BMA
Management Consulting Inc.

Internal Audit
Winter Maintenance

City of Greater Sudbury

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Executive Summary

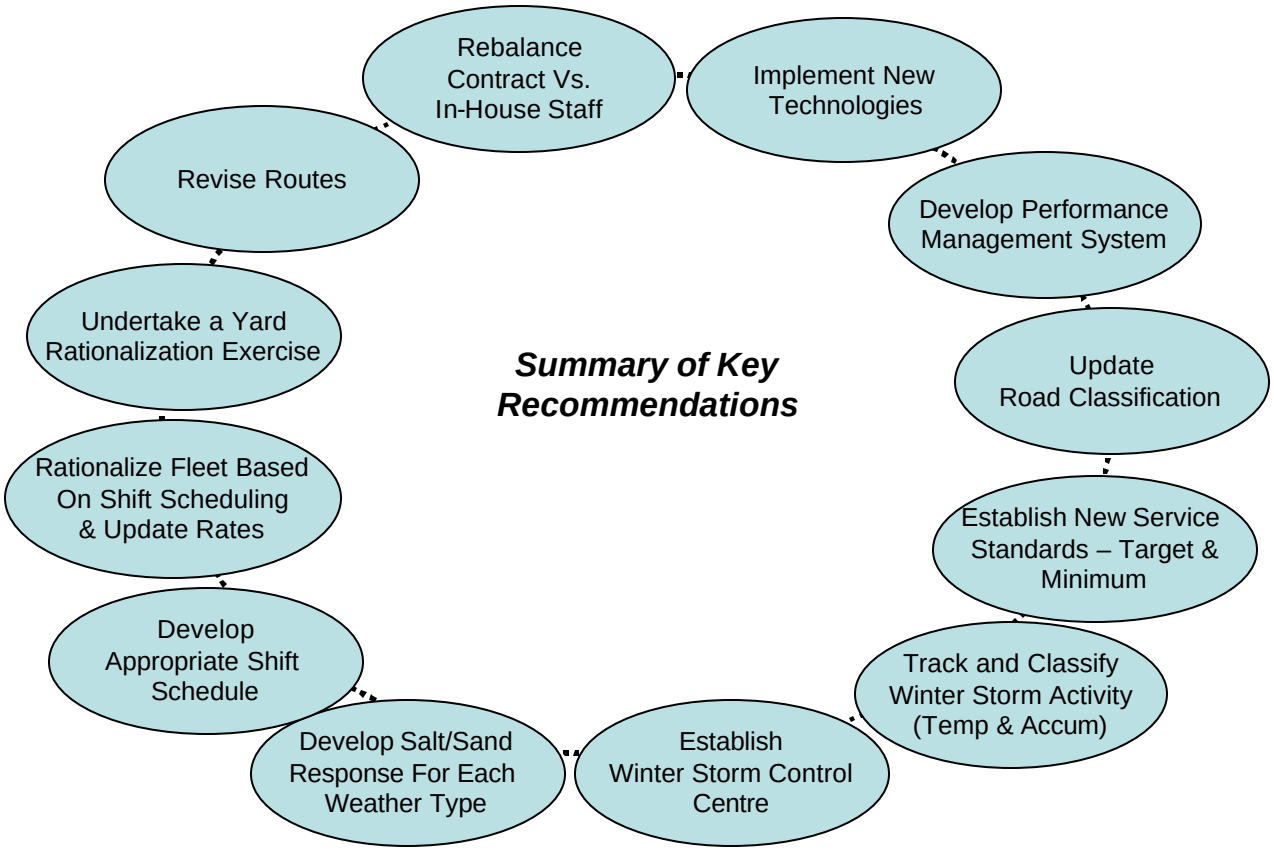
A detailed review of the winter maintenance activities and operations was undertaken with the objectives of ensuring that the City is:

- Acquiring the appropriate type, quality and amount of resources at an appropriate cost;
- Avoiding duplication of effort by employees and work that serves little or no purpose;
- Avoiding idleness and overstaffing;
- Using efficient operating procedures;
- Using the optimum amount of resources (staff, equipment and facilities) in producing or delivering the appropriate quantity of goods or services in a timely manner;
- Using an adequate management control system for measuring, reporting and monitoring a specific program's economy and efficiency;
- Reporting measures of economy and efficiency that are valid and feasible;
- Assessing the effectiveness of the program and/or individual program components;
- Identifying factors inhibiting satisfactory performance;
- Identifying ways of making programs work better;
- Assessing compliance with laws and regulations applicable to the program;
- Assessing the adequacy of the management control system for measuring, reporting and monitoring a program's effectiveness; and
- Determining whether management has reported measures of program effectiveness that are valid and reliable.

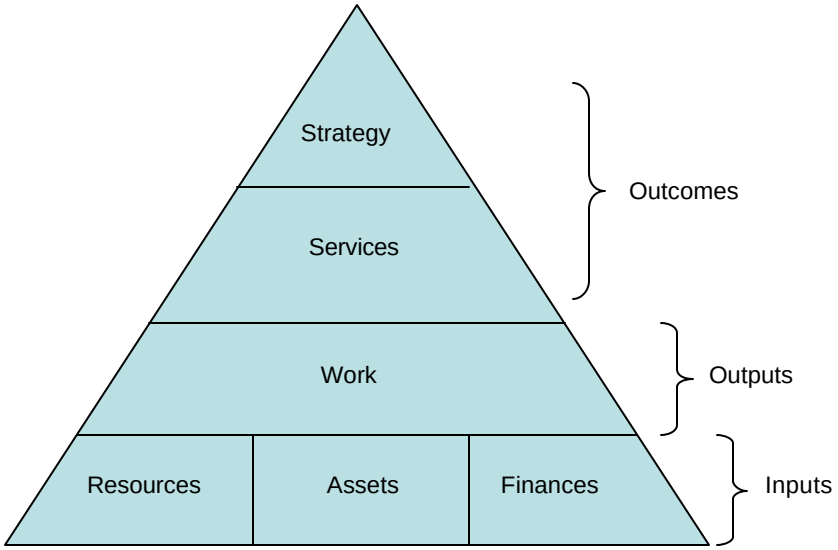
The review included but was not limited to an analysis of staffing, contracting, yards/ deployment centres, fleet management, budget and actual expenditures, work practices, road classifications, service standards, storm tracking and responses as well as performance management.

The report provides an overview of the existing practices, an analysis of other opportunities to create efficiencies and improve the delivery of service, best practices identified in Ontario as well as specific recommendations. In many cases, models were developed to illustrate the proposed change in standards, processes, strategies, services, resources and assets, beyond that included in a traditional internal audit. While further analysis and fine tuning will be needed in some cases, with additional input from management and staff, this report will provide an excellent basis upon which to guide the process moving forward as well as to manage change. A number of opportunities have been identified to improve the service delivered in terms of efficiencies and effectiveness. Some recommendations contained in this report will require a wholesale change in work practices. As such, training and mentoring is needed to effectively facilitate change.

The following chart reflects the key recommendations. The recommendations contained in this report are **largely integrated**, requiring acceptance of multiple changes to achieve the desired results of improved efficient and effective delivery of service. For example, the implementation of a multiple shift structure (e.g. 2 shifts) will have a direct impact on the fleet size of vehicles needed and the balance of contracted versus in-house services. A decision to reduce the number of deployment centres (e.g. from 5 to 3) will have a direct impact on routes and supervisory staffing levels. The establishment of new outcome-oriented service standards (target and minimum) will have a direct impact on staffing and equipment deployment. The development of storm classifications and associated service responses will have a direct impact on staffing, materials and the use of technology to support decision-making. Decisions on employing new technology will impact the staff as well as provide an opportunity to improve customer service.



Implementation of changes to achieve best practices in the City of Greater Sudbury will require the development of a business model that will clearly articulate the strategies, services, work practices, resources, assets and finances. This will become the cornerstone upon which winter maintenance will be provided in the City. The following provides a schematic diagram of the proposed business model.



It is anticipated that implementation of the changes identified in the report could reduce operating costs to the City by approximately $2.4 million, as well as avoiding significant capital outlays that will not be needed in the future. The following table reflects a summary of the current spending and the proposed budget, based on changes recommended in the report.

Winter Activity	Current 4yr avg	Proposed	Difference
Plowing and spreading	$ 6,672,000	$ 4,670,400	($2,001,600)
Ditching & Spring cleaning	$ 1,418,000	$ 1,134,000	($284,000)
Snow Removal	$ 1,091,000	$ 840,000	($251,000)
Misc Winter	$ 878,000	$ 878,000	$0
Sidewalks	$ 712,000	$ 854,000	$142,000
NET Winter Ops	$ 10,771,000	$ 8,376,400	($2,394,600)

Summary of Recommendations

That Senior management implement a business model in the Road Services Division and provide the necessary training and resources to implement the plan.

That Public Works management explore the opportunities to reduce overtime costs, reduce equipment inventories and increase the effectiveness of service delivery by moving to a shift work cycle, designed to meet the specific needs of the City and in accordance with best practices.

That the City monitor the balance of in-house services and contracted services to ensure that the most efficient and effective service delivery model is provided, where consideration is given to the base number of staff needed to provide year round service.

That the City rationalize the winter in-house fleet should changes be implemented in shift practices, deployment centres and routes, with an expectation that the fleet size will reduce by approximately 40-45%. This will result in an estimated reduction in future purchases between 2006-2009 of $4 million.

That the revenues associated with the sale of vehicles deemed to be surplus be placed in a reserve to fund for future equipment replacement and retrofitting costs as outlined in this report to accommodate such technology as GPS and spread rate calibration capabilities.

That the budget be adjusted to reflect the true cost of winter vehicle replacement.

That management undertake a review of the existing fleet to identify the appropriate mix of vehicles and equipment to be maintained based on best practices identified in the report.

That a cost benefit analysis be undertaken to identify the appropriateness of the existing contracts, use of equipment and route deployment.

That the primary winter in house and contractor fleet be outfitted with electronic spreader controls with real time transponders to the Winter Roads Control Centre (WRCC) .

That the City undertake a yards rationalization study to confirm the preliminary findings and analysis that there is an opportunity to deploy winter operations out of three of the five works yards (Chelmsford, Frobisher, St. Clair) which will reduce the annual operating costs by approximately $74,000 and result in cost avoidance of $2.8 million associated with the capital yard expenditures required at the two yards identified for closure.

That winter maintenance fleet be parked indoors to reduce the response time and increase the efficiency and effectiveness of the operations.

That in keeping with industry best practices, that the City move toward storage of sand under cover.

That management review the existing work practice of utilizing midway salt stockpiles (e.g. airport), with a loader as this is not cost effective. Trucks with maximum capacity and optimized routes, need to be arranged to eliminate intermediate depots.

That the City recognize and implement a basic primary classification for roads based on the provincial guidelines as set out in O. Reg. 239/02 and that these classifications form the basis for the service standards.

That a survey and classification of all walkways be undertaken prior to winter 05/06.

That the City of Greater Sudbury recognize a basic primary classification definition for walkways and clearly document service levels associated with each classification.

That the City adopt Winter Road and Walkway Service Standards for both minimum and targeted service standards for snow accumulation, surface exposure and ice accumulation in terms of expectations and outcomes and that these be approved by Council. Samples have been provided in Appendix B of this report.

That the City clearly communicate the Service Standards in a manner that is meaningful and understandable to the public. It is anticipated that this would include the use of the website, newspaper and possibly a direct insert into tax bills.

That the City undertaken pre-wetting in all spreading activity. The entire rejuvenated spreading fleet should be outfitted with pre-wetting capability.

That the City develop a storm based activity analysis within the department business plan and performance review. This will require the tracking and development of a storm classification system, similar to that provided in this report, with associated service responses.

That the City adopt a pavement temperature, precipitation forecast and service standard sensitive spread rate structure. This will require some technology changes to retrofit vehicles with calibration equipment.

That the department undertake a demonstration program to assess the merit of achieving centre bare pavement service post storm by using a sand product mixed with 25% salt by weight.

That a salt management plan be developed immediately as outlined in the report.

That the management update routes to optimize service delivery and to reflect changes in shifts, yards and fleet.

That the City establish a Winter Roads Control Centre (WRCC) for the winter season.

That proposals should be called for the provision of an integrated state of the art web based winter information service.

That the City explore opportunities to add several more RWIS sites at strategic locations.

SWOT Analysis

The following provides a high level summary of the strengths, weaknesses, opportunities and threats identified in the report.

Strengths

- Depth of corporate experience and knowledge of past operations
- Daily activity summary reports are well maintained
- Clear reporting relationships
- Roles and responsibilities clearly defined
- Good mix of outsourced and in-house service resources
- Managed fleet replacement reserve
- Recent improvements in the selection on appropriate winter maintenance equipment
- Recent improvements in budget management

Weaknesses

Service levels

- Current service levels stipulate operating procedures should be outcome oriented
- Service levels are poorly written and require updating
- Local road service levels have not been harmonized

Equipment/Facilities/Materials

- More deployment centres than necessary
- Low fleet utilization as a result of operating on a single shift basis
- Old fleet and poorly specified
- Fleet not rationalized post amalgamation
- Weak tracking capabilities of salt usage
- No covered storage of sand

Staffing

- Trucks are parked when maximum hours are reached
- Call-in exercise takes over half an hour of time
- High management staff/worker ratio
- Service zones are not team focused regarding City-wide planning and the most efficient use of resources
- No dedicated resources for communications
- High ratio of overtime due to single shift
- No “on call” compensation – results in problems with staffing in times of need

Performance Management

- Outdated management systems – not used to effectively manage processes
- Performance measurements are nominal
- Budget lacks activity based structure
- YTD spending is poorly tracked
- Significant variance between budget and actual expenditures over the past 4 years, especially in sanding, salting and plowing

Opportunities

- Develop unifying policy for snow removal criteria
- Adopt outcome based service standards for roads, snow removal and sidewalks
- Rationalize # of yards – possibility to reduce operations out of 3 yards
- Move to 2 drivers per primary maintenance unit – and winter shifts
- Rationalize organization structure and staffing – anticipate reduction in staffing (management and front line)
- Develop an activity based budget and work management system
- Develop a 24/7 storm headquarters
- Improve service delivery and optimization of salt and sand
- Optimize fleet
- Invest in winter weather and road condition technology (RWIS)
- Improve public access to winter/road information (web)
- Prioritize storm system improvements to reduce cost of winter drainage

Threats

- Current approach leaves municipality vulnerable to litigation with respect to how policies on service levels are written
- Operating as opposed to a service standard currently in place
- Costs for NE yard is due for replacement per current plan
- Environmental concerns from outdoor product storage
- Vulnerability to deliver service based on aging fleet

Review Process

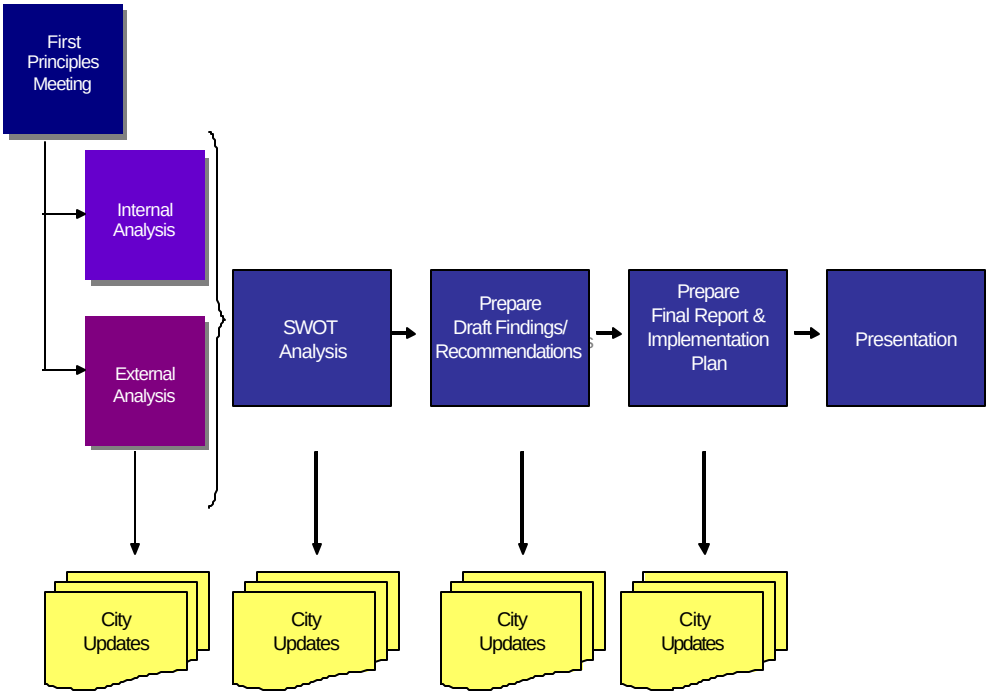
Detailed analysis process was undertaken

The following flowchart provides an overview of the work undertaken in the completion of the internal audit review of Winter Maintenance operations.

The review included an internal and external analysis of winter operations. The analysis included a review of:

- Existing reports, policies and procedures
- Existing services and service levels
- Resources used to provide services
- Work practices
- Systems and management support practices
- Technologies employed

From the internal and external analysis, a SWOT analysis was prepared (Strengths, Weaknesses, Opportunities and Threats) as well as draft findings and recommendations.



Consultation was key to the process

Consultation With Staff

Discussions were held with the Management and select front-line staff. Areas that were reviewed included but were not limited to the following:

- Policies, procedures and practices
- Compliance with legislation/regulations
- Management of the department
- Staffing needs, roles and responsibilities
- Use of technology
- Number of yards, workforce
- Organizational structure
- Performance management and measurement
- Major projects and priorities
- Current and Capital Budgets
- Future challenges
- Use of contracted services
- Assets
- Weather conditions and winter maintenance responses
- Salt/sand spread rates and protocol
- Fleet management
- Routes

The objectives of the study are to ensure that Winter Maintenance programs are provided in an efficient and effective manner and that the City is using best practices in the delivery of services in a predictable manner

Objectives of the Study

The internal audit objectives were to ensure that the City of Greater Sudbury is providing Winter Maintenance Services in an efficient and effective manner. More specifically, the review ensures that the recommendations contained in the report meet best practices by ensuring that the City is:

- Acquiring the appropriate type, quality and amount of resources at an appropriate cost;
- Avoiding duplication of effort by employees and work that serves little or no purpose;
- Using efficient operating procedures;
- Using the optimum amount of resources (staff, equipment and facilities) in producing or delivering the appropriate quantity of goods or services in a timely manner;
- Using an adequate management control system for measuring, reporting and monitoring a specific program's economy and efficiency;
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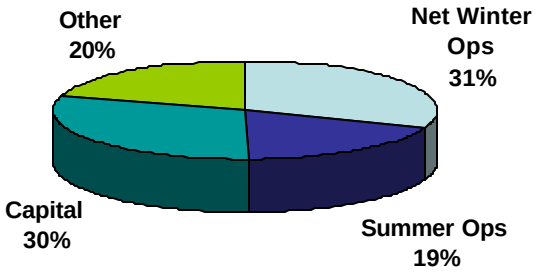
- Determining whether management has reported measures of program effectiveness that are valid and reliable.

To this end, a number of recommendations have been made to further improve the efficient and effective delivery of service.

Budget and Actual Expenditures—Winter

The total Roads program runs at approximately $35.6 million per year. Of this, approximately 31% or $11 million is spent in winter operations in total, based on a 3 year average of actual expenditures. The following pie chart reflects the proportion of roads costs by activity using the 3-year average.

Winter Operations has an annual expenditure of approximately $11 million



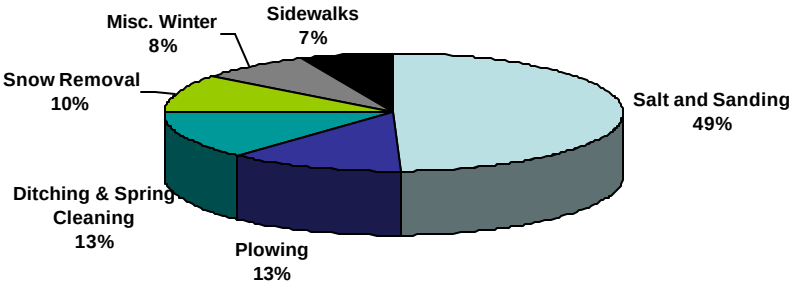
The winter maintenance budget can be summarized into several key areas of operations:

- Sanding and Salting
- Plowing
- Winter Ditching
- Snow Removal
- Winter Sidewalks
- Miscellaneous Roads Maintenance

Of winter operations, plowing, sanding and salting account for approximately 62% of the total winter maintenance expenditures, in the order of $7 million per year (actual expenditures). In this category, spreading of salt and sand tended to be over budget by 30% to 50% or $2 million per year as a result of material costs of $1 million over budget and also $1 million over budget in salaries, wages and benefits.

Issues with respect to budget and actual expenditures in this area have been identified in a later section of the report.

The following pie chart summarizes the average expenditures by major winter activity.



There has consistently been a problem with over expenditures in every major type of expenditure associated with winter maintenance, resulting in higher than anticipated net expenditures

The table below reflects the budget and actual expenditures of the winter operations by major object of expenditure. As shown below, there is a significant variance between the budget and actual for salaries, benefits and materials. For example, over the 4 year period, salaries and benefits were on average, 70% over budget. Each year, the budget to actual had a significant variance. Similarly, there was a significant variance between the budget and actual expenditures for materials, averaging 56% over budget. Equipment and internal recoveries has also been consistently over budget, averaging 20% higher expenditures than budgeted. Contract costs have been over budget in each year, however, the average of 19% over budget is largely driven by the variance in 2002.

It is worth noting that the estimated 2004 budget to actual variance has reduced in all expenditures compared with the 4 year average. For example, salaries and benefits were 44% over budget, in 2004, compared with a 4 year average of 70%.

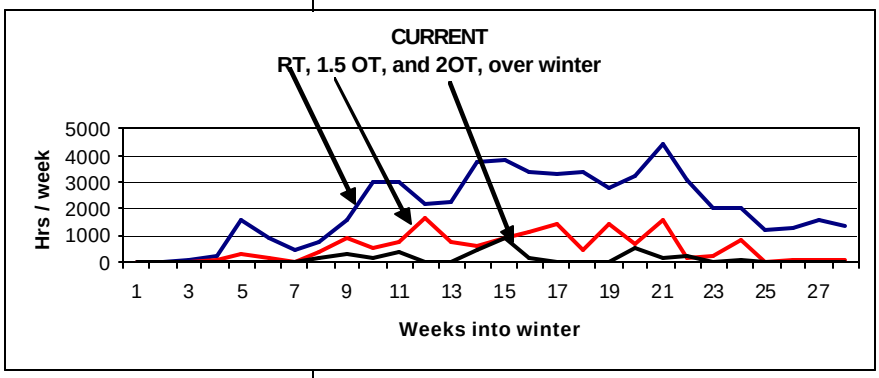
	Budget/Actual	Salaries & Benefits	Materials	Equipment/Internal Recoveries	Energy	Contracts	Subtotal Expenses	External recoveries (fees)	Net Expenditures
4 year avg	Average Budget	$ 1,405,809	$ 1,883,013	$ 2,460,725	$ 1,288	$ 2,239,407	$ 7,990,241	$ 35,535	$ 7,925,101
4 year avg	Average Actual	$ 2,386,431	$ 2,929,200	$ 2,949,814	$ 1,417	$ 2,656,717	$ 11,043,910	$ 149,577	$ 10,771,705
4 year avg	Difference ($)	$ 980,622	$ 1,046,188	$ 489,089	$ 130	$ 417,310	$ 3,053,669	$ 114,042	$ 2,846,604
4 year avg	Difference %	70%	56%	20%	10%	19%	38%	321%	36%
	2004 Budget to Actual	44%	23%	6%		18%			18%

Overtime costs are a significant budget item in Sudbury

One of the key factors impacting the higher than budgeted cost of salaries, benefits and wages is a result of significant overtime hours. This is driven largely by the existing practice of operating only one regular shift as opposed to municipal best practices, which will be discussed later in the report, which recommends operating with two shifts or other more flexible shift structures.

The following table summarizes the 2003/2004 winter hours of operation, broken down into regular hours, time and a half hours and double time hours. As shown below, approximately 25% of the hours worked are at over time premiums (20% at time and a half and 5% at double time). As will be discussed later in the report, there is a need to change work practices to reduce the cost of service provided through a reduction in overtime hours worked. For example, the additional costs associated with overtime as opposed to using regular hours of operations increased the cost of service by approximately $300,000 in 2003. While it would be extremely difficult to eliminate overtime costs in their entirety, there is an opportunity to reduce the number of hours of overtime worked by replacing with regular hours.

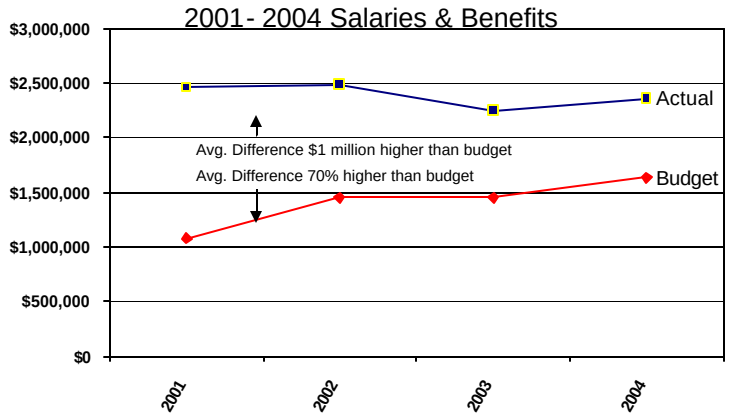
	All Yards			
	Regular Time Hours	Over Time Hours (@time and a half)	Over Time Hours (@double time)	Total
Actual Hours	56,815	15,340	3,803	75,958
% of total	75%	20%	5%	100%
Paid hrs equivalent	56,815	23,010	7,606	87,431
% of total	65%	26%	9%	100%



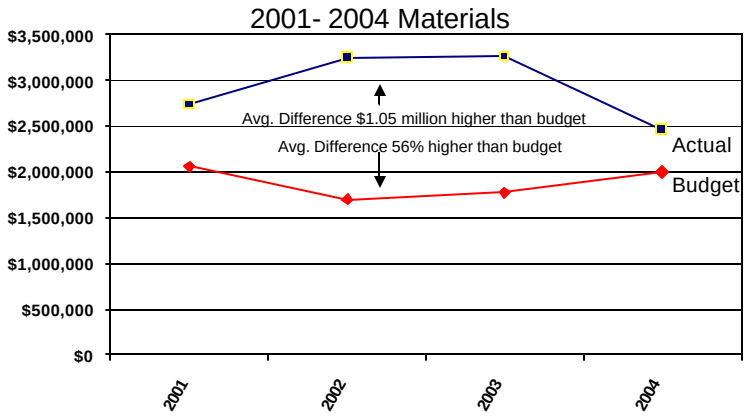
The following graph provides a summary of the distribution of hours regular, time and a half and double time during the 2003/2004 season for winter maintenance operations.

The following summarizes the budget to actual for each of the major expenditure items to provide a graphical summary.

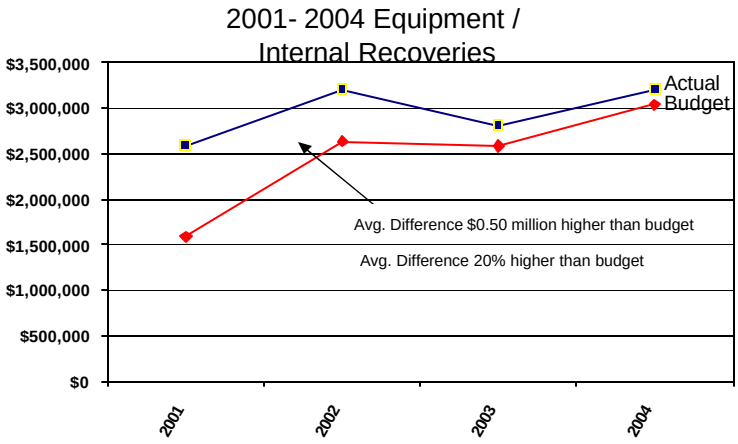
Significant variance between budget and actual expenditures for salaries, wages and benefits, but this has reduced over time



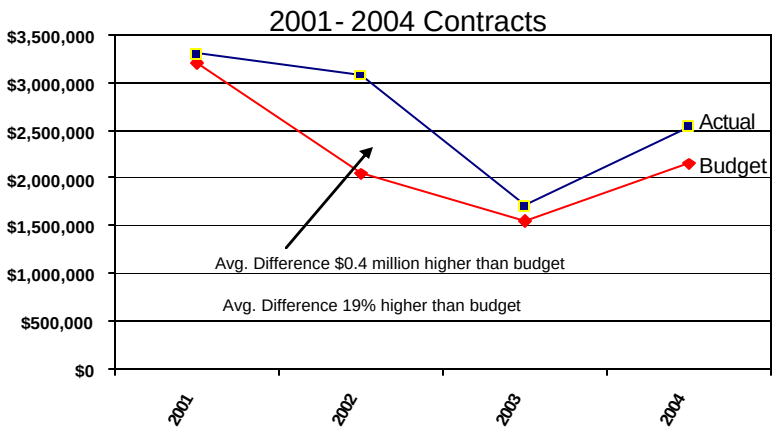
Material costs have consistently been over budget but the gap narrowed in 2004



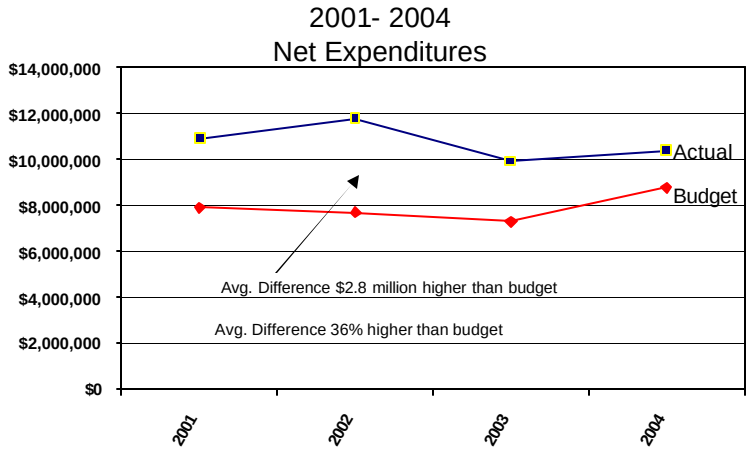
The equipment costs have escalated over the past 4 years both on a budget and actual basis



Contract costs increased between 2003 and 2004..the gap between the budget and actual narrowed in 2004



While the winter maintenance operations has consistently been over budget, the gap narrowed in 2004...the actual new expenditures in 2004 were $1.6 million over budget



Winter maintenance activities are among the more difficult to benchmark due to the high number of variables, particularly in a municipality like Sudbury

Benchmarking—Winter Maintenance Costs

There are a number of factors that impact the cost of winter maintenance services including but not limited to the following:

- Number of winter storm events
- Severity of winter storms—amount of snowfall and length of storm
- Temperatures
- Road types—Extent of road network located in urban centres, urban/rural mix, arterial and non-arterial roads
- Traffic volumes
- Land area, density
- Public expectations
- Policies for snow removal—roads and sidewalks
- Amount of snowfall removed from streets
- Age and type of equipment
- Service standards
- Number and extent of areas prone to drifting
- Maintenance standards
- Cost of standby services
- Competitive market conditions

As such, the ability to provide meaningful comparisons is limited, particularly in Northern Ontario as there are a limited number of municipalities of similar size, land area, population and road mix. The most comparable northern municipalities are Thunder Bay, Sault Ste. Marie, North Bay and Timmins, however, there are significant differences across the survey that would impact the cost of service.

The Province has established a winter control efficiency measure which calculates the operating costs for winter control maintenance of roadways on a per lane kilometre basis. This is part of the Municipal Performance Measurement Program (MPMP) and has been included for illustrative purposes. In addition, the cost per capita has also been included to provide a better understanding of the cost of service in relation to the population. This does not reflect the efficiency of the service, but the burden on tax payers.

Municipality	Population	Land Area	Lane KM	2003 Operating Costs Per Lane KM (FIR)	Winter Control Per Capita (2003 FIR)	2003 Operating Costs Per Lane KM (MPMP)
Sault Ste. Marie	74,566	223	1,178	$ 7,062	$ 112	$ 7,047
Timmins	43,686	2,962	844	$ 2,865	$ 55	N/A
Thunder Bay	109,016	329	2,132	$ 1,732	$ 33	$ 1,061
North Bay	52,771	315	737	$ 2,712	$ 37	$ 2,575
Northern Average				$ 3,593	$ 59	$ 3,561
Sudbury	155,219	3,354	3,522	$ 3,381	$ 75	$ 3,099

Operating costs per lane kilometre tend to be higher in Sudbury than a number of other comparable municipalities

As shown above, the 2003 MPMP efficiency measure for Sudbury is higher than Thunder Bay and North Bay, but lower than Sault Ste. Marie. Timmins has not calculated their MPMP's in a number of years. As such, a comparison was made of the 2003 Operating costs per lane kilometre to provide another comparison of costs. As shown above, the 2003 operating costs per lane kilometre (FIR) are higher in Sudbury than Timmins, Thunder Bay and North Bay.

As shown on the previous page, there are many reasons for the difference in the efficiency measure.

An additional benchmark was calculated (costs/capita) strictly to provide a comparison of the tax burden associated with winter maintenance services. As shown in the table, with the exception of Sault Ste. Marie, the costs in Sudbury are significantly higher than the other municipalities surveyed.

Business Model Development

There is a need for an overall business model to be developed to establish a foundation for accountable management of the services of the roads division, and any other agent of the City placed under the responsibility to manage business in this way.

The purpose of a business model is to provide a framework from which the business can be optimized and managed. Performance management is becoming the central theme for public sector business models managing the inputs, outputs and outcomes, with performance benchmarks and goals.

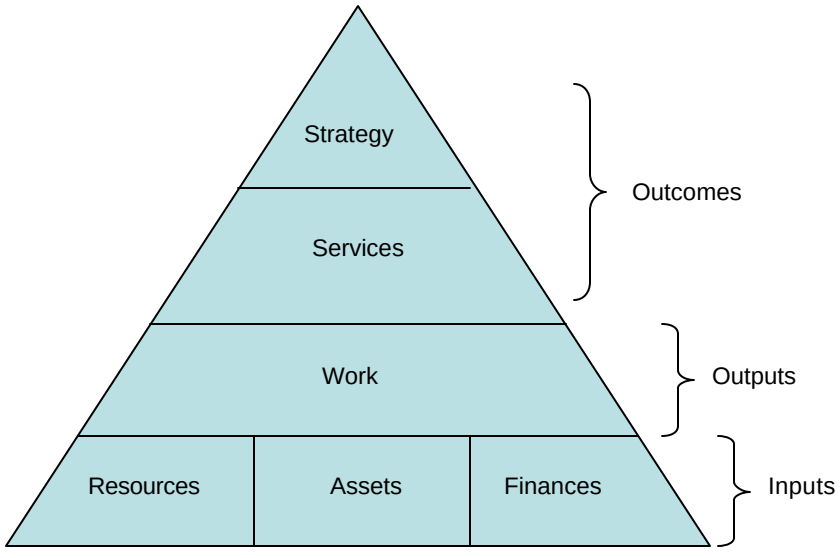
A business model is needed to ensure the efficient and effective delivery of service in Sudbury

Business plans provide assessments for each program area from six integrated perspectives:

1. Finances
2. Resources
3. Assets
4. Work (within service areas)
5. Services
6. Strategy

These six perspectives integrate into a business plan, each enabling a focus on the performance, goals and achievements of the organization. The following provides a graphical representation on the elements contained in the business model.

Inputs, outputs and outcomes form the business model from 6 integrated perspectives



Resources, assets and finances form the foundation of developing a business plan, which are directed from the strategies, services and work practices

The following provides an overview of some information that should be incorporated into the business model for each of the six identified elements.

1. Resource Management and Accountability

This is fundamental to the efficiency of the organization and considers the cost and utilization of the primary "in house" resources. These "input" rates are the basis for activity based work plans and activity based budgets. These rates must be developed on a "total cost" basis, allowing for comparison with outsourced solutions.

- Labour (one or more basic "all in" "on the job" hourly rates)
- Fleet (typically "light" "medium" "heavy" hourly use rate)
- Shop rate $/mechanic hr is a subcomponent
- Inventoried products (salt, sand, culverts, fuel etc)
- Administrative overheads on outsourced resources
- Facilities ($/m^2 attributed to the labour and fleet)

2. Asset Management and Accountability

Asset management assures that existing and proposed assets of the corporation are optimized in terms of design, lifecycle cost, and utilization. Annual lifecycle costs for each type and class of asset can be attributed as a capital cost component to the related service. These assessments can be used to fund asset reserves from which all capital work can be funded. There are three primary asset types which can be further classified.

- Infrastructure (Roads, Bridges, Pipes)
- Properties (Plants, Admin Centres, Service Centres, Yards)
- Fleet (All engine powered equipment, and wheeled accessories)

3. Financial Management and Accountability

Financial management is the primary and traditional system in public sector management. As performance management, it deals with an "input" level element. It integrates all the functions of the City and has a distinctly comprehensive and detailed approach. Modern fiscal management must also address the longer term financial implications of sustainability and relative performance indicators.

- Expenses
- Revenues
- Reserves
- MPMP

4. Work Management and Accountability

This plans and directs resources to meet the expectations of relevant services; in other words the "outputs" of the Department. Work is organized by planned activities and sub-activities clustered under service headings. Each "service" cluster includes an activity called "service management", and "non planned activity". Work assignments (who, where, when, what) implement the work plans when funded. Activity based budgeting (ABC) is an essential element of successful business management.

- Road Service for example would have planned work for the following activities – each with one or more sub activities
- Summer Hard surfaced
- Summer Loose surfaced
- Winter
- Service management
- Unplanned work

5. Service Management and Accountability

Service management defines and assures compliance with specified services within program areas. These are the program "outcomes". Each service is recognized by Council approved service standards and includes planned management goals and expectations. Condition and compliance reports become a central aspect of risk management for the organization. Program areas are:

- Road Services
- Park Services
- Water/Wastewater Services, etc.

6. Strategic Management

The ability to manage change is key to the strategic management of winter operations

This is about managing change in the Department. It evaluates the program objectives and sustainability, and maps a course of action to achieve program goals. For example, organizational restructuring, and program goals are elements of a strategic management plan. Strategy considers the following questions:

- "what is next?"
- "how much?"
- "how fast?"

Recommendations

That Senior Management implement a business model in the Road Services Division and provide the necessary training and resources to implement the plan.

Staffing and Shift Structures

Legislation and Regulations

Legislation and regulations limit the number of hours that an employee can work

The introduction of Minimum Maintenance Standards (O. Reg 239/02 and Sec 44 (3) (c) of the Municipal Act 2001) indicates that, for higher classes of roadways, municipalities must be able to remove snow or treat icy conditions relatively non-stop under some storm conditions in order to claim compliance with the standards.

Municipal fleet operations must accommodate Commercial Vehicle Operator Regulations for hours of operation. This regulation limits driving time and on-duty time per day and per week and enforces rest periods.

The Ministry of Labour provided a written clarification to municipalities that the municipal and contract workers performing winter operations are exempt from the Employment Standards Act as set out in Reg. 285/01 for hours of work but applies for rest and lunch periods.

It is the responsibility of the municipality or contractors to ensure that sufficient staffing plans are in place to meet the requirements of Regulation 4/93. According to the Ontario Good Roads Association, municipalities must monitor conformance with staffing plans and associated driver hours of work must comply and not exceed the specified maximum driving, on-duty and off-duty times in the regulation.

Current Operations

The use of one shift compromises the City's ability to provide efficient and effective service

The current practice in Sudbury is to provide services using **one shift**. With high overtime usage and call-out travel time issues, resulting in increased cost of service and challenges with respect to compliance with legislation and regulations, alternate work practices should be considered.

As shown earlier in the report, there is a significant amount of overtime costs in Winter Maintenance, largely attributed to the current process of providing service using one shift. The current practice does not provide sufficient flexibility to manage winter operations in a cost effective manner.

The most common approaches that municipalities employ are a two-shift operation (partial or full), a three-shift operation or improved flexibility in work hours. To date, the City has not actively pursued alternative shift scheduling to identify the costs/benefits of each scenario.

Best Practices In Shift Structures

Best practices suggest the need to continuously evaluate how best to provide service

As stated in a review of best practices, published by the Ontario Centre for Municipal Best Practices, decisions on how best to deploy winter control manpower (seasonal shift structures) are a critical driver of direct-delivery service costs and quality. The blend of winter control straight time versus overtime service hours varies greatly across the municipal sector. Single shift, two shift, and three shift models are all in place. Local winter event conditions play a role in determining the optimal shift structure. The best practice is not a one-size-fits-all shift structure, but rather a process of experimenting with and learning from various options in order to find one that is best suited to local conditions at the time.

Responses to winter storm events are not typically well suited to rigid start/ stop shift times, particularly when there is only one shift being operated

Responses to winter storm events are not typically well suited to rigid start/stop shift times, with overtime rates paid before and after the fixed shift. According to best practices in winter maintenance, any municipality operating with a single shift, significant overtime usage and 24 hour winter response requirements could benefit from changing its work practices. This is the situation in the City of Greater Sudbury.

A number of municipalities have moved to a full or partial two shift approach to providing winter maintenance or have increased their call-out flexibility. Benefits which resulted from theses practices include:

- Reduced overtime and expenses
- Unit cost reduction through overtime cost avoidance
- Better able to meet requirements of Commercial Vehicle Operator Regulations and Employment Standards Act re hours of work
- Flexibility for employees re winter working hours
- Avoid staff burnout from excessive hours of work during prolonged winter event periods
- Improved response time to evening winter events through a second already-deployed shift – avoids call-out “lag time”

Straight day shifts are recognized in the industry as being detrimental to efficient operations

Flexible work hours are beneficial in that it enables response to storms to be prompt, because road managers are free to respond to road conditions by calling the road crew in early instead of waiting until regular hours commence out of consideration for labour cost differences. Options in this regard should be evaluated by staff on a continuous basis.

Continuous improvement and refinement of work practices are needed

A continuous improvement process that can evaluate current staffing model performance by analyzing historical patterns of overtime costs and the impact of call outs on event response times is realistic and practical for most mid-size and large municipalities. This is needed in the City of Greater Sudbury.

Based on information available through the Ontario Centre for Municipal Best Practices, most collective bargaining situations will allow for multi-shift deployment of municipal staff at straight time rates during weekdays.

Examples of Continuous Process Review of Shift Structures

A number of best practices have been included in this section of the report as the movement to a different shift structure would significantly change the existing work practices and is paramount to improving the efficient and effective delivery of service. In addition, the move to, for example, a two shift structure offers significant cost saving opportunities in terms of fleet usage and route scheduling.

Examples of where a two shift operation has been employed include the County of Middlesex, the City of Belleville and the Municipality of Chatham-Kent. The following examples illustrate the need for continuous monitoring and balancing to find the appropriate shift structure. These examples have been taken from the Ontario Centre for Municipal Best Practices.

*A **Municipal Best Practice** is one which has demonstrably assisted at least one Municipality to achieve a high level of performance or achieve a significant improvement in measured performance in a service or activity.*

Source: Ontario Centre for Municipal Best Practices

Belleville moved to a two shift operation, resulting in reduced costs and improved response times

Winter Maintenance is one area that the Centre has focused on sharing best practices across Ontario. It is well recognized that there is not one model that is suitable for all municipalities in terms of shift operations, but a common theme in each is the need for continuous refinement and improvement to maximize the effective delivery of service at the same time as minimizing the costs.

Belleville changed from a traditional single-shift model to a 24/5 two-shift model. In Belleville, the first shift runs Monday-Friday from 7:30 am to 4:30 pm. The second shift runs from 11:00 pm to 7:30am. Two winter patrol shifts, using internet-delivered weather data to support event respond/not respond decision-making, support both shifts. The 6.5-hour service gap between the day and night shifts is covered on an overtime call-out basis if necessary, with each shift covering a portion of the service gap, thereby remaining in compliance with "hours of work" legislated requirements.

Belleville moved to this two-shift model in order to control overtime costs, prevent staff burnout, and improve night-time response times with expanded "ready to go" coverage, thereby eliminating the considerable lag associated with a call-in. The two-shift model has been achieved primarily by means of voluntary shift selection by the existing crew. In order to avoid the hiring of additional City staff for a weekend shift, an overtime call-out strategy for the weekend has been used. Average annual over-time cost avoidance targets have been consistently met, while evening event response times have improved. This resulted in a net saving of 12% of Belleville's winter control expenditures.

Guelph has experimented with a number of 2 shift, 3 shift models to identify the most appropriate fit for their winter conditions

The overtime net cost avoidance by moving from a single shift to a two-shift model has contributed to Belleville's record as one of the lowest-cost winter operators among comparable municipalities. It has done so by a process of carefully considered trial and error, followed by learning and evaluation, supported by results measurement.

In recent years, the **City of Guelph** has experimented with a 24/7 three-shift model, a 24/5 two-shift model, and then moved to a 24/5 three-shift model. Guelph evaluated its traditional 24/7 three-shift model, and found fixed staffing costs resulting from three shifts every day of the week did not appear to be applied against enough storm responses to merit continuation. A 24/5 two-shift model (featuring reduced staffing) was implemented as a cost reduction option.

Guelph was able to reduce overtime costs by modifying shift practices

However, the overtime costs incurred by the City in this model were unacceptably high during the late afternoon hours between the two shifts. Through experimentation, the City had discovered it had become too lean across its weekday 24-hour service period. Therefore, the two-shift approach has been discarded and a revised 24/5 three-shift model is currently being used.

The overtime avoidance savings generated by the new weekday three-shift model have financed the hiring of the additional operators for the reintroduction of the weekday third shift, and event response times have been restored to desired levels. Anti-icing treatment on Fridays reduces the need for and frequency of weekend overtime call-outs. This shift deployment practice has yielded lower winter costs and more acceptable service.

The Public Works Department outside employees in the **United Counties of Prescott and Russell** have an innovative winter labour practice that exchanges very flexible on-duty winter hours at regular rates of pay, for paid hours on standby (at home) when there is no work required. This practice has reduced the overtime costs by two thirds.

City of North Bay has the ability to call staff in from 4:00 a.m. to 12:00 p.m. without overtime.

Working with the union, the **County of Peterborough** initiated a 3 unit winter night shift, which reduced call-out frequency and facilitated compliance with commercial vehicle operator hours of work.

Preliminary analysis indicates that there are opportunities to reduce operating costs in the City of Sudbury

Move to A Two-Shift Structure

The above noted examples have been included in the report to provide a wide range of options and opportunities that have been pursued by municipalities to provide efficient and effective winter maintenance services. As shown in these examples, there is a need to experiment with various models to identify the best fit for the City of Greater Sudbury.

Based on the information available through the internal audit, various scenarios were analyzed with an effort to:

- Reduce overtime costs
- Maintain or improve on the delivery of service to the public
- Ensure staff hours complied with regulations and legislation

The one shift approach needs to be rationalized as this does not appear to be the most efficient and effective means of providing winter maintenance services….it is projected that overtime hours could be reduced by approximately 40% through changes in work practices

The next section provides the recommended starting point upon which further refinement is needed for the City of Greater Sudbury.

The findings suggest there is an immediate need to re-evaluate the current one shift practice for winter maintenance to deliver effective and efficient services in Sudbury. Based on an analysis undertaken of the existing work practices, over time and general weather conditions, the option most closely aligned with effective and efficient deployment appears to be through crews operating in two shifts. Currently 19,000 hours of overtime are incurred in the deployment structure. By deploying in two shifts as proposed, analysis indicates that this may reduce overtime hours to an estimated 11,500 hours (40% reduction—based on a review of the 2003/04 winter season).

As a part of the proposed two shift system, there will be two drivers assigned to each plow spreader and sidewalk unit. This is known in the industry as “hot seating”. This allows the primary equipment to operate for days – non-stop, with drivers only logging 12 hours in any 24 hour period. This will avoid severe compliance issues related to limited hours of driver time. It will also cut in half the number of hours the employee is expected to be available for extra duties. On the weekend, the day shift crew would be expected to be on call for the similar eight hour period plus the following four.

In addition to a reduction in overtime, there is an ability to reduce the current inventory of equipment, which is another benefit of moving to a two shift operation. As will be shown in the fleet section of the report, implementing this type of work practice will result in savings associated with equipment and will provide funds needed to implement some of the technology solutions contained in this report.

Where conditions require further work beyond that which can be addressed in the two regular shifts, it is expected that the overtime will occur for the “on shift” that is ending. The need to call in workers will be minimized in the proposed plan.

The two shift model could be deployed such that there will be two operating shifts from Monday to Friday:

- Night Shift: 12 am (midnight) to 8:30 am
- Afternoon: 12 pm (noon) to 8:30 pm

The impact on the balance of the year, and the other related duties need to be harmonized with this seasonal schedule.

While an analysis has been undertaken and best practices have been presented as well as a recommended starting point (2 shift operation), further fine tuning and refinement is needed by management. The development of a detailed shift schedule is beyond the scope of the internal audit but sufficient analysis has been undertaken to conservatively estimate that a change of this nature should generate significant savings.

Recommendations

That Public Works management explore the opportunities to reduce overtime costs, reduce equipment inventories and increase the effectiveness of service delivery by moving to a shift work cycle, designed to meet the specific needs of the City and in accordance with best practices.

There is a need to rebalance the mix of in-house and contracted services, should a decision be made to change the existing shift structure

Mix of Contracted versus In-house Services

The City of Greater Sudbury has used a mix of contract and in-house service. With the recommended changes in shift structure, there is a need to rebalance the existing mix of in-house and contracted services. An approach that is considered a best practice is to identify a base number of staff needed to provide year round service and then to determine the most efficient and effective method of meeting the peak demands, whether this is through in-house services or external contractors. Typically, as is the case in the City of Greater Sudbury, the peak periods are in the winter.

Having operations ready in regular time for 16 hours per day, the proposed two shift structure allows for several strategic changes in the requirements of contractors or the extent of in-house staff needed.

A crew of 100 (which is currently the approximate staff level in Sudbury) puts in about 100,000 hours of regular time work in the winter season. Of this only about half is utilized for winter road related operations. Currently there are dozens of contractors hired to supplement City forces, simply because the work needs to be more timely than when City crews "have some time." As such, there is the need to rebalance the mix of in-house services versus contracts if a move to shift scheduling is implemented.

Snow removal occurs at night. With the regular shift reporting to removal operations a major amount of this work can be done "in house." The double shift sidewalk team may be able to clear many of the bus stops, now done by contractors.

As will be shown in the report, there is an opportunity for changes in route deployment, number of yards, implementation of shifts and changes in equipment that will have a direct impact on the balance of staff versus contracted services.

Best Practices

Several best practices were identified in terms of determining the extent to which services should be contracted and how the contract can be structured to ensure effective delivery of service that is economical.

The **City of Burlington** provides 55 guaranteed hours per month per contracted salt/sand unit, resulting in lower costs than a traditional standby price plus call-out price model. Burlington operates in a competitive contract market environment with a fairly predictable annual salt/sanding requirement.

London

London's Winter Maintenance Operations is a 24/7 program delivered through a mix of contracted units and staff-operated units. The program is managed by the Roads & Transportation Division, which also has responsibility for non-winter maintenance activities like Parks and Recreations Operations. This Division manages its mix of fixed and variable labour costs and service hours through an entire fiscal year, not just through the winter season.

London has optimized their staffing by reviewing the base year round needs and identifying then how to most cost effectively provide for peak periods

Full time winter control staffing (representing fixed costs and a bundle of year-round service hours) is carried over into the non-winter road and park maintenance activities.

If London delivered the sanding/salting program with a higher concentration of full time staff, an excess capacity of service hours (and fixed costs) would carry over into the non-winter season – resulting in excess hours of paid staff time searching for viable activities to perform. The key to the practice is the optimal mix of direct staff required year round, and then assembling a team of seasonal winter resources that deliver "peak demand" (variable costs).

Over time, London has determined that a ratio of 55% contracted units to 45% staff-operated units provides the optimal year-round balance across winter roads, non-winter roads, and parks maintenance activities.

In analyzing the potential costs of doing business, London compares winter event hours to non-event hours. Contracted operating hours are compared to the cost of City resources that can be utilized year round across all operations.

Municipalities have struggled for years over the question of whether to contract or directly deliver winter control services. The London practice suggests that the "best practice" answer is not choose-one-or-the-other, but rather to seek the optimal mix.

The following provides the benefits identified by London:

- Improved winter event response times resulting from aggressive patrol coverage & early response decisions
- Reduced year-round costs
- Reduced winter operations costs

Recommendations

That the City monitor the balance of in-house services and contracted services to ensure that the most efficient and effective service delivery model is provided, where consideration is given to the base number of staff needed to provide year round service.

Fleet Management

Current Operations

Due to the current work practices, the City has more equipment than needed...there are opportunities to change work practices

The winter fleet of vehicles and equipment in Greater Sudbury is tired. It represents the collection received from the amalgamation exercise. Many of the trucks are more than 10 years old and are beyond their useful life.

The existing fleet is large in order to accommodate the existing work practice of operating on a single shift basis. Not only does this practice increase the cost of service with respect to staffing and overtime costs as was discussed earlier in the report, there are additional costs associated with maintaining a fleet of this size to accommodate the single shift. The fleet is parked when the 13 hour limit on driving time per employee is reached. As such, with a single operator approach, this increases the cost of operations by maintaining a fleet that is larger than required under alternate service delivery models.

Another historical issue associated with the existing fleet is the heavy reliance on single axle trucks, which, as will be discussed in the analysis section, is not optimal for operations. There has been a recent movement away from single axle vehicles, which is recommended for the City of Greater Sudbury.

There are 81 primary in-house units, with an additional 40 secondary units involved in winter maintenance activities. In addition, there are a total of 56 contract units involved in winter maintenance activities (35 primary and 21 secondary), for a total deployment of 177 vehicles and equipment in winter maintenance activities.

	Description	NOW in pw dept
INHOUSE	Grader plows	6
	TA combi	22
	SA combi	14
	SA underbody combi	13
	SA plows	25
	Loader for plowing	1
	PRIMARY UNITS	81
	Sidewalk combi	22
	Sidewalk plow backfill	3
	Loaders for yards	12
	Snowblower	3
	SA combi backfill	
	SA underbody combi backfill	-
	TA combi backfill (retired primary)	-
	Graders	-
	SECONDARY UNITS	40
Subtotal Inhouse		121
CONTRACT	Loader plows	4
	Grader plows	18
	TA chassis for combi	3
	TA combi	7
	TA spreader	1
	SA spreader/one way plow	2
	PRIMARY UNITS	35
	Loaders for yards	2
	4x4 plows	19
	SECONDARY UNITS	21
Subtotal Contract		56
TOTAL		177

The following table provides a summary of the existing equipment (note that changes may have occurred from the time the report was commissioned to the release of results, thereby representing a point in time). Appendix A provides a detailed listing of each piece of equipment.

As will be shown in the route section of the report, the split between in-house versus contracted is approximately 70:30, based on the primary vehicles used for winter maintenance.

There is an opportunity to reduce the fleet size by moving to a 2 shift service delivery model

Analysis

Reduction in Fleet Size

The strategy to operate in two shifts provides an opportunity to rationalize the existing fleet, with the option to significantly reduce the number of vehicles that will need to be replaced in the upcoming years. The movement to a two shift approach or a modified shift structure, as identified in the staffing section of the report, effectively reduces the fleet, almost in half (with the need for standby units). Given the significant budgetary challenges and over expenditures over the past several years, this approach to providing winter maintenance services also reduces the cost of operation from a fleet perspective.

Based on an analysis of route optimization (as will be discussed in the route optimization section of the report), changes in yard deployment and shift structures, the following table provides an estimate of the current and proposed winter fleet:

TYPE	Current	Deploy	Re deploy or Standby	Replace in 05	Replace in 06	Replace in 07	Replace in 08
Grader	6	3			1	1	
Loader	13	8			1	1	1
SA Trucks	38	0	6				
SA Combi	14	0	4				
TA Combi	22	20	2	8			
Sidewalk Unit	25	15	3		3		3
Snowblower	3	2					
Total	121	52	15	8	5	2	4

Surplus equipment could be sold and the proceeds could be placed in a reserve for future equipment replacement or other technology needs

Based on the analysis undertaken and the recommendations contained in this report vis-à-vis the shift structure and yard optimization, there appears to be a need to maintain approximately 67 vehicles out of a fleet of 121.

This proposes that 54 units in the above described fleet need to be **seriously considered for disposal**. More detailed review of each piece of equipment would determine the optimum method of disposal. The revenue from this sale should be applied against costs of future replacement, a vehicle and equipment replacement reserve or the implementation of new technology, as identified in this report.

The replacement program for fleet is based on revenues received from hourly rental charges to the operating budget. The primary truck fleet, with its anticipated usage may reach end of lifecycle in 8 years.

Recommendations

That the City rationalize the winter in-house fleet should changes be implemented in shift practices, deployment centres and routes, with an expectation that the fleet size will reduce by approximately 40-45%. This will result in an estimated reduction in future purchases between 2006-2009 of $4 million.

That the revenues associated with the sale of vehicles deemed to be surplus be placed in a reserve to fund for future equipment replacement and retrofitting costs as outlined in this report to accommodate such technology as GPS and spread rate calibration capabilities.

Fleet Replacement Reserve

It is estimated that the primary tandem spreaders will be utilized in the order of 1,000 hours per winter season alone. With an additional 500 over a summer period, each unit would have 12,000 hours logged in 8 years. At this rate, an average annual depreciation for these 20 vehicles alone is in the order of $550,000. A basic evaluation of the balance of the winter fleet suggests a further $500,000 per year – thus at least $1 million per year should be drawn in revenues from the winter fleet rental and put into reserve for replacement.

Recommendations

That the budget be adjusted to reflect the true cost of winter vehicle replacement.

There is a need to ensure that the existing fleet is rationalized for the services provided and to ensure that the selection of future vehicles is based on best practices

Selection of Optimal Equipment and Vehicles

The essential service unit is the Tandem Axle (TA) plow with wing, and a spreader capable of pre-wetting. It is proposed that 20 of these units anchor the in house fleet. Some consideration may be given to providing several of these trucks with tri-axle carrying capacity for effective service in snow removal and summer hauling needs. There are several reasons why this unit with approximately 12 m^3 haul box capacity is more effective in Greater Sudbury than any combination of special purpose vehicles including the following:

- can be deployed into any typical need – plow, wing, spread, haul – with full capacity;
- can multi task;
- is an effective unit for summer product hauling vs. single axle vehicles which end up being parked; or
- maximum spreader capacity for available fleet – in event of ice storm or substitution for breakdown.

Graders, while having the advantage of down pressure to scrape ice, travel at slower speeds and cannot spread without another pass by another piece of equipment. Back when plow/spreaders utilized two operators and spreading was intermittent it was justified to have dedicated plows and dedicated spreaders.

In the old part of the City, a team of 19 contracted 4x4 pick up truck plows are deployed to clear laneways and dead ending streets. This is good value as they operate at less than half the cost of a primary unit and do the work twice as fast. There is some time lost to deadheading, and they do not have spreading capacity. In addition, it was noticed that laneways have a tendency of building up snow pack, and then with a thaw, ruts develop requiring special attention. Where this occurs, it may be advisable to switch to loaders with reversible plows to facilitate down pressure and versatility. For City street clearing, the 3 yard loader with reversible plow is recognized as the appropriate compliment to the tandem plow.

Single axle plow spreaders have useful application in several conditions –typically found in urban town settings

- with proximity to stockpile (2km max)
- which utilize salt normally for spreading
- with spot spreading requirements mostly

Approximately 20% of the Single Axle (SA) units currently in the fleet are not yet beyond 10 years of age. While these could be sold for a better price and supplement the purchase of fully equipped vehicles, there may be merit in retaining a few for reassignment to other public works functions.

None of the SA units are equipped with electronic spreader recording controls. With 8 of the current TA units, plus the new 8 TA purchased in 2005, being equipped with in cab electronic controls, there is value in outfitting the remaining 4, to have all the primary in house units (20) with electronic spreader recording and control.

Calibration of spreaders is vital to address spreading issues, as outlined further in the report

Calibration of spreaders is a vital activity in programming spread rates, and documenting salt usage. Every spreader unit, in house and contracted, must be carefully calibrated at the start of the season, and monitored mid season. There is no need to provide weigh scales for winter products provided there is full accounting of all salt products put out through the spreader.

Calibrated spreaders, with spread rate recording by road location would be considered a minimum expectation of a SMP for Greater Sudbury.

A review of contracted services and the deployment strategy is needed

There are 38 primary plow/spreader units proposed in the deployment plan (as will be discussed in the Routes section of the report). This suggests that the equivalent of 18 TA plow/spreaders are to be resourced from the private sector. Currently there are 35 contracts in place for the following until 2007, not counting the loaders dozers and 1 ton contracted equipment.

- 7 TA Plow Spreaders
- 18 Graders
- 2 SA Plows
- 1 SA spreader
- 4 Loader Plows
- 3 TA chassis for Combi

It is recommended that the 18 graders and 3 SA units would be assigned to local road routes and not have responsibilities for class 1 – 3 roads. A further assessment could be done to determine the cost benefit of collapsing these contracts and deploying 11 TA plow/ spreaders.

Spread rate benchmarking should become a management practice

Best Practices

According to best practices identified by the Ontario Centre for Municipal Best Practices, spread rate benchmarking can/should become a key management practice across a consortium of mid and large-scale system operators – thereby supporting and evaluating Salt Management Plans and conforming to Environment Canada requirements/recommendations. In this sense, the upfront financial and technical investment required to implement a municipal Salt Management Plan is the same investment (calibration, spread rate measurement) required of a benchmarking process.

It is recommended that winter patrol vehicles be outfitted with real time location and condition capacity. All units, along with sidewalk units, need position location sending units. This information will be monitored and recorded by the Winter Road Control Centre (WRCC) (as will be discussed later in the report).

The minimum information received in real time from the various units is proposed as follows.

# units	ITEM	Location	Pvt Temp	Spread Rate	Operator Code	Product Type
20	City Primary Plow Spreaders	Yes	Yes	Yes	Yes	Yes
18	Contractor Primary Plow Spreaders	Yes	Yes	Yes	Yes	Yes
4	Patrol vehicles	Yes	Yes		Yes	
4	Spare plow/spreaders	Yes	Yes	Yes	Yes	Yes
15	Sidewalk units	Yes				
59	Total					

Screen views of this information could be updated every 5 minutes. The number of units represents the majority of the primary and secondary units that will be deployed in the recommended structure (excludes several standby units).

The public information screen for operations would show only the location of the above units. Authorized viewers would see the latest reported location and past performance record of the various recorded variables.

Recommendations

That management undertake a review of the existing fleet to identify the appropriate mix of vehicles and equipment to be maintained based on best practices identified in the report.

That a cost benefit analysis be undertaken to identify the appropriateness of the existing contracts, use of equipment and route deployment.

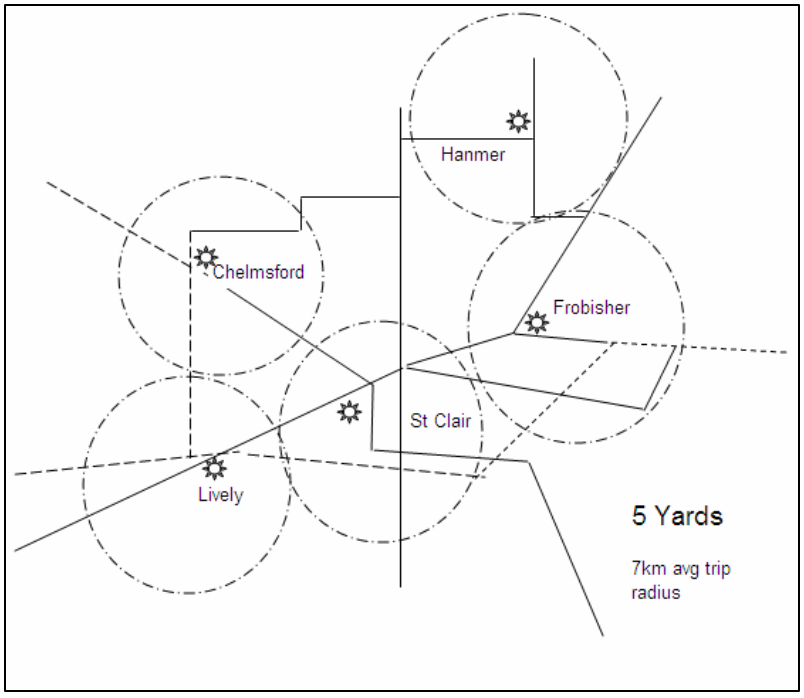
That the primary winter in house and contractor fleet be outfitted with electronic spreader controls with real time transponders to the Winter Road Control Centre (WRCC) .

Yards/Deployment Service Centres & Routes

Current Operations

Currently winter operations are deployed from five deployment service centres and at least one remote salt depot. The following provides a basic schematic diagram of the existing yard locations.

A yard rationalization exercise has not been undertaken since amalgamation



These service centres are historic in nature dating back pre-amalgamation. There are significant capital future requirements associated with the existing yards/facilities. As such, there is a need to rationalize the number of yards prior to committing to capital expenditures that may be avoided.

There are also critical storage needs at a number of the garages.

There is no evidence to support that the existing yard deployment strategy is optimal, nor is there evidence to support the existing locations of the yards.

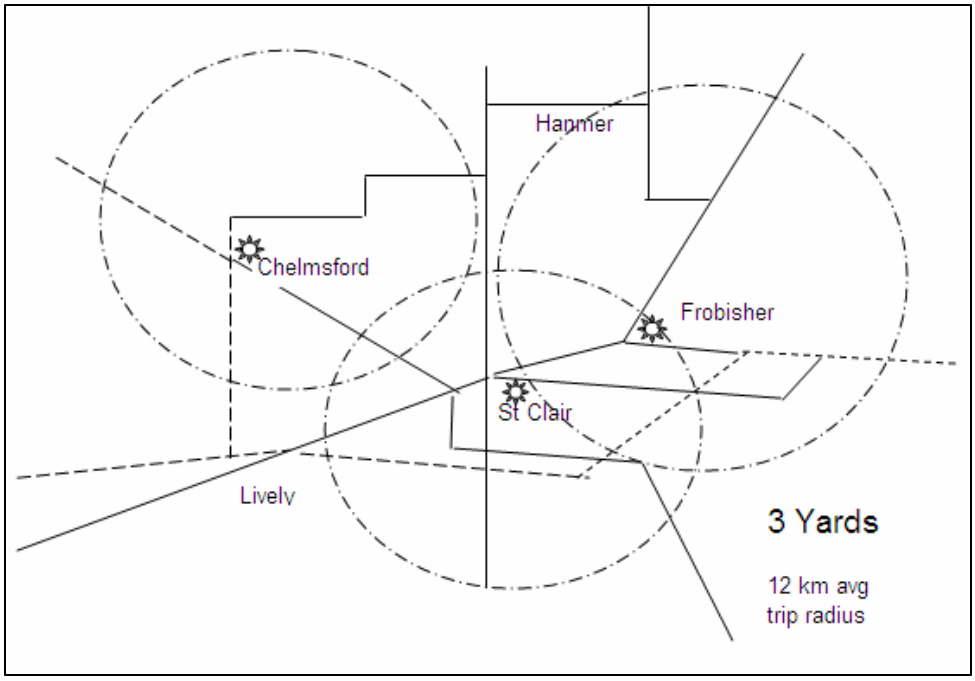
From an efficiency and effectiveness perspective, there appears to be an opportunity to work from 3 rather than 5 deployment centres for winter maintenance activities

Analysis

As part of the review process, an analysis was undertaken to determine whether there is an opportunity to create efficiencies by changing the existing deployment strategy. A service centre optimization model was applied to the known characteristics of the road system and resources of Greater Sudbury limited to using the existing sites only.

A number of factors were considered and conservative assumptions were used to calculate the costs/benefits associated with each option. These include:

- Deadhead costs
- Travel
- Labour rate
- Equipment cost while traveling
- # of trips per day
- Ratio of indoor equipment storage
- Building capitalization
- Building maintenance costs
- Annual overhead cost in operating a yard, including cost of inventory, mgmt facility itself etc.

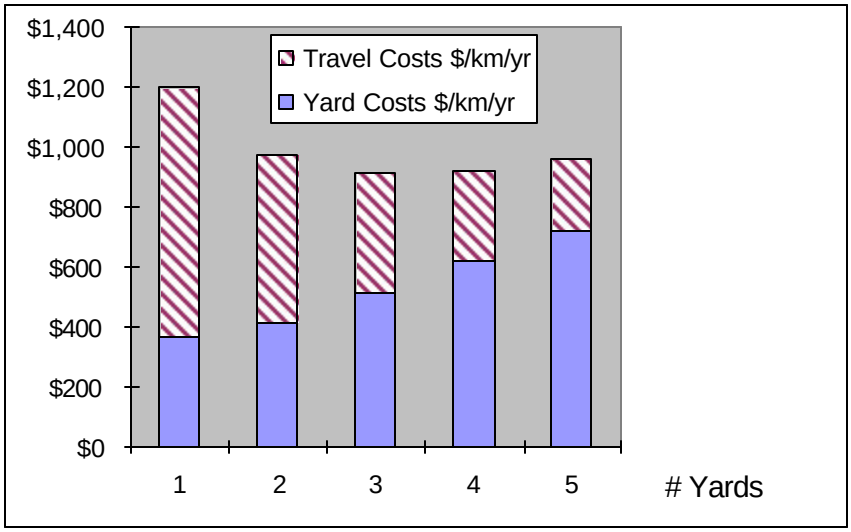


The best overall solution appears to be **three centres** yielding an estimated $74,000 per year operating savings over the existing deployment using 5 yards.

Costs are minimized in the option with 3 deployment stations

$ / km / yr	SCENARIO # Service Centres				
	1	2	3	4	5
Yard Costs $/km/yr	$369	$413	$517	$622	$726
Travel Costs $/km/yr	$831	$565	$399	$299	$233
Total $/km/yr	$1,200	$978	$916	$921	$959
worker yrs in travel	15.3	10.4	7.4	5.5	4.3
costs/savings per year	$414,900	$32,167	($73,917)	($65,567)	$0

The following graph summarizes the breakdown between travel costs and yard costs. As shown below, the option with three yards provides the lowest cost per kilometre per year. While there is an increase in travel costs in the recommended option, the yard costs have declined. Further, with the recommendations contained in this report regarding salt/sand spread rates and the use of larger vehicles, these travel times can be further reduced.



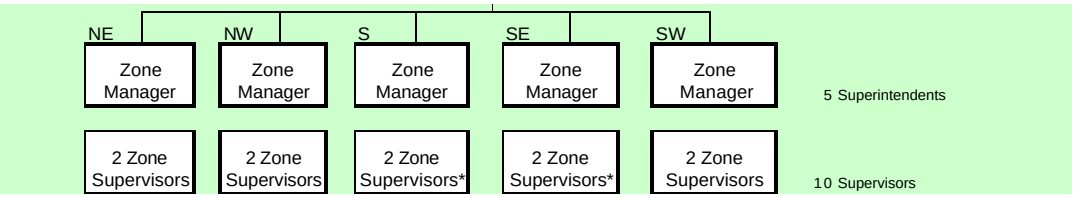
There are additional cost saving opportunities and other benefits that were not quantified in the analysis

There appears to be opportunities to reduce the current number of deployment centres as reflected in the analysis undertaken. There are further advantages to having 3 instead of 5 service centres that have not been quantified in the analysis:

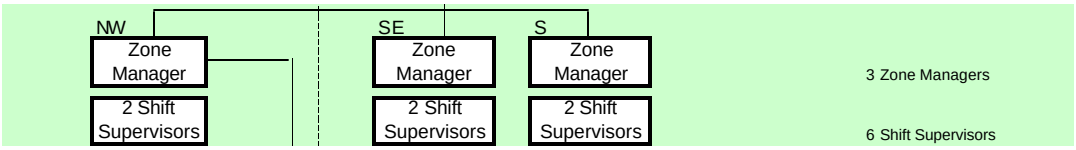
- Reduced number of supervisors. In the proposed configuration there would be a maximum of 16 workers assigned to a supervisor.
- Reduced number of managers. One per service centre would be sufficient to deliver managerial attention to winter operations.
- With the new two shift winter deployment strategy there is sufficient capacity in the staff facilities of the 3 selected service centres. Consideration needs to be given to the impact of summer shift schedules and congestion if the same service centres are utilized year round.
- Only three locations will need salt and sand storage capacity as opposed to five. The two sites identified for closure do not have sand storage. By reducing the number of yards, capital costs will not be required that were identified for the North East and South West facility in the amount of $800,000. In addition, staff identified the need for a new facility in North East which was estimated to be $2 million. This cost can also be avoided.

The following provides the existing and proposed organization structure for supervisory positions. This reflects a reduction of 7 positions.

Current



Proposed



The use of three compared with five deployment centres will also have a positive impact on route scheduling.

A yard rationalization study is needed to confirm the preliminary findings

Given the focus of the internal audit was on winter maintenance activities in isolation, a comprehensive yards rationalization study is needed to confirm the preliminary analysis undertaken and to review corporate wide uses of these facilities/yards. In addition, there may be further opportunities through identifying new yard locations that were not considered as part of the analysis undertaken. A yard rationalization study would include:

- Analysis of all operations using the yards/facilities to identify implications to consolidations, closures etc. (e.g. Water/Sewer, Summer maintenance etc.)
- Inspection of all sites to examine the existing space utilization and gain a full understanding of accommodation requirements
- Review capital and operating budget requirements
- Identify highest and best use of each facility/yard
- Assess the realistic potential to dispose of any properties or alternate uses (remote storage etc.)
- Complete a cost/benefit analysis for various scenarios
- Identify alternate possible locations for yards that would maximize the efficient and effective delivery of services

Recommendations

That the City undertake a yards rationalization study to confirm the preliminary findings and analysis that there is an opportunity to deploy winter operations out of three of the five works yards (Chelmsford, Frobisher, St. Clair) which will reduce the annual operating costs by approximately $74,000 and result in cost avoidance of $2.8 million associated with the capital yard expenditures required at the two yards identified for closure.

Currently, no winter maintenance fleet are parked indoors which compromises the efficiency and effectiveness of the operations

Deployment Centre Practices

Almost the entire winter fleet is parked outside, even through there are bays available for parking. This leads to delays in warming up vehicle windshields and hydraulics. While the crews seem to take this in stride, it adds at least 30 minutes more to the typical response time at the start of the shift. That half hour for the entire crew of approximately 71 front line staff adds up to costs that could be reduced or operational efficiencies through improved staff utilization. Ongoing winter starts on equipment are also rough on the vehicles and compromises the overall condition of the fleet.

There is a recognized conflict of using bays normally occupied by shop services – however solutions must be found to utilize this premium space for full value.

There are enough heated bays in the three proposed winter service centres to house the number of primary truck plow spreaders assigned to them respectively.

It is recognized that garbage trucks and graders have precedence to heated storage over plow spreader trucks. Sidewalk units need to be stored indoors for the same reason. Unheated cover is better than no cover at all. Heated storage for vehicles needs not to be over 50F.

By parking indoors, there is an opportunity to increase the effectiveness of service delivery. This approach is considered to be a best practice.

Other Municipal Experiences

Indoor parking is considered a best practice and is the approach undertaken in a number of other municipalities including but not limited to the City of North Bay, Sault Ste. Marie and Chatham-Kent.

Recommendation

That winter maintenance fleet be parked indoors to reduce the response time and increase the efficiency and effectiveness of the operations.

Salt and Sand Storage Practices

Currently, salt product is able to be stored and replenished under cover and all 3 proposed service centres, an annual amount of winter sand is stockpiled outdoors.

A storage depot for salt should be maintained at the NE yard until the site is disposed of provided, at least 3 spreader trucks can take advantage of the intermediate recharge of sand and salt. However the utilization of midway salt stockpiles (e.g. airport), with a loader is not cost effective. Trucks with maximum capacity and optimized routes, need to be arranged to eliminate intermediate depots.

Further efforts through employing best practices are required to reduce the leachate and environmental impacts

In the cold temperatures of Sudbury winter sand freezes in the stockpile. Adding 5% salt tends to minimize the freezing, yet it is still necessary to put the sand through a grizzly screen to remove the smaller lumps. The loader is preoccupied with setting lumps aside for thaw next spring. Outside stored salt containing product will leach. This leachate forms a plume under every such stockpile. In the case of the S deployment centre the dissolved brine finds its way quickly to the adjacent stream. There is no reasonable treatment of brine. Ultimately, this is unacceptable for the environment. The goal is to ensure that work yards minimize the loss of material to the environment by containing run-off and by providing additional structures for the warehousing of materials.

There is a need for sand domes to be used at the yards

A sand storage facility needs to be installed at both the S and NW service centre, and possibly at the SE service centre if the second dome were to be used for the recommended 25% salt sand demonstration project. Sand under cover can be reduced to 3% salt content to prevent lumping.

The SE service centre has a second dome intended for winter product storage but not currently available for winter maintenance operations (storage currently used by police to store stolen bicycles). Finding alternate space for the current use (for example, the use of one of the underutilized works yards) may easily free up the needed sand storage capacity.

Best practices included in the Code of Practice for the Environmental Management of Road Salts recommend that salt piles and salt-sand piles should be covered. Indoor storage of both sand and salt are identified as a best practice across Ontario and is particularly needed in Northern municipalities. Most municipalities surveyed store sand under cover. Examples, include Guelph, Burlington, Chatham-Kent, North Bay and Timmins.

Recommendations

That in keeping with industry best practices, that the City move toward storage of sand under cover.

That management review the existing work practice of utilizing midway salt stockpiles (e.g. airport), with a loader as this is not cost effective. Trucks with maximum capacity and optimized routes, need to be arranged to eliminate intermediate depots.

There is an increased liability risk associated with not meeting the minimum standards under Ontario Regulation 239/02

Minimum Maintenance Standards for Municipal Highways—Road Classification

Road Authorities now have to operate in compliance with the Minimum Maintenance Standards for Municipal Highways (MMSMH) if they wish to limit their liability and exposure to claims for negligence. The MMSMH were originally developed in the late 1990's as a mechanism to help municipalities deal with the increasing costs of negligence liability insurance as a result of increases in claim settlements. The MMSMH was approved by cabinet as a regulation in the Municipal Act coming into law on November 1, 2002 with the approval of *O. Reg. 239/02.* While the MMSMH does not include a standard for every activity the City undertakes in its Road Services, it includes the following safety related activities:

- Routine Patrolling
- Snow Accumulation
- Icy Roadways
- Potholes on Paved Surfaces
- Potholes on Non-Paved Surfaces
- Potholes on shoulders
- Shoulder Drop-Offs
- Distortions on Paved and Non-Paved Surfaces
- Cracks
- Non-Functioning Luminaries
- Regulatory and Warning Signs
- Bridged Deck Spills
- Surface Discontinuities

This Provincial regulation under the new *Municipal Act* specifies minimum maintenance standards for roads, bridges, shoulders and signs. Although such "standards" have only "**guideline**" status, failure to achieve such 'standards of care' could have liability implications in civil suits. As such, municipalities have typically taken the approach of aligning their standards to the minimum standards set out in the regulation.

In theory, in any potential lawsuit, if the City can show that it meets the Minimum Maintenance Standards for Municipal Highways, then the City has presented the legal argument against the lawsuit.

While municipalities are not required to adopt standards, where there are no standards, courts will rely on the minimum requirements under the regulation

Municipalities have complete administrative control over highways/ roads under the jurisdiction of the new *Municipal Act* but do not have to adopt the Standards. However, in cases where the Standards are not adopted by a municipality, judgements against such municipalities for poor maintenance will be made by the courts after comparison with the Standards. Such being the case, the Standards will be the defacto standard for all municipalities as far as road maintenance is concerned.

The Standards call for the classification of each road in a municipality as one of **six types** based on:

- Average Annual Daily Traffic count (AADT)
- Speed of those vehicles (kilometers per hour)

According to the Provincial guidelines, the highest classification a municipal road would get would be 1. This would apply to the roads where the traffic count is 15,000 AADT or more and the speed is in the 80+ km/hr range. It also applies to roads where the traffic count is 8,000 AADT or more and the speed is 80+ km/hr range. The lowest classification of 6 would be for roads that have a 0-49 traffic count with speeds in the 40-80 km/hr range.

Average Annual Daily Traffic (number of motor vehicles)	Posted or Statutory Speed Limit (kilometres per hour)						
		90	80	70	60	50	40
15,000 or more	1	1	1	2	2	2	2
12,000 - 14,999	1	1	1	2	2	3	3
10,000 - 11,999	1	1	2	2	3	3	3
8,000 - 9,999	1	1	2	3	3	3	3
6,000 - 7,999	1	2	2	3	3	3	3
5,000 - 5,999	1	2	2	3	3	3	3
4,000 - 4,999	1	2	3	3	3	3	4
3,000 - 3,999	1	2	3	3	3	4	4
2,000 - 2,999	1	2	3	3	4	4	4
1,000 - 1,999	1	3	3	3	4	4	5
500 - 999	1	3	4	4	4	4	5
200 - 499	1	3	4	4	5	5	5
50 - 199	1	3	4	5	5	5	5
0 - 49	1	3	6	6	6	6	6

	Accumulation in cm	Time (in hours)	Icy Road time (in hours)
Class 1	2.5	4	3
Class 2	5	6	4
Class 3	8	12	8
Class 4	8	16	12
Class 5	10	24	16
Class 6	no standard		

The table to the left summarizes the O. Regulation 239/02 as it pertains to winter maintenance. For each classification, there are minimum times to effect maintenance in order for the municipality not to be held liable for accidents caused by the condition of the road. For example, a Class 3 road requires a municipality to clear snow that has accumulated to a depth of 8 cm in 12 hours or less and to address icy conditions within 8 hours.

The City's current classification does not fully align with the provincial guideline

Current City of Sudbury Classification

While the City has a roads classification system, it is currently <u>not</u> aligned with the provincial regulations. The following provides a summary of the City's existing road classification system.

CURRENT ASSET CLASSIFICATION

km = centreline km (or 2 lkm in the case of 4 or more lanes per road)

KM Rural Loosetop Roads

	Total km	Less than 60 kph			60kph +	
		0- 50 aadt	50 - 500 aadt	500 +aadt	0- 50 aadt	50 - 500 aadt
NE	46.2	10.3	26			9.9
NW	27.4	15	9.5		2.1	0.8
S	93.2	5	84.2	4		
SE	48.7	0.7	48			
SW	111.7	31.8	76.7	3.2		
Total	327.2	62.8	244.4	7.2	2.1	10.7

KM Rural Hardsurfaced Roads

	Total km	Less than 60 kph				60kph +		
		0- 50 aadt	50 - 500 aadt	500 +aadt	3000 + aadt	50 - 500 aadt	500 - 3000 aadt	3000 + aadt
NE	236		60.1	54.1		15.4	58.1	48.3
NW	200.4	1.3	57	27.7	0.5	34.4	52.1	27.4
S	153.3	0.5	76.5	33.4	5.5			37.4
SE	174.5	5.8	95.5	17.9	6		19.3	30
SW	197.3	3.9	82.7	40.5	2.5	13.3	29.7	24.7
Total	961.5	11.5	371.8	173.6	14.5	63.1	159.2	167.8

KM Urban Road Assets

	Total km	Urban (0 - 50 kph)				> 50 kph
		0- 50 aadt	50 - 500 aadt	500 - 3000 aad	3000 + aadt	3000 + aadt
NE	41.6	0	19	3.6	4.5	14.5
NW	40.6	0.5	21.9	13.9	3.4	0.9
S	173.2	0	66.4	33.9	48	24.9
SE	160.5	0.2	68	30.8	48.7	12.8
SW	16.4	0	7.3	7.6	1.5	0
Total	432.3	0.7	182.6	89.8	106.1	53.1

Summary km	
323.8	NE
268.4	NW
419.7	S
383.7	SE
325.4	SW
1721	Total

As shown on the previous page, while there are classifications established in Sudbury, the classifications do not align with the 6 classifications outlined in the regulation.

Proposed Classification System

Given the new meaning of provincial regulations for municipal roads, it is useful to adopt a primary classification matrix that is aligned with the Provincial regulations.

A special feature of the recommended road system is that it includes a full spectrum of roads from local to arterial, from very low volume rural to high volume urban. This full range provides a unique opportunity to optimize services by full utilization of resources.

Roads are further categorized into the higher service standards of class 1 to 3, and the lower service standards of class 4 to 6. These class codes appear in the articulated service standards. Generally priority for service ranks from 1 to 6.

AADT	60 or more kph	50 or less kph
15,000 or more	1	2
12,000 - 14,999		
10,000 - 11,999	2	3
8,000 - 9,999		
6,000 - 7,999		
5,000 - 5,999		
4,000 - 4,999		
3,000 - 3,999		
2,000 - 2,999	3	4
1,000 - 1,999		
500 - 999		
200 - 499	4	5
50 - 199		
0 - 49	6	

Note that the recommended classification system (table to the left) reflects a broader inclusion of roads in the higher classifications thereby exceeding the minimum standard set out in the regulation.

This represents the proposed classification applied to the known road criteria. These 6 primary classifications will be used to form the service standards.

The following table provides a summary of the recommended road classification and an inventory of the number of kilometers within each classification and within each location in the City. As shown below, the most prevalent type of road in the City is local rural (class 5), which accounts for 46% of the kilometers of road, followed by local urban roads, which comprise 20% of the total road kilometers.

Yard Location	Total km	Service Class (km)					
		Arterial		Collector	Local	Local ST	Local Gravel
	Class	1	2	3	4	5	6
NE	323.8	31.4	33.7	60.4	83.0	105.1	10.3
NW	268.4	14.2	15.9	54.3	76.8	88.4	18.9
S	419.7	31.2	57.9	26.8	71.3	227.1	5.5
SE	383.7	21.4	48.8	46.7	48.7	211.5	6.7
SW	325.4	12.4	13.1	33.0	64.6	166.7	35.7
Total	1721.0	110.5	169.3	221.0	344.4	798.8	77.1
% of Total		6%	10%	13%	20%	46%	4%

Roads are further categorized into the higher service standards of class 1 to 3, and the lower service standards of class 4 to 6. It is recommended that these class codes appear in the articulated service standards.

Other municipalities have adopted similar classification systems, using the 6 classes identified in O. Regulation 239/02 including the City of North Bay, the City of Ottawa, the City of Guelph, the City of Burlington, the City of London and the Municipality of Chatham-Kent.

Recommendations

That the City recognize and implement a basic primary classification for roads based on the provincial guidelines as set out in O. Reg. 239/02 and that these classifications form the basis for the service standards.

Sidewalks

Walkways are not well documented in the City...this poses problems in terms of confirming the level of service provided

Walkways are less well documented, however they represent a distinct service area. Currently, there is no documented distinction between primary and secondary sidewalks, nor is there a classification system to identify distinct service levels. The following provides a summary of the inventory of sidewalks. Management should direct that a survey and classification of all walkways be undertaken prior to winter 05/06. The indicated lengths by type are estimated only.

KM Sidewalks

	Total km		
		Winter	Summer
NE	16	12	4
NW	49	35	14
S	132	100	32
SE	90	60	30
SW	16	12	4
Total	303	219	84

The practice has been that where there are sidewalks on both sides of the road, Public Works clears snow on one side, rotating each year

The term walkway is more appropriate than sidewalk since not all walkways are on the side of roads. Of 303 km of municipal walkways approximately 219 km receive winter service.

As such there is a need for a separate classification system as well as a documentation and inventory of the City's sidewalks. Based on the information available and subject to verification the following additional breakdown of sidewalk inventory was undertaken.

	Total km	Winter service		Seasonal service	
		Primary	Secondary	Primary	Secondary
NE	16	10	2	3	1
NW	49	25	10	10	4
S	132	80	20	25	7
SE	90	50	10	20	10
SW	16	10	2	3	1
Total	303	175	44	61	23

This provides a breakdown between primary and secondary walkways.

A classification system is needed for walkways

To be sustainable, services should be delivered somewhat proportional to the benefit derived from the expenditures incurred to deliver them. To this end, each municipal walkway should be recognized as being in one of four general classifications:

- **Class 1** – rural and park primary trails
- **Class 2** – urban primary walkways serving non residential frontages
- **Class 3** – urban secondary sidewalks and paths
- **Class 4** - rural tertiary trails

It is recommended that all Winter Walkway Services should be extended to:

- All walkways adjacent to class 1 to 3 roads
- Walkways on one side of class 4 to 6 roads where there are two walkways present.
- Connecting links through parks or the grounds of public facilities

This will improve the existing level of service and provide a clearer understanding of the service levels. Appendix B provides walkway service levels that are recommended for implementation in the City of Greater Sudbury. This will clarify service levels for staff and citizens.

Recommendations

That a survey and classification of all walkways be undertaken prior to winter 05/06.

That the City of Greater Sudbury recognize a basic primary classification definition for walkways and clearly document service levels associated with each classification.

Impact of Recommended Changes to the Road Classification on Service Standards

Current Situation

A move to the updated road classifications and associated service standards should be outcome based

While the City currently has defined service levels, they are not current with post amalgamation expectations. Further, the descriptions include imperial measures and the commitment to current spread rates and cycle times is risky.

There is a need to adopt new service standards that are **outcome based.**

Recommended Change to Service Standards

Winter road services are essential and valued by the residents and business of Greater Sudbury. It is important that a balanced and valued set of services be offered to make the roads effective under winter conditions.

The purpose of standards in policy is to set a measurable, realistic, and accountable threshold for performance of the resources of the department. They also define the expectations and priorities of the stakeholders. Winter road services have to do with the availability of certain surface conditions within periods of time after precipitation occurred. A significant measure is the time it takes to restore a condition after the storm has ended. At times, the storm needs to be described as cold temperatures, or freezing rain, or snowfall.

The introduction of planned and minimum standards provides the City with needed flexibility as well as confirming adherence to minimum standards

Formal service standards identify the scope and nature of the services offered by the City of Greater Sudbury. They should be adopted by Council as a clear statement of policy. City resources are directed to deliver the intent of these standards or expectation.

There are effectively two levels of service worth determining; “planned” and “minimum”. Planned service standards direct the preparation and provision of timely resources without further external influences. Planned is the targeted service levels upon which staff should be seeking to provide service. In all cases, the planned targets meet or exceed the provincial minimums.

Such external influences that could impact the target levels include:

- Unexpected change in resource availability (labour, equipment, materials)
- Directives by Council
- Lack of funding
- Extraordinary conditions such as extreme weather or infrastructure failure

In the case where circumstances mitigate the ability to deliver the planned service standard, the expectation is that the minimum service standard will be delivered. Should conditions fall below such minimums there is a further expectation that the City will take appropriate measures to protect public safety, which may be identified in the respective standard.

There is a need to redefine the service standards and establish a minimum service standard as well as a target standard that is clearly articulated and that meets the minimum standards as set out in the regulations

A common standard is the depth to which new fallen snow is considered acceptable to accumulate on the road surface.

The following tables illustrate the minimum provincial standards, the current service levels and the proposed new service levels using the 6 roads classifications. Note that the Ontario guidelines form the maximum allowable snow accumulation and time to respond.

ONTARIO MINIMUM CURRENT **PROPOSED**

Snow accumulation

	O. Reg. 239	
Class	Depth cm	Max. Time hrs
1	2.5	4
2	5	6
3	8	12
4	8	16
5	10	24
6	none	none

	Current City Service Levels	
Class	Depth cm	Time hrs
UE &Arterial	2.5	2
U Collector	4	3
U Local	5	4
G & ST	8	6

	Proposed Service levels			
	Depth cm		Time hrs*	
Class	Reasonable	Maximum	Reasonable	Maximum
1	2.5	2.5	2	4
2		5		6
3		8	4	12
4	8	8	8**	16
5		10		24
6		none		none

* from reaching depth
** after precipitation ends

Surface Exposure

	O. Reg. 239
Class	
1	no standard
2	
3	
4	
5	
6	

	Current City Service Levels	
Class	Condition	Time hrs
UE &Arterial	Bare as possible	2
U Collector	Bare as possible	3
U Local	Centrebare	4*
G & ST	Snowpacked	6*

* after storm

	Proposed Service levels			
	Condition		Time hrs*	
Class	Reasonable	Maximum	Reasonable	Maximum
1	Bare	Bare	2	3
2				
3		Centrebare	4	6
4	Centrebare	Snowpacked	8	16
5				24
6	Snowpacked			none

* after storm

Ice accumulation

	O. Reg. 239	
Class	Cycle* Time	
1	3	
2	4	
3	8	
4	12	
5	16	
6	none	

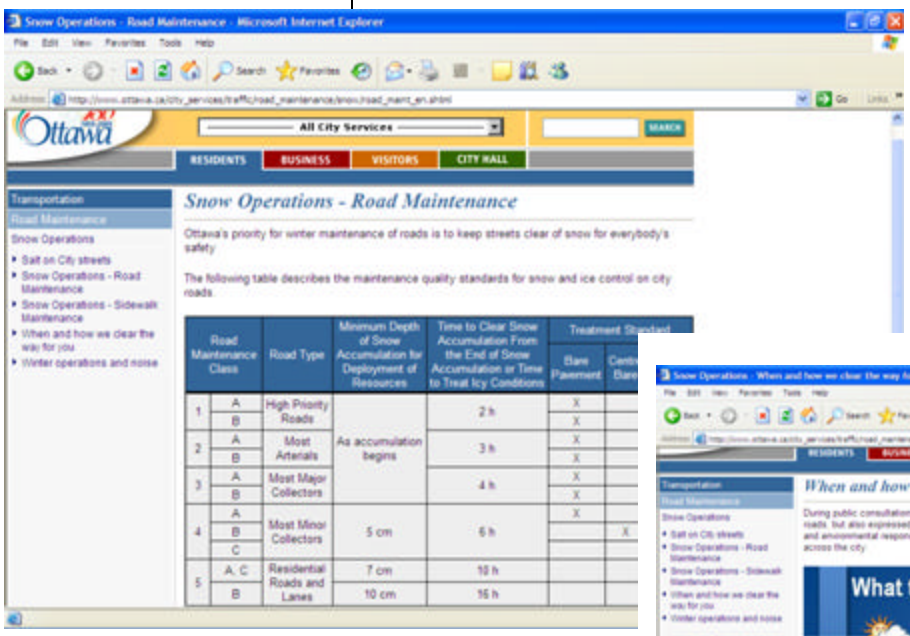
	Current City Service Levels	
Class	Cycle* Time hrs	
UE &Arterial	2	
U Collector	3	
U Local	4	
G & ST	6	

** to sand or salt*

	Proposed Service levels	
	Cycle* Time hrs	
Class	Reasonable	Maximum
1	1	2
2	2	4
3		8
4	6	12
5		16
6		none

** to sand or salt*

As an example of best practices, the City of Ottawa has clearly articulated the standards by providing information directly on their website to educate the public on what they can expect. A similar practice would benefit the City of Greater Sudbury by facilitating an education process.



There are a series of service standards proposed for adoption after review by Council and senior management. Currently there are a few operating procedures set out as standards which need to be removed from policy status. These include:

- Classification of Roads, Classification of Sidewalks
- Customer Service, Non Compliance, Inspection
- Road: Surface Exposure, Snowfall Accumulation, Snow Removal
- Walkway : Snow Accumulation, Ice

The proposed new service standards are results as opposed to operationally focused

Appendix B provides a list of **draft** service standards that should be considered by Council to formalize service levels in the City and to address existing deficiencies in the current policies. The following provides the table of contents from the proposed policy document.

- List of Services
- Introduction to Standards
- Classification of Roads
- Classification of Sidewalks
- General
- Customer Service
- Non Compliance
- Inspection
- Winter Road Services
- Surface Exposure
- Snowfall Accumulation
- Snow Removal
- Winter Walkway Services
- Snow Accumulation
- Ice

The recommended standards in all cases are equal or higher than the existing service levels. Based on the recommendations contained in this report, these service levels will be clearer and more understandable for the customer and also the service providers as well as being results as opposed to operationally based.

Recommendations

That the City adopt Winter Road and Walkway Service Standards for both minimum and targeted service standards for snow accumulation, surface exposure and ice accumulation in terms of expectations and outcomes and that these be approved by Council. Samples have been provided in Appendix B of this report.

That the City clearly communicate the Service Standards in a manner that is meaningful and understandable to the public. It is anticipated that this would include the use of the website, newspaper and possibly a direct insert into tax bills.

Weather, Storm and Spread Rate Management

Current Operations

Knowing the characteristics of winter weather is critical to establishing a winter roads maintenance strategy. Analysis of winter conditions for the 2003/2004 season indicated that it was within a few percent of being an average for winter weather. This assessment was undertaken using information provided by the City's weather provider, World Weather Watch, of Markham. Based on their information and Environment Canada a detailed picture of that winter was developed.

There is an opportunity to use weather information more extensively in the efficient deployment of staff and resources

While this information is available, there is currently no process in place at the City to classify storm activity and provide service specific responses with respect to salt/sand usage or staff deployment. The current approach is more intuitive rather than scientific. As a result, there is a higher current service than the policy guidelines, resulting in consistently higher expenditures than budgeted for salting and sanding activities over the past 4 years.

Classifying Storm Activity

Winter weather arrives in storms. Each storm has particularly significant characteristics. The proposed strategy is to develop a specific service response plan for each type of storm. The benefits of classifying storm activity and developing specific service responses are improved:

- Effectiveness in deploying staff
- Efficiency in salt and sand usage
- Response and winter clearance

In addition, there is an opportunity to reduce the number of kilometres traveled by accurately calibrating the spread rates. An analysis was undertaken on the weather and storm activity to gain a better understanding on the conditions that would impact the provision of service, the use of sand and salt as well as the snow removal practices.

To develop a sound storm classification process requires the identification of the key factors that impact the service response. The **pavement temperature** and the **amount of precipitation** are two primary parameters. In the table on the next page, there were 108 storm events for the winter of 2003/2004, distributed by the selected parameters.

For example there were 3 storms with the average pavement temperature below -10C where the received precipitation was between 2.5 and 7.9 cm.

Storm Classification

Temp Class		A	B	C	
		Temperature Range (deg C)			
Precip Class	cm snow	0>C>-5	-5>C>-10	-10> C	Total
1	.0 - 2.4	30	23	28	**81**
2	2.5 - 7.9	11	4	3	**18**
3	8 +	2	2	5	**9**
	Total	**43**	**29**	**36**	**108**

This objective storm classification includes the **development of 9 activities** to be planned for in the operations budget for the clearing operations of winter. These classifications would then be aligned with service responses.

This approach will allow management to track performance on a cost per storm basis and performance over time

Based on the recommended storm classifications, each type would have a planned amount of resource requirements: salt, sand, hours of equipment time, routes, staff etc.

Operational performance would then be assessed by comparing actual to planned performance for each storm and storm type. This will allow a more accurate approach to managing responses to storm activity than the current approach which does not identify the specific response. Over time, this would also provide management with the ability to modify responses that are required to match the storm responses with the type of winter weather. As will be discussed later in the report, this will require some modifications to the equipment to more accurately calibrate the sand and salt spread rates.

While there is still the possibility of being over budget as a result of having more storms than planned, this approach allows management to demonstrate performance on a cost per storm basis. The focus, therefore, moving forward is to actively manage storm response activity and the associated costs to ensure that an efficient response to storms is provided. This will provide the ability to track performance on a cost per storm basis.

Based on the analysis undertaken of comparing existing practices with the proposed method of winter response, storm classification and use of combined units, it is anticipated that there is an opportunity to reduce operating costs in this area by 30%, with an approximate annual savings of $1.75 million. The following tables reflect the changes as mapped out using the recommendations contained in this report regarding staff deployment, sand and salt usage.

Summary Current Deployment

	Class 1-3	Class 4-6	Net	Gross(175%)	$ Unit	$/yr
Serviced KM	198,277	65,896	264,173	462,303	$ 11.11	$ 5,136,705
SALT tonnes	10,619	-	10,619	18,584	$ 50.00	$ 929,193
SAND tonnes	10,810	7,439	18,249	31,936	$ 10.00	$ 319,359
SS tonnes	-	-	-	-	$ 25.00	$ -
Total Costs						$ 6,385,256

Summary Proposed Deployment

	Class 1-3	Class 4-6	Net	Gross (175%)	$ Unit	$/yr
Serviced KM	126,176	32,948	159,125	278,468	$ 12.00	$ 3,341,615
SALT tonnes	10,536	-	10,536	18,438	$ 50.00	$ 921,876
SAND tonnes	7,210	2,929	10,139	17,743	$ 10.00	$ 177,429
SS tonnes	-	4,344	4,344	7,602	$ 25.00	$ 190,057
Total Costs						$ 4,630,977

Difference

	Class 1-3	Class 4-6	Net	Gross (175%)	$ Unit	$/yr
Serviced KM	- 72,101	- 32,948	-105,049	-183,836	$ 0.89	-$ 1,795,091
SALT tonnes	- 84	-	- 84	- 146	$ -	-$ 7,316
SAND tonnes	- 3,600	- 4,510	- 8,110	- 14,193	$ -	-$ 141,930
SS tonnes	-	4,344	4,344	7,602	$ -	$ 190,057
Total Costs						-$ 1,754,280

Details on response changes have been included, for illustrative purposes in Appendix C. Fine tuning of this model will be needed, with the input of staff.

To implement and be able to achieve efficiencies will require significant changes in current work practices. This will likely require mentoring and front line staff training.

Spread Rates and Anti-Icing Technology

There is a science which can be applied to the application of chlorides and abrasives on road surfaces. Salt (sodium chloride) continues to be the optimum chemical for producing brine which mitigates ice formation.

The use of anti-icing was considered. Anti-icing is the application of brine to pavements prior to, or upon the arrival of the first precipitation. For its successful use, there must be an accurate knowledge of the pavement temperature, the forecast pavement temperatures, the traffic, and the time sensitive arrival of precipitation.

Anti-icing is not recommended at this time...pre-wetting can achieve almost the same results with less risk

Anti-icing requires special application equipment consisting of tanker trucks. There may be a role for this practice in Sudbury but it is proposed that at this time, it not be employed. It's particular merit is that it prevents ice bonding on the surface as precipitation arrives. It has greatest value for high speed roads experiencing many freezing point transitions in a season. It is also of greater value to mitigate effects of freezing rain and fog. In Sudbury the timely application of pre-wet salt can achieve almost similar results with less risk.

Pre-wetting is a very effective practice and should be included in all spreading activity. The entire rejuvenated spreading fleet should be outfitted with pre-wetting capability. The purpose of pre-wetting is to wet the salt or sand for several reasons:

- In the case of cold pavements it enables the grain to freeze to the pavement.
- In the case of snow packed surfaces it enables the grain to "melt" into the snow pack rather than "blowing" off.
- In the case of de icing it begins the brine making process by re-acting with the crystalline salt to produce a brine concentrate which then lowers the freezing point of contact ice resulting in melting.
- In the case of traffic it mitigates bounce off (up to 30% has been measured) by making the grains "stickier," similarly with windy conditions.

In general the benefits include granules adhere to the surface better, there is a faster and longer-lasting effect, spreading speed can be increased and in some cases, the road surface dries more quickly.

Currently there are issues with respect to the efficient and effective use of salt

Current Practice

The practical result of pre-wetting should be a reduction in the resources necessary. The investment in brine making equipment has resulted in economical brine manufacturing on site in the service centres. There is no advantage to using extraordinary chemicals such as calcium chloride. Water could be used to similar benefit if it could be prevented from freezing in the tanks.

With improved calibration and controls in spreader vehicles, it is reasonable to establish a range of spread rates to be applied under certain conditions.

Currently operators are directed to spread not more than 127kg/2lane km of road of salt, with a preference to spreading less if possible. This has resulted in an overall reduction in the spread rates since it has capped the maximum limit. However, there is evidence, based on the analysis undertaken, that this practice has in fact resulted in **more** applications (serviced kilometre trips) being required to restore the road to acceptable service. This results in increased costs for equipment and manpower.

Salt for bare pavement service needs to do its job in 2 hours. Enough should be applied to address the existing condition plus the anticipated new precipitation. In a continuing storm, there is a need to apply salt every 2 hours and thereby prevent the formation of ice between applications. It takes more salt to break the ice bond with the pavement than to keep it in brine wet condition.

Best Practices

The decision whether to apply sand or salt, as well as the application rate is not an exact science and historically has been based in large part on local conditions and the experience of the service provider. As a consequence, there are significant variations in practice across Canada. Having said this however, it is a generally accepted best practice that the spread rates should be calibrated based on storm conditions (temperature and accumulation).

Best practices, as identified by the Ontario Centre for Municipal Best Practices identifies a number of strategies that should be employed for salting, sanding and plowing. Examples were provided which recommend the use of plowing/sanding/salting combined units in the provision of service to reduce the cost of operations and increase the efficiency of operations.

In addition, calibrated units are recommended in order to monitor compliance with its chosen level of service, to control costs, and to limit potential environmental impacts.

Benchmarking is needed to track actual spread rate performance

Benchmarking is recommended, as discussed earlier in the report, for internal performance in sanding/salting spread management practices. Making use of calibrated spread vehicles, municipalities are able to compare actual material spread rates across routes, across vehicle units and across staff operators within a given winter season. It is also recommended that a comparison of spread rate performance for each route and vehicle unit across winter seasons (time series analysis) be undertaken. The actual spread rate performance can also be evaluated against industry (MTO) spread rates associated with bare pavement and centre track-bare service levels.

Disciplined spread management practices should be implemented and should be supported and refined by spread rate benchmarking and measurement. The benchmarking approach is practical because it is internal in focus (avoiding complex apple to apple issues across other municipalities), and it is firmly linked to the enforcement of service levels, individual operator behavior, and cost savings targets.

As suggested in the Ontario Centre for Municipal Best Practices, spread rate benchmarking should become a key management practice for mid and large-scale system operators – thereby supporting and evaluating their Salt Management Plans and conforming to Environment Canada requirements/ recommendations. In this sense, the upfront financial and technical investment required to implement a municipal Salt Management plan is the same investment (calibration, spread rate measurement) required of a benchmarking process. Benchmarking is simply an extension of the necessary process (and cost) of collecting the Salt Management data, but it adds further value to this investment by generating positive financial, service level and environmental outcomes.

The Code of Practice for the Environmental Management of Road Salts identifies an objective for salt application as identifying ways to reduce the negative impact of road salts by delivering the right amount of road salts in the right place at the right time. In pursuit of this objective, it is recommended that consideration should be given to the most recent advancements in the application of winter maintenance anti-icing and de-icing materials, winter maintenance equipment and road weather information and other decision support systems. As well, the Code of Practice recommends training personnel and monitoring the effectiveness of road salt application techniques.

The following provides a summary of the current spread rate applications.

CURRENT SPREADER APPLICATION RATES

450 lb/mile 127 kg / km salt
900 lb/mile 254 kg / km sand

Temp in degrees C	Bare					Centrebare			Snowpacked	
	0 to -5	-5 to -10	0 to -5	-5 to -10	< -10	0 to -5	-5 to -10	< -10	0 to -10	< -10
	grams salt /m2		kg /km			kg /km			kg /km	
Salt, prewet										
Some snowpack or ice, no precipitation	18		127			127*				
Mostly snowpack or ice covered, or light precipitation										
Sand, prewet 5% salt										
Some snowpack or ice, no precipitation	2				254	254			254	
Mostly snowpack or ice covered, or light precipitation										

*HCIB only = hills, curves, intersections, bus routes

Calibration Kg/km

1 127
2 254
3 blast

	Bare			Centrebare			Snowpacked	
	0 to -5	-5 to -10	< -10	0 to -5	-5 to -10	< -10	0 to -10	< -10
Salt, prewet								
Light	1			1*				
Medium								
Heavy								
Sand, prewet								
Light			2	2			2	
Medium								
Heavy								

* salt for hills curves and bus routes only

PROPOSED SPREADER APPLICATION RATES (detailed)

			class 1,2,3			class 4,5			class 6	
			Bare			HCI or Centrebare			Snowpacked	
Temp in degrees C	0 to -5	-5 to -10	0 to -5	-5 to -10	< -10	0 to -5	-5 to -10	< -10	0 to -10	< -10
	grams salt /m2		kg /km			kg /km			kg /km	
Pure Salt, prewet			urban			urban - HCIB (50% of system)				
Some snowpack or ice, no precipitation	12	18	84	126		72	108			
Mostly snowpack or ice covered, or precipitation	18	24	126	168		108	144			
Premix, prewet	*25% salt*		rural			rural centrebare				
Some snowpack or ice, no precipitation	12	18				144	216			
Mostly snowpack or ice covered, or precipitation	18	24				216	288			
Sand, prewet	*5% salt*									
Some snowpack or ice, no precipitation	from .7 at 100 to 4.3 at 600				300			120	100	150
Mostly snowpack or ice covered, or precipitation					500			250	150	250

HCIB = hills, curves, intersections, bus routes

Recommended Approach

The table above provides a summary of the current and proposed spread rates for sand and salt. Based on a required salt per square meter of pavement, a spread rate range for salt from 84 to 168 is proposed for roads classes 1-3 and a range of 72 to 144 for class 4 and 5 roads depending on the temperature and the degree of snow fall.

Calibration	Kg/km		class 1,2,3			class 4,5			class 6	
			Bare			Centrebare			Snowpacked	
			0 to -5	-5 to -10	< -10	0 to -5	-5 to -10	< -10	0 to -10	< -10
1	50									
2	75	**Pure Salt, prewet (urban only)**				* rate on for 50% of system				
3	125	Light	2	3		*2**	*3**			
4	200	Heavy	3	4		*3**	*4**			
5	300	**Premix, prewet (rural)**								
6	400	Light				3	4			
7	500	Heavy				4	5			
8	650	**Sand, prewet**								
9	blast	Light			5			3	3	4
		Heavy			7			4	4	5

When pavement temperatures are below -10C careful consideration is needed in deploying salt. In this condition sand may be necessary until temperatures start to rise above this operational threshold. With sufficient traffic to clear the slush off the road it is possible to prevent icing even below -10C. This situation needs careful direction by seasoned managers.

The current approach is to distribute salt based on a spread rate of 127 kg/km, compared with the recommended approach of calibrating based on the type of storm activity as well as class of road.

Similarly, will vary based on the type of storm activity under the proposed scenario as well as based on the type of road classification.

The recommended approach also includes the use of a premix under certain weather conditions for class 4 and 5 roads.

Typically Greater Sudbury can experience a full month of temperatures below -10C. In that month, any snow packed roads will require regular blading and sanding. Snow packed roads also lead to further operations to deal with conditions as the snow pack breaks up in milder weather. It is for this reason that the centre bare objective for qualifying roads may be more cost effective – and provide a better overall service.

Centre bare conditions cannot be achieved without the application of salt. Currently there are roads which are hard surfaced yet are preserved in a snow packed condition by using only sand. There is a winter road spread product recognized as a best practice in Ontario made of 25% salt, mixed with 75% sand. When this product is applied carefully it will yield centre bare conditions on hard surfaced roads where traffic is sufficient to work the resulting mix. Ice is mitigated in the centre wheel track on commuter roads with 300+ aadt when conditions are right. The sand further tends to mulch with the residual post plowed snow to mitigate hard pack. The centre of the road tends to bare itself within 4 to 8 hours of the application provided the morning and evening traffic can work on it. With the centre bare further heat from the sun is absorbed enhancing the progression of clearing of the outside tracks naturally.

There is a need to develop a Salt Management Plan

Salt Management Plan

Federal environmental regulations now require salt users over 500 tonnes/yr to file a Salt Management Plan (SMP). All municipalities meeting this criteria were asked to file a letter of intent with Environment Canada by October, 2004 indicating what they intend to do with respect to preparing a Salt Management Plan in accordance with "Environment Canada's Code of Practice for the Environmental Management of Road Salts". Although preparing a Salt Management Plan is not mandatory at this time Environment Canada is measuring how successful they have been at convincing municipalities to voluntarily comply with the Code of Practice. Timmins has filed a letter of intent and is preparing a Salt Management Plan.

A SMP plan would illustrate how salt is inventoried, stored, and attributed to various road sections. It also requires that spread rates have regard for identified environmentally sensitive areas. The goal of the plan is to optimize the use of salt without compromising road safety. This review has not developed a SMP however, many recommendations will support the quality of a SMP.

The SMP should cover all activities which may result in release of road salts to the environment, such as salt storage, application of salts on roads, and disposal of snow containing road salts. of road salts. A salt management plan is needed in the City of Greater Sudbury. To develop the plan, it is necessary to undertake the following steps:

- Benchmarking current policy practice and process in salt management
- Define the role of the SMP in the policy framework of the City.
- Review available historic data to determine performance benchmarks for key performance indicators.
- Develop results based, environmentally sensitive, goals and minimum standards
- Identify environmentally significant lands (susceptible roadside vegetation) and waters relative to the influence of road salt. This should be done in consultation with local MNR representatives and City planning staff. Potential sensitive receiving water bodies will be sampled and with benchmark water sampling, specific watersheds will be identified for salt utilization restrictions, if appropriate.

- Identify and evaluate relevant environmental regulations, municipal policy, and service standards.
- Identify performance goals and standards (thresholds) for indicators to lead the strategic efficiency and effectiveness of road salt utilization.
- Review and revise policy, process and practices to assure goals and standards are met.
- Evaluate current and proposed practices against emerging best practices as identified by the Regulations, TAC, Infraguide, OCMBP (Ontario Centre for Municipal Best Practices), OGRA etc.
- Develop best practices in management and operations, including
  - Salt purchasing and delivery
  - Salt storage and containment
  - Salt handling and loading
  - Spreader fleet calibration
  - Capacity
  - Spread rates having regard for road conditions, roadside environment, road class, weather and time of day
  - Off road surface water effects and mitigation
  - Uncontrolled releases “spills” protocol
  - Snow removal and disposal/storage
  - Training of all related personnel
  - Record keeping and annual review
- Undertake a Cost Benefit Analysis to ensure an equitable and sustainable policy for road salt management. It quantifies the balance between too high a salt usage vs. too much impact on the environment. The “Environment” in this case can be defined in terms of human accessibility, safety and convenience, public and personal property, and the physical environment of water soil flora and fauna.
- Accounting for Salt - This is the essence of the regulation, and the business. The SMP will develop practices to improve performance around these. Projected reduction goals in salt use can be set for each of these areas specifically, and achieved through careful management.
  - Environmentally sensitive
  - Mix design of chloride based products
  - Spreading rates and practices
  - Service Level optimization
  - Housekeeping

Identify how salt use will be tracked:

- **Salt Spread by Location** - Kgs / road section / time period, Kg / road class / time period, Kg / identified watershed / time period, Kg / environmentally significant zone / time period
- **Salt Spread by Spreader Vehicle** - Comparing performance of each spreader will allow trouble shooting and strategic improvement of poor performers. Indicators such as the following will allow analysis and improvement of the operations. Calibration of spreader mechanisms and recording systems is critical to identifying. kg / km / class by spreader, kg spread vs design kg spread by spreader route, calibration check, Actual vs recorded kg/km
- **Salt Spread by Storm** - There are many different types of storm. Over time, with sufficient samplings a trend may appear in the amount of salt utilized to service the road system on a per storm basis. A correlation needs to be made between the amounts spread and the different service results experienced. Service levels need to be stabilized by modifying spread practices. Correlations need to be found with selected spread rates and predictable weather conditions.

It is expected that a SMP will be evolving over time because it is based on best management practices. As new technologies and ideas develop, the SMP will change to incorporate these ideas. The plan will set out guidelines for continually improving methods for keeping the roads safe and reducing the use of salt. The plan should also provide a benchmark from which progress can be monitored.

Recommendations

That the City undertaken pre-wetting in all spreading activity. The entire rejuvenated spreading fleet should be outfitted with pre-wetting capability.

That the City develop a storm based activity analysis within the department business plan and performance review. This will require the tracking and development of a storm classification system, similar to that provided in this report, with associated service responses.

That the City adopt a pavement temperature, precipitation forecast and service standard sensitive spread rate structure. This will require some technology changes to retrofit vehicles with calibration equipment.

That the Department undertake a demonstration program to assess the merit of achieving centre bare pavement service post storm by using a sand product mixed with 25% salt by weight.

That a salt management plan be developed immediately as outlined in the report.

Route Optimization

Current and Proposed Allocation of Kilometres to Service Centres

Based on the proposed move to 3 yards, there is a need to reallocate the kilometres to be serviced from each yard...a first attempt has been made

Currently, the City is operating 63 routes out of 5 deployment centres. Based on the proposed recommendations to move to three deployment centres, there is a need to assign the kilometers of roads that require service to each centre. The following provides a draft of how this may be accomplished. As shown below, there are 1,721 km of road to be services. Approximately 50% of the NE kilometres have been assigned to the NW yard and 50% to the SE yard. Approximately 80% of the kilometres from the S yard have been assigned to the SE centre, with the remaining 20% to the SW yard.

CURRENT DEPLOYMENT - 5 centres

	Total km	Service Class (km)					
		Arterial		Collector	Local	Local ST	Local Gravel
	Class	1	2	3	4	5	6
NE	323.8	31.4	33.7	60.4	83.0	105.1	10.3
NW	268.4	14.2	15.9	54.3	76.8	88.4	18.9
S	419.7	31.2	57.9	26.8	71.3	227.1	5.5
SE	383.7	21.4	48.8	46.7	48.7	211.5	6.7
SW	325.4	12.4	13.1	33.0	64.6	166.7	35.7
Total	1721.0	110.5	169.3	221.0	344.4	798.8	77.1

PROPOSED DEPLOYMENT, 3 centres

	Total km	Service Class (km)					
		Arterial		Collector	Local	Local ST	Local Grave
	roposed Clas	1	2	3	4	5	6
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW +.5NE	430.3	29.9	32.7	84.5	118.3	141.0	24.1
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE +.8S +.5NE	755.5	52.7	94.5	90.2	125.9	377.6	14.6
SW +.2S	535.3	27.9	42.1	46.3	100.3	280.3	38.5
Total	1721.0	110.5	169.3	221.0	344.4	798.8	77.1

In establishing routes from first principles one begins with the question – how many kilometers of road can a TA plow spreader plow and spread in the given cycle time? The following provides a summary of the number of km per cycle time for each class of road. On Class 2 roads, for example a unit is capable of servicing 20 km within a 3 hour cycle time. On Class 6 roads, for example, a unit is capable of servicing 45 km in 6 hours.

Class of Rd	1	2	3	4	5	6
#km/route	15	20	25	25	35	45
Cycle Time	3	3	3	6	6	6

It is recommended that for route optimization, roads should be split into 2 groups:

- Class 1-3—2 hour cycle
- Class 4-6—6 hour cycle

Based on the analysis undertaken using the redistribution of roads to the three service centres, it can be estimated that 25 routes need to be developed in the first round of clearing during the storm and 38 routes need to be developed for the second round.

With the available in-house work force deployed in two shifts per primary unit, there is a capacity in-house to deploy 20 units. Of the remaining, 18 primary routes need to be delivered by contractors, 5 will serve along with the City units in both rounds, being given a class 1-3 set of roads and a class 4 – 6 set of roads.

By developing a matrix of roads and known number of pieces of equipment the following performance has been demonstrated to be achieved by equipment in Sudbury. Appendix D provides the detail of the routes currently deployed as well as the proposed routes.

Recommendations

That the management update routes to optimize service delivery and to reflect changes in shifts, yards and fleet.

A winter control centre would provide benefits to staff and the public

Winter Roads Control Centre

There is an opportunity to improve the current practices in managing information with respect to winter operations, both internally and also the communication with the public.

It is recommended that the City implement a winter roads control centre (WRCC). This centre would provide the first contact for customer service inquiries and be a liaison with other City agents, and department managers.

It is further recommended that to improve customer services, a web-based public information service should be offered from the WRCC for road condition and status of operations.

There is a lot of information to be managed related to winter operations. For an effective program, this information needs to be optimized in several ways. It need to be:

- Sufficient
- Timely
- Useful
- Accessible

It is proposed that four department administrative staff be organized into shifts to operate the WRCC 24/7. This means that, including 24/7 patrol, at any given time in winter season there will be two non management persons watching out for winter related issues relevant to the department. This will also greatly improve the public service when all calls can be routed to this centre. Managers and supervisors can be briefed on status at any point in time. Call in of resources would be managed from the WRCC on direction from, but not done by, zone shift supervisors.

Central to the regulation is the need to monitor or patrol city streets in order to detect deficiencies and to respond within certain time periods, depending on the specific deficiency. A parallel patrol service would provide a field contact for and with the WRCC.

Recommendations

That the City establish a Winter Roads Control Centre (WRCC) for the winter season.

Integrated Web Based Winter Information Service

Currently, there is very limited information available to the public on the City's web site regarding winter maintenance practices, procedures and weather conditions. Some leading municipalities have used the website to provide extensive and timely information to the public as well as to the staff providing the service.

An integrated state of the art web based winter information service is recommended in the City of Greater Sudbury. This service would have regard to:

- Road weather information and forecasting
- Road Weather Information Systems (RWIS) connectivity (and installation of further networked RWIS sites)
- Road condition prediction reporting and recording.
- Road section specific real time operational activity
- Resource and inventory alerts and management (driver time, salt, sand)
- Strategic information – web cam, traffic movement monitoring

These services will process around the Winter Roads Control Centre and possiblly extend to other aspects of city services. It is proposed that when fully implemented, this information system will eliminate the need for any routine paperwork related to winter operations.

The following provides the opportunities and advantages that will be addressed by moving to an integrated web based winter information services.

There is a need to improve the level of information provided on weather conditions to more effectively manage service responses

Improved Weather Condition Information

Receiving and assessing emerging weather conditions is critical to service decisions. This service is currently provided by World Weather Watch – a commercial weather information provider. Currently faxed reports are provided daily to alert managers of pending weather conditions. This information stream needs to be more technically specified and be presented on a monitor to illustrate trends and alert to immediate change of conditions. Forecasts need to be tailored to the known triggers and desired alerts.

Improved Ability to Effectively Respond to Storm Activity

Road weather information systems (RWIS) provides very specific "on the ground" information. The system uses weather and road data from automated weather reporting stations installed along the roadway and special sensors imbedded in and below the road. The information gathered assists weather forecasters in predicting icing conditions before they occur. This data allows road maintainers to better track evolving road conditions and to intervene proactively, before road friction is lost.

Road maintenance crews can use this information to decide if road treatment is necessary, the best time to treat, what chemicals or mixture to use and how much is required. Best practices suggests this information results in reduced salt usage thus protecting the environment while at the same time providing significant cost savings in costs to road maintainers. This information can also contribute to reducing traffic congestion, thus reducing the levels of greenhouse gases released.

There is opportunity for strategic placement of several more sites to map out the City at this standard. MTO currently have two RWIS stations providing point source road weather information.

Improved Public Service

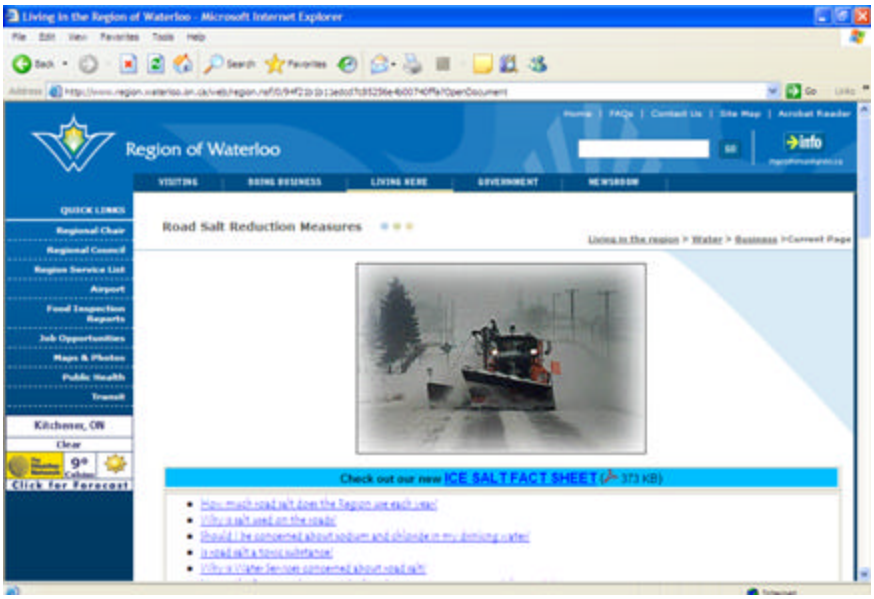
The public and many stakeholders in road conditions want to know what shape the roads are in. It is an appropriate service for the WRCC to provide a streamed web accessed map of the know current City road conditions. Road patrol reports would validate estimated conditions. Road conditions also trigger operations.

GPS technology is needed for all primary equipment

Every primary piece of equipment should be outfitted with a GPS sending unit, including the ability to communicate specific conditions. Information from the onboard plow spreader control unit should be transponded to the WRCC for visualizing and records management. A web service for public and stakeholders could illustrate current location of primary equipment. This will give them the information they may need to know in choosing when and where to travel.

In the Region of Waterloo, for example, salt trucks are linked to a Global Positioning System that can record the location and amount of road salt applied to the roadway. Supervisors can review the application locations and assist salt truck operators in developing skills to minimize the application of road salt while achieving the level of service requirements of the community.

While not a fully integrated website, the Region of Waterloo has also provided pertinent information to the public regarding winter maintenance and the salt management strategy. This helps increase the level of understanding to the public.



The City of North Bay is in the process of implementing a pilot study for the implementation of GPS in primary snow removal equipment.

Recommendations

That proposals should be called for the provision of an integrated state of the art web based winter information service.

That the City explore opportunities to add several more RWIS sites at strategic locations.

Summary of Annual Costs and Savings

Implementation of the recommendations contained in this report will result in reduced overall annual operating costs. Several first year investments are required as the deployment centres, equipment and systems are rationalized and revitalized. An annual reduction in cost is estimated at $2.4 million. Many of the recommendations are inter-related such that the savings will not materialize unless these inter-related changes are implemented. For example, much of the savings are associated with the ability to reduce the size of the fleet, which can only be accomplished by moving to a two shift service delivery.

The following table reflects a summary of the current spending (4 year average) and the proposed budget, based on changes recommended in the report.

Winter Activity	Current 4yr avg	Proposed	Difference
Plowing and spreading	$ 6,672,000	$ 4,670,400	($2,001,600)
Ditching & Spring cleaning	$ 1,418,000	$ 1,134,000	($284,000)
Snow Removal	$ 1,091,000	$ 840,000	($251,000)
Misc Winter	$ 878,000	$ 878,000	$0
Sidewalks	$ 712,000	$ 854,000	$142,000
NET Winter Ops	$ 10,771,000	$ 8,376,400	($2,394,600)

Appendix A

Unit No.	Description	YR	LIFETIME	LIFE	Make	Area	Now $	Sell	Buy 2005	Buy 2006	Buy 2007	Buy 2008	Buy 2009
S 190	Grader	88	15	-1	Champion	S	$ 10,000	$ 10,000					
S 350	Grader	89	15	0	Champion	N-E	$ 10,000			200,000			
S 351	Grader	90	15	1	Champion	S-W	$ 10,000				200,000		
S 353	Grader	81	15	-8	Champion	N-W	$ 5,000	$ 5,000					
S 354	Grader	86	15	-3	Cat	S-W	$ 8,000	$ 8,000					
S 359	Grader	94	15	5	Champion	N-E	$ 50,000						
	GRADER keep 3 out of 6						$ 93,000	$ 23,000	$ -	$ 200,000	$ 200,000	$ -	$ -
S 418	Loader	86	15	-3	John Deere	N-E	$ 8,000	$ 8,000					
S 416	Loader	94	15	5	Volvo	N-E	$ 50,000						
S 176	Loader	88	15	-1	Cat	S	$ 10,000	$ 10,000					
S 180	Loader	99	15	10	Komatsu	S	$ 100,000						
S 409	Loader	94	15	5	Volvo	S-E	$ 50,000						
S 411	Loader	74	15	-15	Trojan	N-W	$ 5,000	$ 5,000					
S 412	Loader	90	15	1	Case	S-W	$ 15,000				$ 200,000		
S 413	Loader	89	15	0	Cat	N-W	$ 10,000	$ 10,000		$ 200,000			
S 414	Loader	99	15	10	JBC	N-W	$ 100,000						
S 415	Loader	92	15	3	Dresser	S-E	$ 40,000					$ 200,000	
S 417	Loader	96	15	7	Volvo	S-W	$ 70,000						
S 422	Loader	72	15	-17	Case	N-E	$ 3,000	$ 3,000					
	LOADER keep 8 out of 12						$ 461,000	$ 36,000	$ -	$ 200,000	$ 200,000	$ 200,000	$ -
S 128	SA Plow & wing	95	10	1	GMC	S	$ 10,000	$ 10,000					
S 129	SA Plow & wing	96	10	2	GMC	S-E	$ 10,000	$ 10,000					
S 130	SA Plow & wing	96	10	2	GMC	N-E	$ 10,000	$ 10,000					
S 131	SA Plow & wing	95	10	1	GMC	S-E	$ 10,000	$ 10,000					
S 133	SA Plow & wing	96	10	2	GMC	N-W	$ 20,000	$ 20,000					
S 134	SA Plow & wing	98	10	4	Ford	S-W	$ 40,000	$ 40,000					
S 139	SA Plow & wing	92	10	-2	Ford	S-W	$ 7,000	$ 7,000					
S 140	SA Plow & wing	93	10	-1	GMC	S-E	$ 7,000	$ 7,000					
S 144	SA Plow & wing	98	10	4	Ford	S-W	$ 7,000	$ 40,000					
S 145	SA Plow & wing	95	10	1	GMC	S-E	$ 10,000	$ 10,000					
S 644	SA Plow & wing	90	10	-4	International0	S-W	$ 5,000	$ 5,000					
S 647	SA Plow & wing	87	10	-7	International	N-W	$ 5,000	$ 5,000					
S 652	SA Plow & wing	93	10	-1	International	S-E	$ 7,000	$ 7,000					
S 653	SA Plow & wing	91	10	-3	International	S-E	$ 7,000	$ 7,000					
S 655	SA Plow & wing	88	10	-6	International	S	$ 5,000	$ 5,000					
S 656	SA Plow & wing	88	10	-6	International	S	$ 5,000	$ 5,000					
S 662	SA Plow & wing	90	10	-4	Ford	S-E	$ 5,000	$ 5,000					
S 663	SA Plow & wing	91	10	-3	Ford	S	$ 7,000	$ 7,000					
S 664	SA Plow & wing	91	10	-3	Ford	S	$ 7,000	$ 7,000					
S 665	SA Plow & wing	91	10	-3	Ford	S	$ 7,000	$ 7,000					
S 666	SA Plow & wing	91	10	-3	International	S-E	$ 7,000	$ 7,000					
S 672	SA Plow & wing	89	10	-5	Ford	N-E	$ 5,000	$ 5,000					
S 673	SA Plow & wing	93	10	-1	International	N-E	$ 7,000	$ 7,000					
S 680	SA Plow & wing	84	10	-10	Ford	N-E	$ 2,000	$ 2,000					
S 660	SA Plow & wing	89	10	-5	International	S	$ 5,000	$ 5,000					
	SA PLOW & wing - dispose all 25 - redeploy s134,s144 for other duties						$ 217,000	$ 250,000	$ -	$ -	$ -	$ -	$ -

Unit No.	Description	YR	LIFETIME	LIFE	Make	Area	Now $	Sell	Buy 2005	Buy 2006	Buy 2007	Buy 2008	Buy 2009
S 671	SA Plow & Spreader	88	10	-6	International	S-E	$ 4,000	$ 4,000					
S 681	SA Plow & Spreader	90	10	-4	Mack	N-E	$ 5,000	$ 5,000					
S 633	SA PLOW & wing & spreader	88	10	-6	International	N-W	$ 4,000	$ 4,000					
S 634	SA PLOW & wing & spreader	0	10	-94	International	N-W	$ 4,000	$ 4,000					
S 635	SA PLOW & wing & spreader	97	10	3	International	N-W	$ 40,000						
S 636	SA PLOW & wing & spreader	96	10	2	International	N-W	$ 40,000						
S 637	SA PLOW & wing & spreader	95	10	1	Chev Top K.	S-W	$ 15,000	$ 4,000					
S 638	SA PLOW & wing & spreader	97	10	3	International	S-W	$ 40,000						
S 639	SA PLOW & wing & spreader	90	10	-4	Ford	S-W	$ 4,000	$ 4,000					
S 648	SA PLOW & wing & spreader	97	10	3	International	N-W	$ 40,000						
S 649	SA PLOW & wing & spreader	94	10	0	International	N-W	$ 10,000	$ 10,000					
S 651	SA PLOW & wing & spreader	89	10	-5	International	N-W	$ 4,000	$ 4,000					
S 654	SA PLOW & wing & spreader	92	10	-2	International	S-E	$ 4,000	$ 4,000					
S 661	SA Plow & wing (asphalt box)	90	10	-4	International	S	$ 4,000	$ 4,000					
	SA PLOW & wing & spreader	keep 4 of 14					$ 492,000	$ 354,000	$ -	$ -	$ -	$ -	$ -
S 620	SA UNDERBODY & Spreader	99	10	5	International	S	$ 80,000	$ 80,000					
S 621	SA UNDERBODY & Spreader	99	10	5	International	S	$ 80,000	$ 80,000					
S 623	SA UNDERBODY & Spreader	90	10	-4	Ford	S	$ 4,000	$ 4,000					
S 624	SA UNDERBODY & Spreader	90	10	-4	Ford	S	$ 4,000	$ 4,000					
S 626	SA UNDERBODY & Spreader	92	10	-2	International	S	$ 7,000	$ 7,000					
S 627	SA UNDERBODY & Spreader	92	10	-2	International	S	$ 7,000	$ 7,000					
S 628	SA UNDERBODY & Spreader	93	10	-1	International	S-E	$ 10,000	$ 10,000					
S 629	SA UNDERBODY & Spreader	93	10	-1	International	S-E	$ 10,000	$ 10,000					
S 630	SA UNDERBODY & Spreader	93	10	-1	International	S-E	$ 10,000	$ 10,000					
S 631	SA UNDERBODY & Spreader	99	10	5	International	S	$ 80,000	$ 80,000					
S 632	SA UNDERBODY & Spreader	100	10	6	Frieghtliner	S	$ 100,000	$ 100,000					
S 641	SA UNDERBODY & Spreader	87	10	-7	Ford	S-W	$ 4,000	$ 4,000					
S 642	SA UNDERBODY & Spreader	87	10	-7	International	S-W	$ 4,000	$ 4,000					
	SA UNDERBODY & Spreader sell all 13 (or redeploy s620,s621,s631,s632 out of winter use)						$ 400,000	$ 400,000	$ -	$ -	$ -	$ -	$ -
S 236	Sidewalk Plow	102	12	10	MT5	S	70,000						
S 237	Sidewalk Plow	102	12	10	MT5	S-E	70,000						
S 239	Sidewalk Plow	104	12	12	MT5	S	80,000						
S 247	Sidewalk Plow	103	12	11	MT5	S	75,000						
S 248	Sidewalk Plow	103	12	11	MT5	S	75,000						
S 253	Sidewalk Plow	99	12	7	MT5	S	60,000						
S 256	Sidewalk Plow	94	12	2	MT5	N-W	20,000					90000	
S 257	Sidewalk Plow	98	12	6	MT5	S-E	55,000						
S 258	Sidewalk Plow	102	12	10	MT5	N-W	70,000						
S 259	Sidewalk Plow	95	12	3	MT5	N-E	25,000					90000	
S 260	Sidewalk Plow	92	12	0	MT5	N-E	10,000	10,000					
R 862/S-23	Sidewalk Plow - (Temporary U	88	12	-4	MT5	N-E	5,000	5,000					
R 861/S-24	Sidewalk Plow - (Temporary U	91	12	-1	MT5	S-E	5,000	5,000					
R 860/S-23	Sidewalk Plow - (Temporary U	89	12	-3	MT5	S	5,000	5,000					
S 238	Sidewalk Plow / Tow Behind Spr	103	12	11	MT5	S	75000						
S 240	Sidewalk Plow / Tow Behind Spr	90	12	-2	MT5	S-E	5,000	5,000					
S 241	Sidewalk Plow / Tow Behind Spr	104	12	12	MT5	S-E	80000						
S 242	Sidewalk Plow / Tow Behind Spr	91	12	-1	MT5	S-E	5,000	5,000					
S 243	Sidewalk Plow / Tow Behind Spr	92	12	0	MT5	S	5000	5000					
S 244	Sidewalk Plow / Tow Behind Spr	92	12	0	MT5	S-E	10000			90000			
S 245	Sidewalk Plow / Tow Behind Spr	92	12	0	MT5	S	10000			90000			
S 246	Sidewalk Plow / Tow Behind Spr	92	12	0	MT5	S	10000			90000			
S 249	Sidewalk Plow / Tow Behind Spr	97	12	5	MT5	S	50000						
S 250	Sidewalk Plow / Tow Behind Spr	97	12	5	MT5	S	50000						
S 251	Sidewalk Plow / Tow Behind Spr	95	12	3	MT5	S	25000					90000	
S 252	Sidewalk Plow / Tow Behind Spr	96	12	4	MT5	S	35000						
S 254	Sidewalk Plow / Tow Behind Spr	102	12	10	MT5	S-E	70000						
S 152	Sidewalk Plow / blower / Tow Be	94	15	5	Ford	S-W	50000						
	Sidewalk Plow / blower / Tow Behind Spreader keep 18 of 25 with 3 of them as backfill						1,105,000	40,000	0	270,000	0	270,000	0

Unit No.	Description	YR	LIFETIME	LIFE	Make	Area	Now $	Sell	Buy 2005	Buy 2006	Buy 2007	Buy 2008	Buy 2009
R 852	Snow Blower	84	15	-5	Blanchet	S							
R 867	Snow Blower	96	15	7	Blanchet	S							
S 380	Snow Blower	75	15	-14	Sicard	N-W							
	Snow Blower keep 2 of 3												
S 135	TA Plow & Spreader	91	10	-3	Ford	N-E	$10,000		220,000				
S 136	TA Plow & Spreader	91	10	-3	Ford	S-E	10000		220000				
S 141	TA Plow & Spreader	93	10	-1	GMC	S-E	12000		220000				
S 142	TA Plow & Spreader	93	10	-1	GMC	S-E	12000		220000				
S 143	TA Plow & Spreader	94	10	0	GMC	S-E	12000		backup				220000
S 146	TA Plow & Spreader	95	10	1	International	N-E	12000		220000				
S 604	TA Plow & Spreader	103	10	9	International	S-E	150,000						
S 605	TA Plow & Spreader	103	10	9	International	S-E	150,000						
S 606	TA Plow & Spreader	103	10	9	International	S	150,000						
S 607	TA Plow & Spreader	103	10	9	International	S	150,000						
S 608	TA Plow & Spreader	103	10	9	International	N-E	150,000						
S 609	TA Plow & Spreader	103	10	9	International	N-W	150,000						
S 610	TA Plow & Spreader	103	10	9	International	S-W	150,000						
S 611	TA Plow & Spreader	105	10	11	International	S-W	150,000						
S 612	TA Plow & Spreader	105	10	11	International	N-E	150,000						
S 667	TA Plow & Spreader	93	10	-1	Frieghtliner	S	12000		220000				
S 668	TA Plow & Spreader	93	10	-1	Frieghtliner	S	12000		220000				
S 669	TA Plow & Spreader	96	10	2	Frieghtliner	S	20,000		backup				220000
S 670	TA Plow & Spreader	98	10	4	Frieghtliner	S	40,000						backup
S 675	TA Plow & Spreader	98	10	4	International	N-E	40,000						backup
S 677	TA Plow & Spreader	93	10	-1	Frieghtliner	N-E	12000		220000				
S 679	TA Plow & Spreader	100	10	6	Frieghtliner	N-E	100,000						
	TA Plow & Spreader keep 22 of 22 (use 4 retiring units as backfill)						$1,654,000	$0	$1,760,000	$0	$0	$0	$440,000
S 727	TA Plow & Spreader (on hired ch	89	10	-5	TENCO	S-E							
S 733	TA Plow & Spreader (on hired ch	98	10	4	TENCO	S							
S 734	TA Plow & Spreader (on hired ch	98	10	4	TENCO	S-W							
	TA Plow & Spreader on hired chassis do not renew contract												
	Total						$4,422,000	$1,103,000	$1,760,000	$670,000	$400,000	$470,000	$440,000

Greater Sudbury	**Service Standards**	*Public Works*
# 101	*Title* List of Services	*Effective* Proposed

100
- 101 List of Services
- 102 Introduction to Standards
- 103 Classification of Roads
- 104 Classification of Sidewalks

110 General
- 111 Customer Service
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- 121 Surface Exposure
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- 123 Snow Removal

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- 132 Ice

199 Glossary of terms

Minimum Municipal Road Maintenance Standards

Greater | Grand Sudbury	**Service Standards**	*Public Works*
# 102	*Title* Introduction to Standards	*Effective* Proposed

These Service Standards identify the scope and nature of the services offered by the City of Greater Sudbury. They are adopted by Council as a clear statement of policy. City resources are directed to deliver the intent of these Standards or expectation.

These services may be considered as the primary objectives for the preservation of assets and deployment of operations. Business Plans, Management Systems and budgets have regard for the strategies, resources and deployments to deliver according to these service levels.

While these are the primary services there are other services offered which are not defined by these standards. In such cases the City will determine its ability to offer or sustain the expectation.

There are effectively two service levels determined in these common standards ; "planned" and "minimum". Planned service levels are such which direct the preparation and provision of timely resources without further external influences. Such external influences could include

- Unexpected change in resource availability
  (labour, equipment, materials)
- Directives by Council
- Lack of funding
- Extraordinary conditions such as extreme weather or infrastructure failure

In the case where circumstances mitigate the ability to deliver the planned service level the following expectation is to deliver the service within the minimum expectations outlined in the Standard. Should conditions fall below such minimums there is a further expectation that the City will take appropriate measures to protect public safety, which may be identified in the respective Standard.

Greater Sudbury	Service Standards	Public Works

#	Title	Effective
103	Classification of Roads	Proposed

Road Services are intended for the benefit of the citizens of Greater Sudbury. To be sustainable, services are delivered somewhat proportional to the benefit derived from the expenditures incurred to deliver them. To this end each road in the municipal road network is recognised as being in one of six general classifications. A similar model has been recognised by the Ontario Mimimum Municipal Road Maintenance Standards, provincial regulation 239 of 2002.

There are two criteria applied to roads and streets : average traffic volume, and posted speed, per the table below. This standard recognizes that professional staff of the City apply this classification method and publish a list/map of roads by classification. This list/map, revised from time to time, forms a part of this standard and is recognized as the interpretation of these criteria. It may be that due to operation logistics a road receives, on average, a higher service than is articulated in the standard. This is not considered over service, nor is the basis for reclassification..

AADT = Average Annual Daily Traffic (number of motor vehicles)

AADT	60 or more kph	50 or less kph
12,000 or more	**1**	**2**
3,000 - 11,999	**2**	**3**
500 - 2,999	**3**	**4**
50 - 499	**4**	**5**
0 - 49	**6**	**6**

Greater Sudbury	Service Standards	Public Works

#	Title	Effective
104	Classification of Walkways	Proposed

Walkway Services are intended for the benefit of the citizens of Greater Sudbury. To be sustainable, services are delivered somewhat proportional to the benefit derived from the expenditures incurred to deliver them. To this end each municipal walkway is recognised as being in one of four general classifications

Class 1 – rural and park primary trails
Class 2 – urban primary walkways serving non residential frontages
Class 3 – urban secondary sidewalks and paths
Class 4 - rural tertiary trails

.

Winter Walkway Services are extended to:

- All walkways adjacent to class 1 to 3 roads
- walkways on one side of class 4 to 6 roads where there are two walkways present*.
- Connecting links through parks or the grounds of public facilities

* Service will be alternated annually unless there is a safety or operational consideration establishing a preferred side as determined by the City.

This standard recognizes that professional staff of the City will apply this classification method and publish a list/map of roads by classification. This list/map, revised from time to time, forms a part of this standard and is recognized for the interpretation of these criteria. It may be that due to operation logistics a walkway receives, on average, a higher service than is articulated in the standard. This is not considered over service, nor is it a basis for reclassification

Greater Sudbury	Service Standards	Public Works
# 111	Title Customer Service	Effective Proposed

Road and Sidewalk users have an expectation of prompt and courteous attention to

a) notice of significant change to service
b) response to requests for service, and
c) response to formal written comments and inquiries.

There will be planned access by the customer to persons qualified to attend to customer service requests.

Known service conditions are considered to be public information, and on request, will be passed along to the customer subject to Freedom of Information Act requirements. Minor service adjustments, and incidental/informal customer inquiries and comments will be handled in a planned, undocumented way.

Emergency situations must be responded to with due diligence.

All formal communications with customers of road and sidewalk services will be handled promptly, courteously, and according to the following:

a) All formal requests for service will be recorded with appropriate information, including evidence of process management.
b) Where the response requests operations to be undertaken, the customer will be advised of the decision in that regard, unless agreed to otherwise by the customer.
c) Unless requested by the customer otherwise, a follow up communication, upon completion, will be made.
d) Verbal response to verbal inquiries will be made within two working days by a person able to respond.
e) Written response to inquiries will be made within one week of receipt by a person able to respond.

The Department Manager will be copied with all written correspondence to formal customer inquiries or comments to or by department staff or contractors.

City staff are available to respond to customer inquiries which cannot be addressed appropriately by the Agent or contractor for the City.

Review of customer service will be undertaken by the City and it's contractors responsible for the service on a regular basis, and at least annually.

Greater Sudbury	Service Standards	Public Works
# 112	Title Non Compliance	Effective Proposed

Road and Sidewalk users have an expectation that where conditions will not, or do not, meet Minimum Standards,

a) public safety will be paramount in the response to sub-standard conditions
b) effective action will take place to mitigate the situation, and
c) an investigation will take place to identify and address the cause.

For the purpose of this Standard, "sub-standard" will refer only to Conditions below Minimum (or Maximum) Levels.

Where substandard Conditions are predictable, or in fact exist, the following procedure will be followed:

a) The Inspector will notify his/her supervisor.
b) Where the public safety is in question the inspector or supervisor will notify the City and the Police.
c) As required by policy or good judgment one or more actions as follows may be taken
    - The road/sidewalk is closed
    - emergency measures are implemented
    - planned warning is given to users of unsafe conditions

Where time is of the essence, the inspector and/or supervisor is authorized to undertake a *planned response* .

Where substandard Conditions have occurred a Non-compliance Report will be completed by the Supervisor of the Inspector (if the Inspector is not a Supervisor), describing the circumstances surrounding the occurrence.

Non-compliance Reports will be reviewed by the Department Manager, who will investigate the preventable nature of the occurrence, consider changes to procedures, and take planned action. A summary of non compliance occurrences will be kept by the Department Manager.

Greater Sudbury	Service Standards	Public Works
# 113	Title Inspection	Effective Proposed

Road users have an expectation that *conditions* of roads and walkways are *inspected*, and that such *inspection* is conducted at regular *Cycle Times* throughout the year. The purpose of *road and walkway condition inspection* is to take *notice* of the *conditions* relevant to *service standards*, and initiate an appropriate *response.*

The purpose of *winter storm inspection* in particular is to take notice of significant hazards relating to the nature of the *winter storm.*

During non regularly scheduled workdays such as weekends, nights and holidays, inspection may follow *maximum Cycle Times*.

During, and for a full cycle following, the *storm* , the *inspection Cycle Time* should not exceed the *Storm Cycle Time*.

Winter *condition inspections* may be conducted simultaneous with general *condition inspections* and w*inter storm inspection* (see *standard* D.2.)

Storm cycle time commences from when the *storm effects* first *occur* until a full storm cycle period after the end of the *storm effects.*

Winter sidewalk inspections may be conducted from a patrol vehicle where sidewalk parallels road.

Class	Non Storm Cycle (Days)		Storm Cycle Time(hrs)	
Road	Planned	Maximum	Planned	Maximum
1	Every	3x per wk		
2	Work	2x per wk	4	
3	Day	7 days		
4	weekly	14 days		
5		30 days	24	
6	Monthly	none		
Walkway (in season)				
1	monthly	Annual	1x within	
2	Weekly	Monthly	2 days	None
3	week	Annual		
4	n/a	Annual	None	

Greater Sudbury	Service Standards	Public Works
# 121	Title Winter Roads :Surface Exposure	Effective Proposed

Road users have an expectation that *winter roads* are restored to *planned conditions* within a r*esponse time* after the end of *storm effects*.

Bare pavement is a surface condition where the pavement is exposed in a wet or dry condition, to at least 1.5m for each wheel track of the traveled lanes. Centrebare conditions requires at least 1m of one wheel track in each traveled lane to be bare. This standard does not apply to turn out lanes, or passing lanes.

Ongoing precipitation, temperatures below -10C, reduced traffic volumes and blowing snow are *storm effects* which may delay the achievement of *planned conditions.*

The *minimum condition* expectation will apply during the *storm* for class 1 to 3 roads.

Where ice *conditions* occur an appropriate *response* to mitigate the conditions will occur in the frequency of the planned and maximum response time, during the *storm* for class 1 to 3 roads, and following the end of *storm effects* for class 4 to 6 roads.

Where *minimum conditions* cannot be restored by the *response time*, the appropriate emergency services will be informed. Roads may be temporarily closed by police or the City until *safe conditions* are restored. Road closings and /or extreme conditions will initiate procedures identified in the City Snow Emergency Measures policy.

CLASS	Condition		Response time (hrs)		CLASS
	Planned	Minimum	Planned	Maximum	
1	Bare	Centrebare	2	3	1
2			4	4	2
3				8	3
4	Centrebare	Snowpacked	8	12	4
5				16	5
6	Snowpacked			none	6

Greater Sudbury	**Service Standards**	*Public Works*
# 122	*Title* Winter Roads :Snowfall Accumulation	*Effective* Proposed

Road users have an expectation that all traveled *lanes* during winter are cleared of accumulating snow to *planned conditions* within a *planned response time* from when the *maximum condition* occurred in the case of class 1 to 3 roads, and from the end of the *storm* in the case of class 4 to 6 roads.

Depth is measured in the accumulation of new fallen snow on at least 50 % of a traveled lane, and not including existing snow pack on the road.

Where *maximum conditions* cannot be restored by the maximum *response time*, the appropriate emergency services will be informed. Roads may be temporarily closed by Police or the City until *safe conditions* are restored. Road closings and /or extreme conditions will initiate procedures identified in the City Snow Emergency Measures policy.

Road	Depth (cm)		Response time (hrs)	
	Planned	Maximum	Planned	Maximum
1	2.5	2.5	2	4
2		5		6
3		8	4	12
4	8		8	16
5		10		24
6		none		none

Greater Sudbury	Service Standards	Public Works
# 123	Title Winter Roads : Snow Removal	Effective Proposed

Accumulated Snow on public Roads and roadsides may present a hazard to vehicles and pedestrians. Accumulated snow will be removed to less than the limiting dimensions within 7 days of exceeding these limits in the case of class 1 to 3 roads, and 14 days in the case of class 4 to 6 roads.

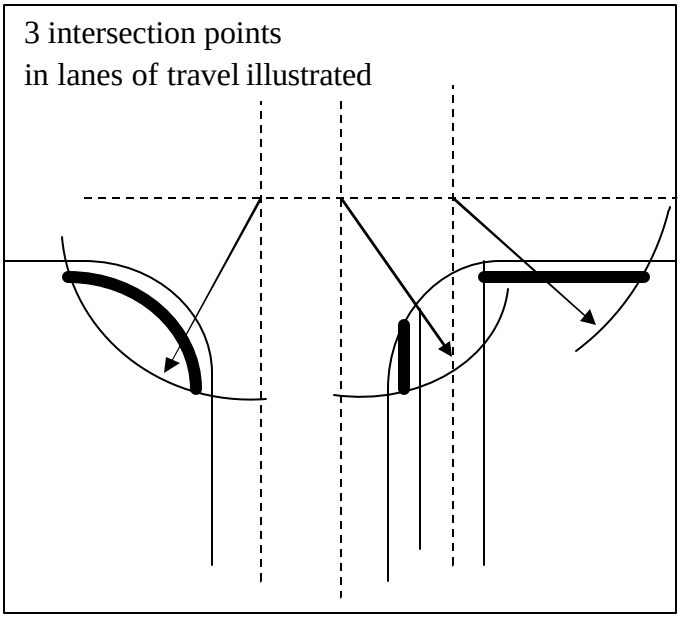
1. TRAVELED LANES

Traveled lanes will be maintained at a surface width of no less than 3m on any municipal road, as encumbered by snow banks. Laneways, and gravel surfaced roads that are less than two full lanes normally will require only a single 3 m clearance, with consideration for providing passing zones of 6m width.

2. INTERSECTIONS

Snow banks, snow drifts, or snow piles interfering with lines of sight above 1.5m above the traveled surface will be lowered at intersections of one street with another and bus stops, and in the case of the CBD and Class 1 to 3 roads also with winter maintained sidewalks as follows,

a. to less than .5 m within 15 m of the point of intersection with class 1 to 3 roads, or
b. to less than .5m within 10 meters of the point of intersection with class 4 to 6 roads.



SNOW ACCUMULATED BY PRIVATE OPERATORS

Where unacceptable snow accumulations occur on public ROWs due to private operations not otherwise under the direction of the City such encroachment will be required to be removed or desisted from accumulating upon direction by the City to the property owner. If such snow encroaches per the above criteria it may be removed by City forces and costs recovered from the property owner.

PRIVATE DRIVEWAYS

Removal of accumulations of snow interfering with sight lines at intersections of private entrances with winter maintained sidewalks or roads are the responsibility of the users.

Greater Sudbury	**Service Standards**	*Public Works*

#	Title	Effective
131	Winter Walkways:Snow Accumulation	Proposed

Where walkways qualify for winter service the *maximum condition* is the average depth to which new fallen or general wind blown snow is allowed to accumulate on the walkway surface for more than the *response time. Response time* is measured from the end of the *storm effects.*

Continuing *storm effects* can be considered to be occurring when the operations cannot *respond* within the planned *time*. Where *maximum conditions* are exceeded during continuing *storm effects*, priority for *service* should be established first by higher *class* and then exceeded response *time*.

	Depth (cm)		Response	
Class	Planned	Maximum	Planned	Maximum
1	8	15	12 hrs	24 hrs
2				
3		none		none
4				

Greater Sudbury	**Service Standards**	*Public Works*
# 132	*Title* Winter Walkways : Ice	*Effective* Proposed

Walkways are intended to be a *snow packed* condition, unless storm effects and utilization result in the formation of ice.

The walkway *surface* should be treated with a *response* within the *maximum response time*. A sufficient response is considered to be the application of sand and/or salt to mitigate the condition. Should a *substandard condition* persist, a *response* should again occur within the *time* since the previous *response*. For *class* 2 and 3 *walkways,* where the *condition* occurs between 3:00 p.m. and 6:00 a.m., the *lag time* begins at 6:00 a.m.

Class	Planned Cycle Time	Maximum Cycle Time
4	8 hrs	None
2,3	2 hrs	8 hours
1	1day	None

The following definitions support specific words used in the text of these Services. Words in italics are further defined.

Conditions...defines the state in which the road infrastructure is found. Specific conditions, which are used to evaluate the performance of the service, are indicated in the *Services*.

Classification (class)... refers to the primary criteria for the purpose of articulating *services*.

Cycle Time...is that time interval between *inspection*s or operational *response* conducted for a specific purpose.

Day...is a calendar day, measured to the end of the following day, or in the case that that day is a Saturday, Sunday or Holiday, the next regularly scheduled work day. Reference to hours cannot be construed as proportions of days.

Response time...means the period of time any *aspect* of a *roadway* may be in a *substandard condition*. Response time is the period of time in which *responses* to the *condition* take place. Unless qualified in the *standard*, the *Response time* is measured from when the condition was noticed. Some *standards* identify the Response time as being measured from the *occurrence* of the *condition*.

Effect...is the acting of an external influence on the *condition* of any *aspect* of the *roadway,* such as *storm* effects, traffic effects, and adjacent development.

Encroachment...is an obstacle inside the *clearance* zone which may or may not be permitted by these *standards*.

Inspection...is the activity performed by a person qualified by the City, or it's Agent or Contractor for that purpose, to investigate and report on the relevant *conditions* of the *roadway or walkway*. Qualifications for inspector relevant to the nature of the inspection performed. General inspection has regard for all *standards*. *Winter* inspection has regard for *winter road surface standards* during *winter*. *Storm* inspection and, *winter* related *storm* inspections are also identified.

Lane...is that portion of the *road* designated for a single file of vehicles travelling in one direction. For *roads* where two way traffic is permitted, the lane width is half the road surface width, unless delineated otherwise by pavement marking. Ramps and turning lanes are not considered as travelled lanes.

Local...*conditions*, for the purpose of *standards*, occur on short lengths of *roadway* typically on bridges, and at intersections, curves and/or hills, clearly less than 20% of the road surface.

Maximum...in the context of these *standards* refers to the limit of *service condition* set by the *City*, which the *roadway user* can expect to be *responded* to within a *Response time* of time. In effect it is the *minimum service*. Where conditions exceed maximum, or *minimum*, a specific *response* may be required. The province may regulate minimum standards, which supersede these *standards* for the purpose of defining negligence.

Minimum...in the context of these *standards* refers to the lowest level of *service* set by the *roadway authority*, which the *roadway user* can expect. Sometimes *maximum* defines the minimum service. Where conditions exceed maximum, or *minimum*, specific *response* may be required. The province may regulate minimum standards, which supersede these *standards* for the purpose of defining negligence.

Notice...of an *effect* or *condition* is deemed to have been given when observed during *inspection* for that purpose, or notice of the condition having been given to the supervisor by a third party such as councillor, employee, police or the public. Road operations workers, in the course of work, who identify safety hazards should give planned notice of same to the appropriate supervisor.

Occur…is the beginning of the existence of a specific *condition* regardless of notice, where evidence may be found to prove that the condition occurred. The *Response time* for some standards is determined from the earliest point of occurrence.

Operations...are those activities which are deployed to *improve* a *condition* or sustain a *roadway standard*. Operational procedures are normally defined by best practice guidelines, with discretion for the *supervisor* to choose various methods to achieve results cost effectively. Operations are regulated by *agreements*, *standards, directives* and *work orders*.

Police…means the Police Force of the City of Sudbury, or the Ontario Provincial Police, or other specially qualified officers of the law.

Policies...are decisions of a formal nature made by the *City* to enable, qualify and direct the *City,* its *Agents* and contractors. Policies are normally qualified as to scope and application.

Posting… of a warning, by sign, flagging, barricade, delineator or marker, as is appropriate or available, is considered an acceptable response in some standards.

Planned...describes that level of *service standard* which the *City* has established as a threshold or target performance for *operations*. While users have expectations for planned service, such service is in fact only limited by *maximum* or *minimum standards*. Where not defined, planned shall mean "appropriate under the circumstances", and " as planned" by city operations.

Response...describes that action taken in regard to an *effect* or *condition*. *Inspection* and/or *posting* a warning may constitute a response, where no *operational* activity will have an effective value.

Road...refers specifically to the travelled road *surface* on a *roadway* maintained by the City. On-street parking or stopping zones are part of the *roadside.* Road/s, in a general context, may also refer to the City road system.

Roadside...refers to all the elements or *conditions* which make up the *roadway* within the jurisdiction of the City, except for the *road surface* itself.

Roadway, ROW...means any *City road* Right of Way, open and intended for vehicular traffic. It refers not only to the travelled *road surface*, but to all *services* relevant to the *road*, within *the right of way*. Roadway = road + roadside

City...is the City of Sudbury, it's officers and delegates.

Service... refers specifically to the provision or restoration of the *condition* of a *roadway* to the *conditions* as defined in the Services. Services are seen from the perspective of the user and do not normally reference the operations commonly deployed.

Service Levels...are a range of values which quantify a particular *service standard*, by one or more parameters, across a range of *roadway classifications*. Service levels typically reflect a *maximum/ minimum* and *planned.*

Shoulder...is that *roadside* immediately adjacent to the travelled *surface* of the *road*. The shoulder is not considered a part of the *road* surface in these *standards*.

Sightline…is that line of sight defined in technical manuals and more specifically in *City policy* which is the design area for unimpeded vision by vehicle operators travelling on, entering or changing direction on or off a City road.

Standards...are quantified statements, formally defining the nature of a service or activity. Standards refer specifically to the *road services* adopted by City Bylaw, as amended.

Storm...*conditions* or *effects* are where natural *effects* are acting upon the *roadway* to reduce the *condition* as defined by one or more *roadway services*. It

does not refer to weather conditions which do not impact on the infrastructure. Storm *effects* could include wind, rising and moving water, precipitation, cold temperatures (below -10C), snowfall, freezing rain, hail, blowing snow, drifting snow or sediment etc. Storm related *conditions* result from storm *effects*.

Substandard...refers to a *condition* which is outside the defined minimum or maximum standard. Normally a substandard condition requires a *response*, unless otherwise considered in the *standard*.

Supervisor...refers to a manager accountable for the deployment of *operations* which impact on the *condition* of *roadway services*. The i*nspector* need not be a supervisor. A supervisor must be a qualified *inspector*. The supervisor may be employed by the City, it's agent or contractor for that purpose.

Surface...is the exposed top of the travelled *road* and includes adjacent surfaces for ramping or turning, but not parking areas or *shoulders*.

User...refers to any person legally travelling on or over the *roadway*, including vehicle operators, passengers and pedestrians. All users are *customers.*

Winter...is that season when cold weather *effects* on *road conditions* can be reasonably expected. This season is specifically defined by the *City.* However, winter *storms* may occur outside the defined winter season.

Greater Sudbury	Service Standards	Public Works

#	Title	Effective

EXERPTS FOR RELEVANCE TO WINTER ROADS

Municipal Act, 2001
Loi de 2001 sur les municipalités

ONTARIO REGULATION 239/02

Amended to O. Reg. 288/03

MINIMUM MAINTENANCE STANDARDS FOR MUNICIPAL HIGHWAYS

This Regulation is made in English only.

Definitions

1. (1) In this Regulation,

"cm" means centimetres;

"day" means a 24-hour period;

"motor vehicle" has the same meaning as in subsection 1 (1) of the *Highway Traffic Act*, except that it does not include a motor assisted bicycle;

"non-paved surface" means a surface that is not a paved surface;

"paved surface" means a surface with a wearing layer or layers of asphalt, concrete or asphalt emulsion;

"roadway" has the same meaning as in subsection 1 (1) of the *Highway Traffic Act*;

"shoulder" means the portion of a highway that provides lateral support to the roadway and that may accommodate stopped motor vehicles and emergency use;

"surface" means the top of a roadway or shoulder. O. Reg. 239/02, s. 1 (1).

(2) For the purposes of this Regulation, every highway or part of a highway under the jurisdiction of a municipality in Ontario is classified in the Table to this section as a Class 1, Class 2, Class 3, Class 4, Class 5 or Class 6 highway, based on the speed limit applicable to it and the average annual daily traffic on it. O. Reg. 239/02, s. 1 (2).

(3) For the purposes of subsection (2) and the Table to this section, the average annual daily traffic on a highway or part of a highway under municipal jurisdiction shall be determined,

(a) by counting and averaging the daily two-way traffic on the highway or part of the highway for the previous calendar year; or

(b) by estimating the average daily two-way traffic on the highway or part of the highway in accordance with accepted traffic engineering methods. O. Reg. 239/02, s. 1 (3).

TABLE CLASSIFICATION OF HIGHWAYS

Average Annual Daily Traffic	Posted or Statutory Speed Limit (kilometres per hour)						
		90	80	70	60	50	40
15,000 or more	1	1	1	2	2	2	2
12,000 - 14,999	1	1	1	2	2	3	3
10,000 - 11,999	1	1	2	2	3	3	3
8,000 - 9,999	1	1	2	3	3	3	3
6,000 - 7,999	1	2	2	3	3	3	3
5,000 - 5,999	1	2	2	3	3	3	3
4,000 - 4,999	1	2	3	3	3	3	4
3,000 - 3,999	1	2	3	3	3	4	4
2,000 - 2,999	1	2	3	3	4	4	4
1,000 - 1,999	1	3	3	3	4	4	5
500 - 999	1	3	4	4	4	4	5
200 - 499	1	3	4	4	5	5	5
50 - 199	1	3	4	5	5	5	5
0 - 49	1	3	6	6	6	6	6

O. Reg. 239/02, s. 1, Table.

Application

2. (1) This Regulation sets out the minimum standards of repair for highways under municipal jurisdiction for the purpose of clause 44 (3) (c) of the Act. O. Reg. 288/03, s. 1.

(2) The minimum standards of repair set out in this Regulation are applicable only in respect of motor vehicles using the highways. O. Reg. 239/02, s. 2 (2).

(3) This Regulation does not apply to Class 6 highways. O. Reg. 239/02, s. 2 (3).

Minimum Standards

Routine patrolling

3. (1) The minimum standard for the frequency of routine patrolling of highways is set out in the Table to this section. O. Reg. 239/02, s. 3 (1).

(2) Routine patrolling shall be carried out by driving on or by electronically monitoring the highway to check for conditions described in this Regulation. O. Reg. 239/02, s. 3 (2).

(3) Routine patrolling is not required between sunset and sunrise. O. Reg. 239/02, s. 3 (3).

TABLE ROUTINE PATROLLING FREQUENCY

Class of Highway	Patrolling Frequency
1	3 times every 7 days
2	2 times every 7 days
3	once every 7 days
4	once every 14 days
5	once every 30 days

O. Reg. 239/02, s. 3, Table.

Snow accumulation

4. (1) The minimum standard for clearing snow accumulation is,

(a) while the snow continues to accumulate, to deploy resources to clear the snow as soon as practicable after becoming aware of the fact that the snow accumulation on a roadway is greater than the depth set out in the Table to this section; and

(b) after the snow accumulation has ended and after becoming aware that the snow accumulation is greater than the depth set out in the Table to this section, to clear the snow accumulation in accordance with subsections (2) and (3) or subsections (2) and (4), as the case may be, within the time set out in the Table. O. Reg. 239/02, s. 4 (1).

(2) The snow accumulation must be cleared to a depth less than or equal to the depth set out in the Table. O. Reg. 239/02, s. 4 (2).

(3) The snow accumulation must be cleared from the roadway to within a distance of 0.6 metres inside the outer edges of the roadway. O. Reg. 239/02, s. 4 (3).

(4) Despite subsection (3), for a Class 4 highway with two lanes or a Class 5 highway with two lanes, the snow accumulation on the roadway must be cleared to a width of at least 5 metres. O. Reg. 239/02, s. 4 (4).

(5) This section,

(a) does not apply to that portion of the roadway designated for parking; and

(b) only applies to a municipality during the season when the municipality performs winter highway maintenance. O. Reg. 239/02, s. 4 (5).

(6) In this section, "snow accumulation" means the natural accumulation of new fallen snow or wind-blown snow that covers more than half a lane width of a roadway. O. Reg. 239/02, s. 4 (6).

TABLE SNOW ACCUMULATION

Class of Highway	Depth	Time
1	2.5 cm	4 hours
2	5 cm	6 hours
3	8 cm	12 hours
4	8 cm	16 hours
5	10 cm	24 hours

O. Reg. 239/02, s. 4, Table.

Icy roadways

5. (1) The minimum standard for treating icy roadways is,

(a) to deploy resources to treat an icy roadway as soon as practicable after becoming aware that the roadway is icy; and

(b) to treat the icy roadway within the time set out in the Table to this section after becoming aware that the roadway is icy. O. Reg. 239/02, s. 5 (1).

(2) This section only applies to a municipality during the season when the municipality performs winter highway maintenance. O. Reg. 239/02, s. 5 (2).

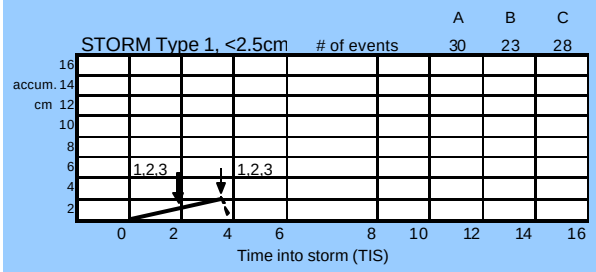
TABLE
ICY ROADWAYS

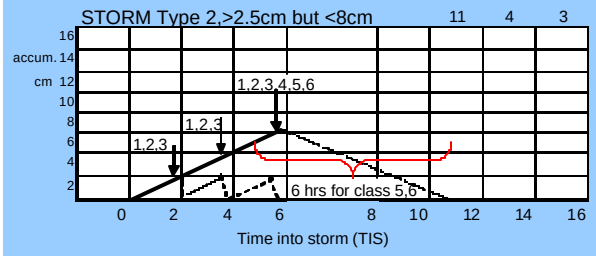
Class of Highway	Time
1	3 hours
2	4 hours
3	8 hours
4	12 hours
5	16 hours

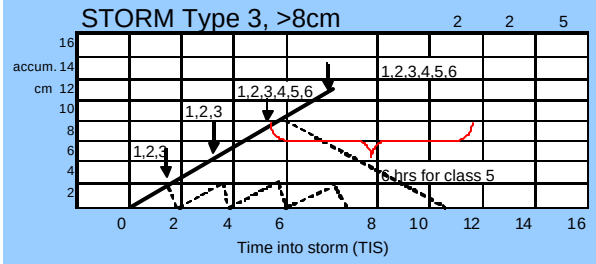
Excerpts - O. Reg. 239/02, s. 5, Table.

Appendix C

Current Storm Deployment







$ 100.00	$/hr/truck with operator
9	service km/hr
$ 11.11	$/service km

254 kg/km sand
127 kg/km salt

total	system km					
1721	110.45	169.25	221	344.4	798.8	77.1

	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	A,B	A,B	A,B			
Plow Sand	C	C	C	0	0	0
Plow SS						
Sand	C	C	C	0	0	0
Serviced KM		121670			0	
SALT tonnes		6740			0	
SAND tonnes		7122			0	

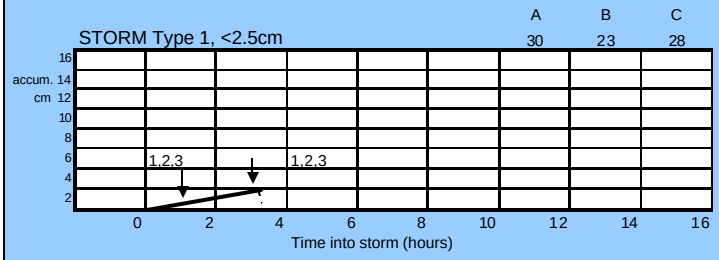
	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	2A,2B	2A,2B	2A,2B			
Plow Sand	2C	2C	2C	A,B,C	A,B,C	A,B,C
Plow SS						
Sand	C	C	C	0	0	0
Serviced KM		45063			43931	
SALT tonnes		2862			0	
SAND tonnes		1145			2790	

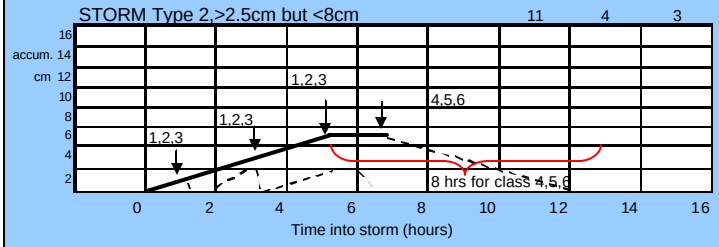
	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	3A,3B	3A,3B	3A,3B			
Plow Sand	3C	3C	3C	2A,2B,2C	2A,2B,2C	2A,2B,2C
Plow SS						
Sand	C	C	C	0	0	0
Serviced KM		31544			21965	
SALT tonnes		1017			0	
SAND tonnes		2544			4649	

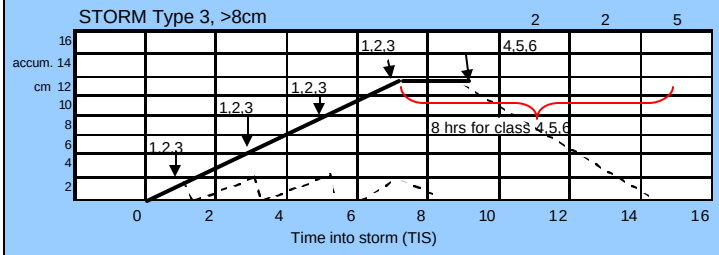
Summary Current Deployment

	Class 1-3	Class 4-6	Net	Gross(175%)	$Unit	$/yr
Serviced KM	198,277	65,896	264,173	462,303	$ 11.11	$ 5,136,705
SALT tonnes	10,619	-	10,619	18,584	$ 50.00	$ 929,193
SAND tonnes	10,810	7,439	18,249	31,936	$ 10.00	$ 319,359
SS tonnes	-	-	-	-	$ 25.00	$ -
Total Costs						$ 6,385,256

Proposed Storm Deployment Strategy







total	200 ss 300 sand 126 salt system km					
1721	110.45	169.25	221	344.4	798.8	77.1

	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	A,B	A,B	A,B			
Plow Sand	0	0	0	0	0	0
Plow SS	0	0	0			
Sand	C	C	C	0	0	0
Serviced KM		81113			0	
SALT tonnes		6687			0	
SAND tonnes		4206			0	
SS tonnes		0			0	

	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	2A,2B	2A,2B	2A,2B			
Plow Sand	2C	2C	2C	C	C	A,B,C
Plow SS	0	0	0	A,B	A,B	0
Sand	C	C	C	0	0	0
Serviced KM		27038			21965	
SALT tonnes		2839			0	
SAND tonnes		0			1098	
SS tonnes		0			3430	

	Service class					
Event	1	2	3	4	5	6
Anti- ice						
Salt	A,B	A,B	A,B			
Plow Salt	3A,3B	3A,3B	3A,3B			
Plow Sand	3C	3C	3C	C	C	A,B,C
Plow SS	0	0	0	A,B	A,B	0
Sand	C	C	C	0	0	0
Serviced KM		18025			10983	
SALT tonnes		1009			0	
SAND tonnes		3004			1830	
SS tonnes		0			915	

Summary Proposed Deployment

	Class 1-3	Class 4-6	Net	Gross (175%)	$ Unit	$/yr
Serviced KM	126,176	32,948	159,125	278,468	12.00	3,341,615
SALT tonnes	10,536	-	10,536	18,438	50.00	921,876
SAND tonnes	7,210	2,929	10,139	17,743	10.00	177,429
SS tonnes	-	4,344	4,344	7,602	25.00	190,057
Total Costs						4,630,977

Appendix D

CURRENT DEPLOYMENT - 5 centres, 63 routes

	Total km	Service Class (km)					
		Arterial		Collector	Local	Local ST	Local Gravel
	Class	1	2	3	4	5	6
NE	323.8	31.4	33.7	60.4	83.0	105.1	10.3
NW	268.4	14.2	15.9	54.3	76.8	88.4	18.9
S	419.7	31.2	57.9	26.8	71.3	227.1	5.5
SE	383.7	21.4	48.8	46.7	48.7	211.5	6.7
SW	325.4	12.4	13.1	33.0	64.6	166.7	35.7
Total	1721.0	110.5	169.3	221.0	344.4	798.8	77.1

Primary Units including spreaders plows, combo's and graders (not loaders)

#km/route		15	20	25	25	35	45
	# routes	1	2	3	4	5	6
NE	12.7	2.1	1.7	2.4	3.3	3.0	0.2
NW	9.9	0.9	0.8	2.2	3.1	2.5	0.4
S	15.5	2.1	2.9	1.1	2.9	6.5	0.1
SE	13.9	1.4	2.4	1.9	1.9	6.0	0.1
SW	10.9	0.8	0.7	1.3	2.6	4.8	0.8
Total	63.0	7.4	8.5	8.8	13.8	22.8	1.7

PROPOSED DEPLOYMENT, 3 centres, 38 routes

	Total km	Service Class (km)					
		Arterial		Collector	Local	Local ST	Local Grave
	Proposed Clas	1	2	3	4	5	6
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NW +.5NE	430.3	29.9	32.7	84.5	118.3	141.0	24.1
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE +.8S +.5NE	755.5	52.7	94.5	90.2	125.9	377.6	14.6
SW +.2S	535.3	27.9	42.1	46.3	100.3	280.3	38.5
Total	1721.0	110.5	169.3	221.0	344.4	798.8	77.1

#km/route		15	20	25	25	35	45	
	# routes	1	2	3	4	5	6	# routes
New NW	7.0	2.0	1.6	3.4	4.7	4.0	0.5	9.3
New SE	11.8	3.5	4.7	3.6	5.0	10.8	0.3	16.1
New SW	5.8	1.9	2.1	1.9	4.0	8.0	0.9	12.9
TOTAL	24.7	7.4	8.5	8.8	13.8	22.8	1.7	38.3