
 - High Quality Hand Patch
- Creating a process to introduce, deliver, review and improve new preventative maintenance work activities across an entire network involving many maintenance crews

INTRODUCTION

In many infrastructure industries the value of preventative maintenance is readily understood and adopted. Preventive maintenance is characterised as maintenance that occurs early in the life of the asset while it is still in good operating condition. For example changing the oil in your car is preventative maintenance. You don't wait until the car breaks down before you change the oil. In fact, you don't even wait until the engine starts to heat up before you change the oil. You simply change the oil to avoid a severe problem from ever occurring! In many industries like facilities management, industrial plant maintenance, and everyday life preventive maintenance is intuitive. However, when it comes to large highway networks maintained with taxpayers dollars and used by the public, the need for good preventative maintenance often gets lost in competing priorities and the mindset of needing to respond to complaints. Often the maintenance budget is limited to repairing visible problems and addressing complaints. As it is very unlikely the public would ever complain about the lack of preventative maintenance on highways; this valuable component in the arsenal of highway managers often becomes overlooked or unaffordable due to budget constraints.

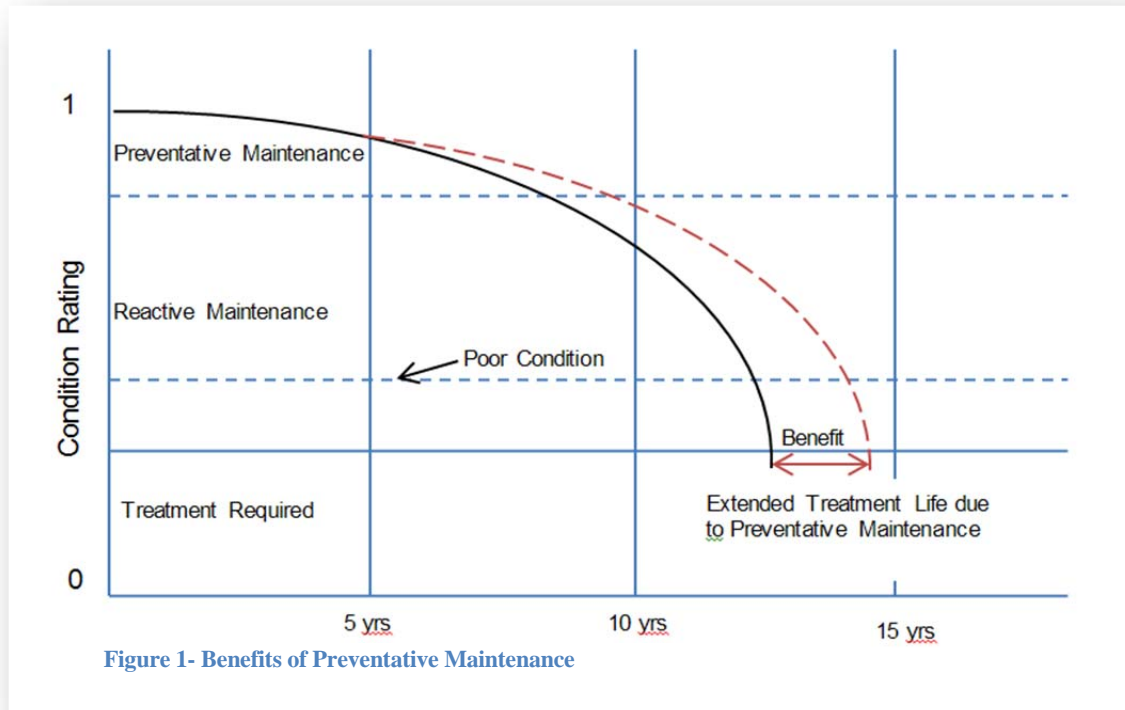
In the case of the province of Saskatchewan many new highways have been built in the past 15 years. Many highways have been twinned and are currently providing a very high standard of service to the community. The majority of these roads are good candidates for preventative maintenance, however; the Ministry has not performed preventative maintenance to any significant scale in recent history. Maintenance crews are reluctant to interrupt traffic to take on isolated, low productivity work on these heavily trafficked roads. In particular, if there are no visible problems to the travelling public it is counter intuitive to intervene when it is not obvious why the work is being done.

The impact of ignoring preventative maintenance only becomes evident when you look at the lifecycle for a pavement that must sustain a high service level standard through out it's lifetime. Value for money to the community in performing preventative maintenance then becomes readily apparent. Because maintenance dollars are needed every year this seemingly small amount of money per unit of inventory adds up quickly over a 60 year lifecycle. Dollars spent on preventative maintenance early in the life of a new pavement vastly reduce the lifecycle costs.

In the past few years the Ministry has completed work on a project looking at the lifecycle of a highway over 60 years in concurrent with projects looking at what is needed in terms of maintenance on highways. These two separate initiatives occurring at the same time have triggered the insight that we don't fully understand what is needed in terms of maintenance on high-speed, high-volume roads that are in the early part of life.

It is important to note in Saskatchewan that maintenance is defined as work that results in no overall improvement to the segment level condition of the road. Pavement preservation treatments such as chip seals and microsurfacing are not maintenance. Maintenance includes small localized repairs (such as pothole filling or crack sealing) or work activities that delay deterioration of conditions but do not improve it (such as fog seals and joint sealant).

From an asset management perspective the big benefit in preventative maintenance is extending the life of the current pavement and therefore deferring the significant investment of the next rehabilitation. This benefit is shown diagrammatically in *Figure 1- Benefits of Preventative Maintenance*.



HOW PREVENTATIVE MAINTENANCE WAS DEVELOPED IN SASKATCHEWAN

Once the concept of preventative maintenance had been discussed amongst key internal stakeholders; a briefing document was created that described the issues around implementing preventative maintenance on the most heavily trafficked networks in Saskatchewan. There are isolate pockets of the province where maintenance crews are using a few preventative maintenance work activities but the practice was adhoc and not driven by an overall network level strategy. In general there was little expertise about what preventive maintenance activities were, what triggers them and how to ensure high quality results when doing the work. This led to a literature review and environmental scanning of highway agencies, material vendors and equipment manufacturers in North America to identify current state of the practice for preventative maintenance of highways.

Many innovative practices were identified that could be adopted by Saskatchewan. It was more difficult to identify the benefit of preventive maintenance regimes from literature studies only. Therefore, it was decided to have a task group of practitioners look at the concept and the

information available to identify whether or not there were any practical implications for Saskatchewan adopting these work activities and moving towards a preventive maintenance regime. The task group was also tasked with trying to identify appropriate triggers for preventative maintenance on the high class highway network.

The task group spent a lot of time working through all the details necessary to enable the Ministry to deliver prevented maintenance on high class highways. They also confirmed the value of having a unified maintenance planning business process illustrated in *Figure 2- high Level Maintenance Planning Process*.

Specifically, the Task Group assignment was to:

- Review and evaluate a business process for maintenance planning which incorporates preventative maintenance;
- Discuss and record the issues associated with adopting the process described;
- Objectively evaluate the concepts and the details to determine what “makes good business sense” from a practical viewpoint;
- Develop specific work activity guidelines for preventative maintenance activities on the high-speed high volume networks;
- Discuss and record how the new business process varies from current Ministry practice; and
- Discuss and record issues associated with current practice.

The task group also reviewed some existing life cycles of highways for Saskatchewan to determine for themselves the value of preventative maintenance reasonably soon after major treatments have been applied. During the overall project it was demonstrated many times that keeping good roads good is vastly more cost effective than relying on reactive maintenance to halt poor roads from becoming poorer and having to entertain investment in a major capital treatment. If over a 60 year life cycle the need for one major rehabilitation is eliminated by good preventative maintenance the return on investment is extraordinary to the community in terms of value for money in sustaining the overall level of service throughout the 60 years.

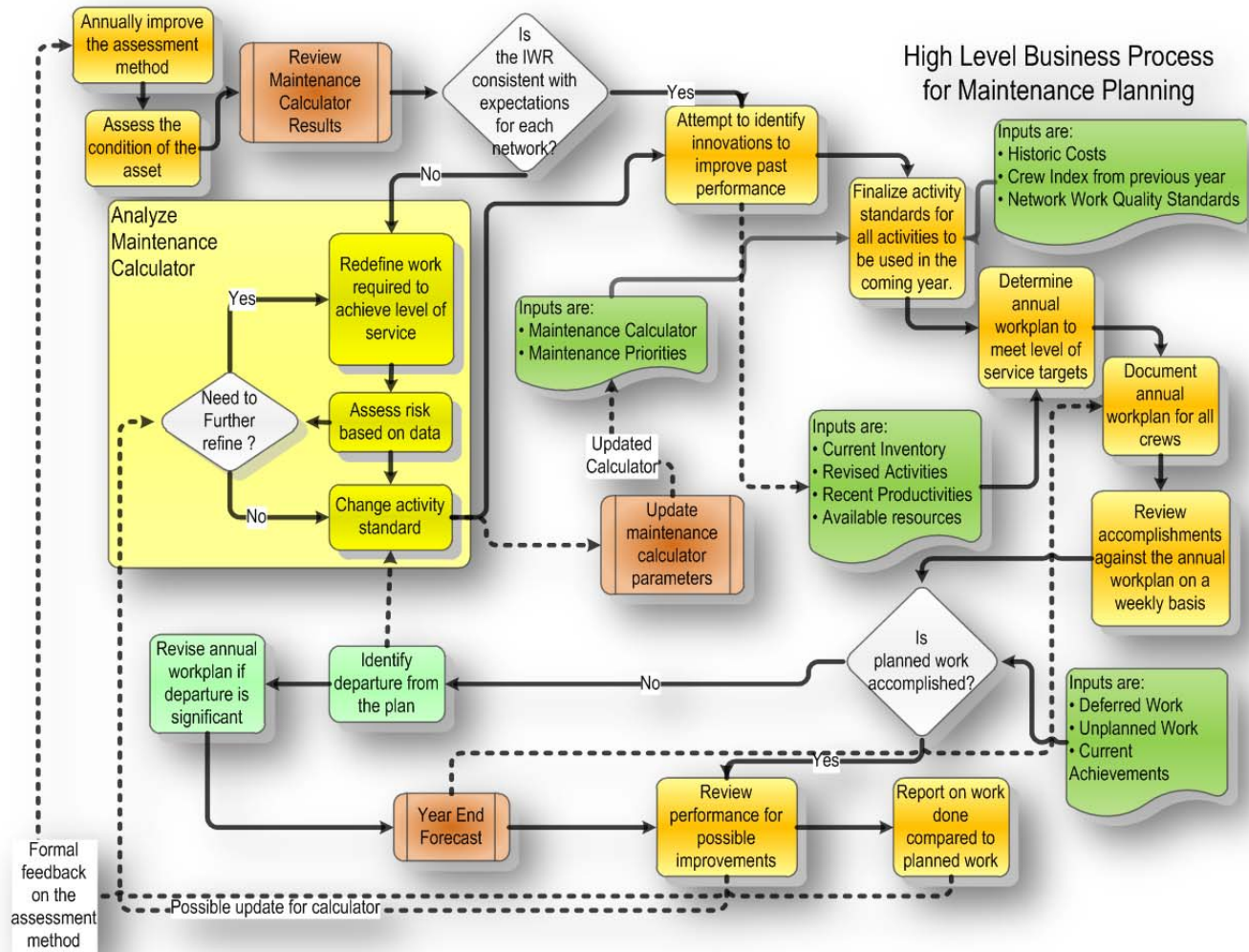


Figure 2- High Level Maintenance Planning Process

Key Concepts

The principles of preventive maintenance that were conveyed to the task group focused on five main result areas which included:

- **Waterproofing** – preventing water from entering the pavement structure from above through cracks, joints, porous pavement surface materials and unsealed shoulders.
- **Drainage** – removing water from the pavement structure and subgrade by improved drainage.
- **Strengthening** – strengthening of localized areas that show signs of weakness before major distresses appear on the surface.
- **Resurfacing** – protecting the pavement surface from localized progressive ravelling and coarse aggregate loss that can lead to potholing

- **Stopping Debris from Entering Joints** – sealing of joints and cracks in pavements not only for water proofing, but also to prevent incompressible debris from entering the joint.

Work activities that delivered these results became the main focus for developing the preventative maintenance activities for the maintenance plan. A key concept emerging from this initial development of preventive maintenance techniques was that all maintenance work on the high quality primary network should embody the following principles:

- High quality end result
- High durability repair
- Low impact on users

The task group identified and documented work methods that are applied in other jurisdictions that could be implemented within Saskatchewan without major commitments to new equipment or materials that are not readily available. Preventive maintenance activities that met these requirements were chosen to be piloted in 2013.

Piloting of the New Work Activities

To pilot the new preventative maintenance activities, a provincial workshop was run in order to identify supervisors interested in trying them. The workshop provided an information session on each activity the task group had identified and the type of problems the work addresses. Supervisors then worked in groups to identify practical issues in adopting each work method for their crews. Supervisors of eight different maintenance crews volunteered to be involved in the planned pilots.

The activities to piloted included:

- High Quality Centerline Crack Repairs
- Preventative Fog Seals
- Restorative Fog Seals
- Joint Sealant
- High Quality Deep Patch
- High Quality Mill Fill Spot Repair
- High Quality Hand Patch

The seven activities listed above were some of the dozen preventative maintenance activities that were identified during the project.

To enable the supervisor to pilot an activity that they had never done before the detailed work method needed to be thoroughly documented including the equipment, materials and labour needed.

The documentation of the detailed work method was in the form of a storybook. The storybook style was adopted to create a knowledge book that is easy to read, very visual with photos of each

step in the process, and can be easily updated as we learn more and gain experience. The information in the storybook was gathered from the state of the practice study conducted as part of the project. The storybooks were reviewed and refined in planning sessions with the supervisors who volunteered to pilot the work activities. *Figure 3 - A Preventative Maintenance Storybook* shows the cover of one of the storybooks.



Figure 3 - A Preventative Maintenance Storybook

The next major section in a storybook details the work method to be used broken down by each step as illustrated in *Figure 4 -example of part of a detailed work method description*.

The final section in each storybook is a detailed description of finishing the job before opening the road to traffic. This is the section that allows us to ensure we concentrate on high quality finish that delivers a low impact to the road user. *Figure 5 - the final part of the work method* illustrates typical details found in that section of the storybook.

Each storybook contains very specific sections of information. The first part of the storybook discusses the need for the activity (*what is the problem we are trying to correct?*) and why intervening early with this activity is a good thing. The events that specifically trigger this preventative activity are described in detail.

Site Preparation

- Work should be done during dry weather conditions;
- Provide appropriate traffic accommodation; Traffic control includes placing construction signs, construction cones and/or barricades, flag personnel, and pilot cars required to direct traffic clear of the maintenance operation.
- Determine the extent of repair; establish failure boundaries using the pavement square, completely remove all failed material in the marked square or rectangular area; **all** patches should have squared ends and straight sides for a properly finished performance.
- Mark the area for repair, in a straight line, for ease of cutting. (The width of the cut area should accommodate compacting equipment.);

Milling

- Cut the boundaries of the patch square area with a diamond saw or cold milling machine
- Square up the sides of the hole until the edges of the hole are sound pavement, square and not spalled.
- Remove water and debris from the hole.



Figure 4 -example of part of a detailed work method description

Finishing

- ❑ Compact each lift using equipment similar to that typically used in hot-mix asphalt compaction operations. Compact the patch material with a hand device or a small vibratory roller or using a pneumatic tired roller and possibly a steel wheel finish roller.
- ❑ The finished patched area should have a crown of 1/8 to ¼ in
- ❑ If possible, fog seal (after 1-2 weeks). Avoid traffic twisting, screwing or torquing action on the newly repaired area



Figure 5 - the final part of the work method

A checklist of the finished job description is shown in *Figure 6- What the job should look like when finished*. The check list concludes each storybook.

Each story book also has sections on:

- Quality Assurance
- Equipment Needed
- Materials Needed
- Labour Needed
- Unresolved Issues

- ✓ The newly repaired area should be flush with the surrounding surface.
- ✓ The result should be a repair that has similar strength, quality, smoothness and seamless blending with surrounding pavement.
- ✓ It is important that it not be finished below the surrounding pavement level when compacted as it would hold water.
- ✓ High quality, very smooth ride and eliminating pothole.
- ✓ Treatment should stay permanently.

Figure 6- What the job should look like when finished

BUDGETING FOR PREVENTATIVE MAINTENANCE WORK

A critical part of being able to implement preventive maintenance is being able to identify the annual impact on your budget to pursue a preventative maintenance regime. To facilitate that work had to be done to identify triggers for preventive maintenance, collecting the information and storing it in the surface condition database. Triggers for the work identified by the task group that were not already part of the annual condition and defect assessment were added. Information on these triggers was collected in the fall of 2013.

As some preventive activities are based on age of the current treatment (as we want to intervene before something goes wrong) it became important to capture the age of that current treatment in the database. A lot of work was done recently to identify the age of the current treatment and provision of that data is now formally within the preservation database. That means we are able to trigger activities such as rubber asphalt crack filling and preventative fog seals based on age as part of the annual maintenance planning cycle. Other preventive activities are based on local early triggers such as early signs of pickouts in the surface. A rationale has now been developed and encoded within the database that will provide quantities of needed preventive work on heavily trafficked highways that are officially in good condition.

The Ministry's maintenance management system was reconfigured to incorporate preventative maintenance work activities that have never been performed before. Much of the information for the new configuration came from the pilot activities in the previous season.

For the 2014 year the maintenance budgets have included provision for preventative work on the heavily trafficked networks for the first time. Quantities and cost estimates of needed preventative maintenance work were provided to all supervisors in the province before sitting down to develop their 2014 summer maintenance plan.

All preventative maintenance work performed will be tracked in detail to a condition segment. A review of the cost and quantity of work delivered in the fall of 2014 will allow the Ministry to refine the calculations based on planned versus actual work done. The expectation is that after a few years of performing preventative work we will better understand the relationship between the triggers and the amount of work needed to successfully performed preventative maintenance work. This will lead to an ongoing refinement in the calculated quantities each year.

THE RESULT

As a result of performing pilots on many of the preventative maintenance activities during 2013 the Ministry has learnt a lot about how preventative maintenance should be performed and what the potential benefits of doing it are. Also of equal importance the pilots enable the Ministry to accurately track the cost per unit of work of performing preventative maintenance. Unresolved issues for each preventative maintenance work activity are documented in the appropriate activity storybook. The intention is that as each season passes and more supervisors do preventative maintenance work the body of knowledge within the Ministry about how preventative maintenance is to be delivered will become clearer.

With a new business process for maintenance planning that includes preventative maintenance and completion of successful pilots in 2013 the tools are in place to move toward implementation of network level preventative maintenance. The benefits of doing preventative maintenance are very hard to quantify at this stage as it is early days for Saskatchewan. At this stage we are still relying on the car and engine oil analogy to a great degree. The goal going forward is to make preventative maintenance more intuitive for the maintenance crews and maintenance managers.

The vast majority of the high class network within Saskatchewan is of a high quality condition at the moment. There is a significant desire to keep it that way via preventative maintenance thereby dramatically reducing the overall lifecycle costs to the community of providing consistent high levels of service over the life of the asset.