

The Impact of Changes To Road Design

By: Brian Bigger, Auditor General
On: August 14, 2012
To: Audit Committee

Audit Objectives

- Our audit procedures were designed to evaluate whether:
 1. Value for money was achieved and expected costs/benefits of road projects were evaluated in regards to the design change impacting cross fall, the quality of the road constructed and/or volume of reclaimed asphalt pavement (RAP);
 2. Contractors were delivering the cross fall as specified in the contract;
 3. The City of Greater Sudbury's (City) controls and safeguards for proper asphalt mix ratios were operating effectively;
 4. The asphalt removed from City road projects were safeguarded and could be accounted for;
 5. The asphalt removed from City road projects was directed to the City's highest and best use.

Audit Methodology

- Our audit methodology:
 1. We reviewed City standards, policies and procedures, Ontario Provincial Standard Specifications (OPSS) and Ministry of Transportation (MTO) policies and procedures;
 2. Reviewed contracts for five major construction projects done between 2008 and 2011;
 3. Reviewed asphalt test results performed by the City's lab and independent consultants;
 4. Measured delivered cross fall on the sample of five major construction projects;
 5. Reviewed controls over and alternate uses of RAP.

General Findings

- Our General Findings:
- It has been recognized that the demand for funds to support maintenance of the City's roads exceeds available funding.
- As a result, the quality of service delivery (the longevity and condition of roads), is heavily reliant on the City's stewardship (inspection and testing controls) over the reliability of the contractor's quality control systems and procedures to comply with City engineering designs, standards and specifications.

General Findings

- We found that changes to the City's road design were occurring:
 1. There was inconsistent handling of the three percent road cross fall specification within City contracts and specifications for the three percent road cross fall, and acceptable tolerances were not clearly stated;
 2. Contractors had not consistently delivered the three percent road cross fall specified in City contracts;
 3. The City's quality assurance testing of asphalt was not operating effectively to ensure that the asphalt mix supplied and installed in City roads met OPSS 310 and OPSS 335 tolerances;
 4. The City was not able to account for the volume of RAP removed from City road projects, and when RAP was hauled to City Depot sites, any value that it might have had, was quickly reduced due to the City's storage and handling methods.

Quality Assurance – Asphalt Testing

- Without strong inspection and testing controls, “unauthorized” changes can and do occur



Exhibit 1 – Inferior Asphalt Supplied



Inferior Asphalt Removed Next Day

The above sequence of photos shows that vigilance in quality assurance and inspection is essential, and was successful in this case.

Quality Assurance – Asphalt Testing

- Good practice is to test asphalt incorporated into city roads to ensure that the asphalt the City requested and is paying for, is what the City got. (Within allowable OPSS tolerances from the Job Mix Formula submitted to the City)
- We found that the City had not been testing asphalt incorporated into city roads against Job Mix formulas provided to the City to ensure that the asphalt the City requested and was paying for, was what the City got.
- We also found that significant quantities of asphalt “rejectible by OPSS standards”, had been built into our City’s roads.

Quality Assurance – Asphalt Testing

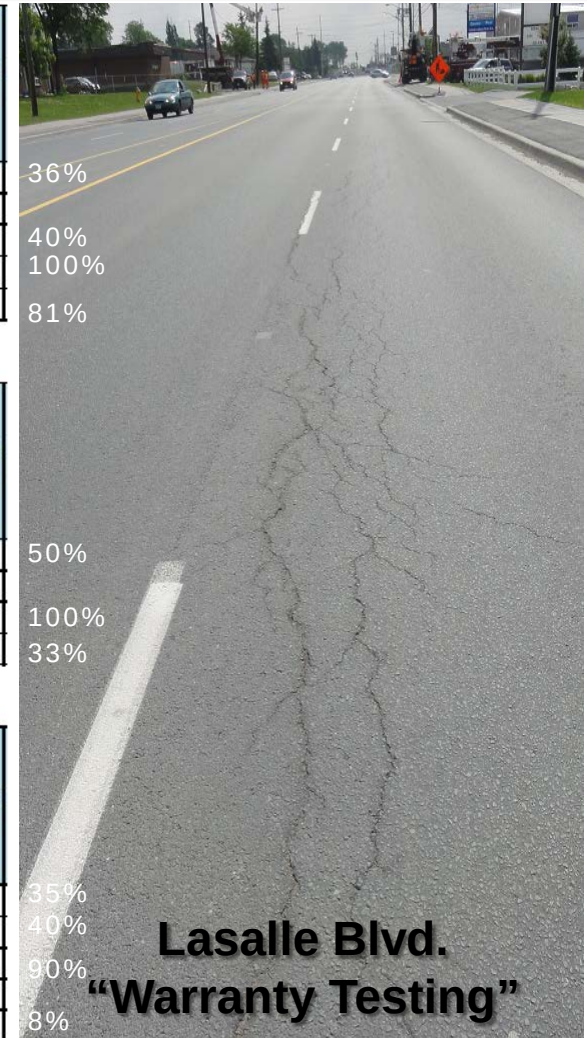
- “Failure to prevent rejectable material from being incorporated into the work when rejectable test results were available (or should have been available) beforehand, or when results were not available/required but rejectable results had been given to the contractor beforehand” **is a major deficiency**. (Source: Ministry of Transportation, Construction Administration And Inspection Task Manual, Appendix C, April 2008)
- A passive quality assurance process that relies on “monitoring” of completed project work, retroactive warranty inspection, testing and claims, is less efficient, economical and effective than a proactive quality assurance process.

Quality Assurance – Asphalt Testing

HL3	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	25	4	16%	3	12%	2	8%
Regent Street	10	0	0%	0	0%	0	0%
MR 80	5	2	40%	0	0%	0	0%
Main Street	3	3	100%	0	0%	0	0%
Radar Road	16	8	50%	4	25%	1	6%

HL8	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	2	0	0%	1	50%	0	0%
Regent Street	1	0	0%	0	0%	0	0%
MR 80	4	2	50%	0	0%	2	50%
Radar Road	3	1	33%	0	0%	0	0%

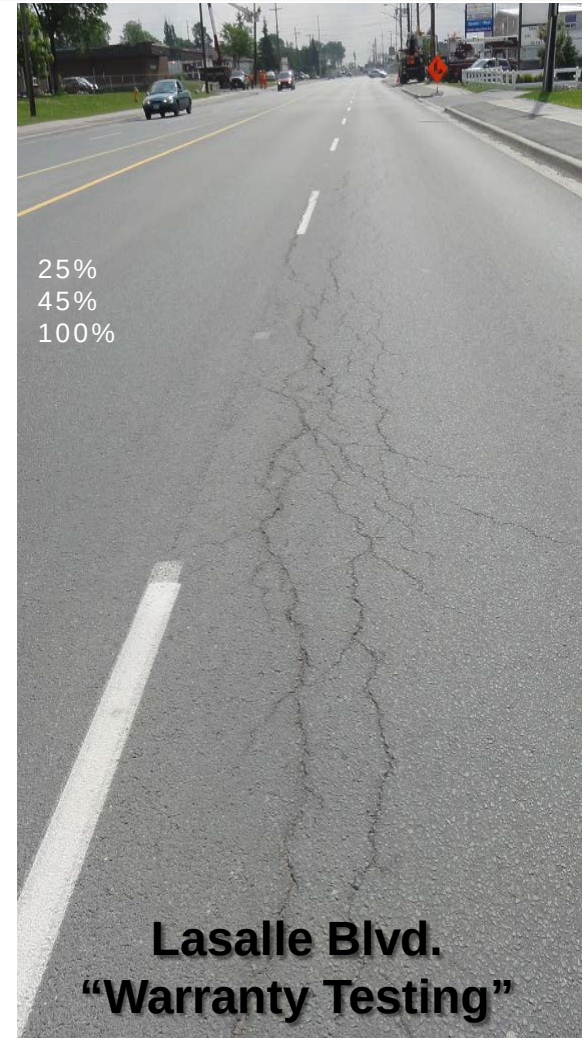
HDBC	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	23	2	9%	5	22%	1	4%
Regent Street	5	0	0%	2	40%	0	0%
MR 80	10	2	20%	7	70%	1	10%
Main Street	1	0	0%	0	0%	0	0%
Radar Road	12	0	0%	1	8%	0	0%



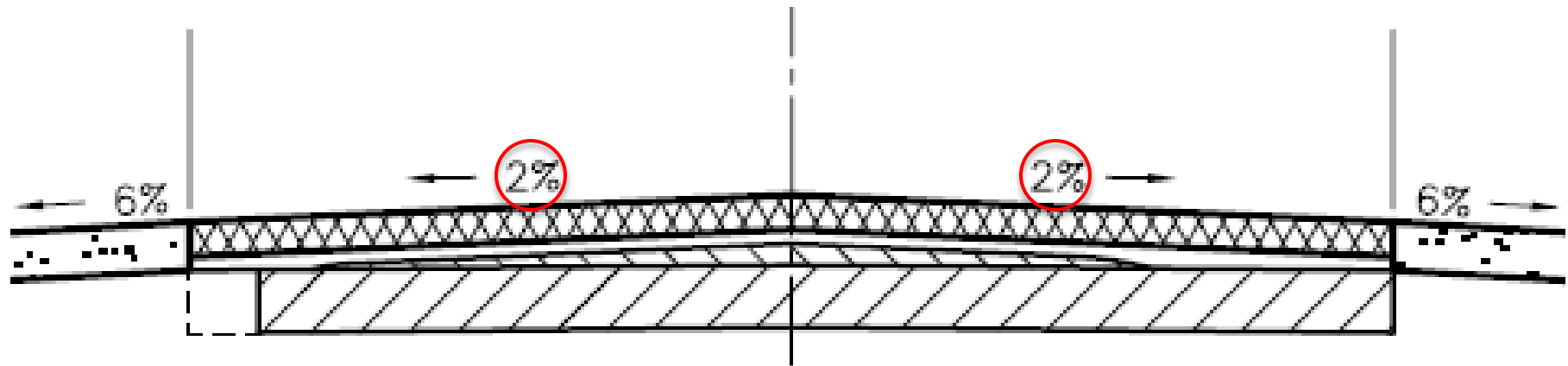
Quality Assurance – Asphalt Testing

CIREAM Project Name	Number of Samples	2005 OPSS Standards		November 2009 OPSS Standards		November 2011 OPSS Standards	
		Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength	Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength	Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength
Lasalle ISF (2009)	20	20	0	19	2	5	0
Regent Street (2011)	11	NA	NA	11	11	4	1
Radar Road (2011)	9	NA	NA	9	9	8	9

- As part of the City's General Conditions, there is a minimum two year warranty period from the date of substantial performance for road work.
- The City did identify the CIREAM concern and obtained an extension of the warranty for this section of Lasalle Blvd.
- An independent third party has been retained to test and evaluate the reasons for the cracking on Lasalle Blvd..



Quality Assurance – Road Crossfall

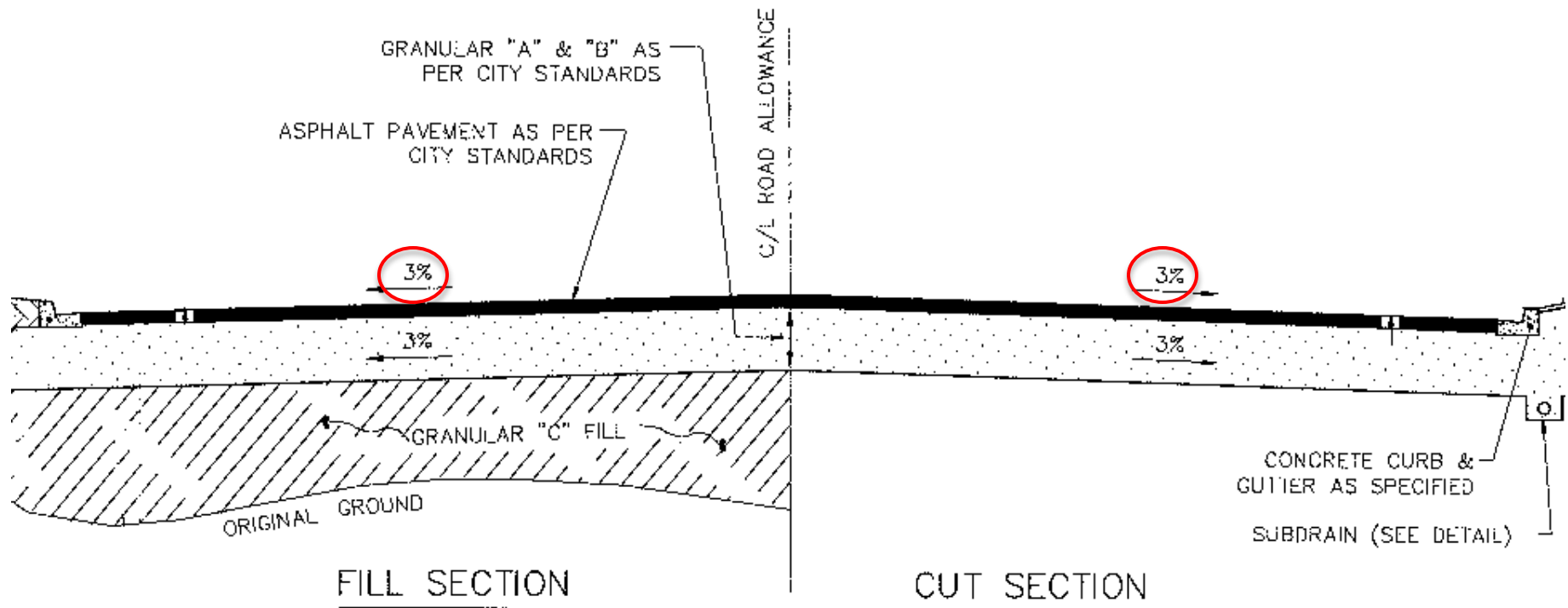


LEGEND:

 Existing pavement  Hot mix padding  Hot mix surface

OPSS 212.010 – Design of Resurfacing With Cross Fall Correction

Quality Assurance – Road Crossfall



City of Greater Sudbury Engineering design of a cross section of a road requires a 1% greater cross fall than is common in North America

Quality Assurance – Road Crossfall

Project Name	Number of Measurements Taken	Number of Measurements Taken Within CGS Tolerance (+/-1%)	Percentage Within CGS Tolerance (+/-1%)	Number of Measurements Taken Outside Tolerance (+/-1%)	Percentage Outside CGS Tolerance (+/-1%)
Hwy 69 North (MR80)	32	23	72%	9	28%
Radar Road	20	16	80%	4	20%
Main Street (MR15)	24	22	92%	2	8%
Regent Street	24	15	63%	9	38%
Lasalle Blvd (MR71) ISF	36	30	83%	6	17%

- It follows that any real or perceived performance benefits of the City's desired enhanced cross fall will be lost if the cross fall is not delivered.
- In search of good industry practice, the auditors referred to The Ministry of Transportation (MTO) Construction Administration and Inspection Task Manual. The MTO manual states that "**Paving an incorrect** super-elevation or **cross fall**" **is a major deviation**. The contractor is held accountable if it does not maintain appropriate quality controls to ensure that the specified cross fall is achieved.

Value For Money – RAP (Recycled Asphalt Pavement)



“Asphalt pavement is the most recycled material in North America.”

- In discussions with local asphalt suppliers, City staff confirmed that the grindings supplied to their yards is used either by blending with granular material or used in the production of virgin asphalt.
- The difference of just 1% in road cross-fall can significantly impact the volume of excess asphalt grindings (RAP), produced, or available for recycling.

Value For Money – RAP (Recycled Asphalt Pavement)

- The recent Roads Infrastructure Stimulus Projects (2009-2010) included rehabilitation of Paris/Notre Dame, Lasalle Blvd, and Falconbridge Road.
- The local asphalt producers confirmed that they estimate the volume of RAP to be hauled away from the project sites, relative to a 1% increase in cross fall. Based on this assumption, their bids would have included the cost of hauling approximately 44,000 tonnes of RAP from the project sites to the Frobisher yard.
- Once these projects were complete, the auditors asked City staff to measure the volume of asphalt grindings that ended up at the City's Frobisher depot. Only 14,000 tonnes of RAP was found in the stock pile at The City's Frobisher Depot.

Quality Assurance – Road Crossfall

- Unfortunately, **the Auditors were unable to find a way to account for the 30,000 tonne difference**, nor determine if the City achieved maximum value for money.
- One local asphalt producer did acknowledge that RAP would sell for \$15 / tonne if picked up at their plant site.
- Audit Estimate of the value of 30,000 tonnes of RAP in the Sudbury market:
 $44,000 \text{ tonnes} - 14,000 \text{ tonnes} = 30,000 \text{ tonnes} \times \$15 = \text{\$450,000}$



Quality Assurance – Road Crossfall

- According to The Ontario Hot Mix Producers Association, “It is only when RAP is used as hot mix raw material that engineers can take full advantage of the engineering properties of both the aggregate and asphalt cement and maximize the economic value of recycling.”
- In the past, **the City has not requested a blending of RAP in the asphalt it uses on local City roads.**
- The auditors confirmed that asphalt designed for City roads by local asphalt producers does not include any percentage of RAP in the Job Mix Formulas.
- We encourage the ongoing efforts of City staff to search for additional uses for RAP** as it has already been paid for, and can contribute to reduced operating expenses, as well as reduced capital costs when directly recycled back into City roads (the highest and best use from the taxpayer’s perspective).

Auditor General's Office {

Management Response and Proposed Actions

2011

Audit of Impact of Changes to Road Design

Brian Bigger, C.G.A

Auditor General, City of Greater Sudbury

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/ Time Frame
1	The City should improve policies, procedures and reports supporting accountability for rejection of inferior products and enhanced follow-up on warranty issues.	X			Will formulate reporting procedure for test results. This can be completed within six months (March 2013).
2	The City should further investigate rejectable materials from previous and current projects, and establish appropriate remedies where warranty provisions allow.	X			Will monitor and continue to monitor areas already identified and determine corrective measures. This has been implemented.
3	The City should require asphalt suppliers to provide their quality control test results in accordance with OPS to Construction Services (as they become available) for all asphalt supplied to the City. Any deficiencies in the quality of the asphalt should be made known to management immediately so that corrective action can be taken if deemed necessary.	X			Asphalt suppliers will provide their quality controls results to Construction Services as per Ontario Provincial Standard Specification 310 Construction Specification for Hot Mix Asphalt Table 6 Sampling & Testing Frequency of Hot Mix Asphalt. This will be introduced starting January 1, 2013 and will become a standard for all future contracts. Contractors will be informed at the Annual Contractors Meeting.

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/ Time Frame
4	The City lab should immediately begin testing gradation and asphalt cement content according to the job mix formula as specified under OPSS 310 – Construction Specification for Hot Mix Asphalt.	X			Our laboratory started testing the gradation and asphalt cement content of the job mix formula in June 2012.
5	Costs and quantities related to major items used in change orders should be identified and tracked separately under the change order item in progress payments.	X			This was performed in the past when requested by the Project Manager. To be consistent, this had been implemented as of July 2012.
6	The City's current standard and tolerances to achieve a three percent cross fall on new construction, reconstruction or when grinding is done during a resurfacing or rehabilitation process, should be clearly stated in the contract.	X			Will state or indicate 3% crossfall and tolerances in standard drawings & specifications effective January 1, 2013. Contractors will also be made aware of this standard and tolerance at the Annual Contractors Meeting.
7	The City should improve policies, procedures and reports supporting accountability for rejection of incorrect cross fall as specified in the contract and/or drawings in order to comply with City standards.	X			Will research policies and procedures of the Ministry of Transportation and other municipalities in Ontario. Time frame may be 12 to 18 months.

Report# 2011INFRA04 – Impact of Changes to Road Design

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/ Time Frame
8	The City should communicate their willingness to accept RAP in the job mix formula for local roads in accordance with OPSS standards.	X			Will communicate our willingness and encouragement to local asphalt suppliers to use RAP in the production of hot mix asphalt. Will communicate this to contractors at the Annual Contractors Meeting.
9	The City should communicate their willingness to accept RAP mixed with Granular A and Granular B Type I in accordance with OPSS standards.	X			Will communicate our willingness and encouragement to local aggregate suppliers to use RAP in the production of granular products. This will be communicated to contractors at the Annual Contractors Meeting.
10	The City should continue to identify further opportunities for cost savings where road work is planned so that the asphalt removed from one road can be used on other nearby City use(s). The objective is to minimize trucking costs while recycling the greatest volume of RAP possible (in its highest and best use) to the advantage of the City.	X			Have performed this recommendation in the past and will continue to do so. Will continue to monitor best practices and other uses. (i.e. shouldering around guiderails, washouts, etc.).

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/ Time Frame
11	The City should continue to work with other interest groups and other Departments that could use the City's RAP in their nearby projects.	X			Have performed this recommendation in the past and will continue to do so. By January 2013, establish a request process where a master list will be created and maintained.
12	Ownership and disposition of RAP should be clearly stated in the contract documents.	X			Will include appropriate clauses in contract specifications for all future contracts starting January 1, 2013.
13	If alternate City uses are not identified for the RAP, they should be directed to go to the contractor.	X			Have performed this recommendation in the past and will continue to do so as contractors become better equipped to handle large volumes of RAP.

Value For Money

- The most notable of improvements expected as a result of this audit, will be to increase the effectiveness of the City's quality assurance procedures related to asphalt.
- The taxpayer's can be assured that in the future, asphalt producers will be accountable to deliver quality asphalt products in accordance with OPSS, and each producer's unique job mix formulas.
- Other recommended improvements are intended to achieve the highest and best value through:
 - a more consistent improvement of road cross fall to three percent, and an
 - increased focus on ways to save operating and capital costs by recycling the City's asphalt

Conclusion

- We were unable to develop a precise estimate of a dollar contribution or savings for this audit. Nevertheless, we are confident that very significant improvements to the City's quality assurance processes, and the City's ability to reject inferior materials or work for asphalt quality and road cross fall have occurred.
- We have ensured that both the City and local asphalt producers now have a heightened awareness of the value of RAP. Through the audit process, the Auditors, along with City staff have made it clear to asphalt producers that the City is willing to explore further opportunities to reduce operating costs and / or capital costs through increased recycling of the City's RAP. We expect that future benefits will be realized through the competitive bidding process.

"My interest is in the future because I am going to spend the rest of my life there."

Ralph Waldo Emerson