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PAVEMENT MANAGEMENT FOR REGIONAL ROADS

The Transportation and Works Committee recommends:

- 1. The presentation by Brian Harrison, Director, Transportation Operations, be received; and**
- 2. The recommendations contained in the following report, January 21, 2004, from the Commissioner of Transportation and Works be adopted:**

1. RECOMMENDATIONS

It is recommended that:

1. A \$2.0 million increase in funding for road resurfacing each year to a maximum \$10.0 million, from the \$3.4 million included in the approved 2003 budget to \$5.4 million in 2004, \$7.4 million in 2005, \$9.4 million in 2006 and \$10.0 million in 2007, be considered for inclusion in future budget and business plans.
2. The Commissioner of Finance be directed to report to the Finance and Administration Committee regarding establishing a Roads Rehabilitation Reserve to help cover costs of future pavement rehabilitation such that contributions to the Roads Rehabilitation Reserve would be made annually from the operating budget based on the number of new lane kilometres added through the roads capital program and transfers.

2. PURPOSE

This report is prepared to propose increased funding for road rehabilitation projects for 2004 and beyond in order to maintain a satisfactory level of service to the driving public.

3. BACKGROUND

Over the last 15 to 20 years, roads have been resurfaced based on visual observations carried out by staff. Recommendations were generally based on resurfacing the worst first with the limited funds that were allocated to the resurfacing program. In some cases, resurfacing was carried out at the end of the year when major capital reconstruction projects were either behind schedule or not started leaving surplus funds available for other works. This was a very arbitrary process which provided a new surface, but did not take into account the best use for these resurfacing dollars.

For the past few years, Regional staff has made use of a computer-based pavement management system (PMS) to determine the necessary rehabilitation techniques for sections of Regional roads. These techniques include crack sealing, pavement rehabilitation, resurfacing, asphalt recycling and reconstruction.

The computer program recommends the treatment and timing of the treatment within a set budget. It optimizes the funding by selecting the appropriate treatment where it will be the most effective in extending the life of the pavement. The goal of the system is to maximize the network-wide road condition index (RCI), within the available budget.

3.1 Pavement Management System (PMS)

The fundamental step in the PMS is an evaluation of the condition of all paved Regional road sections. The evaluation covers each section of road, typically every three years, when the extent and severity of pavement distresses (such as rutting, roughness, longitudinal cracking, alligator cracking, patching, and block cracking) are recorded in numerical terms. See *Attachment 1* for definitions.

Staff adds a variety of road system data for each section of Regional road (such as traffic volumes, and structural and drainage characteristics), as well as a list of optional treatments to improve the pavement, the average life span of each treatment and its cost.

The final step in the process is for staff to input the anticipated funding levels over a 10-year horizon for road resurfacing and minor road maintenance activities (such as patching, and crack-sealing, for example) and the road sections proposed for widening and reconstruction through the roads capital program.

The software then carries out a network-wide optimization routine, to maximize the effectiveness of every dollar allocated to the resurfacing and minor maintenance programs, and determines a program of resurfacing and other minor work for each year over a 10-year timeframe.

Staff then reviews this information and makes minor adjustments based on specific field conditions and the advancement or deferral of a resurfacing project to avoid conflict with other capital projects.

The software can also be used to show how the overall network condition rating can be expected to change over time with different funding levels. Low funding levels result in a decreasing condition rating (i.e. worse roads, in general) and higher funding leads to better roads. The intent is to establish the funding level that maintains the overall condition rating approximately at today's level.

3.2 Asset Management

Over the past couple of years, there has been a move towards a strategic approach to managing our assets to achieve specific benefits and objectives. This is the foundation of Asset Management. The physical assets of the Regional road system include pavement structures, bridges, storm sewers, curb-gutter, boulevards, signs, etc. Currently, a number of programs are used to manage individual assets such as the PMS, the bridge management program and the road maintenance management system. These work well independently, but there is a need to integrate all this information under an umbrella program for Asset Management.

The Regional road system, based on replacement value, is worth about \$1.5 billion, not including the cost of land. Asset Management, and in particular the PMS, will help us manage this very valuable asset.

4. ANALYSIS AND OPTIONS

With the use of the modern technology, the PMS can assist staff in determining which roads should be rehabilitated and when. This system provides us with the best value for each dollar spent on the roads. It also provides a condition rating based on the allocated funding so the condition can be predicted for different funding scenarios. Staff investigated the appropriate level of funding required to maintain the Regional road system at its current condition rating and also obtained the condition ratings for different funding scenarios.

4.1 Pavement Condition Rating

The RCI or condition index is a way of evaluating the overall acceptance of the road surface to the user. A condition rating of 100 is the best possible rating, typical of a newly paved road.

The average condition rating for the Regional road system in 2002 was approximately 83. This rating appears to be acceptable to most of the drivers on Regional roads. In order to maintain this rating, the level of funding needs to be reviewed.

4.2 Extended Life Pavements and Road Maintenance Strategies

Researchers world-wide have made great strides in pavement design and road maintenance technology over the past few years, with a focus on minimizing the life-cycle costs of owning and operating a road network. Pavement designs are now based on the dynamic effects of loading by vehicles more than ever before, and numerous studies have shown that a well designed and constructed pavement can have a life span of 40 years or more, with only periodic rehabilitation of the wearing course.

The subsequent costs of maintaining a road section that has an extended life pavement over its life span will be significantly reduced. Major reconstruction or rehabilitation will be deferred, and delays and inconvenience to drivers during maintenance work will be greatly reduced.

4.2.1 Road Maintenance Strategies

The RCI of an individual road section in the Region varies from fair to very good. This range averages out to the current RCI of 83 for the Regional road system.

The goal of the PMS system is to apply the most appropriate treatment at the appropriate time to each road section. The proper treatment at the proper time will extend the life of a pavement quite significantly.

Some road sections require relatively minor treatment, such as crack-sealing or microsurfacing, others may require a replacement surface course or recycling of the upper layers, whereas, the worst sections may have to be reconstructed. It is the goal of the pavement management program to determine what treatment should be applied and when it should be applied in order to extend the life of the pavement before it gets to the point of complete reconstruction.

Experience has shown that early treatment pays handsome dividends by halting or slowing the damage that results from cracking of the pavement. This approach to road maintenance is the most cost effective strategy and has been shown to reduce the overall costs of ownership of a typical road section. It also minimizes inconvenience and delays to road users during maintenance activities.

In a network of road sections of different ages, with different traffic conditions, it is clear that a flexible approach is required.

A well designed and constructed road section (using extended life pavement principles) can be maintained in excellent condition by periodic replacement of the wearing course or microsurfacing.

An older, under-designed road section that has had some maintenance in the form of an overlay or microsurfacing can be brought up to standard by recycling or reconstruction, and then maintained in good condition by periodic minor maintenance work.

In many public agencies, the “shave and pave” technique is the mainstay of the road resurfacing strategy. In this process, the surface layer of the road (40 or 50 mm thick) is removed by grinding (shaving) and a new surface layer is applied. The Region followed this approach in previous years. If this approach was continued, with the budget of \$3.4 million, it would take approximately 28 years, and cost \$95.0 million to resurface the approximately 2,700 lane km of paved Region roads (assuming no cost escalation or budget increases in line with cost escalation).

This strategy, in effect, assumes that the resurfacing would have a life of 28 years, when the acceptable life of this treatment is 10 to 15 years (typically 12 years) depending on various factors such as the road structure, traffic loadings, drainage and weather.

More recently, staff has applied new techniques to road rehabilitation. These include cold-in-place recycling, foamed asphalt recycling and microsurfacing. These new treatments are the tools that are needed to extend the pavement life in order to help avoid the complete reconstruction that would be required if the preventative maintenance was not performed.

The costs of these new techniques are more expensive than simple resurfacing, but the new techniques provide stronger pavements. These stronger pavements, coupled with the preventative maintenance techniques will extend the life of the pavement and reduce the need for complete reconstruction.

4.3 Proposed Funding Requirements for Road Resurfacing

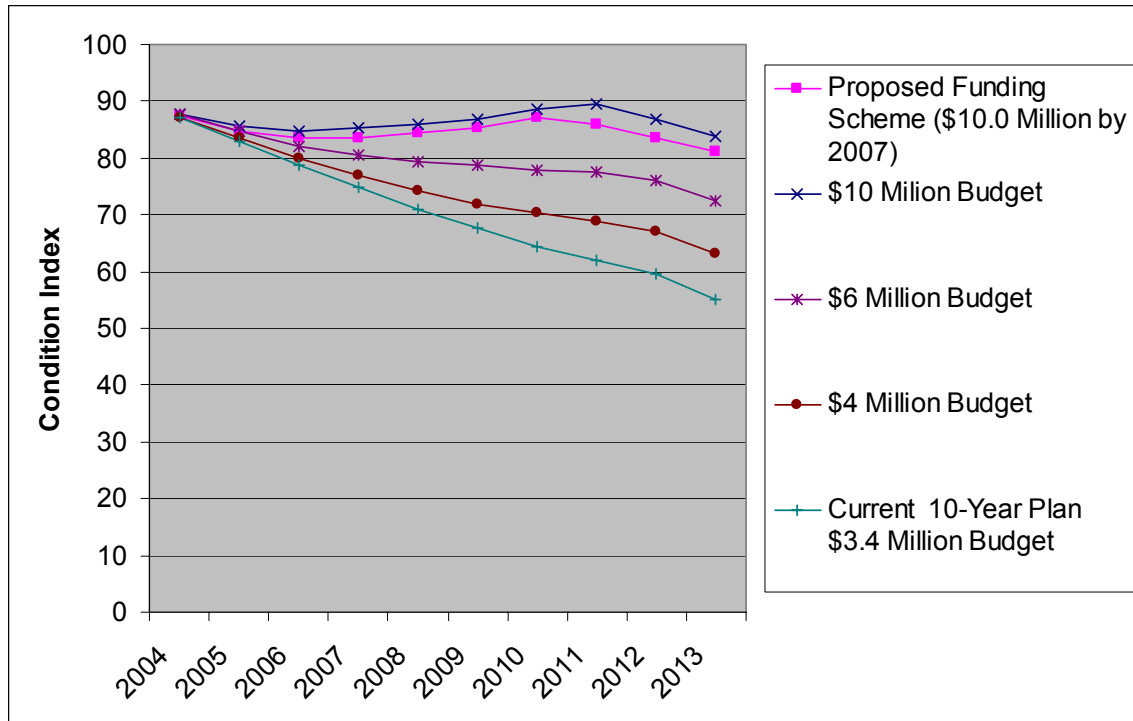
It is critical that the existing road infrastructure be maintained in good condition. Residents and businesses depend on a good road network for goods movement, personal travel and transit accessibility.

With the current funding levels, road conditions across the Region will fall below acceptable levels. Many of the roads in the Region were constructed in the early 1980s and have received little if any preventative maintenance. The current road system is ageing and unless additional funds are directed towards road maintenance, in a few years more funding will be required to reconstruct these roads. With an increase in the funding for road preventative maintenance, the high cost of reconstruction can be delayed significantly.

In order to maintain the planned program of road widening and reconstruction projects, required to accommodate the planned future growth in population and employment throughout the Region, additional funding will be required in future Transportation and Works Department budgets for road maintenance projects. This road maintenance will use the new materials and processes discussed here.

Figure 1 shows how different funding levels for road maintenance affect the overall condition rating for the Regional road system.

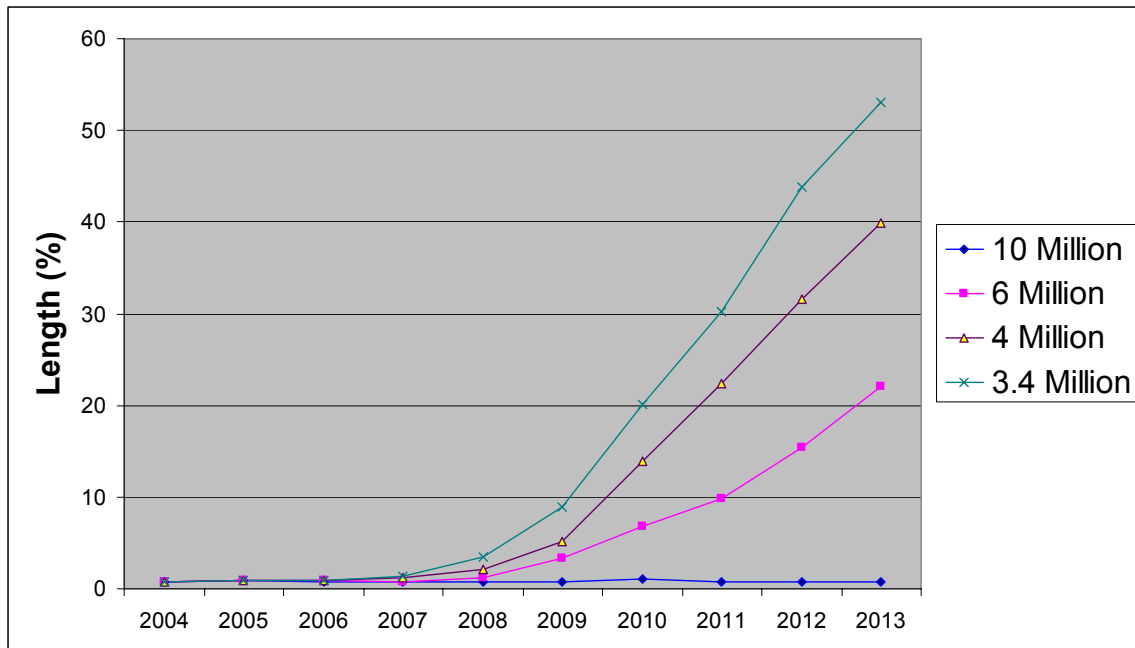
Figure 1
Network Average Condition by Annual Budget



With the current funding level, it is anticipated that the RCI for the road system will be reduced from the current 83 to 55 in 10 years. The recommended funding level of \$10.0 million per year predicts a levelling off of the RCI to 80 for the 10 year projection.

Four funding scenarios were developed to show the impacts of the different levels of funding on the condition of the road system over a period of 10 years. The PMS predicts the percentage of roads that are very poor, poor, fair, good and excellent condition. Figure 2 shows the percentage of the road system that is predicted to be only very poor and poor for each of the funding scenarios. It can be seen that, at the current funding level, the percentage of roads that will be in poor and very poor condition in 10 years time, increases from approximately 3% in 2004 to 54% in 2013. In the scenario that allocated \$10.0 million per year, the percentage of roads that are poor and very poor remains constant at approximately 3%.

Figure 2
Percentage of Road System Poor and Very Poor



The current funding level of approximately \$3.4 million per year is no longer adequate to maintain the overall condition rating at its present level, even allowing for the proposed capital road widening and reconstruction program.

This is largely a direct result of the extensive road widening and reconstruction program undertaken by the Region from the early 1980s to the present day. Most of these roads were designed for a 12 to 15 year life, and many are now approaching the time when major rehabilitation is required.

To some degree, changes in the transportation industry have accelerated the deterioration of road structures. Commercial vehicle weights have increased over the years. This additional load on the pavement has contributed to the premature deterioration of the pavements resulting in shorter pavement life and/or increased maintenance costs.

Increasing congestion also causes roads to rut, as slow-moving or stationary trucks impart loads to the road structure over a longer period than free-flowing traffic.

Staff will continue to undertake analysis of this sort, as more pavement condition data is obtained from the annual field surveys. The additional data will be used to improve the calibration of pavement performance curves, which describe how the condition of a pavement changes with time under given traffic conditions.

The additional funds identified above are required as soon as practicable to ensure that the condition of the Regional road system remains at approximately the current level.

Annual increments of \$2.0 million would raise the 2003 budget figure of \$3.4 million to the required level of \$10.0 million by 2007. Roads Transportation staff has reviewed the implications of this proposed funding stream with staff of the Finance Department, and will present the recommended funding in the 2004 budget and business plan process.

4.4 Business Case

In developing the business case to substantiate the recommended change in the resurfacing program, the current funding level and the proposed funding level are compared based on the life of the road. Under the current funding, a road is expected to provide a 25 year life. The proposed funding is expected to increase the life of a road to 40 years.

4.4.1 Current Funding Level

The current funding allows staff to only carry out minimal maintenance on roads and resurface only the roads in the poorest condition. In recognition of this, it has been determined that many roads will require major rehabilitation or even reconstruction in years to come.

For one kilometre of four-lane road under the current funding, the estimated costs are as follows:

Sometime between year 10 and year 20, the road is resurfaced. This is not a scheduled resurfacing nor is it planned. It usually occurs as a result of a complaint, a request or a recommendation from staff.	<u>\$95,000 - 190,000</u>
Year 25 reconstruction (pavement and granular "A" 14,000 sq. metres @ \$35.00	\$490,000
TOTAL	\$585,000 - 680,000
AVERAGE COST OVER 25 YEARS	\$632,500
ANNUAL COST	\$25,300

At year 25, the section of road is in good condition. However, without the preventative maintenance, the cycle will repeat in the next 25 years. Using an average cost of \$632,500 to conduct reactive maintenance on four lane- kilometres over 25 years, the paved road system will require \$17.1 million per year using the current methodology. This cost is for the current paved roads in York Region. It does not include the gravel sections or the surface treated sections of road, nor does it include any widening costs or rehabilitation of future widenings.

4.4.2 Proposed Funding Level

The proposed funding scenario will allow staff to implement a proactive maintenance program that will reduce the long-term needs on the road system. Most road sections will

be adequately maintained through proper pavement management, which will eliminate the need to perform major rehabilitation and reconstruction.

The proactive program includes regular crack sealing, microsurfacing, pavement rehabilitation and resurfacing at critical time intervals designed to prolong the service life of the road.

This proactive approach is estimated to cost in the order of \$10.0 million per year for 40 years. This proposal will provide funds for preventative maintenance that will eliminate the need for the 15 to 20 year reconstruction.

For one kilometre of four-lane road over 40-year period, the estimated cost is as follows:

Year 1 - 2 crack sealing - 250 metres @ \$1.25	\$312
Year 2 - 5 crack sealing - 500 metres @ \$1.25	\$625
Year 10 microsurfacing 1,000 metres x 14 metres = 14,000 sq. metres @ \$4.25	\$59,500
Year 15 resurfacing (grind and pave) 14,000 sq. metres @ \$10.00	\$140,000
Year 17 - 20 crack sealing 750 metres @ \$1.25	\$937
Year 25 microsurfacing 1,000 metres x 14 metres = 14,000 sq. metres @ \$4.25	\$59,500
Year 32 resurfacing (pave only) 14,000 sq. metres @ \$5.00	\$70,000
Year 40 reconstruction (pavement and granular "A" 14,000 sq. metres @ \$35.00	\$490,000
AVERAGE COST OVER 40 YEARS	\$820,874
ANNUAL COST	\$20,521

At year 40, the section of road is in good condition. If the preventative maintenance cycle is continued, it is expected that this cycle will repeat in 40 years. Based on \$622,000 to conduct proactive maintenance on four-lane kilometres for 40 years, the paved road system, approximately 2,700 lane kilometres, would require approximately \$10.5 million per year for preventative maintenance. The current proposal is for \$10.0 million per year as the costs are based on estimated quantities and timeframes.

4.4.3 Life Cycle Costing

Under the current funding levels, a road would require reconstruction after approximately 25 years. However, it is expected that a road under the proposed funding would not require complete reconstruction, but a repetition of the maintenance as noted above. For the purposes of comparison, a 40 year life has been used. The costs associated with these two scenarios are as follows:

Current funding, as above, is estimated to cost \$632,500 for 25 years. This equates to \$25,300 per year.

Proposed funding, as above, is estimated to cost \$622,000 for 40 years. This equates to \$15,534 per year.

These costs will vary with road, traffic and weather conditions. However, staff is confident that the proactive approach, with adequate funding, will offer the level of service demanded by road users. The timely preventative maintenance dollars indicated here will save capital dollars later.

Staff has refined the cost estimates and used the PMS to assist in determining the most appropriate spending level to maintain the road system in a safe and effective manner. It is felt that increasing the funding for the resurfacing program to \$10.0 million from the current \$3.4 million will save money in the long run.

In effect, if the current level of funding is maintained for resurfacing, it is expected that the roads capital program will have to be increased by \$17.1 million per year (see section 4.4.1) to cover the cost of reconstructing paved roads that are not maintained in a proactive manner. If the proposed proactive approach is adopted, the roads capital program will need only a \$6.6 million increase (\$6.6 million plus the current \$3.4 million for a total of \$10.0 million).

In addition, maintaining the current level of funding will result in a reduction in the RCI. The RCI is expected to drop to 52 with the current level of spending by 2009 (see Figure 1). With the proposed level of funding, it is expected that the RCI will stay in the 80 range. The RCI is explained in section 4.1. An RCI of 80 is acceptable to the general public. An RCI less than 80 would mean more cracks, more ruts and generally poorer riding quality of the pavements.

4.4.4 Proposed Increments to Reach \$10.0 Million Funding Level

The proposed funding increases of \$2.0 million per year will reach the proposed \$10.0 million level over four years as shown below.

<u>Year</u>	<u>Budget</u>
2003	\$ 3.4 million
2004	\$ 5.4 million
2005	\$ 7.4 million
2006	\$ 9.4 million
2007	\$10.0 million

4.4.5 Rehabilitation Reserve

In order to reduce the impact of future rehabilitation costs on the tax levy budget the Commissioner of Finance should be directed to report to the Finance and Administration Committee regarding establishing a Roads Rehabilitation Reserve to help cover costs of future pavement rehabilitation. This could be set up such that contributions to the Roads Rehabilitation Reserve would be made annually from the operating budget based on the number of new lane kilometres added through the roads capital program and transfers.

4.5 Relationship to Vision 2026

Vision 2026 speaks to "ensuring best-quality government through improvement and management of change", and "delivering leading-edge, effective, timely services to meet the needs of York Region's residents and businesses", as guiding principles. It also speaks to the conservation of natural environments, conservation and recycling in general, responsible waste management and better service delivery.

The issues discussed here provide very specific examples of how the principles of Vision 2026 can be put into practice.

5. FINANCIAL IMPLICATIONS

If adopted by Regional Council, the funding for the resurfacing program will be considered in the 2004 business plan and budget preparation. The funding is proposed to increase over four years from \$3.4 million in 2003 to \$10.0 million in 2007.

Funding for resurfacing projects is 100% tax levy. There will need to be an increase in the tax levy for the next four years to cover this increased resurfacing program.

Investment in the resurfacing program will increase the roads capital budget by \$6.4 million. If the current resurfacing funding level is maintained it is expected that the roads capital program will have to be increased by \$17.1 million, in years to come, to cover the cost of reconstructing poorly maintained roads.

6. LOCAL MUNICIPAL IMPACT

There are no local municipal implications associated with this report.

7. CONCLUSION

The use of a computerized PMS has provided staff with information on the average condition of the road system. The PMS is able to predict condition ratings based on different funding levels for the resurfacing program. In order to maintain acceptable condition ratings, greater than 80, it is necessary to increase funding for the resurfacing program.

This report recommends an increase in funding for resurfacing from \$3.4 million in 2003 to \$5.4 million in 2004, \$7.4 million in 2005, \$9.4 million in 2006 and \$10.0 million in 2007 be considered in future budget and business plan discussions.

The Senior Management Group has reviewed this report.

(A copy of the attachment referred to in the foregoing is included with this report and is also on file in the Office of the Regional Clerk.)