

3.14–Maintenance of the Provincial Highway System

BACKGROUND

Under the *Public Transportation and Highway Improvement Act*, the Ministry of Transportation is responsible for building and maintaining the province’s 39,000 lane kilometres of highway. The Ministry is also responsible for the province’s bridges and other transportation-related structures (for example, lighting, signs, guiderails, and buildings such as equipment storage facilities). The regional breakdown of the highway system is as shown in the following table.

The Highway System by Region, May 2004

Region	Lane Kilometres of Highway	# of Bridges
Southwest	5,251	594
Central	5,296	943
Eastern	5,715	474
Northeast	14,025	380
Northwest	8,885	321
Total	39,172¹	2,712²

¹ The Ministry uses three measures of highway length: centre-line, two-lane-equivalent, and lane kilometres (km). A four-lane, 100-km highway represents 100 centre-line km, 200 two-lane-equivalent km, and 400 lane km of highway.

² The total excludes 100 bridges owned by local road boards in the Northeast region that the Ministry provides funding to maintain. It also excludes tunnels and structural culverts.

Source of data: Ministry of Transportation

The Ministry estimated that the current value of the provincial highway system is approximately \$39 billion. The following table shows the breakdown of the system into its components and their estimated current values.

**Value of the Highway System at June 10, 2004
(\$ million)**

	Land and Land Improvements	Highways	Bridges	Other	Total
replacement cost	17,768	19,299	4,404	4,244	45,715
deterioration	-967	-3,842	-1,147	-864	-6,820
current value	16,801	15,457	3,257	3,380	38,895

Source of data: Ministry of Transportation

In managing the highway system, the Ministry's primary goals are to contribute to economic development by maximizing highway capacity, efficiency, and safety and to protect highway infrastructure by performing needed preventive and preservation maintenance. To accomplish these objectives, the Ministry has organized highway programs into three major categories of work—maintenance, minor capital projects, and major capital projects, as described in the following table.

Maintaining the Highway System

Maintenance
Moving people and goods safely and efficiently
<ul style="list-style-type: none"> ▪ ongoing maintenance activities include snow plowing and salting (the major cost in this category), shoulder grading, line painting, grass cutting, filling in potholes, cleaning up after accidents and spills, and repairing guiderails after accidents.
Minor Capital Projects (less than \$1 million)
Protecting roads and bridges in order to prolong their useful lives
<ul style="list-style-type: none"> ▪ <i>Prevention</i>: work to slow the deterioration of the surface layer (for example, crack filling). ▪ <i>Preservation</i>: work that both extends the life and improves the ride quality of a road or a bridge (for example, milling off and replacing the surface layer of pavement). ▪ <i> Holding</i>: work done to maintain safety and usability of a road in cases where major rehabilitation or reconstruction projects must be deferred for a few years.
Other: repairs and improvements to both highways and ancillary assets
Major Capital Projects (\$1 million and more)
Maintaining and expanding the highway system's capacity and improving safety
<ul style="list-style-type: none"> ▪ <i>Rehabilitation</i>: extensive work on bridges and roads that restores them to close to new (for example, milling off and replacing more than one layer of pavement); each successive rehabilitation adds fewer years of service life to the asset, so that eventually it is more cost effective to reconstruct it. ▪ <i>Reconstruction</i>: typically done after two or three rehabilitations and results in the same quality and life expectancy as a new road/bridge (for example, on roads this involves removal of all old pavement, some improvements to the roadbed, and new pavement). ▪ <i>Expansion</i>: construction of a new or expansion of an existing highway; expansions of existing highways are usually conducted concurrently with reconstruction of existing lanes.

Source of data: Ministry of Transportation

Maintenance program spending is driven mostly by events outside the Ministry's control—weather and accidents—whereas capital spending is driven by asset management and transportation planning considerations. The Ministry spent \$241 million on highway maintenance and \$1 billion on its highway capital program in the 2003/04 fiscal year.

AUDIT OBJECTIVES AND SCOPE

The objectives of our audit were to assess the adequacy of the Ministry's procedures for ensuring that:

- the province's highway assets were maintained safely, cost effectively, and in accordance with legislation and policies; and
- its performance in managing the provincial highway system was properly measured and reported.

Our audit, which was carried out from September 2003 to April 2004, was conducted in accordance with professional standards for assurance engagements, encompassing value for money and compliance, established by the Canadian Institute of Chartered Accountants, and accordingly included such procedures as we considered necessary in the circumstances.

Specifically, it included examining documentation, analyzing information, and interviewing staff at the Ministry's head office and at selected regional and area offices.

We identified criteria that would be used to conclude on our audit objectives. These were discussed with and agreed to by senior management of the Ministry.

The Ministry's Internal Audit Services Branch had recently completed an audit of the Ministry's major provincial highway construction activities, and, after reviewing its report and supporting documentation, we determined that we did not need to re-examine the administration of major capital projects as part of this audit. Highlights of Internal Audit's more significant observations are included in this report.

OVERALL AUDIT CONCLUSIONS

While the Ministry had adequate procedures in place to ensure that contractors bidding on routine maintenance and minor capital projects are qualified and that the services are acquired competitively, we concluded that its systems and procedures were not sufficient to ensure the province's highway assets are being maintained cost effectively. In particular, we noted the following:

- In measuring and evaluating the performance of contractors engaged to maintain provincial highways, the Ministry:

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- did not have assurance that its oversight of the work of contractors was effective and efficient;
 - did not have adequate procedures to ensure that sanctions for contract violations were administered in a consistent manner; and
 - could not readily combine inspection results with other data, such as complaints by highway users and service-level data, to provide comprehensive information about the performance of contractors and ministry inspection staff.
- The Ministry did not adequately prioritize its capital projects to ensure those with the highest benefit/cost ratio were performed first. In addition, although the Ministry is aware that the long-term financial impact of deferring preventive and preservation maintenance projects can be significant, only about half of prevention and preservation projects that ministry engineers had identified for immediate attention were able to be done each year.
 - The Ministry did not have adequate systems and procedures in place to ensure that all bridges it is responsible for are inspected at least once every two years, as legislation requires. As well, the Ministry did not obtain adequate assurance that municipalities are meeting the legislated requirement to inspect the thousands of bridges for which they are responsible.

We also noted that the Ministry's measures of bridge and pavement condition indicate that about 32% of provincial bridges and about 45% of highway pavements will require major rehabilitation or replacement within the next five years. Historical funding levels will not be sufficient to address these needs.

With respect to performance measurement and reporting, we concluded that in some areas the Ministry had not adequately reported on performance where information such as pavement condition ratings was available. In other areas it was failing both to collect the performance information it needed and to report the results to the public. For example, we found ministry reporting to be inadequate with respect to:

- the condition of highway assets;
- service levels to users, such as response times and construction delays;
- comparisons of such data for Ontario with that of neighbouring jurisdictions (the Ministry also did not carry out meaningful analysis of the differences noted between Ontario's performance and that of the other jurisdictions); and
- the effectiveness of the Ministry's efforts to reduce the significant damage to bridges and highways caused by heavy trucks.

The Ministry is in the process of implementing an Asset Management Business Framework; it expects that the implementation will be completed by 2007 and that this approach will address most of the gaps in performance information for decision-making and for reporting that we observed.

In a recent report on the management of major highway construction projects, the Ministry's Internal Audit Services Branch made a number of significant observations on the Ministry's processes for controlling the quality and cost of construction work. They found weaknesses in project design, monitoring during construction, pavement-quality testing, and warranty administration.

DETAILED AUDIT OBSERVATIONS

MANAGING MAINTENANCE

As has been done in several other jurisdictions, the Ministry outsourced almost all maintenance work on provincial highways and bridges to the private sector between 1996 and 2000. The Ministry uses two contracting arrangements—area maintenance contracts (AMCs) and managed outsourcing contracts (MOCs). The key aspects of AMCs and MOCs are described in the following table.

Maintenance Work Contracts

Area Maintenance Contract (AMC)	Managed Outsourcing Contract (MOC)
one contract for all maintenance activities	separate contracts for each activity (snow plowing, line painting, etc.)
cover sections of highway ranging from 370 to 1,350 two-lane-equivalent km	cover sections of highway ranging from 350 to 2,300 two-lane-equivalent km
contractors responsible for all patrolling and maintenance activities	Ministry does patrolling and calls in contractors as needed
terms of contracts: seven to nine years with fixed annual fees	terms of contracts: three to five years with <i>per diem</i> fees or unit prices
total of 13 AMC areas, with 29 contracts, that cover 60% of the highway system	total of nine MOC areas, with many contracts, that cover 40% of the highway system

Source of data: Ministry of Transportation

Although it has outsourced most highway maintenance work, the Ministry retains responsibility and accountability to the public for the quality and timeliness of maintenance operations.

The expenditures for highway maintenance from 1997 to the time of our audit are given in the following table. The table shows that the significant shift from in-house to contract maintenance was completed in the 1999/2000 fiscal year.

Highway Maintenance Expenditures, 1996/97–2003/04

Maintenance Program	Interim 2003/04	2002/ 03	2001/ 02	2000/ 01	1999/ 2000	1998/ 99	1997/ 98	1996/ 97
	(\$ million)							
AMC	118	117	105	89	44	11	6	4
MOC	72	78	72	72	20	3	—	—
in-house work ¹	24	25	26	31	106	155	158	174
contract oversight ²	16	15	14	10	3	1	—	—
general costs ³	11	17	19	20	34	41	39	38
Total highway maintenance	241	252	236	222	207	211	203	216
	(thousand)							
Total lane kilometres maintained ⁴	46	46	45	45	45	46 ⁵	53	56
Maintenance cost/km (\$)	5.3	5.5	5.2	4.9	4.6	4.6	3.9	3.9

¹ The Ministry's accounts for in-house work do not include a charge for the cost of equipment (plows, spreaders, etc.) or for certain overhead costs that are reflected in payments to contractors.

² Contract oversight includes compensation of maintenance co-ordinators and winter seasonal staff.

³ General costs include administration, WSIB and liability insurance premiums, and training. However, non-recurring costs related to outsourcing have been excluded.

⁴ Total includes ramps, ramp terminals, passing lanes, and truck climbing lanes, which the Ministry commonly does not include when reporting the total for highways alone (see "Background").

⁵ The reduction in the number of lane kilometres maintained between 1996/97 and 1998/99 was the result of the transfer of certain roads and bridges to municipalities.

Source of data: Ministry of Transportation

We found that the Ministry had appropriate controls over the contracting and payments processes. Specifically, the Ministry ensured that contractors bidding on Ministry work were financially sound, a competitive number of bids were received for each contract, and the best bids were accepted. Despite the competitive acquisition of services, costs have continued to rise, as the table above shows. The Ministry informed us that higher costs are due to a number of factors, such as above-inflation increases in salt prices, a requirement that contractors make use of advances in winter maintenance equipment, new safety regulations governing road maintenance, and increased traffic. However, we noted that it is not the Ministry's practice to analyze the year-to-year change in maintenance costs in order to identify the source of major increases and therefore the areas to which management should direct its attention.

Ministry contracts contain very detailed specifications regarding the services to be provided and associated performance standards that contractors are expected to meet. The Ministry's maintenance co-ordinators are responsible for verifying whether contractors have met their contractual obligations. Each co-ordinator is assigned sections of highway to inspect—generally about 200 to 300 two-lane-equivalent kilometres—to determine whether maintenance work (snow plowing, pothole filling, grass cutting, etc.) has been done according to the terms of the contract. They report

their findings to maintenance superintendents, who may also inspect the work done by contractors.

If contractors do not fulfill their obligations, the contracts provide for a range of sanctions, depending on the seriousness of the violation and the contractor's history of violations. Sanctions include warning letters, small financial penalties, demerit points with financial penalties, and infraction reports that restrict the contractor's ability to bid on future work for the Ministry. The Ministry retains the right to terminate contracts in cases of frequent and serious violations. MOCs provide for financial penalties of up to \$1,500 per occurrence. For AMCs, demerit points accumulate over the life of the contract and the associated financial penalty per point increases as points are accumulated, up to a maximum of \$10,000 per point. Examples of violations that could result in demerit points are failure to mobilize snow plows or salt spreaders within the response time indicated in the contract, improper application of salt or sand, and failure to maintain proper records regarding maintenance operations. For the year ended March 31, 2004, the two regions that we visited had levied demerit penalties of \$210,000 on AMCs (annual payments by the Ministry on these contracts were \$52 million) and financial penalties of \$14,000 on MOCs.

Inspecting Maintenance Work

The Ministry provides maintenance co-ordinators with guidelines for carrying out their inspections of the highway sections that have been assigned to them. However, while helpful, the guidelines are not specific enough either to define what constitutes an adequate inspection regime for effectively monitoring contractor performance and ensuring safety or to ensure that the Ministry can hold co-ordinators accountable for meeting the guidelines. For example, the guidelines state that the time of day that inspections are conducted should be random, but it is not clear how often a superintendent should expect to see inspections carried out on evenings and nights, weekends, and holidays, particularly with respect to winter operations. In another example, the guidelines state that all highway sections should be inspected, but they do not suggest a minimum frequency.

As well, the only detailed data available about inspections with respect to date, time, and results are the notes co-ordinators record in their diaries. In the absence of electronic records, summary information regarding the inspection work of each co-ordinator is not available. This makes it more difficult and time-consuming for superintendents to monitor whether inspection activities are adequately ensuring effective contract oversight. It would be more efficient to use electronic checklists, with the details about each inspection entered by co-ordinators using hand-held computers and uploaded daily to a ministry system. Having this information in a central system not only would help management review inspection activities but would also provide an accessible trail if subsequent events suggested that an inspection was improperly done

or not done at all. It would also make it easy to compare inspection data with the operating data submitted by contractors.

We also noted that the Ministry does not have a process for organizing information regarding complaints, accidents (where road conditions were a factor), and claims for damages by users in a way that facilitates comparison to activity reports submitted by contractors and to the results of inspections by co-ordinators. Such information would help the Ministry to:

- incorporate risk into the selection of sections/contractors to inspect;
- evaluate the performance of contractors; and
- assess the quality of inspection work by co-ordinators.

Measuring Contractor Performance

The Ministry, through inspections by maintenance co-ordinators, determines whether contractors have met the performance standards set out in their contracts. However, it has not established procedures for measuring the extent to which their performance exceeded or fell short of ministry standards. Consequently, the Ministry cannot compare year-to-year results for the same sections of highway or for similar sections across the province and therefore cannot identify best practices that should be adopted throughout the province. Measures that the Ministry might use in this regard include:

- number of hours required to achieve bare pavement after a snowfall combined with a measure of the severity of weather (for example, temperature and amount of snow);
- number of days to fill potholes;
- response time to remove debris and dead animals; and
- appearance of highway corridors (for example, landscaping).

In its response to our report on highway maintenance in our *1999 Annual Report*, the Ministry agreed that performance measures for contractors were desirable management tools, but none had been established at the time of our current audit.

Signing the Code of Conduct

Whenever ministry staff oversee the work of service providers, there is a risk that they will be inappropriately approached by the service providers. A code of conduct helps manage this risk by clarifying the Ministry's expectations for employees to discharge their duties in an impartial, objective, and accountable manner and provides guidance to staff on the risks to be managed and behaviours to be avoided. While the Ministry has a code of conduct, it does not require staff to periodically reaffirm in writing that they are familiar with it and have complied with it. We believe this is a prudent practice to help reduce the risk that an employee will not comply with the code.

Managing the Sanctions Process

In the regions we visited, the sanctions process was initiated by the Ministry's maintenance co-ordinators, who reported violations to their superintendents. The superintendents assessed the seriousness of the violations and determined whether to issue warning letters or recommend to regional management that penalties be levied on the contractors concerned. We had the following concerns regarding the sanctions process.

ENSURING FAIR AND CONSISTENT SANCTIONS

Maintenance superintendents from the Ministry's various field offices meet periodically to discuss contract management issues, including the administration of sanctions. Regional staff also receive training on the administration of sanctions. However, these procedures have not been sufficient to ensure that violations are assessed and sanctions administered in a fair and consistent manner. We found cases where:

- sanctions were recommended by maintenance superintendents but were not issued by regional management, with no supporting documents on why the superintendent's recommendations were overturned;
- sanctions should have been issued but were not because regional management felt that too much time had elapsed between the date of the violation and the date of their review of the recommendation;
- different sanctions were imposed for the same violation—for example, with respect to record-keeping violations, one contractor was issued demerit points for the first documented violation, whereas two others received only written warnings; and
- some sanctions taken appeared to be inconsistent with the severity of the violations. For example:
 - Presumably in order to avoid being assessed demerit points, a contractor did not accurately reflect the late response time of plows in winter operations records. Although the contractor was assessed a financial penalty for the late response, the contractor was not assessed demerit points for the full extent of the lateness, which was never recorded. Since, as mentioned earlier, demerit points accumulate over the life of the contract with progressively greater penalties per point, there is great advantage in avoiding demerit points in cases such as this one.
 - A contractor found to be using a salt/sand mix instead of more expensive straight salt as required under the contract received only a warning letter.

MAINTAINING A COMPREHENSIVE RECORD OF CONTRACT VIOLATIONS

The Ministry does not have a system that contains comprehensive information for all contract violations, such as the nature of each violation, the date of occurrence, the

actions recommended and taken (for example, warning letters, penalties, demerits plus penalties, infraction reports) with the rationale for these decisions, and the name/ position of the personnel making the recommendations and decisions. Such a system could help management monitor that both actions taken in response to contract violations and contractor performance evaluations are appropriate and consistent throughout the province. Also, if the system were computer-based using wireless hand-held devices, co-ordinators and superintendents could directly update it with their reports of violations and recommendations for sanctions, thereby eliminating the need to maintain records at both the field office and the head office.

Recommendation

In order to manage maintenance contractors more effectively, the Ministry should:

- **provide co-ordinators with more specific guidelines to assist them in performing inspections effectively;**
- **implement systems for managing and analyzing data regarding inspections, violations, complaints from and claims for damages by highway users, and service levels achieved;**
- **require staff to annually sign a code of conduct governing their relationship with the contractors that they manage; and**
- **take steps, such as reviews of regional procedures and records by head office, to ensure fairness and consistency throughout the province in the sanctions applied to contractors for violations.**

Ministry Response

The Ministry has detailed guidelines for co-ordinators that were established to provide direction for consistent and unbiased monitoring. The Ministry will review these guidelines with a view to being more specific regarding monitoring frequency and summarizing results.

Currently, the Ministry informally uses data from a variety of sources to establish inspection frequencies and monitor contractor performance. The Ministry is conducting trials of new electronic diary technology to enhance the recording and analyzing of data. The Ministry will continue to explore improvements in systems for integrating and analyzing data for more effective contract oversight.

The Ministry has a corporate Guide to Business Conduct; all staff sign a public servants' oath; and conflict of interest is a key element in training. The Ministry will work with the central government ministries to ensure our code-of-conduct approach is effective.

The Ministry will review the administration guideline for sanctions and investigate mechanisms for better tracking and monitoring of sanctions.

Monitoring the Impact of Salt on the Environment

Because of the impact that road salt has on surface water and groundwater, the Environmental Commissioner of Ontario recommended in his 2001/02 annual report that “MTO explore the establishment of an ecological monitoring program involving vegetation or aquatic organisms near road-salt release reduction areas in order to evaluate the impact of reducing road-salt releases over time.”

The Ministry advised us that it plans to engage a consultant to propose how this monitoring can be done and has made arrangements with the Ministry of the Environment regarding technical assistance for this project. However, little progress had been made on this recommendation at the time of our audit.

As well as monitoring the impact of salt on the environment, it is important to collect data and use analytical tools to determine the appropriateness of the amount spread on provincial highways so that the Ministry can:

- identify specific cases of overuse based on current safety standards; and
- track annual usage on a weather-adjusted basis as a means of assessing the impact of the Ministry’s initiatives to reduce salt use (such as requiring that contractors use more sophisticated electronic spreaders that limit the salt spread to the amount needed by particular types of roads in particular conditions).

In this regard, only about a quarter of the salt spreaders in use in the winter of 2003/04 were equipped with the electronic monitoring devices needed to collect data on the spreading rate by time and location.

Recommendation

In order to identify and better manage the impact of salt use on the environment, the Ministry should take steps to acquire the information and develop the analytical tools necessary to properly monitor salt use and work with the Ministry of the Environment to establish ongoing testing and tracking of the impact of changes in salt use on the local environment.

Ministry Response

The Ministry currently tracks salt usage and is working to improve this, particularly through the development and implementation of advanced winter maintenance technology and methods and the use of an Automatic Vehicle Location system that provides real-time, accurate information on the location of plows and spreaders and the amount of salt placed.

The Ministry, in co-operation with the Ministry of the Environment, is starting a project to establish a practical approach for environmental monitoring that is intended to demonstrate the impact of reduced salt use on the environment.

PRIORITIZING CAPITAL EXPENDITURES

Capital projects are designed and delivered primarily by private-sector consultants and contractors selected by the Ministry, although the Ministry still does some design work. Capital expenditures are segregated into three separate funding envelopes: minor capital, rehabilitation/reconstruction, and expansion projects (see the “Background” section for a description of the work involved for each category). Funds are allocated to each envelope by senior management based on a number of considerations. Allocations to the rehabilitation/reconstruction and expansion project envelopes must be approved by the Management Board of Cabinet. The following table sets out these components of total capital expenditures, including various overhead items.

Capital Expenditures, 2000–2005

	Expenditures for the year ended March 31 (\$ million)					
	Estimates 2005	Interim 2004	2003	2002	2001	2000
rehabilitation/reconstruction	435	379	391	422	577	456
expansion	335	247	250	272	213	186
minor capital (preservation/prevention and other)	55	62	91	27	43	49
engineering, design, and program support	189	191	184	193	186	171
acquisition of property	35	46	56	39	54	61
other (mostly transfers to municipalities)	116	87	50	83	49	73
Total capital expenditures	1,165	1,012	1,022	1,036	1,122	996

Source of data: Ministry of Transportation

Minor capital and rehabilitation/reconstruction projects maintain and improve existing highways, bridges, and structures. Expansion projects improve safety and reduce congestion by building new highways and bridges and adding lanes to existing ones. Rehabilitation/reconstruction and expansion projects are prioritized at head office, whereas minor capital projects are prioritized at the regional level. Projects in one funding envelope do not compete for funding with those in the other envelopes.

Deterioration of Pavement

Pavement deteriorates naturally over time. The process is accelerated by cracking, which is caused by settling of the roadbed; expansions and contractions due to temperature extremes; and the impact of vehicles—in particular, heavy trucks. Cracks allow water to infiltrate the pavement structure, which weakens it and subjects it to the freeze-and-thaw cycle that leads to potholes and ultimately to pavement breakup.

High-quality highways, such as the Ministry’s freeway class of highways, typically last about 17 years if no action is taken to delay deterioration of the underlying pavement structure. However, the ministry engineers we interviewed and our research indicated that with proper preventive and preservation maintenance and rehabilitation—filling

cracks, patching, resurfacing—the useful life of these highways can be extended to 50 years or more before the underlying structure needs to be replaced.

Funding of Preventive and Preservation Maintenance Projects

Our research and the ministry personnel we interviewed both indicated that preventive and preservation maintenance is:

- time sensitive. For example, delaying an important preventive maintenance activity such as filling cracks for even one year can have a significant impact on pavement condition. Moreover, the delay and resulting impact also affect how long major rehabilitation or reconstruction can be deferred.
- very cost effective. Performing maintenance when recommended extends the useful life of a highway from 17 years if no maintenance is done to more than 50 years. The estimated present value of the savings to the Ministry of this extension over the life of a six-lane freeway is approximately \$116,000 for each kilometre. However, the Ministry advised us that fewer than half the maintenance projects recommended by its engineers can be funded in any given year.

The Ministry estimates expenditures on necessary preventive/preservation maintenance and rehabilitation for the 2004/05 fiscal year to be about \$1.7 billion, whereas the budget has been set at \$490 million, leaving a backlog of \$1.21 billion.

In our review of the prioritization and funding of preventive and preservation maintenance projects at the regions we visited, we noted the following:

- The prioritization process was subjective and not adequately documented. The Ministry had not developed criteria that regions should follow in prioritizing these projects, and it had not established oversight procedures to verify that each region makes the best use of available funds.
- The Ministry's allocation of funding to the regions for preventive and preservation maintenance projects was primarily based on the number of lane kilometres of highway each region is responsible for. Other factors—notably, the cost of having to prematurely rehabilitate or reconstruct highway sections because required preventive and preservation maintenance was not done—were not estimated or taken into account. As a result, project priorities could not be compared and evaluated across regions, and the Ministry could not ensure that, on a province-wide basis, projects with the highest benefit/cost ratio were performed first.

Because of the cost effectiveness of preservation/preventive maintenance, some U.S. jurisdictions have decided to place greater emphasis on funding these projects rather than expansion. For example, in 2003 Michigan began deferring expansion projects in favour of preservation projects until such time as “the goal of having 90% of state roads

and bridges in good condition is met and can be sustained” (Michigan Department of Transportation). The high payback of preservation/preventive maintenance projects calls into question the practice of having separate envelopes of funding for each category of capital expenditures, because it does not allow these projects to compete with expansion projects for funding.

Recommendation

In order to make the best use of available capital funds, the Ministry’s prioritization process should allow preservation and prevention projects to compete with all other projects for the available funding based on a full analysis of their costs and benefits.

Ministry Response

The Ministry agrees with this recommendation and is currently implementing the Asset Management Business Framework, which includes additional analytical tools such as benefit/cost and other economic assessments that will allow for a more consistent means to prioritize all highway investments. It is expected that this framework will be fully implemented in 2007.

INSPECTING BRIDGES

Compliance and Enforcement

Under the regulation in the *Public Transportation and Highway Improvement Act* dealing with inspections of bridges, every bridge must be inspected for structural deficiencies at least once every two years under the direction of a professional engineer and in accordance with the Ministry’s *Ontario Structure Inspection Manual*.

MINISTRY BRIDGES

The Ministry’s bridge inspections are organized at the regional office level, with the results being reported to the head office’s bridge office. Inspections are performed by senior structural engineers assisted by one or two engineering students or technicians, or by engineering firms engaged by the Ministry. The time required to inspect a bridge varies with its size and design, but is typically about two hours, not including preparation and reporting time. Inspection results are recorded on a standardized template that is entered into a Bridge Management System (BMS) that the Ministry began to implement in November 2002 and expects to be complete by the end of 2005.

A key starting point to complying with the regulation is an accurate inventory of the more than 2,700 provincially owned bridges to be inspected. At present, each ministry

region maintains its own inventory, which must be updated for changes affecting ministry bridges (for example, new bridges being constructed and old bridges being reconstructed or demolished), changes in regional boundaries that result in ministry bridges being transferred from one region to another, and transfers of ministry-owned bridges to municipalities and vice versa. Once the BMS is fully implemented, these regional inventory records will no longer be required. In view of the large number of bridges to be inspected, we expected to see, but did not find, procedures in place for periodically verifying that all ministry bridges were accounted for in the regional inventories and that details about each bridge were accurate.

In addition, the regions do not prepare summary information that would enable management to effectively ensure that the Ministry is complying with the regulation. Such summary information could include, for example, a history of major maintenance or improvement work done, as well as the date of last inspection and the inspector's name and employer.

We also noted that inventory records did not identify key aspects of each bridge's structure that would assist inspectors in conducting an effective inspection. The usefulness of such information is clear in cases such as the January 2003 collapse of the Latchford bridge over the Montreal River in northern Ontario. A ministry inspection found that a pre-collapse inspection had missed the deterioration of important "but difficult to inspect" parts of the structure. Had the 40-year-old bridge's unique design features and risks been flagged for inspectors, inspectors might have detected the deterioration of the components concerned before the bridge failed.

Although the BMS has the capacity to address existing gaps in information, we noted that it does not automatically generate reports on overdue inspections for management's attention.

MUNICIPAL BRIDGES

While municipal governments are responsible for inspecting the bridges they own—which amount to several times the number of bridges owned by the province—the province still has overall responsibility for bridge safety. We were therefore concerned to note that the Ministry had not established procedures for obtaining assurance that municipal governments are complying with the regulation on inspections of bridges. Such procedures would include ensuring that municipal governments maintain accurate inventories of their bridges. In this regard, we contacted two municipalities to determine whether two bridges that had been transferred to them many years ago—but had not been deleted from the Ministry's inventory—had in fact been inventoried by the municipalities. We were advised that, while they had been inventoried, they had not been inspected by the municipalities for at least several years. The municipalities subsequently informed us that one of the bridges had recently been inspected and that the other would be later this year.

Measuring and Reporting on Bridge Condition

The Ministry recently implemented a measure of “bridge condition” called the Bridge Condition Index (BCI). The previous measure, “optimal state of repair,” was concerned only with the condition of the bridge deck—it did not accurately measure the overall condition of the province’s bridges and therefore was not a good basis for prioritizing and costing future repairs or replacements.

The BCI attempts to address these problems. It is derived as follows. In the course of each inspection, the engineer estimates the level of deterioration of each major structural component of a bridge. The level of deterioration, when deducted from the replacement cost for each component, yields the component’s current value. The BCI is the percentage of the total replacement cost represented by the sum of the current values of the components. Thus, in the case of a bridge with a total replacement cost of \$1,000,000 and a total current value of \$700,000, the BCI is 70 (total current value = 70% of total replacement cost).

The Ministry expects to have a BCI for all bridges in the Bridge Management System by the end of 2004. We were advised that the index is still being calibrated but that, based on the work done to May 2004, bridges with a BCI greater than 70 will be considered to be in good condition; that is, they will not have to be replaced or rehabilitated within five years from the date of the inspection. The work done to May 2004 also suggests that about 68% of the Ministry’s bridges have a BCI greater than 70, as compared to the Ministry’s target of 85%. Until the condition of the entire bridge inventory has been assessed, the Ministry is not in a position to estimate the costs required to meet its target.

Recommendation

In order to meet its responsibilities for complying with and enforcing the regulation of the *Public Transportation and Highway Improvement Act* dealing with inspections of bridges, the Ministry should:

- **ensure that its Bridge Management System (BMS) contains complete and accurate information needed for the inspection of each bridge—including details of recent structural and maintenance work done and the key aspects of each structure that must be inspected;**
- **ensure that the BMS can automatically generate reports on overdue inspections for management’s attention; and**
- **take steps, perhaps in conjunction with stakeholders, to obtain adequate assurance that local governments have appropriate systems and procedures in place, including reliable bridge inventories, to comply with the regulation requiring bridges to be inspected every two years.**

Ministry Response

The Ministry periodically assesses its procedures for effectiveness and will continue to do so.

The Ministry will enhance the Bridge Management System to collect and provide structure details such as those recommended and to provide a notification flag if inspection reports are not filed every two years.

With respect to municipal structures, the province will continue to work closely with municipalities to remind municipalities of their responsibilities to conduct bridge inspections. The province is also working with the federal government to assist our municipal partners with the tools they need, such as through recent and upcoming funding assistance initiatives.

MEASURING AND REPORTING ON PERFORMANCE

The *Public Transportation and Highway Improvement Act* assigns stewardship over the province's highway assets to the Ministry. Stewardship includes being responsible for developing methods of measuring and reporting on the state of assets under management and on the cost effectiveness with which financial and other resources have been employed to maintain existing assets and expand the highway system.

Performance Measures Currently Reported On

The Ministry currently reports to the public on its performance through its business plan. The most recent plan, for the year ended March 31, 2003, contained only two performance measures related to maintaining and expanding the province's highway system:

- *Highway accessibility*—the Ministry has established a target of having 93.7% of the population living within 10 kilometres of major provincial highway corridors, up from 90% in 1996/97.
- *Construction efficiency*—the Ministry has established and achieved a target of having 80% of total highway capital costs spent on actual construction versus administration, up from 76% in 1996/97.

In its construction audit report, Internal Audit Services criticized the construction efficiency measure for not directly addressing “efficiency”—the measure captures the ratio of construction costs to administration costs but does not specifically examine the amount of construction work done in return for the dollars invested. Also, performance measures such as this one may have the undesirable result of encouraging managers to economize on the cost of necessary administrative work (such as design work and

pre-engineering services) that, if not done properly, can have a significant impact on the total cost of construction projects.

Performance Measures to Be Considered

Based on our review of research and information reported by other jurisdictions, there are a number of performance measures that the Ministry should consider monitoring and publicly reporting on each year.

LEVEL OF SERVICE PROVIDED TO HIGHWAY USERS

It is important that, in conjunction with measuring and reporting on *cost*, the *level of service* provided to users be measured and reported on. This can help ensure that the public does not misinterpret as performance improvements any cost savings that have been achieved through reducing the level of service. For example, closing off lanes on Monday to Friday during the day rather than at night in order to perform maintenance would reduce costs—but at the expense of long delays for motorists. Measures of service levels include access to the provincial highway system (currently reported); the level of congestion; service outages (that is, lane closures) due to routine maintenance work and capital projects; and response times associated with maintenance activities such as snow removal, filling of potholes, repair of guiderails and signs, removal of dead animals and debris, and accident cleanups.

FINANCIAL IMPACT OF MAJOR VARIATIONS FROM DESIGN LIFE

The Ministry bases its calculation of and reporting on depreciation for management purposes on the entire pool of pavement and bridge assets rather than each individual pavement section and bridge. As a result, when a bridge or pavement section must be replaced earlier than expected due to faulty design, poor construction, or failure to perform preventive/preservation maintenance when needed, no loss is calculated or reported for management purposes. Information about the frequency and cost of such premature replacements would help the Ministry assess the adequacy of its design and construction processes. As well, it would assist in evaluating the costs and benefits of transferring more of the risk of poor construction to the contractors that do the work, via extended warranties or holdbacks. Similarly, if there were cases where actual useful life significantly exceeded expectations, quantifying the benefits would assist the Ministry in identifying best practices and in estimating the savings that might be realized by implementing the best practices throughout the province.

CONDITION OF PAVEMENTS AND BRIDGES

The Ministry currently measures pavement condition using a Pavement Condition Index (PCI) but does not publicly report the results. With respect to bridges, as stated earlier, the Ministry expects to have a reliable measure of bridge condition (the BCI) by

the end of 2004. The Ministry does not collect condition data for ancillary assets such as signs and buildings.

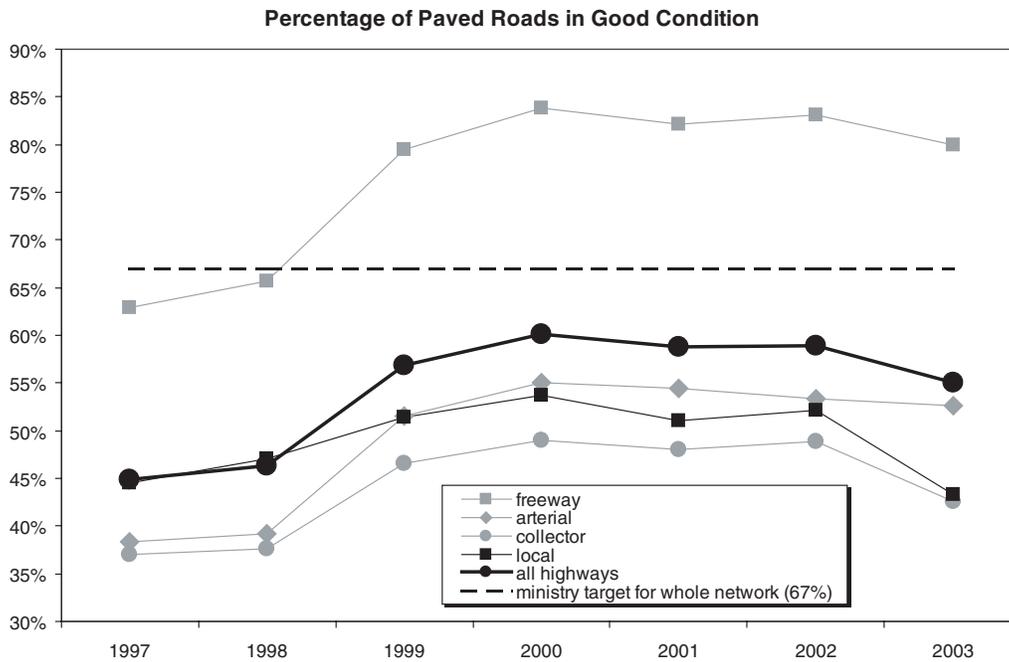
The PCI is applied to four different types of paved roads, as follows:

- *freeways*—limited-access, high-volume roads (for example, Highway 400, the Queen Elizabeth Expressway), of which there are 8,400 lane kilometres (24% of the province's paved roads);
- *arterials*—roads where traffic flow is interrupted by traffic signals at grade-level intersections (for example, Highway 10, Highway 9), of which there are 12,600 lane kilometres (35%);
- *collectors*—generally, two- to four-lane roads where traffic flow is interrupted to allow for grade-level access to property (for example, Highway 48, Highway 49), of which there are 8,700 lane kilometres (25%); and
- *locals*—typically, low-volume, two-lane roads with few restrictions on access (for example, the 600 and 500 series highways in northern Ontario), of which there are 5,800 lane kilometres (16%).

The PCI cannot be applied to the province's 3,500 lane kilometres of gravel roads.

The PCI consists of two components: the international roughness indicator (IRI), which measures pavement smoothness; and the distress manifestation index (DMI), which measures the level of cracking, rutting, and so on. IRI measurements are made using a machine that takes readings as it is driven over highways. The Ministry has engaged a contractor to measure the IRI of half the highway system each year. The measurement for each section of highway is recorded in the pavement management system (PMS). DMI measurements are made by regional geotechnical personnel who inspect highway sections for distresses annually and complete a standardized report, the details of which are also recorded in the PMS.

The Ministry has calibrated PCIs so that they can be translated, for each highway section, into the number of years until major rehabilitation or reconstruction is needed and in this regard uses four categories: now, one to five years, six to 10 years, and more than 10 years. Roads in the six-to-10-years and more-than-10-years categories are considered to be in good condition. The following line graph shows the percentage of lane kilometres of provincial highways in good condition from 1999 to 2003.



Other useful measures related to asset condition include:

- the remaining service life of assets, defined as the number of years until reconstruction; and
- the current value of assets, defined as replacement cost minus deterioration as determined by inspections.

These measures decline as the assets deteriorate and increase when preservation and rehabilitation are performed. A declining trend in remaining service life and current value would indicate that major capital expenditure requirements will increase in the foreseeable future.

Also, an analysis of year-to-year changes in these measures in relation to changes in PCIs and BCIs would help the Ministry, legislators, and the public assess whether the Ministry is making wise capital investment decisions. For example, simply resurfacing a road that requires major rehabilitation will temporarily improve ride quality and therefore PCI but won't significantly increase the useful life or current value of the road. Such quick fixes would not be a cost-effective use of funds.

We also noted the following:

- The PCI and BCI measures indicate that 45% of pavements and 32% of bridges will require rehabilitation or reconstruction within the next five years.
- The Ministry does not yet forecast capital expenditure requirements beyond one year based on a rigorous assessment of asset condition and the timing of needed expenditures. Thus, neither management nor legislators have information about

peaks in capital expenditure requirements, in addition to the current backlog, that may arise in future. Based on available asset condition data, such expenditures will be substantial and clearly in excess of historical funding levels if the backlog is to be addressed.

HIGHWAY SYSTEM COSTS PER KILOMETRE

Two measures that would assist legislators and the public in assessing how effectively the Ministry spends its funding are:

- a highway's life cycle cost per lane kilometre, calculated by adding together the highway's original construction expenditures and all the subsequent preventive/preservation maintenance and rehabilitation expenditures made over the highway's useful life and annualizing the cost on a per-lane-kilometre basis; and
- a highway's annual routine maintenance cost per lane kilometre, adjusted for the impact of winter weather fluctuations on salting and plowing costs.

EFFECTIVENESS OF EFFORTS TO REDUCE EXCESS-WEIGHT DAMAGE

As shown in the following table, Ontario's maximum allowable gross vehicle weight of 63,500 kilograms is higher than that of most other North American jurisdictions.

Allowable Gross Vehicle Weights by Jurisdiction

Jurisdiction	Maximum Weight (kg)	
	Semi-trailer	Double trailer
Ontario	63,500	63,500
Quebec	57,500	62,500
other Canadian jurisdictions	46,500	62,500
New York	48,500	36,300
Michigan	68,000	72,500
other U.S. jurisdictions	36,300	36,300

Source of data: Ministry of Transportation

The Ministry estimated that certain heavy-truck and tractor-trailer configurations (especially those equipped with liftable axles) cause in the order of \$300 million of avoidable damage per year to municipal and provincial roads and bridges. Therefore, the Ministry initiated its four-phase Vehicle Weight and Dimension Reform Project. Phases One and Two were implemented by amendments to the *Highway Traffic Act* in 2001 and 2002. These amendments force a gradual migration to less damaging vehicles over time as vehicles are replaced. Accordingly, carriers can obtain permits allowing them to use—for up to 20 years—existing equipment that does not comply with the project's requirements.

Another issue with respect to trucks is that there is a significant economic incentive for freight carriers to overload trailers, as the incremental costs of heavier loads are low compared to the additional revenues. Therefore, the Ministry has an enforcement program to detect overweight trailers and deter them, via fines, from exceeding weight limits. However, the Ministry does not collect and analyze the data necessary to determine whether the enforcement program is, in fact, an effective deterrent. For example, the Ministry does not have information on:

- the resolution of each charge for weight violations by its enforcement officers—was the carrier convicted or did the court throw the charge out? if the carrier was convicted, did the court impose the full fine or a reduced amount?;
- the program totals regarding the resolution of charges—that is, the percentage of charges that resulted in convictions, the percentage of the statutory fines actually imposed by the courts, the percentage of the fines collected; and
- the reasonableness of the fines collected compared to economic benefits gained as a result of the violations—in other words, given the likelihood of being caught and convicted, are the fines a sufficient deterrent or just a nuisance cost of doing business?

Other Information for Decision-making

Expanding the province's highway system—with new highways or new lanes for existing highways—increases both the routine maintenance costs immediately incurred (for example, snow removal costs) and the prevention, preservation, and rehabilitation work that will be required in the future. When submitting expansion projects for approval to the Management Board of Cabinet, the Ministry estimates their impact on routine maintenance expenses but does not include the projected ongoing costs of maintaining the new assets in good condition.

The Ministry has estimated the present value of the life cycle costs to maintain the freeway class of highways in good condition at approximately \$250,000 per lane kilometre (life cycle costs for bridges and other classes of highways have not yet been developed). This estimate does not include costs such as those for traffic control, which are significant in urban areas. In view of the size of this ongoing obligation, these life cycle costs should be included in proposals for new highways. Otherwise, expansion projects will continue to be approved on the basis of incomplete information.

Asset Management Business Framework

Since our last audit in 1999, the Ministry has been implementing an Asset Management Business Framework. The framework is intended to help the Ministry manage its assets better and to set priorities for sound investment decisions; it will consider a full life-cycle analysis of costs and all relevant measures of performance,

including system condition, traffic mobility, safety, environmental impact, and asset value. The Ministry advised us that implementation is underway and is expected to be completed by 2007 and that this new approach will enable management to address most of the gaps in performance measurement and reporting noted above.

Recommendation

To better support decision-making and strengthen accountability to the public the Ministry should:

- **implement performance measures dealing with the condition of assets under management and the cost-effectiveness with which resources have been employed in managing the province's highway system and report annually on the results; and**
- **ensure that proposals for expansion projects contain information on the costs of maintaining the new highways.**

Ministry Response

The Ministry agrees with this recommendation and is in the process of developing a comprehensive suite of performance measures that will focus on the outcomes of transportation investments. These measures will include pavement and bridge conditions, asset value, safety, mobility, and cost efficiency measures. In addition, the province will benchmark its pavement and bridge measures against other highway jurisdictions. It is the Ministry's intention to include the new measures as part of our annual planning process.

The Ministry is very supportive of providing all life cycle cost commitments associated with expansion projects in project proposals and will be able to do this using the Asset Management Business Framework tools.

INTERNAL AUDIT OF HIGHWAY CONSTRUCTION

Major construction projects—comprising construction of new highways and expansion, reconstruction, and rehabilitation of existing highways—were examined extensively by Internal Audit Services during 2002/03. Internal Audit Services made recommendations with respect to a number of issues, and we have summarized those that are related to the Ministry's procedures for controlling the quality and cost of construction work.

Internal Audit Services identified significant weaknesses in the systems and procedures in place for ensuring that construction funds have been spent effectively. We will assess the Ministry's progress in addressing these recommendations in our follow-up report on this audit in 2006.

Quality of Work by Design Consultants

The Ministry tenders to external design consultants the tasks of preparing detailed project specifications for construction contractors and estimating the cost of projects based on their designs. Certain of Internal Audit Services' findings raised concerns regarding the quality of design work, as follows:

- Successful bid prices for construction projects often had a variance of more than 20% from the design consultant's estimate.
- The Ministry incurred significant costs over the bid prices on construction contracts due to the large number of change orders and additions.

Inaccurate cost estimates and numerous change orders and additions call into question whether consultants have a thorough understanding of ministry requirements, construction costs, and what drives those costs. This in turn calls into question whether the design services acquired by the Ministry resulted in cost-effective highway construction projects.

The internal audit observations were supported by a February 2004 report to the Ministry by consultants it engaged to assess the relationship between the Ministry and its service providers. The consultants found "that construction companies hold an extremely negative view of the quality of design work, and that companies in the design business are themselves only in the neutral range" in rating the quality of their work.

Internal Audit Services recommended that the Ministry revise its management processes governing project design and cost estimation in order to reduce the need for change orders and additions.

Quality of Work by Contract Administrators

The Ministry hires contract administrators to manage major capital projects on its behalf. Internal Audit Services found "wide-ranging differences in the quality of documentation and reporting provided by [contract administrators]," with the result that it was "difficult to see how Ministry staff are able to monitor the quality of projects." Internal Audit Services recommended that the Ministry require proper documentation and checklists from contract administrators to ensure that it is receiving value for money.

Testing the Quality of New Pavement

The quality-assurance process for new pavement includes taking core samples of the pavement and having them tested by certified laboratories for the quality of materials and adequacy of compaction. Contractors receive bonuses or pay penalties where pavement quality is above or below ministry standards.

Internal Audit Services noted that the laboratories that conduct the pavement tests are hired by the contractors and in some cases are owned by them. It found that, although the Ministry does some pavement-quality testing on its own, these tests do not provide adequate assurance that the contractor test results are reliable and that bonuses paid to contractors based on the results are appropriate. Allowing contractors to hire/own the laboratories that measure how well they have performed a key element of their job represents a conflict of interest. Internal Audit Services recommended that the Ministry conduct a comprehensive review of the effectiveness of laboratory testing procedures and the accuracy of test results.

Construction Warranties

The Ministry requires contractors to provide a one-year warranty on their work. Roads and bridges are inspected by ministry staff or contract administrators engaged by the Ministry prior to the expiry of the warranty. Contractors are required to perform remedial work to correct any deficiencies identified. Contractors that refuse to perform the required remedial work receive a reduction in their qualification ratings and are less likely to obtain future contracts. Internal Audit Services found that:

- provisions related to warranties in ministry construction contracts “are weak and vague, resulting in inconsistencies in warranty administration and implementation across the province”; and
- four neighbouring states required warranties of five to seven years. Officials of two states that were contacted were of the view that while extended warranties increased their contract prices, the increases were “more than offset by reductions in maintenance costs.”

Ministry staff we interviewed felt that extended warranties on minor capital projects do not provide much benefit when the full costs are considered (that is, the increase in contract prices and in staff time and costs involved in enforcing warranties). However, the Ministry has not conducted an in-depth study of the costs and benefits of extended warranties for capital projects to either support or contradict this perception.

Internal Audit Services recommended that the Ministry strengthen the wording of warranty provisions in its construction contracts, implement procedures for ensuring consistency in warranty administration throughout the province, and pilot-test the use of extended warranties.