



OFFICE OF THE
City Auditor

Snow and Ice Control Cost Effectiveness

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The Office of the City Auditor conducted
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*International Standards for the
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Executive Summary

City Council approved the City's updated snow removal policy; Policy C409E – Winter Road Maintenance Program Policy (the Policy) on July 17, 2007. They also increased the Winter Road Maintenance budget by \$16.5 million to \$49 million for 2008. On September 17, 2008 City Council passed a motion that “the City Auditor complete an audit in 2009 on the cost effectiveness of the City's 2007/2008 snow removal policy.”

Roadway Maintenance used the additional dollars provided in 2008 to meet the Policy requirement of clearing snow from arterials and bus routes within 48 hours of the end of a storm five out of six times. They had not been able to do this in the past. Also, after Roadway Maintenance received the additional funding the number of collisions on snowy and icy roads decreased by 14% and citizen satisfaction increased by 9%. Overall citizen satisfaction is below 50%, but the majority of people who responded that they were dissatisfied with winter road maintenance were dissatisfied with residential street clearing, which is not the focus of the Winter Road Maintenance Program. Also, the number of inquiries from citizens regarding plowing, sanding and snow and ice increased by 15%. Roadway Maintenance has not determined citizen expectations since 1992. We recommended that Roadway Maintenance become more aware of citizen expectations.

Edmonton spends the most money on winter road maintenance compared to Calgary, Winnipeg, Saskatoon and Regina. However, winter road maintenance costs in different cities are affected by many things. For example, the costs to remove and store snow are less in Winnipeg and Calgary. In Winnipeg they do not have to remove snow from the majority of their streets due to the structure of their roadway system and in Calgary, they have warmer weather (chinooks) and thus less snow to remove. Edmonton has to remove and haul snow from the majority of the arterial and bus routes to ensure safe driving lanes throughout the winter season. After removing snow removal and storage costs Edmonton's cost per lane-kilometre per number of days with snowfall is actually lower than Winnipeg and Calgary.

Roadway Maintenance does not perform own vs. hire analyses for the equipment used in the Winter Road Maintenance Program. We completed an own vs. hire analysis for graders as part of the scope of this audit and determined that Roadway Maintenance is using an appropriate mix of hired and owned graders. However, we recommended that Roadway Maintenance complete own vs. hire analyses on all their winter road maintenance equipment on a regular basis to ensure they have the optimal mix of hired and owned equipment.

Due to the increase in funding received in 2008, and the many uncontrollable factors that affect spending on snow removal, it is difficult to use year over year cost comparisons to determine if Roadway Maintenance has become more efficient over time in conducting the Winter Road Maintenance Program. However, we did observe many areas where Roadway Maintenance is working efficiently. We found that

Roadway Maintenance is providing training to staff and hired equipment operators to ensure efficient use of equipment, materials and operator time. We also found that they are using predetermined routes for sanding and plowing to ensure they service roads in an efficient manner and that they are using criteria to ensure they deploy resources efficiently. We also found that Edmonton's Winter Road Maintenance Policy covers similar winter road maintenance activities to that of Calgary, Winnipeg, Saskatoon and Regina but at different service levels.

To reduce costs, the City could change winter road maintenance service levels and consider snow removal costs when designing new roads. Service level changes could include decreasing the use of hired equipment, decreasing the amount of snow removed, increasing the allowable time to clear sidewalks and decreasing the amount of residential plowing. There are risks associated with service level changes including decreasing citizen satisfaction and increasing costs in other areas like pothole repair and spring cleanup. As well, Council will have to approve changes to the policy for Roadway Maintenance to make some of the service level changes.

We also found that there is room for improvement to the winter road maintenance budget process to ensure the budget is reliable and appropriate. Roadway Maintenance is using a base budget each year to calculate the budget, but they are not reviewing the assumptions used to calculate this base on an annual basis. This budgeting process is a similar practice to the other municipalities we surveyed. It is also consistent with City-wide practices, as determined and reported on in our April 2009 Budget Review Report.

Snow and Ice Control Cost Effectiveness

1. Introduction

City Council approved the City's updated snow removal policy; Policy C409E – Winter Road Maintenance Program Policy (the Policy) on July 17, 2007. It also increased the Winter Road Maintenance Budget for 2008 by \$16.5 million to allow Roadway Maintenance to meet the requirements of the Policy. City Council passed a motion on September 17, 2008 that "the City Auditor complete an audit in 2009 on the cost effectiveness of the City's 2007/2008 snow removal policy."

2. Audit Objective, Scope, and Methodology

Audit Objective

The objective of this audit was to assess the cost effectiveness of the City of Edmonton's Winter Road Maintenance Program and Policy.

Scope

The scope of this audit includes the snow-related activities of the Winter Road Maintenance Program for the 2007/2008 winter season which runs from October 15 to December 31, 2007 and January 1 to April 15, 2008. It also includes cost comparisons for the budget years of January to December 2007 and 2008. The scope does not include spring clean-up activities, which include the removal and disposal of street sand.

Methodology

The methodology we followed to complete our assessment included:

- Comparing the 2007/2008 winter season performance to that experienced in the 2006/2007 winter season;
- Observing winter maintenance activities;
- Discussing service delivery with Roadway Operations staff;
- Reviewing performance measures results;
- Benchmarking winter maintenance services with those provided by other municipalities.

3. Winter Road Maintenance Program

3.1. Background

The Roadway Maintenance Section of the Transportation Operations Branch of the Transportation Department manages the Winter Road Maintenance Program. To facilitate management of the program the city is divided into five districts; North East, North West, Central, South East, and South West.

The 2008 approved operating budget for winter road maintenance was \$49.2 million, an increase of \$16.5 million over 2007. This budget includes funding for 182 full time positions (FTE's), the operation of 100 City-owned plow/sander trucks, 20 graders, 12 snow blowers, and 20 sidewalk plows. The budget also includes funding for hired equipment including approximately 149 hired graders, 100 dump trucks hired to haul snow to snow storage sites, 12 dozers used at snow storage sites, and five loaders used in the district yards to load snow melting materials. It also includes funding for sidewalk clearing contractors.

Roadway Maintenance maintains approximately 5,900 lane-kilometres of arterial, bus route and collector roads plus approximately 5,500 lane-kilometres of residential and local industrial roads when required. They are also responsible for 1,273 kilometres of sidewalks out of the total 4,835 kilometres of sidewalks in the City.

The purpose of the Winter Road Maintenance Program, as specified in the Policy, is to provide road safety while protecting the environment. The objectives are to:

- Minimize economic loss to the community;
- Prevent or reduce accidents and injury;
- Facilitate the handling of emergencies by emergency responders and police services.

The winter road maintenance budget is allocated to five key activities as follows:

**Table 1 - Winter Road Maintenance Budget
(Thousands of dollars)**

Activity	2007 Budget	2008 Budget	Increase
Plowing	\$8,862	\$17,837	\$8,975
Sanding	8,716	12,179	3,463
Snow removal	4,520	5,482	962
Sidewalk	3,371	5,281	1,910
Snow storage	984	1,312	328
	\$26,453	\$42,091	\$15,638
Other expenses ¹	6,242	7,093	851
TOTAL	\$32,695	\$49,184	\$16,489

There are many factors that will affect the actual amount of money spent on winter road maintenance. The environmental factors include:

- Amount and frequency of snowfall
- Temperature

¹ Other expenses are fixed equipment costs, supervision, training, snow removal at civic buildings, and other miscellaneous costs.

- Number of major snow storms
- Freeze/thaw cycles
- Drifting

Other factors impacting costs include:

- Service contract rates
- Hired equipment rates
- Residential plow cycles

3.2. Plowing

The Policy requires the City to plow snow from arterial and bus routes within 48 hours following the end of a storm to achieve bare pavement. To meet this requirement Roadway maintenance uses 100 City-owned truck plow/sanders, 20 City-owned graders and approximately 149 hired graders to clear snow from City roadways. Roadway Maintenance usually commences plowing with City-owned equipment after two to three centimetres of snow has accumulated on the roads. They will call in the hired graders after major storms to help meet the Policy requirements.



Roadway Maintenance will only plow residential streets when rutting or snow drifting occurs or to ensure the level snow pack does not exceed 10 centimetres in the driving lanes. Depending on the condition of the residential streets, they may choose to plow all residential streets or only specific sections of streets. Also, after receiving a complaint regarding a specific section on a residential street Roadway Maintenance will assess the condition and plow the street if required. In extreme situations, the City Manager can make the decision to plow residential roads to bare pavement.

Table 2 shows the budget vs. actual spending on plowing in 2007 and 2008.

Table 2 Budget vs. Actual Spending on Plowing in 2007 and 2008

	Budget	Actual	Budget Variance \$	Budget Variance %
2008	\$17,837,000	\$9,815,000	\$8,022,000	45%
2007	\$8,862,000	\$6,512,000	\$2,350,000	27%

Roadway Maintenance attributes under spending in 2008 to not having to call in the hired graders from October to December because there were no major storms. They attribute the 2007 under spending to fewer than anticipated major snowfalls and no residential street plowing cycles.

3.3. Sanding

The Policy states that crews will be on duty at all times from mid October to mid April to provide sand/salt mixture to meet weather conditions. Roadway Maintenance uses 100 City-owned truck plow/sanders to apply the sand/rock chip/salt mixture and a de-icing agent (calcium chloride) to City roadways whenever snow and ice on the pavement surface reduces traction. They use five hired loaders to load the sand/salt/rock chip mixture into the trucks. The amount and mix of materials used on each application depends on the temperature of the road surface. Roadway Maintenance uses de-icing materials on all arterial and bus routes as well as intersections leading onto these roads. Table 3 shows the amounts of sand, rock chips and salt used in the last three winter seasons.



Table 3 Snow and Ice Material usage by Winter Season (in tonnes)

Winter Season	Sand	Salt	Salt Chip	Total
2008/09	152,505	20,280	3,215	176,000
2007/08	137,494	22,464	3,876	163,834
2006/07	152,652	24,727	4,042	181,421

Table 4 shows the budget vs. actual spending on sanding in 2007 and 2008.

Table 4 Budget vs. Actual Spending on Sanding in 2007 and 2008

Year	Budget	Actual	Budget Variance \$	Budget Variance %
2008	\$12,179,000	\$11,159,000	\$1,020,000	8%
2007	\$8,716,000	\$7,763,000	\$953,000	11%

Roadway Maintenance attributes under spending on sanding in 2008 to their increased plowing and snow removal efforts prior to the snow melting. This did not allow the melting snow to freeze on the roads and require sanding. They attribute the under spending in 2007 to decreased requirements for sanding in January, March, October and November due to favorable weather.

3.4. Snow Removal

Roadway Maintenance removes the windrows of snow from business districts as required, usually within 24 hours of plowing. They also remove the windrows from arterials, bus routes and from school frontages when they become so large that they impede the driving lanes or sidewalks.



Each of the five districts usually run two snow removal crews during a snow removal cycle. Three to four hired graders lift the snow and ice from the gutters and position the windrow so a City-owned blower can blow the snow into a hired dump truck. There are usually between 10-14 hired dump trucks per crew depending on how close they are to a snow storage facility. Each crew has a foreman on site to deal with issues and two flag people.

Table 5 shows the budget vs. actual spending on snow removal in 2007 and 2008.

Table 5 Budget vs. Actual Spending on Snow Removal in 2007 and 2008

Year	Budget	Actual	Budget Variance \$	Budget Variance %
2008	\$5,482,000	\$6,100,000	\$(618,000)	11%
2007	\$4,520,000	\$2,232,000	\$2,288,000	51%

Roadway Maintenance attributes over spending in 2008 to higher than anticipated unit costs for hired equipment due to market conditions. They attribute the under spending in 2007 to not removing the snow from the collector and bus routes between January and May.

3.5. Sidewalks

Bylaw 14600 – Community Standards Bylaw, states that a person shall maintain any sidewalk adjacent to land they own or occupy clear of all snow and ice. The bylaw covers 4,835 kilometres of sidewalks. Roadway Maintenance and their contractors maintain 1,273 kilometres and citizens or businesses maintain the remaining 3,562 kilometres. Roadway Maintenance uses 20 City-owned sidewalk plow/sanders to service 481 kilometres of sidewalk and the contractors service the remaining 792 kilometres. This includes multi-use trails and sidewalks on public utility lots and around storm water ponds.



Table 6 shows the budget vs. actual spending on sidewalks in 2007 and 2008.

Table 6 Budget vs. Actual Spending on Sidewalks in 2007 and 2008

Year	Budget	Actual	Budget Variance \$	Budget Variance %
2008	\$5,281,000	\$4,539,000	\$742,000	14%
2007	\$3,371,000	\$4,119,000	\$(748,000)	22%

Roadway Maintenance attributes under spending in 2008 to the minimal amount of snowfall in October and November. They attribute over spending in 2007 to higher than anticipated contract costs due to the frequency of sidewalk snow plowing that was required.

3.6. Snow Storage Sites

The snow removal crews haul the snow to one of five City-owned snow storage sites. Four of these sites are also open to the public to dump snow. Roadway Maintenance hires 12 dozers to pile the snow in the winter and move it around to facilitate melting through the spring and summer. Dollars are also spent on cleaning and disposing of accumulated silt from the bottom of the ponds, erosion control, and environmental monitoring.



Table 7 shows the budget vs. actual spending on snow storage sites in 2007 and 2008.

Table 7 Budget vs. Actual Spending on Snow Storage Sites in 2007 and 2008

Year	Budget	Actual	Budget Variance \$	Budget Variance%
2008	\$1,312,000	\$5,163,000	\$(3,851,000)	294%
2007	\$984,000	\$6,615,000	\$(5,631,000)	572%

Roadway Maintenance attributes \$3.1 million of the over spending in 2008 to the under funding of erosion control and snow site clean-up in the 2008 Budget. The remaining amount is due to more than anticipated hired equipment hours used to stack and move snow to increase melting rates. They attribute \$5.1 million of the over spending in 2007 to the under funding of environmental issues and pond clean-up in the 2007 Budget.

4. Observations and Analysis

4.1. Cost Effectiveness

4.1.1. Actual spending and results

How much did the City spend on the Winter Road Maintenance Program?

Roadway Maintenance spent \$46.6 million in 2008 and \$34.6 million in 2007.

Table 8 shows the budget vs. actual spending on the Winter Road Maintenance Program in 2007 and 2008. In 2008, City Council approved a \$16.5 million increase in the Winter Road Maintenance Program Operating Budget to meet the requirements of the Policy. Roadway Maintenance actually increased spending by \$12.0 million.

Table 8 Budget vs. Actual Spending on the Winter Road Maintenance Program for 2007 and 2008

Year	Budget	Actual
2008	49,184,000	46,640,000
2007	32,695,000	34,622,000
Difference from 2007 \$	16,489,000	12,018,000
Difference from 2007 %	50%	35%

What did the City get for the extra dollars spent?

In the 2007/08 winter season, Roadway Maintenance met the Policy requirements for plowing five out of six times, citizen satisfaction increased by 9%, and number of collisions decreased by 14%; however, citizen inquiries and complaints in 2008 increased by 15%.

Met the Policy requirements for plowing:

The Policy states that the City will plow snow from arterials and bus routes within 48 hours following the end of a snow storm to achieve bare pavement. Before the 2007/2008 winter season Roadway Maintenance had not been able to meet this requirement due to the unavailability of the required graders when they needed them.

In order to meet this requirement in the 2007/2008 winter season, Roadway Maintenance put approximately 154 hired graders/operators on retainer to ensure they would be available after a storm. This costs the City \$150 per day per grader. The total cost of the retainer for the 2007/2008 winter season was \$3.4 million.

The addition of the hired grader retainer and the purchase of seven additional truck plow/sanders helped Roadway Maintenance meet the Policy requirement five out of six

times in the 2007/08 winter season and three out of three times in the 2008/09 winter season.

Number of collisions:

The objective of the Policy is to prevent or reduce accidents and injuries. The Edmonton Police Service (EPS) records the number of collisions on City roads and the road condition at the time of the collision. In the 2007/2008 winter season the EPS recorded 6,420 collisions when streets were snowy or icy and in the 2006/2007 winter season they recorded 7,494 collisions.

Collision data on its own cannot be used to measure the effectiveness of the winter road maintenance program as shown by the fact that there are actually more accidents on the roads when they are dry. In 2008 there were 12,886 collisions on dry streets and 6,600 collisions on snowy and icy streets.

Citizen satisfaction and inquiries:

The City conducts an annual Citizen Budget Survey that includes questions on citizen satisfaction with winter road maintenance. In 2008, citizen satisfaction with winter road maintenance increased to 45% from the 36% in 2007.

The survey also asks the people who were dissatisfied to provide the reason for their response. The most frequent response in both 2007 and 2008 was related to residential street clearing. In 2007, a number of citizens also identified dissatisfaction with grading of roads. This was not a reason in the 2008 survey results.

Although satisfaction remains below 50%, the citizens that are dissatisfied appear to be focusing on residential street clearing not arterials and bus routes, which are the main focus of the Winter Road Maintenance Program.

The City also keeps track of the number of inquiries and complaints received regarding sanding, plowing and snow and ice. Although service to arterial and bus routes increased in 2008 due to additional funding, there were still more complaints and inquiries than in 2007. In 2008 there were 6,920 inquiries and complaints and in 2007 there were 6,012. Inquires are not categorized into those relating to residential roads and those relating to arterial and bus routes.

Roadway Maintenance has not conducted an in-depth analysis of citizen expectations of the Winter Road Maintenance Program since 1992. There may be an advantage to getting a better understanding of citizen expectations while ensuring they are aware of the costs associated with each activity. Roadway Maintenance should share the results with City Council to ensure they are making informed decisions about service level changes to the winter road maintenance program. **Recommendation 1**

4.1.2. Opinion on cost effectiveness

The increase in funding allowed Roadway Maintenance to meet the operational requirements of the Policy. There was an increase in citizen satisfaction with winter road

maintenance and a decrease in collisions after the funding was increased. However, there was an increase in the amount of citizen complaints and inquiries regarding sanding, plowing and snow and ice. Also, citizen satisfaction remains below 50%.

4.2. Reliable and Appropriate Budgeting

Does Roadway Maintenance have a reliable and appropriate method to prepare the budget for the Winter Road Maintenance Program?

In our opinion there is room for improvement in the budget process to ensure the Winter Road Maintenance Budget is reliable and appropriate.

Roadway Maintenance uses the Winter Road Maintenance Program budget from the previous year as a base for the current budget. They increase this base for inflation and approved service level increases each year. When available they use actual rates for certain items like hired equipment and contracts. Roadway Maintenance bases the current budget base amount on assumptions that include the average number of plowing cycles required each year, the average number of pass kilometres sanding trucks will make each year and the 30-year normal amount of snowfall as determined by Environment Canada. However, they do not assess the appropriateness or reliability of the base amount on an annual basis. The other cities we surveyed (Calgary, Winnipeg, Regina and Saskatoon) all prepare their Winter Road Maintenance Program budget in a similar manner.

We looked at the budget to actual variances for the past five years and compared them to the actual amount of snowfall and the 30-year normal amount of snowfall from Environment Canada. Table 9 shows that in the last five years the variance between budget and actual has been over or under by less than 6% for three of the years and over by 30% for two of the years, which were when Edmonton experienced higher than normal snowfall.

Table 9 Budget Variance vs. Snowfall Amounts

Year	Budget vs. Actual Variance	Amount of Snow (in cm)	Difference from normal snowfall of 121.4 cm
2008	5% under	100.2	(21.2)
2007	6% over	110.3	(11.1)
2006	31% over	149.5	28.3
2005	3% under	87.3	(34.1)
2004	30% over	147.4	26

Although Roadway Maintenance is preparing their budget in a similar manner to other cities, there is room for improvement to ensure the appropriateness and reliability of the base amount used. In our Budget Process Review released on April 2, 2009 we reported

that this is a City-wide issue and the City administration will be addressing this observation for the 2010 budget.

4.3. Resource Mix and Efficiency

4.3.1. Resource mix

Is Roadway Maintenance using an appropriate mix of resources (City-owned and contracted) to conduct the Winter Road Maintenance Program?

Roadway Maintenance does not complete own vs. hire analyses for any of their equipment so we are unable to conclude on whether or not they are using an appropriate mix of resources. We completed an own vs. hire analysis on graders and concluded that Roadway Maintenance is using an appropriate and cost effective mix of hired and owned graders.

We compared the actual operating costs in 2008 for the City's 20 graders and the approximately 149 hired graders and operators to the estimated operating costs had the City owned all 169 graders. We found that the City would have saved approximately \$470,000 in operating costs if it had owned and operated all 169 graders instead of hiring 149 of them. However, after factoring the costs to purchase 149 graders (\$54 million) and the land to store them on (\$24 million), plus the need to find enough operators and mechanics to operate and maintain them, plus the fact that the City only utilizes approximately 10 graders year-round, we concluded that the City is better off hiring the additional graders when they need them. Even if the City purchased just one more grader, at the current rate of savings the pay-back period would be 117 years.

However, as the City grows and Roadway Maintenance needs more graders in the summer and winter, there may be a benefit to the City purchasing more graders. Roadway Maintenance needs to regularly analyze their grader needs and determine if it is more cost effective for them to own or hire them.

Roadway Maintenance also needs to regularly perform own vs. hire analyses on the other equipment it uses in the Winter Road Maintenance Program. The City may not have the optimal mix of hired and owned equipment or there may be potential for cost savings in the future based on results of these types of analyses. **Recommendation 2**

4.3.2. Efficiency

Is Roadway Maintenance using resources efficiently to conduct the Winter Road Maintenance Program?

We found that Roadway Maintenance is providing training to staff and hired equipment operators to ensure efficient use of equipment, materials and operator time. We also found that they are using predetermined routes for sanding and plowing to ensure they service roads in an efficient manner and that they are using criteria to ensure they deploy resources efficiently.

To determine the efficiency of the winter road maintenance program we spent time observing the winter road maintenance operations. We also determined if Roadway Maintenance is using technology to try to increase their efficiency. Due to the increase in funding received in 2008 and the many uncontrollable factors that effect spending on snow removal, it is difficult to use year-over-year cost comparisons to determine if Roadway Maintenance has become more efficient over time in conducting the Winter Road Maintenance Program.

An example of the efficient use of City-owned resources is that in December of 2008, Edmonton received 26 centimetres of snow, spread out over the entire month, and did not call in the hired graders. Roadway Maintenance was able to ensure they plowed all streets in the 48 hour timeframe allowed by the Policy using City-owned resources.

Areas of efficiency that we observed are:

- Roadway Maintenance plows and sands all roads and sidewalks based on predetermined routes. The predetermined routes ensure that all roads are appropriately serviced in the most efficient manner. This also prevents duplication of effort as each operator reports where they ended on the route so the next operator knows where to start their shift. Roadway Maintenance management reviews the routes each year to ensure they are still the most efficient and to ensure that all new roads are included.
- All Winter Road Maintenance personnel attend a snow and ice seminar and all hired grader operators attend a training session at the beginning of each season. The City staff training covers material from the Snow and Ice Control Manual as well as other topics such as safety, environmental issues, and City Employee Code of Conduct. The hired grader training goes over safety, environmental issues, and arterial and collector snow plowing requirements.
- Resource deployment depends on the road and weather conditions. The supervisors and foremen constantly monitor road and weather conditions to ensure they are deploying the appropriate resources. The General Supervisor of each district determines when to extend the shifts of City workers and the Director of Roadway Maintenance determines when to bring in the hired graders.

We found that the Transportation Department is constantly looking for new technology or ways to improve current technology to help enhance the efficiencies of the Winter Road Maintenance Program or make roads safer in the winter. These are some examples of technology and techniques they are currently researching:

- Optimal blend of chips and sand that will lead to better braking and control on the roads,
- Snow melting technology,
- Improved equipment technology:
 - Sander controls,
 - GPS in trucks,
- Fixed Automatic Spray Technology (FAST) that will spray a liquid de-icer onto the deck of a bridge when needed,

- Technology that reduces the amount of waste in the snow storage ponds or decreases the cost of cleaning it out.

4.4. Comparison to Other Cities

We surveyed four other western Canadian winter cities to see how Edmonton’s Winter Road Maintenance Program costs compared. Calgary, Winnipeg, Saskatoon, and Regina were selected due to their similar economic and/or winter weather conditions.

4.4.1. Survey results

The results of our survey show that Edmonton is spending the most money on winter road maintenance. It also spends the most per lane-kilometre of road serviced, per centimetre of snow, per day with snowfall, and per capita. Edmonton also spends the highest percent on external service providers (hired equipment and service providers) and the third highest percent on materials. Table 10 shows the cost comparison between Edmonton and the other cities.

Table 10 Comparison to Other Cities

City	2008 Actual \$ (millions)	% to external service providers	% to materials	\$/lane-km of road (including residential)	\$/cm of snow	\$/# of days with snowfall	\$/capita
Edmonton	\$46.7	49%	13%	\$4,069	\$465,462	\$475,912	\$62
Winnipeg	\$29.8	27%	11%	\$3,872	\$316,030	\$381,667	\$44
Calgary	\$23.9	5%	18%	\$2,952	\$125,742	\$284,417	\$23
Saskatoon	\$5.0	5%	17%	\$1,552	\$107,973	\$110,372	\$25
Regina	\$4.2	14%	9%	\$704	\$72,324	n/a	\$21

There are many factors that affect the costs of winter road maintenance in the different cities including:

- Weather (temperature, amount of snow, frequency of snow)
- City road structure (room to store snow beside streets or not)
- Amount of lane-kilometers serviced
- Snow removal and storage costs
- Labour rates (internal and external)
- Snow and ice control policy requirements
- Sidewalk policy or bylaw requirements

4.4.2. Policy comparison

We compared Edmonton’s Winter Road Maintenance Policy to that of the other cities we surveyed. While all of the policies cover similar winter road maintenance activities and include a system to prioritize roads, they are not all the same when it comes to service level. For example:

- Edmonton’s Policy states that they will plow snow from all arterial and bus routes within 48 hours following a storm. The other cities set different timelines depending on

the priority level of the road. The longest time allowed by Winnipeg to complete plowing of all arterials and collectors is 12 hours less than Edmonton, Regina allows 12 hours more, Saskatoon allows 24 hours more, and Calgary's policy does not include timeframes.

- Edmonton's Policy allows for snow pack up to 10 centimetres on residential roads before plowing commences, Saskatoon allows for ruts up to 15 centimetres before plowing.
- Edmonton's policy states that they will plow snow from sidewalks adjacent to City owned land within 48 hours to meet the requirements of Bylaw 5590, Section 801. Only Winnipeg commits to doing this in less time (36 hours). Regina sets a timeframe of 72 hours, while the other cities do not set timeframes for clearing sidewalks.
- All cities, including Edmonton, commit to removing snow from designated streets and areas, including arterials and collector roads, emergency access roads, bus lanes, schools, handicap loading zones, etc. Some cities include height restrictions on windrows that trigger snow removal. Only Edmonton's Policy is specific about where snow is taken to. Some of the other cities are able to use snow blowers to move snow to a different location, like boulevards or nearby private property instead of hauling it away like Edmonton.

Appendix 1 includes a more detailed comparison of Edmonton's Winter Road Maintenance Policy to that of Calgary, Winnipeg, Saskatoon and Regina.

4.4.3. Comparison after removal of snow removal and storage costs

We also found one of the largest differences between Edmonton and the other cities is the amount of money each city spends on snow removal and storage. In 2008, Edmonton spent 24% (\$11.2 million) of their total winter road maintenance dollars on snow removal and storage. In contrast, Winnipeg spent 8% (\$2.4 million) and Calgary spent 2% (\$0.5 million) of their winter road maintenance dollars on snow removal and storage. The amount spent on snow removal depends considerably on the road structure of the City. For example Winnipeg's roads have room to store snow beside them, while in Edmonton most of the arterial and bus routes have sidewalks right beside the road.

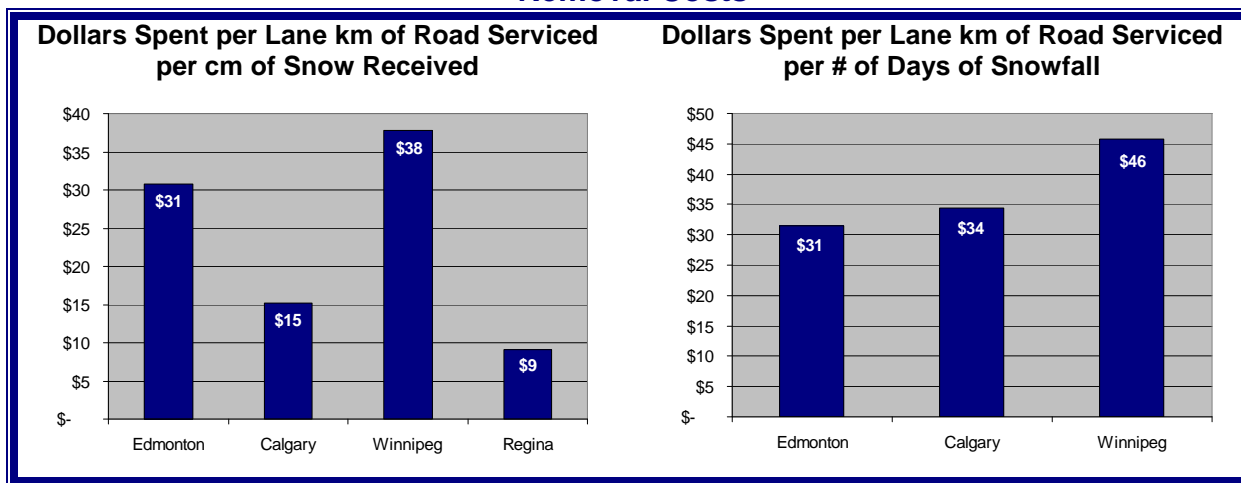
When we remove the snow removal and storage costs from the total Winter Maintenance costs, Edmonton's costs per lane-km, per centimetres of snow and per number of snowfalls are more comparable to Winnipeg and Calgary.

Table 11 Comparison to Other Cities - Excluding Snow Storage and Removal Costs²

City	2008 Actual \$ (in millions)	\$/lane-km of road	\$/cm of snow	\$/# of snowfalls
Edmonton	\$35.4	\$3,086	\$353,056	\$360,981
Calgary	\$23.4	\$2,893	\$123,221	\$278,714
Winnipeg	\$27.4	\$3,565	\$290,977	\$351,410
Regina	\$3.2	\$536	\$55,053	n/a

Also, when snow removal costs are removed, Edmonton’s costs per lane-kilometre per centimetre of snow or number of days with snowfall are more similar to the other cities.

Chart 1 Cost Comparison using Two Factors - Excluding Snow Storage and Removal Costs³



4.4.4. Opinion on comparison to other cities

This analysis shows that while Edmonton does have the highest costs for winter road maintenance the variables that determine spending are different in each city and need to be considered when comparing the cities. When taking these factors into consideration Edmonton’s costs do become similar to some of the other cities, but not all. Comparing Edmonton’s Policy to the other cities has pointed out some areas of potential savings for Edmonton. These areas are discussed in the following section.

4.5. Areas of Potential Savings

Listed below are areas where we believe the City could save money on winter road maintenance. The potential savings may require changes to the Policy and have associated risks. These risks include decreasing citizen satisfaction, increasing

² We did not include the results from the City of Saskatoon in this analysis because they did not provide us with their snow removal costs.

³ We did not include the results for the City of Regina in the “Dollars spent per lane km of road serviced per number of days snow fell because they did not provide us with the total number of days snow fell.

complaints, not meeting the current Policy requirements, and increasing pothole repair and spring clean up costs.

4.5.1. Decrease the use of hired graders

In 2008 Roadway Maintenance spent a total of \$7.9 million on hired graders. The retainer was \$3.4 million and actual usage costs were \$4.5 million. On April 15th, 2009 Council approved the elimination of the hired grader retainer for the remainder of 2009 for a savings of \$1.755 million. The retainer has also been eliminated in the 2010 budget. By changing the Policy requirements to allow more time to complete the plowing of bus routes, Roadway Maintenance could also reduce the use of hired graders. Roadway Maintenance may have to alter the service level they currently provide to eliminate the clearing of windrows in front of schools, bus stops and driveways during plowing if they use fewer graders as these extra services are not easy to perform with the City-owned truck plow/sanders.

4.5.2. Decrease the amount of snow removed

In 2008, Roadway Maintenance removed snow from approximately 950 kilometres of roadway at a cost of \$6.1 million. That is approximately \$6,400 per kilometre. Currently the Policy requires Roadway Maintenance to remove snow from arterials, bus routes, and other roadways carrying in excess of 1,500 vehicles per day when the driving width or parking area restricts safe vehicular movement. Removing less snow would also decrease snow storage costs. In 2008, these costs were \$5.2 million.

4.5.3. Consider snow removal costs in new road development

By designing roads and subdivisions to eliminate the need for snow removal, the Transportation Department could save approximately \$6,400 per kilometre in snow removal costs for each snow removal cycle completed in a year. If the Transportation Department designs roads to provide adequate room to store snow on or near the road then Roadway Maintenance may not need to remove the snow.

4.5.4. Increase allowable sidewalk clearing response time

The Policy states that the City will plow snow from sidewalks adjacent to City-owned land within 48 hours to meet the requirement of Bylaw 5590, Section 801. In 2008, Roadway Maintenance spent \$1.7 million on contractors to meet this requirement. However, in February 2008 the City consolidated this part of Bylaw 5590 into Bylaw 14600, the Community Standards Bylaw, and did not include the 48 hour timeframe. Bylaw Enforcement's internal procedures include allowing a 48 hour grace period before inspecting any sidewalks and ticketing offenders. Increasing this grace period for sidewalks adjacent to City-owned lands, especially those not on road right-of-ways and using fewer contractors will reduce costs.

4.5.5. Decrease the amount of residential plowing

There is the potential to decrease snow plowing costs if the maximum height of the snow pack allowed on residential streets is increased. Currently the Policy allows for a level snow pack depth of 10 centimetres. It costs the City \$200,000 for one residential plow cycle that is completed by the City-owned truck plows to maintain a level snow pack. It

costs the City approximately \$5.0 million to do a cycle of residential plowing with graders down to bare pavement.

5. Conclusion

The objective of this audit was to assess the cost effectiveness of the City's Winter Road Maintenance Program and Policy.

City Council approved additional funding for Winter Road Maintenance in 2008. Roadway Maintenance used this money to meet Policy requirements for the first time, which led to an increase in citizen satisfaction. Also the number of collisions decreased. However there was also an increase in citizen inquiries and citizen satisfaction remains below 50%.

We found that Edmonton's Policy has similar activities to other Western Canadian winter cities, but with differing service levels and that Edmonton spends the most money on winter road maintenance compared to the other cities we surveyed. However, there are many factors that affect the amount of money spent on winter road maintenance in each of the Cities we surveyed including weather and city design. Edmonton is designed with curb lined sidewalks and spends 24% of their total winter road maintenance dollars on snow removal and storage while Winnipeg has mainly boulevard walks and spends 8% and Calgary has warmer weather (chinooks) and spends 2%. Edmonton is also not conducting regular analysis of whether they should be purchasing or hiring equipment.

We did not find any other areas to improve efficiencies in the Winter Road Maintenance Program operations. We determined that there is potential to reduce winter road maintenance costs by modifying service levels and considering snow removal costs when designing new roads. We recommended that Roadway Maintenance take steps to understand citizen expectations regarding the service level and costs of the Winter Road Maintenance Program.

We also found that Roadway Maintenance has room for improvement in their budget process to ensure the appropriateness and reliability of the budget produced. This was covered for the City as a whole in our Budget Process Review released on April 2, 2009.

The Office of the City Auditor thanks the management and staff of Roadway Maintenance for their cooperation and assistance during this audit.

6. Recommendations and Management Responses and Action Plans

We are making two recommendations to improve the cost effectiveness of the Winter Road Maintenance Program.

Recommendations	Management Response and Action Plan
<p>1. We recommend that Roadway Maintenance take steps to understand citizen expectations regarding the service level and costs of Edmonton’s Winter Road Maintenance Program. They should include these results as part of the Roadway Maintenance performance reporting to City Council.</p>	<p>Accepted Comments: <i>Roadway Maintenance will initiate a public consultation process to get a better understanding of citizen expectations and how these expectations align with current service levels and to educate the public on the policy requirements and associated costs of the winter road maintenance program.</i></p> <p>Planned Implementation: <i>This process will be implemented during the 2009/2010 winter season.</i></p> <p>Responsible Party: <i>Director of Roadway Maintenance</i></p>
<p>2. We recommend that Roadway Maintenance prepare a regular analysis, for each type of equipment used in the Winter Roadway Maintenance Program, on whether it is more cost effective for the City to own and operate the equipment or contract the equipment and operator.</p>	<p>Accepted Comments: <i>Roadway Maintenance will identify the various equipment types used in winter road maintenance and complete an analysis for each equipment type. This analysis will look at the cost effectiveness of the City owning and operating these various equipment types verses contracting the equipment and operator as well as the market availability for contracting these services. We propose that this type of analysis be completed every 3 to 5 years.</i></p> <p>Planned Implementation: <i>This analysis will be initiated in the fall of 2009 to be completed during the 2009/2010 winter season.</i></p> <p>Responsible Party: <i>Director of Roadway Maintenance</i></p>

Appendix 1 – Winter Road Maintenance Policy Comparison

The following is a summary prepared by the OCA based on the Snow and Ice Control Policies for each city at the time of this audit.

	Edmonton	Calgary	Winnipeg	Regina	Saskatoon
Priority/ Category 1	River valley hills, bridges, grade separations, freeways, and business areas.	Central business districts (CBD), high volume arterials, and designated emergency routes.	All regional streets and some streets to facilitate ambulance access to hospital.	Freeways/ expressways, major arterial roads and designated emergency routes.	Roadways with high volume and some designated roads with lower volumes.
<i>Timeframe</i>	<i>Within 48 hours</i>	<i>No timeframe</i>	<i>Within 36 hours</i>	<i>Within 24 hours</i>	<i>Within 12 hours</i>
Priority/ Category 2	Arterial Roadways	Designated mid volume streets, traffic lights and controlled crosswalks, and designated emergency routes.	Non-regional bus routes and collector streets based on traffic counts.	Minor arterial roads, major collector roads (high volume), and all roads in the areas referred to as Regina Downtown.	Roadways with lower volume than Priority 1 and some designated roads with even lower volumes, streets adjacent to emergency facilities, and BRT bus routes.
<i>Timeframe</i>	<i>Within 48 hours</i>	<i>No timeframe</i>	<i>Within 36 hours</i>	<i>Within 36 hours</i>	<i>Within 36 hours</i>
Priority/ Category 3	Collector I Roadways - carries vehicles between Arterial and Residential roadways.	Designated feeders, collectors, and bus routes.	Residential and little used industrial streets.	Major collectors (mid volume), minor collectors, industrial roads, transit, and truck routes.	Remainder of the arterials and collectors, local bus routes, and access to schools.
<i>Timeframe</i>	<i>Within 48 hours</i>	<i>No timeframe</i>	<i>Within 5 days of commencement</i>	<i>Within 48 hours</i>	<i>Within 72 hours</i>
Priority/ Category 4	Collector II Roadways - Designated bus routes through residential areas.	Residential spot sanding at playgrounds, and designated hills. Plowing impassable sections.	n/a	Minor collector roads and major residential roads leading to schools.	n/a
<i>Timeframe</i>	<i>Within 48 hours</i>	<i>No timeframe</i>		<i>Within 60 hours</i>	
Residential and Alley	Priority 6 - Bladed to maintain snow pack condition only.	Priority 4 - Alleys are only sanded or plowed if required for garbage pick up.	Priority 3 – Residential: maintained to snow pack conditions after 10cm of snow Alleys: maintained to snow pack conditions after 5cm of snow.	Residential (Category 5) and Alleys – Triggered by 25cm accumulation during a single snow event. Residential - Maintained to snow pack conditions of 10cm or less.	Looked at once priority roads are completed. Cleared to packed snow when ruts greater than 15cm.

<i>Timeframe</i>	<i>No time frame</i>	<i>No time frame</i>	<i>Residential - Within 5 days of commencement. Alleys - Within two days following the end of a storm.</i>	<i>Residential - Completed 21 days following completion of main plowing. Alleys – Within 96 hours.</i>	<i>Impassable roads done within 5 days of a storm. Alleys – Maintained to passable conditions.</i>
Rural Roadways	Priority 5	Not mentioned	Not mentioned	Not mentioned	Included with residential
<i>Timeframe</i>	<i>No time frame</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Snow Removal	Removed from business districts as required, when the driving width or parking area restricts safe vehicular movement on arterials, bus routes, other roadways carrying in excess of 1500 vehicles per day, and when abutting school zones and emergency access routes.	Commences when plowed snow impedes traffic in the CBD and on major arterial roadways.	Removed on Priority I and II streets from bridges and underpasses, when traffic lanes are reduced, when movement of pedestrians is prohibited, and beside guardrails and impact barriers. Will mechanically blow snow to adjacent properties to accommodate snow storage.	Removed from school bus unloading zones, designated seniors complex unloading zones, and disabled metered parking stalls. Will remove snow when height is not in compliance with traffic bylaws at intersections adjacent to schools, on category 1 and 2 roads, and at signal controlled pedestrian corridors.	Limited to the central business district and Priority 1 and 2 streets. Windrows that exceed 60cm will be removed from the right-of-ways adjacent to elementary schools. Snow at principal intersections will be removed in order to maintain adequate sight lines.
Sidewalks	Plow snow from sidewalks adjacent to city owned land within 48 hours to meet requirements of Bylaw 5590.	Prioritized clearing of specific malls, overpasses, steps, and sidewalks adjacent to majors, collectors, and bus routes where snow clearing is not the owner's responsibility.	Priority I, II and III (residential) - Sidewalks maintained to a compact snow surface. Priority I and II in downtown - Maintained to bare pavement.	Maintain sidewalks adjacent to City owned building or property, bridge deck or subway, transit stops on the Heritage bus route which are not covered by the Clean Property Bylaw and designated senior's complex's to compact snow surface of 5cm or less.	Maintain sidewalks adjacent to major arterial and collector streets, bus routes, elementary and secondary schools, university and SIAST campus', hospitals, senior's multi-housing units and other designated sites to compact snow surface.
<i>Timeframe</i>	<i>Within 48 hours</i>	<i>No time frame</i>	<i>Priority I and II - within 36 hours. Residential - within 5 days of commencement.</i>	<i>Within 72 hours of freezing rain. No time frame for other snow events. (Not plowed during snow events.)</i>	<i>Typically takes 5 days following a snow event.</i>