COORDINATING INFRASTRUCTURE WORKS

A BEST PRACTICE BY THE NATIONAL GUIDE TO SUSTAINABLE MUNICIPAL INFRASTRUCTURE

National Guide to Sustainable Municipal Infrastructure

Guide national pour des infrastructures municipales durables

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FOREWORD

In spite of recent increases in public infrastructure investments, municipal infrastructure is decaying faster than it is being renewed. Factors such as low funding, population growth, tighter health and environmental requirements, poor quality control leading to inferior installation, inadequate inspection and maintenance, and lack of consistency and uniformity in design, construction, and operation practices have impacted on municipal infrastructure. At the same time, an increased burden on infrastructure due to significant growth in some sectors tends to quicken the ageing process while increasing the social and monetary cost of service disruptions due to maintenance, repairs, or replacement.

With the intention of facing these challenges and opportunities, the Federation of Canadian Municipalities (FCM) and the National Research Council (NRC) have joined forces to deliver the *National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices*. The Guide project, funded by the Infrastructure Canada program, NRC, and through in-kind contributions from public and private municipal infrastructure stakeholders, aims to provide a decision-making and investment planning tool as well as a compendium of technical best practices. It provides a road map to the best available knowledge and solutions for addressing infrastructure issues. It is also a focal point for the Canadian network of practitioners, researchers, and municipal governments focused on infrastructure operations and maintenance.

The *National Guide to Sustainable Municipal Infrastructure* offers the opportunity to consolidate the vast body of existing knowledge and shape it into best practices that can be used by decision makers and technical personnel in the public and private sectors. It provides instruments to help municipalities identify needs, evaluate solutions, and plan long-term, sustainable strategies for improved infrastructure performance at the best available cost with the least environmental impact. The five initial target areas of the Guide are potable water systems (production and distribution), storm and wastewater systems (collection, treatment, disposal), municipal roads and sidewalks, environmental protocols and decision making and investment planning.

Part A of the *National Guide to Sustainable Municipal Infrastructure* focuses on decision-making and investment planning issues related to municipal infrastructure. Part B is a compendium of technical best practices and is qualitatively distinct from Part A. Among the most significant of its distinctions is the group of practitioners for which it is intended. Part A, or the decision making and investment planning component of the Guide, is intended to support the practices and efforts of elected officials and senior administrative and management staff in municipalities throughout Canada.

As previously discussed, current funding levels are insufficient to meet infrastructure needs. Municipal infrastructure tends to be taken for granted, so much so that the fundamental role it plays relative to both our standard and quality of life is marginalized. Infrastructure competes with corporate priorities such as police, fire, social services, parks, recreation, and libraries, which often tend to receive higher priority for funding. The net effect of this situation is a chronic deficiency in capital budgets for infrastructure to the point that infrastructure, both current and new, is rapidly deteriorating. In an attempt to mitigate this situation, Part A of the Guide has identified specific best practices.

These best practices are intended to articulate the relevance and fundamental importance of municipal infrastructure by simplifying complex and technical material into "non-technical" decision-making concepts and principles. By doing so, it is anticipated that the need for adequate sustainable funding can be understood and ultimately realized. However, Part A best practices should not be construed as definitive "best" practices; rather, they should be interpreted as guidelines and concepts. Furthermore, Part A best practices are not normative and, as such, are not intended to usurp the discretion of those most knowledgeable about the local municipality. Quite the contrary, it is hoped that the best practices will inspire decision makers to optimize their municipal infrastructure management practices by providing high level, simple, easy to understand approaches and concepts for representing municipal infrastructure issues. In this way, the gulf between the non-technical community and the technical community of engineers and public works officials may be bridged.

It is expected that the Guide will expand and evolve over time. To focus on the most urgent knowledge needs of infrastructure planners and practitioners, the committees solicited and received recommendations, comments, and suggestions from various stakeholder groups, which shaped the enclosed document. Although the best practices are adapted, wherever possible, to reflect varying municipal needs, they remain guidelines based on the collective judgements of peer experts. Discretion must be exercised in applying these guidelines to account for specific local conditions (e.g., geographic location, municipality size, climatic condition).

For additional information or to provide comments and feedback, please visit the Guide Web site at www.infraguide.gc.ca or contact the Guide team at infraguide@nrc-cnrc.gc.ca.

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The dedication of individuals who volunteered their time and expertise in the interest of the *National Guide to Sustainable Municipal Infrastructure* is acknowledged and much appreciated.

This best practice was developed by stakeholders from Canadian municipalities and specialists from across Canada, based on information from a scan of municipal practices and an extensive literature review. The following members of the National Guide's Decision Making and Investment Planning Technical Committee provided guidance and direction in the development of this best practice. They were assisted by the Guide Directorate staff and by New East Consulting Services Ltd.

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This and other best practices could not have been developed without the leadership and guidance of the Project Steering Committee and the Technical Steering Committee of *the National Guide to Sustainable Municipal Infrastructure*, whose memberships are as follows:

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EXECUTIVE SUMMARY

This document outlines best practices for the coordination of infrastructure works, to minimize disruption and maximize value. All public works managers have, at one time or another, been exposed to significant public complaints about the lack of effective coordination among the various infrastructure components. How well this issue gets handled, significantly affects the overall effectiveness of infrastructure providers and, therefore it is important for the various infrastructure renewal programs to be coordinated to the maximum extent possible.

A wide variety of practices exist across the country. The review identifies best practices, which will work in different situations. This, in turn, will enable individual municipalities to choose the practices appropriate for their organization. The review included:

- preliminary interviews with a wide variety of municipalities across the country;
- the selection of 20 municipalities for detailed follow-up interviews;
- the development of a series of detailed questions;
- detailed follow-up interviews with the 20 final municipalities;
- a literature review of pertinent aspects of other formal studies;
- a review of a variety of consultant reports and models; and
- the use of the personal experiences of the team members who were involved in creating this best practice.

The benefits anticipated from improving service delivery models in this area include:

- reduced costs;
- increased sensitivity of infrastructure managers to considerations in other infrastructure components;
- reduced disruption and social costs;
- improved coordination of long-term infrastructure works with development related works;

- improved full cost accounting;
- improved public perception of infrastructure providers;
- increased council and public awareness for the need of life cycle replacement strategies; and
- improved funding approval procedures.

A number of risks and possible consequences are associated with how the practices itemized are dealt with, including:

- increased administrative costs;
- premature replacement;
- skewed priorities;
- opposition from external utilities;
- reduced flexibility; and
- lost opportunity costs.

The various best practices identified as a result of this review can be placed in five generic areas with a number of subcategories.

1. Coordination Practices – The effective coordination of the various utilities involved is critical. The following specific practices are highlighted:
    - multi-year plans;
    - formal committees (both internal and external committees); and
    - coordination of development-related works.
2. Corridor upgrades – Corridor upgrades have significant benefits with respect to maximizing coordination and minimizing repeat disruption. Care needs to be taken to ensure the economic life lost to early replacement does not exceed the economic benefits resulting from improved coordination. In situations where a "smaller percentage life" is still remaining in an underground utility, additional economic analysis should be undertaken to evaluate and justify complete corridor renewal and rehabilitation. Refinement on the corridor approach includes the installation of utilidors, and the upgrading of many blocks on a particular street or an entire neighbourhood at the same time.

3. Restrictive practices – Municipalities use a variety of restrictive practices to promote enhanced coordination. They include:

    - permit requirements;
    - no-cut rules;
    - pavement restoration procedures; and
    - pavement degradation fees.

    The above restrictive practices all form incentives to minimize disruption to a particular road surface and to enhance the coordination of various infrastructure programs.

4. Approval processes/communicating needs – A variety of planning processes and how the needs get communicated are outlined as part of this review. They include the role of:

    - dedicated funding sources;
    - block funding;
    - formal planning tools; and
    - presentations, public notices, and other information dissemination.

All these areas serve specific roles in the infrastructure approval process and affect how well individual programs are coordinated.

5. Technical considerations – In addition to policy and procedure-related best practices, there are some technical considerations. They include how to account for social and environmental costs, pre-installation of services, use of computer software for coordination of capital works programming of various infrastructure components, and trenchless technologies.

How this best practice should be applied and its limitations are also outlined as part of this review. Due to the wide variation in the number of practices employed, in most cases, the review lists the various practices without specifying which are preferable. However, on occasion it is clear that some practices are preferable to others. Where this occurs, commentary is provided. Examples include:

- multi-year plans;
- formal coordination committees;

- corridor reviews;
- pavement degradation fees;
- dedicated funding approvals for infrastructure needs;
- block funding approvals; and
- highlighting life cycle costing in presentations.

Since the success of the various practices outlined is subjective, evaluations of the performance of individual municipalities are difficult. However, criteria to measure the success of particular organizations include:

- the length of the plans distributed to the various infrastructure providers;
- the frequency of contact with external agencies;
- the existence of a formal multi-agency committee to review these issues;
- the existence of no-cut rules and pavement degradation fees;
- the size of the annual infrastructure deficit and the frequency of reporting to council and the public on these issues; and
- the existence of block funding approvals.

It should always be remembered that the primary indication for success is the overall effectiveness of infrastructure providers in the eyes of the local council and the community.

1. GENERAL

1.1 INTRODUCTION

This best practice document is part of the *National Guide to Sustainable Municipal Infrastructure*. Its goal is to assist municipalities with the management of all components of the municipal infrastructure and provide a road map for the Canadian network of practitioners, researchers, and municipal officials to solve today's municipal infrastructure challenges. This best practice document is concerned with the coordination of infrastructure works to minimize disruption and maximize value. It has been produced under the guidance of the Decision Making and Investment Planning Committee but targets more of a technical audience compared with other best practices produced by this Committee.

All public works managers have, at one time or another, been exposed to significant public complaints about the lack of effective coordination among the various infrastructure components. The problems associated with effective coordination are significant as various components of the infrastructure are installed at different times, with different expected life cycles, differing degrees of maintenance, and management by different staff groups. Some components are managed by entirely different organizations, which have different mandates and funding sources. This presents a significant technical and communication challenge in minimizing the disruption caused to the community and maximizing the value of infrastructure investments. There is little that is more disturbing to the public than to see a significant public works project in progress, with the associated disruption and social cost to the community, and to observe the reinstatement of the pavement surface only to have the entire street dug up again for an entirely different purpose a short time later. While technical explanations for this phenomenon can be offered, the perception of waste and inefficiency in the service delivery of infrastructure works is an inevitable outcome. It is therefore important for the various infrastructure renewal programs to be coordinated to the maximum extent possible.

1.2 PURPOSE AND SCOPE

The overall purpose of this best practice is to conduct a review of the various practices that cities across Canada use, to improve coordination among the various infrastructure programs, and identify the best practices used. It should be noted that there is a wide variety of needs across the country and a wide variety of cultures within both the cities at large and within their council make-up. It is not a purpose of this review to attempt to change the culture of individual cities. Rather, its goal is to identify a variety of best practices, which work in different situations that, in turn, will enable individual municipalities to choose which practices are appropriate for their organization. On occasion, some practices offer enhanced opportunities for effective co-operation, and these are noted, yet it

must be acknowledged that implementation may not be possible in all organizations.

1.3 REVIEW METHODOLOGY

The Decision Making and Investment Planning Committee of the National Guide used the services of a consultant who had extensive background in the management of municipal government, general engineering practices, and related practical experience. The assembled consultant team also had significant background in infrastructure-related topics. It was generally felt that although many cities had previously participated in extensive technical surveys, the required input for this survey would be difficult to achieve following traditional survey methodologies. Consequently, municipalities across the country with varying population, size, and climatic considerations were contacted directly by telephone. Brief descriptions of the practices followed in each of these municipalities were produced, and 20 municipalities were selected for follow-up interviews. A series of detailed questions were developed that were distributed in advance of the interviews. In addition, a request was made that, for each infrastructure area involved, technical experts be present at the follow-up interviews. The detailed interviews were conducted with representatives from the various technical and decision-making and investment planning committees in attendance, along with the consultants carrying out the detailed reviews. This provided consistency and allowed synergies to develop in a committee format. The background information on each municipality, produced from the preliminary interviews, served as a valuable starting point for the detailed interviews. Anywhere from one to six representatives of the municipality assisted in answering the detailed questions (depending on the size, complexity, and expertise involved). It was felt that this review methodology obtained the required information in a co-operative, cost-effective manner. In addition, rapport was established between the Guide team and the various municipalities involved, which will aid in future best practice scans.

A literature review was conducted to incorporate pertinent aspects of other formal studies. A specific review was made of a variety of consultant reports and models in current use in the municipalities involved. The best practice scan also used the personal experiences of the team members who had significant expertise in the management of these types of processes. This review methodology was successful in obtaining the information required in a very co-operative manner and should be considered for other best practices.

1.4 HOW TO USE THIS DOCUMENT

This best practice reveals that there are a variety of techniques being used throughout the country. The outcome is a mix of considerations including physical, financial, organizational, and behavioural. Many of the practices identified involve values, which are difficult to measure with fixed criteria. As

there is wide variation in the stakeholders involved, there is a danger of trying to make one model fit all communities. A number of factors influence this issue:

- **political:** how a community is represented (ward basis or at large elections), the council term (very short compared to the time frame of infrastructure-related issues) and the values/preferences a particular council has with respect to capital verses operating, user pay, fees and charges, etc.;

- **socio-economic:** the community size and its relative budgets and affordability, the community age, and where it is in the infrastructure life cycle;

- **financial considerations:** competition for tax funds, the effects of downloading and general cutbacks in the government sector, the existence of dedicated funding and who owns the various infrastructure areas, and the general practice of locating external utilities (above or below ground);

- **asset-related issues**;

- **organization:** how an organization is staffed and structured; and

- **culture.**

All these factors result in the use of a wide variety of detailed techniques; however, there are also significant consistencies between municipalities when this issue is considered in an overview manner. The strategies employed by the various municipalities contacted fall into the following five broad categories.

1. **Coordination practices** include utility committees, the development of multi-year plans and the formal circulation of plans and programs among various infrastructure components.

2. **Corridor upgrades** involve the replacement of a variety of infrastructure components at the same time.

3. **Restrictive practices** include no-cut rules and pavement degradation fees.

4. **Approval processes/communicating needs** includes the role of dedicated funding, block funding approvals and the timing of approvals, and how the issues are presented.

5. **Technical considerations** refer to the pre-installation of lateral and service connections, trenchless construction techniques, etc.

In each category, a wide variety of practices have been followed. It is the general conclusion of this review that no one approach will fit all organizations, and

variety is appropriate. Rather than make specific recommendations, it is preferable to list a variety of practices that seem to work in different situations and provide commentary on the relative merits of each. This allows a wide variety of municipalities and individual areas to select from the various best practices listed that best fit the culture of their community and council.

1.5 GLOSSARY

Asset management — The combination of management, financial, economic, engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner.

Best practices — State of the art methodologies and technologies for municipal infrastructure planning, design, construction, management, assessment, maintenance and rehabilitation that consider local economic, environmental, and social factors.

Block funding — Approval of budgets on a program level for roads, drainage, water/sanitary, etc. as opposed to at an individual project level. This allows for significant flexibility with respect to changing priorities among individual projects.

Corridor upgrading — The upgrading of all elements of infrastructure on a specific street or in a geographic area at the same time.

Dedicated funding — Funding raised for a specific utility and restricted by a policy framework for use on one infrastructure component.

External utilities — Commonly refers to utilities not owned and operated by the municipality. They typically include hydro, telephone, cable, and fibre optics but may include infrastructure, which is traditionally municipal in nature (if it is owned by an external company or another level of government).

Full cost accounting — A process, which relates all the associated costs and effects of a particular program to its funding source.

Infrastructure renewal programs — A systematic program, which rehabilitates or reconstructs an infrastructure system near the end of its physical life.

Life cycle replacement strategy — An infrastructure renewal strategy, which recognizes that each component has a limited life span and takes that life span into account when determining an annual program.

Long-range infrastructure planning processes — Refers to a planning horizon of five to ten years.

Municipal infrastructure — Roads, water, sanitary sewer, and stormwater systems which form a network and serve whole communities, where the system as a whole is intended to be maintained indefinitely at a particular level of service potential by the continuing replacement and refurbishment of its components. The network may include normally recognized ordinary assets as components.

Municipality — A legally incorporated or duly authorized association of inhabitants of limited area for local governmental or other public purposes.

No-cut rule — A moratorium on all excavation activity within the pavement surface for a specific period of time after a pavement overlay.

Pavement degradation fee — A fee charged to an agency cutting the pavement, which is in addition to the repair cost. This accounts for the reduced service life of the pavement infrastructure as a result of the excavation process.

Short-term infrastructure planning processes — Generally refers to a planning horizon of less than five years.

Utilidor — A linear utility chamber constructed to accommodate a variety of utilities. (Those utilities could include hydro, telephone, cable, steam heat, etc.).

2. RATIONALE

2.1 BACKGROUND

Although specific procedures and followed practices varied significantly among municipalities, there was instant recognition that the topic of this best practice was very pertinent to all the communities surveyed. All the staff involved quickly recognized that the need for effective coordination was one of the most important building blocks to an effective infrastructure replacement strategy. The five key elements listed in this best practice were prevalent in most of the communities surveyed. While the precise methodology of addressing this issue did differ significantly among the communities, the various practices used can be grouped into:

- coordination practices;
- corridor upgrades;
- restrictive practices;
- approval processes/communicating needs; and
- technical considerations.

2.2 BENEFITS

A wide variety of benefits result from improving service delivery models.

2.2.1 REDUCED COSTS

The net effect of improved coordination includes reduced project costs through efficiencies of scale and avoidance of repeat repair costs, primarily in the pavement repair area. Since funding allocations are often made on overall affordability criteria, more efficient use of funding enables more projects to be implemented, thereby reducing the infrastructure deficit.

2.2.2 INCREASED SENSITIVITY OF INFRASTRUCTURE MANAGERS TO CONSIDERATIONS IN OTHER INFRASTRUCTURE AREAS

The inevitable result of many of the improved coordination techniques is improved education, and sensitivity of infrastructure providers and project managers in one utility area of the needs and considerations in other areas. This, in turn, leads to improved decision making, even before any specific coordination efforts are undertaken.

2.2.3 REDUCED DISRUPTION AND SOCIAL COSTS

Infrastructure works result in the inevitable physical disruption, which leads to social costs, which are incurred but are not accounted for in the project budget.

This would include lost time and business opportunities, additional fuel consumption, etc., resulting from the effects of traffic disruption, noise, air pollution, and other environmental/social impacts. Improved coordination has the potential to reduce these impacts dramatically.

2.2.4 Improved Coordination of Long-Term Infrastructure Works with Development-Related Works

This capitalizes on the possible efficiencies and the benefit of having new development works fund some long-term infrastructure priorities.

2.2.5 Improved Full Cost Accounting

Traditionally, the roads area has had the greatest difficulty in maintaining appropriate funding levels, as its traditional funding source is the highly sensitive tax base. Historically, this area also has greater infrastructure deficits associated with it. Some practices identified in this review highlight areas where more full cost accounting may be possible. As an example, the effects of the underground utilities on the life of the road infrastructure are often not captured in traditional cost sharing practices even though those utilities can be on a user pay basis and have a more secure funding source. Some practices would transfer some long-term funding requirements from the more sensitive roads area to the utilities, which often have dedicated funding sources. This shift is fair and appropriate, and would result in increased balance in funding infrastructure priorities and improved overall service to the community.

2.2.6 Improved Public Perception

Poor coordination reduces the public image of infrastructure providers. As public perception is invariably reflected in a local council's attitudes and actions, any improvements in co-coordinating efforts have long-term benefits to all public works service providers.

2.2.7 Increased Council and Public Awareness of Life Cycle Replacement Strategies

A number of the education and communicating needs/procedures highlighted are required on an annual basis for budget purposes. However, they also have the tangential effect of increasing awareness of infrastructure needs, which has long-term benefits.

2.2.8 Better Funding Approval Procedures

A number of the practices highlighted involve approval processes, which can significantly increase the flexibility and coordination procedures surrounding these issues. Better funding approval procedures that allow planning for individual projects to occur earlier and more cost effectively result in significant benefits. They also have the potential to reduce administrative costs associated with the approval process and to increase the opportunities for coordination mid-year, which have direct financial benefits.

2.3 RISKS/POSSIBLE CONSEQUENCES

There are risks associated with a number of the practices itemized.

2.3.1 INCREASED ADMINISTRATIVE COSTS

There is a cost in terms of staff time and direct funding associated with a number of the committees/processes highlighted. Increased staff workload and costs associated with establishing some of the committees listed may result. In larger urban areas, where a number of different committees can be set up on various aspects related to this issue, this risk is greater.

2.3.2 REPLACEMENT TIMING

The corridor upgrade philosophy highlighted may result in replacing some individual infrastructure works before the end of their life. This may offset some benefits gained through increased coordination, reduced disruption, and reduced pavement repair costs. Therefore, proper analysis is critical in deciding on the degree to which these practices should be followed.

2.3.3 IMBALANCED FUNDING

Many communities do not have sufficient funding to balance infrastructure renewal works among various program areas and, therefore, effective coordination in certain program areas is difficult. In extreme cases, the vast majority of program funding can be totally consumed in coordinating works related to either development or one of the other program areas, leaving few resources to fund the remainder of the utility needs. This can result in insufficient flexibility to coordinate with other utilities while addressing the individual utility's needs.

2.3.4 OPPOSITION FROM EXTERNAL UTILITIES

Since a number of outside utilities have different cost centres and different mandates than that of municipalities, resistance may be incurred by adopting some of the techniques highlighted. Depending on the degree of opposition, this can become a major issue, and can by itself consume significant time and resources. Consequently, care must be taken to ensure that relationships do not deteriorate due to the practices outlined.

2.3.5 REDUCED FLEXIBILITY

Adoption of some of the restrictive practices highlighted (e.g., no-cut rules) can reduce the flexibility but increase the criticism of an operation. Care should be taken to ensure that the created expectations can be met.

2.3.6 LOST OPPORTUNITY COSTS

Not following a number of the practices highlighted has the potential of increasing the costs of individual projects and reducing resources available to fund fixed needs.

3. DESCRIPTION OF APPROPRIATE PRACTICE AREAS

As indicated earlier, the various practices identified as a result of this review can be placed into five generic categories with a number of subcategories. They are discussed in more detail in the following subsections.

3.1 COORDINATION PRACTICES

A wide variety of coordination practices were evident among the various municipalities interviewed. Despite the variety, the intent of each municipality's practice was similar: to provide more effective coordination among the various utilities (both internal and external). The following specific practices were in use.

3.1.1 MULTI-YEAR PLANS

The development of multi-year plans, which have specific projects identified, is key to effective coordination of different programs. The practices seem to vary significantly in this area with some cities having plans that are projected out for 10 years, and others which only concentrate on the coming year. The development of multi-year plans is an important consideration for this best practice. The prevailing best practice seems to concentrate on a three to five year horizon. One-year horizons coordinate the upcoming construction season, but do not offer enough lead time for effective long-term coordination and the pursuit of joint opportunities. Many municipalities indicated that outside utility companies in their areas were unable to produce plans for more than a one or two year horizon for a variety of reasons (e.g., unpredictable customer demand). It is noted that municipalities seem to have the ability to project further than most of the outside utility companies although municipal services are planned to meet the customer demand as well. This difference in approach is a significant roadblock to coordinating effective long-range programs.

Once the multi-year plans are developed, many municipalities have a formal circulation system wherein each area's plans/programs are circulated to the other areas. Through that process, it is ensured that pending underground works are completed before the street works.

In addition to providing a good base for coordinating programs, the distribution of longer-term capital plans can reduce the tendency for political direction to modify priorities for the upcoming year. This is especially important for communities governed by wards.

Once the following year's program has been selected, some municipalities mail specific letters for each project to all the other utilities to ensure that attention is brought to the specific project. This seems to be more prevalent in smaller areas

where there are fewer projects. A benefit of this type of process is that specific attention is brought to the street in question. This practice concentrates on the short term (upcoming construction season) but is useful in ensuring that all affected program areas conduct a final check on coordination issues before construction begins.

Some communities (e.g., Kelowna, British Columbia) have an extensive communications plan process for significant projects. This degree of formalized communication with the public is the exception rather than the standard. Others publish notices in the local papers or distribute letters to adjacent directly affected properties.

3.1.2 FORMAL COMMITTEES

A very common method of coordination is the establishment of formal committees with representation from a variety of service areas. This method seeks to ensure there are open lines of communication between the various service providers. There seems to be two distinctly different types of committees used to coordinate these types of works.

- Internal committees include representatives from each of the internal areas affected, which are usually sewers, water, drainage, and roads.

- External committees are sometimes called joint utility coordination committees and generally concentrate on the relationship of the external utility companies to the city programs. These external committees involve the various agencies responsible for the infrastructure, which the municipality does not own. They are usually coordinated and chaired by the municipality, but participation and commitment from the external utility companies seem to be greater if they are involved in chairing and coordinating the committee. Specifically, some municipalities use a rotating chair concept (e.g., Sudbury). In Winnipeg, all participants fund the coordinating efforts and the budget of the committee. These techniques maximize the involvement of the outside utility companies, which is an important factor in effective coordination.

Occasionally, the internal and external committees are combined and, in some cities, a number of other specific purpose committees are set up. (For example, Edmonton uses neighbourhood improvement committees.)

The frequency of meetings of these committees seems to vary dramatically with some meeting just once a year, while others meet monthly or more often.

Individual practices, with respect to committees, vary significantly depending on circumstances. There is no preferred set-up as the individual needs, staff resource levels, and other factors vary significantly. However, strategies involving outside utility companies directly in the management of the overall

issue increase their participation and improve coordination efforts. It is noted that earlier coordination achieves better integration.

3.1.3 COORDINATION OF DEVELOPMENT-RELATED WORKS

Other municipalities coordinate development-related works with ongoing program areas through development-related committees. Some municipalities take cash in lieu of the required works from the developer to coordinate the development-related works with their capital programs. Occasionally, an annual budget amount is set aside to undertake capital works in conjunction with development works in high growth municipalities (e.g., Surrey).

3.2 CORRIDOR UPGRADES

It is relatively common, in a number of areas, to look for opportunities for redevelopment of an entire corridor. The trigger for review of the corridor, however, seems to vary significantly depending on the specifics of the municipality involved. Some municipalities start with the street program and once the street is identified, specific reviews are conducted for the other internal programs, such as water, sewer, and drainage, with priority given to upgrading as many elements as possible. Other municipalities start with a program, such as the water program. In those cases, the overall corridor upgrading starts with the specific underground program, and the opportunity is taken to repave the entire roadway when the underground utility is complete.

While corridor upgrades are relatively common in many cities, the practice itself varies significantly depending on a number of factors, such as balanced funding availability, and the age and condition of infrastructure components. The range of practice varies all the way from very few corridor upgrades to it being the upgrading approach of choice (e.g., Yellowknife, Hamilton). Many believe that complete corridor upgrades are the best practice for their community as it maximizes the coordination benefits and minimizes repeat disruption to the community. However, concerns with this practice have also been articulated (e.g., Saskatoon). Those concerns centre on the economic life lost due to premature replacement of some infrastructure components. In many cases, the economic benefits of corridor replacements are not sufficient to offset the lost life. When considering this issue, cities should conduct an economic analysis of the trade-off between economic life lost due to premature replacement and the cost avoided by repeat pavement repairs and social disruption to the area. The effects of a complete renewal on revitalizing the area and encouraging other investment in the area should also be considered. In situations where a “smaller percentage life” is still remaining in an underground utility, additional economic analysis should be carried out to evaluate and justify complete corridor renewal and rehabilitation.

Partial corridor upgrades can also occur with some but not all program areas being upgraded at the same time. In those cases, it is common to complete a

check on all other utilities and rectify any deficiencies before the corridor upgrade. Another approach, which provides enhanced economies of scale, is to seek approval for upgrading for many blocks of a particular street or an entire neighbourhood at the same time. This provides construction efficiencies and concentrates the disruption to the community to a very specific time frame.

3.3 RESTRICTIVE PRACTICES

Individual municipalities use a variety of restrictive practices to promote coordination and, more important, minimize the disruption to a newly completed project for a number of years.

3.3.1 PERMIT REQUIREMENTS

Most of the municipalities interviewed use a system requiring all excavators to obtain a permit from the municipality before excavation. The permit fee itself is generally nominal; however, the practice does enable the municipality to exercise a degree of control over the excavation of streets. This enables municipalities to implement additional restrictive policies if they wish.

3.3.2 NO-CUT RULES

About half the municipalities surveyed had a no-cut rule of some sort in their municipality. A no-cut rule or moratorium on excavations specifies that no excavations are allowed for a certain number of years after pavement overlays unless emergency circumstances prevail. If a no-cut rule exists, the most common time frame is three years, although in some cases it is longer (e.g., five years). The prevalence of a no-cut rule varied significantly depending on the culture in the municipality, the degree of development (high development areas used fewer no-cut rules) and the sensitivity of the elected officials and the community to repeat disruptions. There were different levels of approvals required with some organizations, requiring approval of Council for an exception to the rule and others producing a wide variety of circumstances, which would allow exceptions to the policy. It is noted that even when a no-cut rule exists, its success in restricting repeat excavations is variable. A recent study prepared for Ottawa highlighted that even very proactive cities found a significant percentage of their moratorium streets had been re-excavated within two years of resurfacing. Unless this is understood when instituting a no-cut rule, false expectations can be raised which, in turn, can lead to additional negative perceptions of public works coordinators.

3.3.3 PAVEMENT RESTORATION PROCEDURES

With respect to the actual road repair procedures, various mechanisms are used, ranging from the utility company repairing the excavation to municipal specifications, to the city coordinating the final pavement restoration at the utility company's expense, to a flat charge pavement repair system which transfers the responsibility for the final repair to the city in exchange for a per square metre charge to the utility company. The individual system adopted varies significantly

among municipalities. While it is difficult to indicate a preferred approach, there is a tendency for individual municipalities to pay more attention to the quality of the final repair than outside excavation agencies, as the municipality will ultimately inherit any deficiencies in the repair process. This leads to the conclusion that the best practice is the one with very active involvement by the municipality.

3.3.4 PAVEMENT DEGRADATION FEES

Pavement degradation fees have been studied in detail by some municipalities. An inherent by-product of utility cuts is the reduced service life of pavements. No matter how well a utility cut is repaired, the nature of the excavation process and the disturbance of the sub base have a significant effect on lessening the overall life of the pavement infrastructure. In general, road infrastructure is in poorer condition than the underground utilities and is usually the more difficult area for raising funds due to the lack of a dedicated funding source. This fee for excavations was discussed in significant detail with the majority of municipalities interviewed. While few municipalities across the country are using the concept (Ottawa, Surrey), there was significant interest and support for it. It assists in moving toward full cost accounting and appropriately charges the agencies responsible for long-term costs. It also has the side benefit of encouraging coordination among the various infrastructure areas to avoid repeat fees.

A number of the municipalities that have implemented such a fee have related the fee to the age of the last overlay. Others have adopted a flat rate for ease of administration. Technically, a relationship to the age of the last overlay is a more accurate method of reflecting the true effects of utility cuts on pavement life, but a flat rate is much easier to administer, and does not require a large database. It is suggested that adopting the concept of a pavement degradation fee in addition to proper road repair procedures is a worthwhile practice for most municipalities to pursue. The choice of a flat or variable rate can be left to the discretion of the individual municipality.

3.4 APPROVAL PROCESSES AND THE NEED FOR BETTER COMMUNICATION

As part of this best practice, a review was carried out of existing planning procedures and how the needs get communicated to the elected officials and the public, along with the adequacy of existing budget levels, in each of the areas for which municipalities were responsible.

3.4.1 DEDICATED FUNDING SOURCES

Existing budgets were generally not sufficient to replace the infrastructure components in question on a life cycle basis, but there was significant variation among urban areas in this regard. The roads and drainage areas usually had greater difficulty in obtaining adequate funding than the sewer and water areas. This was primarily due to the existence of dedicated funding for the sewer and

water areas through utility rates. Generally, roads and drainage were funded from the general tax base and had to compete directly against many other program areas. The relatively higher level of funding for the roads program is evident where a dedicated funding source is available to subsidize the program (e.g., a share of fuel tax in Edmonton and in the member municipalities of the Greater Vancouver Regional District). It appeared that the public and the funding agency are much more willing to provide adequate funding levels if there is a direct link between the users of the system and how the funding is raised. It follows logically that establishing dedicated funding for the various infrastructure service areas should be an overall priority for all infrastructure providers.

3.4.2 BLOCK FUNDING

The timing of the approvals of different funding programs did not seem to be a significant deterrent to enhance coordination as the key coordinating efforts occurred at separate times from the approval process. It was generally acknowledged that early approvals (preferably in the fall for the following year) are very important for effective coordination processes to occur. In addition, the way individual programs and projects were approved has a significant effect on the ability to coordinate throughout the year. Specifically, a number of cities have approval processes, which concentrate on block funding approvals with individual projects submitted only for information purposes or not submitted at all. These types of arrangements are very flexible and allow the municipality to change individual projects if information comes up late in the planning process. This increases the ability of the relevant agencies to coordinate individual program areas with other works. Other cities need to specify exactly which projects will be constructed that year and need council approval in that regard. This practice prevents coordination with other outside influences. It is suggested that the best practice, in this regard, is to seek program level approvals and to supply project detail for information. It is recognized that the ability of individual municipalities to achieve this is influenced significantly by the culture within the community and its council, and this practice may only be achieved over time.

3.4.3 PRESENTATIONS OF INFRASTRUCTURE NEEDS

Most organizations make periodic presentations to their council on their long-term infrastructure plans, and a wide variety of detail is used. It is suggested, as a minimum, that each municipality include in its presentations the replacement value of each infrastructure component, the expected life of that component, a calculated life cycle replacement target, a description of proactive initiatives to meet the target, and the benefits of meeting the target. This budget should then be compared to the actual expenditures in each program area. The difference highlights the needs. Some organizations formalize this to the extent that they call that difference the infrastructure deficit, and it is reported annually. The political support organization's experience varies dramatically with some communities expressing strong support for infrastructure-related issues and others receiving the information with seldom any action taken. The goal should

not be to obtain specific funding levels, but to inform the council and the community of infrastructure issues, to make them aware that continued deferral of this issue is a form of deficit, and that long-term support be generated for infrastructure-related issues. Presentations which address positive outcomes for individual councils and the community as a whole (e.g., reduced emergency repairs with their associated disruptions) are better received than those dwelling on negative outcomes. Regardless of the specific responses, it is apparent that knowledge and awareness of infrastructure-related issues have increased dramatically since the infrastructure movement started in Canada in the early 1980s, and there has been a substantial number of initiatives (the Guide being only one).

3.5 TECHNICAL CONSIDERATIONS

3.5.1 FORMAL PLANNING TOOLS

Many municipalities used formal planning tools. It is very common to use computerized pavement management systems to aid in the prioritization of individual projects. In the sewer and water areas, available models seem to concentrate more on capacity issues than condition issues. A number of cities are participating in pilot projects involving an integrated infrastructure management-upgrading program (e.g., Hamilton). This process concentrates on integrating all aspects of infrastructure into one program. However, while a number of municipalities have started to use this technology, it is premature to provide commentary as to how well it works. In addition to formal planning tools, a number of cities (e.g., Saskatoon, Hamilton) have restructured their public works and engineering departments to include a formal asset management branch. This ensures that attention is being placed in an ongoing manner on infrastructure-related issues and is a very effective way of ensuring a continued long-term focus on these issues.

Municipalities use various means to test the condition of infrastructure. They range from the use of field observation and maintenance records to condition rating equipment. Condition rating data are compiled manually or with computer software. Using the condition rating data, municipalities develop capital programs in conjunction with capacity upgrading needs, which are identified through field monitoring and capacity modelling software. When the infrastructure capacity is upgraded, municipalities consider the projected future demand growth in the range of 10 to 30 years.

Several observations are made in the usage of various tools.

- Most municipalities use capacity modelling software for roads, water, sewer, and drainage systems. Some software is integrated with a municipal geographical information system (GIS), which presents better opportunity for coordination of individual capacity upgrading programs.

- Pavement condition rating and rehabilitation strategy/program development software is more widely used by municipalities than similar software for water, sewer, and drainage systems.

- Some municipalities use closed-circuit television (CCTV) inspection and leak detection to determine underground infrastructure rehabilitation needs or in reaction to frequent maintenance requirements. Some municipalities use a computer-based maintenance management system to track the maintenance cost of specific components in the infrastructure. These systems are sometimes integrated with a GIS.

- Many municipalities have specific material replacement programs, such as paving unpaved roads and replacing cast iron or asbestos cement pipes.

In summary, it has been observed that even partial integration of infrastructure capital works programming aspects facilitates coordination among the various program components. However, there is a need for more comprehensive infrastructure capital works programming software to integrate the various areas.

3.5.2 Social and Environmental Costs

Most organizations were aware of the social and environmental costs of their projects, but very few attempted to quantify them in any formal sense. Most environmental considerations were dealt with as a result of formal mandated senior level government environmental review and assessment processes. The social issues were generally acknowledged but not dealt with in any formal sense. One example of attempting specifically to quantify social costs is through the concept of a lane rental charge included in the project budget (e.g., Hamilton). This formally quantified traffic disruption to some degree in that municipality. As part of the literature research, Alberta's Transportation Environmental Construction Operations Plan was reviewed. It outlines a very detailed framework for considering environmental issues and ensures that they receive a very high profile as part of project planning. Although this type of detailed environmental planning framework was not prevalent, many acknowledged the need for such an approach.

3.5.3 Pre-Installations and Interim Services

The pre-installation of lateral service connections is a refinement of the corridor upgrade approach. Some pavement cuts resulting from land development can be avoided if lateral and building service connections are pre-installed in anticipation of future development. The cost of such pre-installations can usually be recovered from future developers. To install an appropriate number of connections at appropriate locations, future development layouts must be predicted.

In some cases, where accurate future development layouts are difficult to predict, a larger than standard building service connection may be installed to

accommodate higher demand than that expected from a single building service connection (e.g., for multiple buildings).

Municipalities with very high growth rates also occasionally install interim size utilities first and then upgrade the utilities when future demand warrants it. Sometimes, interim size utilities are installed under interim roads to be widened in the future. In such cases, the location of ultimate utilities should be predetermined to avoid or minimize pavement cuts during upgrading.

3.5.4 UTILIDOR AND TRENCHLESS TECHNOLOGIES

A refinement to the corridor upgrade approach is the installation of a utilidor to house a variety of utilities, such as fibre optics, telephone, cable, and hot water for central heating. While utilidors are relatively common in Europe and in buildings throughout North America, their application to urban infrastructure is new. This type of installation, which is relatively uncommon in Canadian urban infrastructure at present, is usually justified only in downtown cores, where utility space is at a premium or under extreme weather conditions. The benefits of utilidors include:

- one-time construction of the corridor;
- long term access to utilities;
- ease of maintenance; and
- minimal disruption to surfaces, such as roads.

Prince George, British Columbia is moving forward on the installation of a utilidor in its downtown over the next few years, and the city's experience will be useful to monitor.

Many municipalities use various trenchless construction techniques to rehabilitate or install underground utilities. Overall benefit can be achieved by avoiding pavement cuts and the resulting disruptions.

4. APPLICATIONS AND LIMITATIONS

4.1 APPLICATIONS

In their efforts to improve coordination of the various infrastructure works, local governments employ a wide range of practices. The exact practices employed vary due to a number of factors, which are often community or politically based. It is felt that, except in some specific circumstances, it is not appropriate to specify which practice should be used in all situations. This report generally provides a listing of the various practices, which have been employed, to enable individual communities looking to improve their practices to choose from the options. On occasion, it is clear from a technical perspective, that some practices are preferable from the context of maintaining infrastructure. Where this occurs, commentary is provided. Examples include:

- multi-year plans;
- formal coordination committees;
- corridor reviews;
- pavement degradation fees;
- dedicated funding approvals for infrastructure needs;
- block funding approvals; and
- highlighting life cycle costing in presentations.

The actual implementation of those practices will be affected to a significant degree by the community culture and the specific council's attitude. It may not be possible to achieve certain practices in some areas.

4.2 LIMITATIONS

Practices are often driven by a number of factors, specific to the municipality or area in question. For example, Yellowknife practices a high degree of corridor replacement, which is largely driven by history and the climate of the far north. Other urban centres have not yet hit the replacement phase, which is common in older cities. For example, Gander, Newfoundland was largely developed at one time after the war, but Surrey, British Columbia, with its very high growth rates in the last two decades, has the vast majority of its infrastructure in good condition due to its relatively young age. Specific potential limitations on the success of some of the practices outlined include the short planning horizon of some infrastructure providers (e.g., external utility companies), which are not within the control of individual municipalities. The trends in government toward downsizing and cutting administrative costs also may significantly limit the

ability of individual organizations to undertake many of the practices listed. The attitude of some councils regarding delegation, approval processes, and equity across the city also pose significant limitations on implementing a number of practices.

Many other limitations not discussed here, relate to community acceptance of restrictive practices and disruption.

5. EVALUATION

Success in implementing the practices outlined in this best practice is subjective. Due to the differing cultural attitudes within communities, priority should be placed on achieving incremental improvements in the various tools used. Evaluations can be made to measure a particular community against its past practice and the practices employed by other municipalities, as outlined in this best practice. However, it needs to be recognized that there is a wide range of practices in use, and the need for certain practices varies significantly with respect to the size of the community. The larger the community, the more complex the various procedures generally need to be.

Notwithstanding that many of these practices vary significantly among communities, it is possible to review the various practices outlined and periodically evaluate the success of a particular organization in implementing them. Appropriate criteria might include:

- the length of the plans distributed to the various infrastructure providers;
- the frequency of contact with external agencies;
- the existence of a formal multi-agency committee to review these issues;
- the existence of no-cut rules and pavement degradation fees;
- the size of the annual infrastructure deficit and the frequency of reporting to council and the public on these issues; and
- the existence of block funding approvals.

It should always be remembered that the primary consideration for success in this area is the overall effectiveness of the infrastructure providers in both the eyes of the local council and the community. This is affected by many intangible factors, but is the ultimate measure of success.

REFERENCES

Ainley Group, 2000. "Management of Regional Rights-Of-Way for Utility, Construction and Maintenance Activities," From Director Infrastructure Maintenance, Environment and Transportation Department, Region of Ottawa-Carleton.

Alberta Transportation, 2001. "Environmental Construction Operations Plan (ECO Plan) Framework," July.

Calgary, City of, 2000. "Roads – Maintenance – Utility Excavation <http://www.gov.calgary.ab.ca/roads/about_calgary_roads/roads_mainte.../utility_excavation.htm>, accessed January 15, 2003.

CRTC (Canadian Radio-television and Telecommunications Commission), 2001. "Decision CRTC 2001-23," <http://www.crtc.gc.ca/archive/ENG.Decisions/2001/DT2001-23.htm> accessed January 15, 2003.

CRTC (Canadian Radio-television and Telecommunications Commission), *Telecommunications Act*, Statutes of Canada, Chapter 38, <http://www.crtc.gc.ca/eng/LEGAL/TELECOM.HTM> accessed January 15, 2003.

El Hussein, H. Mohamed, 2003. "Guidelines for the Restoration of Utility Cuts," National Research Council Canada and US Army Corps of Engineers.

Ghassan, Tarakji, 1995. "The Effect of Utility Cuts on the Service Life of Pavements in San Francisco," Volume I: Study Procedure and Findings. Study conducted for the Department of Public Works City and County of San Francisco, San Francisco, CA.

Gustafson, Jan-Mark and Lynn Higgins, 2002. "An Interim Framework for Asset Management," Prepared for the City of Saskatoon. Panel Discussion for Asset Management Systems – Implementation Strategies and Lessons Learned at the 2002 Annual Conference of the Transportation Association of Canada, Winnipeg, MN.

Kelowna, City of, 1999. "Consultation Guidelines for Transportation Initiatives," March.

Lee, Stephen Q.S.and Katherine A. Lauter, 1999. "Impact of Utility Trenching and Appurtenances on Pavement Performance in Ottawa-Carleton," Environment and Transportation Department, Regional Municipality of Ottawa-Carleton.

Marcus, William B., nd. "Economic Report: Estimated Costs of Accelerated Repaving Required as a Result of Utility Excavation in San Francisco Streets."

Nichols, Vallerga & Associates, 2000. "City of Seattle Impact of Utility Cuts on Performance of Seattle Streets."

San Francisco, City and County of, 2000-02. "5 Year Proposed Utility Excavation and Paving Plan," <http://www.sfdpw.org/sfdpw/download/fiveyear.htm> accessed January 15, 2003.

San Francisco, City and County of , 2000-02. "Regulations for Excavating and Restoring Streets in San Francisco," <http://www.sfdpw.org/sfdpw/download/download.htm> accessed January 15, 2003.

San Francisco, City and County of, Department of Public Works and The Blue Ribbon Panel on Pavement Damage, 1998. "The Impact of Excavation on San Francisco Streets."

Schaeffer & Associates Ltd. and L & N Koehle Consulting Services, 2002. "Municipal Fees for Utilities in the Right-of-Way."

Steblin, Peter (Solid Foundations Consulting Ltd.), 2002. "Flat Charge Pavement Repair System," City of Surrey and Township of Langley.

Steiger, Frank, 1997. "The Second Law of Thermodynamics, Evolution, and Probability," <http://www.talkorigins.org/faqs/thermo/probability.html> accessed January 15, 2003.

Technical Committee on Canada's Urban Infrastructure, 1984. "Canada's Urban Infrastructure – Physical Condition and Funding Adequacy," Prepared for the Federation of Canadian Municipalities Task Force on Municipal Infrastructure.

Winnipeg, City of, Public Works, nd. "Permit Service" <http://www.city.winnipeg.mb.ca/publicworks> accessed January 15, 2003.