

DEVELOPING INDICATORS AND BENCHMARKS

A BEST PRACTICE BY THE NATIONAL GUIDE
TO SUSTAINABLE MUNICIPAL INFRASTRUCTURE

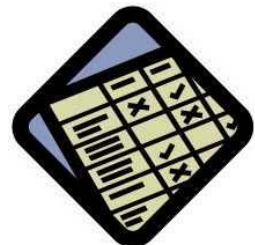
National Guide
to Sustainable
Municipal
Infrastructure



Guide national pour
des infrastructures
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durables

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Developing Indicators and Benchmarks

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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 and therefore is qualitatively distinct from Part B. Among the most significant of its distinctions is the group of practitioners for which it is intended. Part A, or the DMIP 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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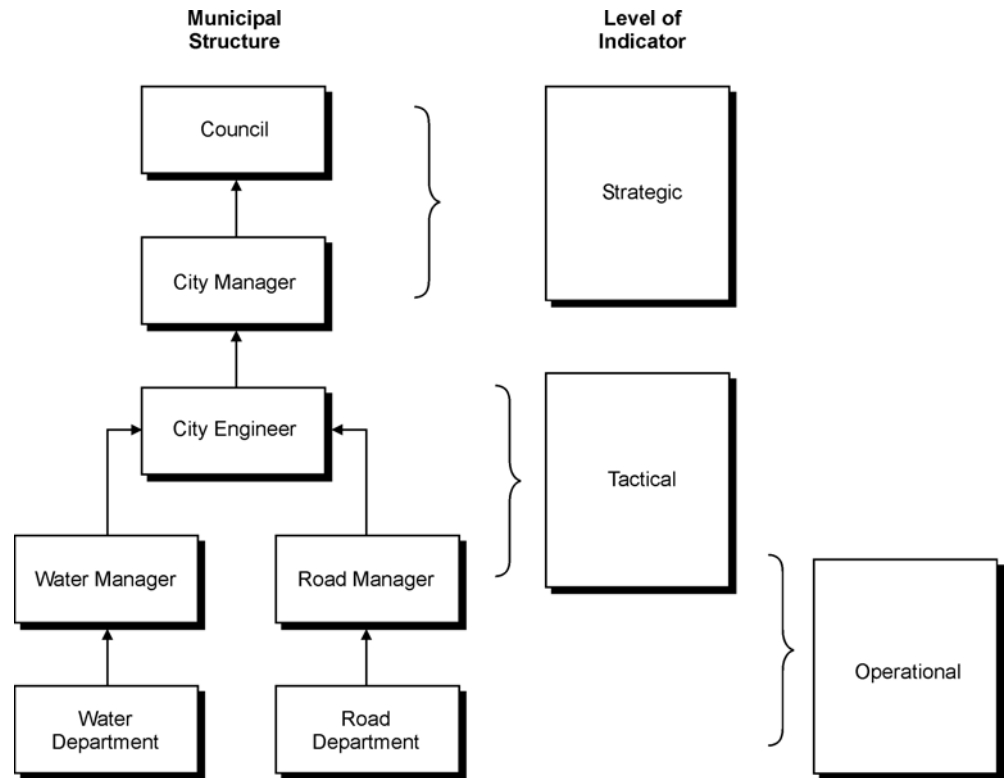
EXECUTIVE SUMMARY

This best practice focuses on developing indicators and benchmarks, specifically as they relate to roads, water, wastewater and sewers. Accordingly, it provides a framework or methodology to assist Canadian municipalities to develop, for themselves, the basic indicators, benchmarks and performance measures necessary to assist them in their infrastructure planning and decision-making processes. This framework describes a guide for municipalities in developing and using indicators in support of high-level infrastructure decision making. It also attempts to foster a deeper understanding of the relationship between planning decisions and the state of infrastructure assets. As such this best practice is best construed as an inspirational ‘how to’ framework for the development of indicators and benchmarks, as opposed to a definitive prescription.

Operational and technical indicator use is now widespread among Canadian municipalities, but it is often in a state of early development or has not yet been tied to the decision-making process itself. This report provides assistance in the further development and use of indicators within the decision making. Canadian municipalities vary considerably in the resources available to them, whether it is financial constraints, staffing issues or varying degrees of technological advancement. Individual constituent elements of this best practice may be found in municipalities, regardless of size and geographic location. It is the intent to provide a framework that allows, to the greatest extent possible, all Canadian municipalities to benefit from this best practice and to participate, to the extent they are able, in developing indicator-based infrastructure decision-making support.

There are two major challenges in dealing with municipal infrastructure planning and decision making. One is internal and the other is external. The internal challenge is a disconnect within many municipalities between those with the operational knowledge and understanding of infrastructure asset conditions and needs (generally public works or engineering managers) and those municipal officials making the actual infrastructure funding decisions. The external challenge in dealing with municipal infrastructure planning and decision making is the chronic lack of funding many municipalities live with in managing their hard infrastructure assets.

In creating a methodology that would be useful for municipalities, several considerations are required. First among these considerations is that the people making funding decisions in municipalities often do not have an in-depth understanding of infrastructure engineering considerations. It is therefore important to start by identifying indicators that are meaningful to decision makers. The following figure illustrates this.



To develop and use indicators for decision-making support, several steps are required. The most important among these are:

1. The identification of the high-level (strategic/tactical) indicators that would assist your municipality in its infrastructure decision-making process. This consists of determining what you are trying to measure and the information needed to measure it.
2. Implementation of an indicator data collection system. An information management system to contain and make data available for analysis is recommended as part of this framework. This recommendation does not necessarily require municipalities to invest in large, complex or expensive computer systems. Systems or tools should, however, be appropriate to the context of the municipality's needs and resources.
3. Convey useful and understandable information to the various levels of decision makers within the municipality. This includes the tactical decision makers (e.g., engineering or public works managers with a knowledge of engineering and asset management issues), as well as strategic decision makers, who do not have the same level of technical knowledge but make critical infrastructure funding and planning decisions.

A second important consideration is that indicators are only as useful as the information and decision-making support they provide. They are a means to an

end — the end being the effective management of assets to provide maximum life and value in a cost-effective manner. It is important to note that the use of indicators is not intended as a substitute for exercising judgement in infrastructure decision making, but is intended as a tool to assist in the decision-making process.

Indicators are becoming increasingly recognized as an important tool in understanding municipal infrastructure conditions and needs. There is an overwhelming trend among Canadian municipalities toward indicator-supported infrastructure planning and decision making. Properly implemented, indicators are an attempt to solve the problem best expressed as “you cannot manage what you do not know.” They also attempt to create a decision-making process based less on personal (although professional) experience of a municipality’s infrastructure assets, and more on measurable conditions and results. This gives decision makers the ability to see more clearly the consequences of their decisions and avoid the many pitfalls that result from making funding decisions with an incomplete understanding of their infrastructure assets and needs.

1. INTRODUCTION

With some exceptions, there is a strong overall commitment among Canadian municipalities to develop and use indicators to assist in municipal infrastructure decision making. It is clearly viewed as a goal and an expected next step in the evolution of infrastructure planning.

This report provides a framework or methodology to assist Canadian municipalities to develop, for themselves, the basic indicators, benchmarks and performance measures necessary to assist them in their infrastructure planning and decision-making processes.

Moving away from reactive and wasteful “worst first” planning to maintaining assets in a “state of good repair” is becoming the goal of almost every municipality. To the extent that current funding permits, municipalities are seeking new approaches to infrastructure funding and planning decision making to better manage scarce resources and prioritize infrastructure spending and planning.

Operational and technical indicator use is now widespread among Canadian municipalities, but it is often in a state of early development or has not yet been tied to the decision-making process itself. This report provides assistance in the further development and use of indicators within decision making.

1.1 THE CHALLENGE

There are two major challenges in dealing with municipal infrastructure planning and decision making. One is internal and the other is external.

The internal challenge is a disconnect within many municipalities between those with the operational knowledge and understanding of infrastructure asset conditions and needs (generally public works or engineering managers) and those municipal officials making the actual infrastructure funding decisions. At its highest level, the primary purpose and objective of this best practice is to create a framework to help improve articulation and conveyance of municipal infrastructure funding needs to the decision makers. Expressing infrastructure needs, in a manner that clearly shows the effect of each funding or planning decision, allows public works or engineering departments to substantiate their recommended priorities. It also allows decision makers to evaluate the consequences of their decisions. Providing measurable outcomes allows municipalities to ensure their funding decisions have the desired effect and, if necessary, gives them the leeway to adjust planning goals and priorities.

The external challenge in dealing with municipal infrastructure planning and decision making is the chronic lack of funding many municipalities live with in managing their hard infrastructure assets. To a certain extent, this best practice

also provides a framework to help municipalities better manage these assets in the face of this funding crisis.

In Canada, the infrastructure maintenance deficit has been estimated at upward of \$44 billion, and climbing. This is evidence of the general feeling that municipal hard infrastructure is not getting its “fair share” of funding for proper maintenance due to the difficulties in measuring need. Municipal road, water, sewer and storm drainage infrastructures are often characterized by less immediately obvious or measurable needs.

With many infrastructure budgets frozen, it has become increasingly important for municipal engineering and public works departments to search for ways to prioritize the allocation of their limited resources and to prolong the life cycles of their assets. They tread the delicate balance between spending money on rehabilitation before it is necessary and waiting so long, the infrastructure asset is past repair. In this sense, municipal infrastructure decision making is not only about the allocation of scarce resources it is also about knowing when to intervene in an asset’s life cycle to maximize economic return.

This best practice does not attempt to dictate a rigid set of rules or formulas for dealing with the management of municipal infrastructure. It is not a simple list of operational indicators to be collected by municipalities. Rather, it is meant to provide a conceptual framework, to assist municipalities in developing and incorporating their own indicators, benchmarks and performance measures into their infrastructure planning and decision-making processes.

It is important to note that it is not the intention of this best practice to replace current municipal decision-making processes with one that strictly or slavishly follows the results of indicator analysis. Rather, this best practice provides municipal decision makers, at all levels, with the basics to understand the impact of their infrastructure planning and decision-making process, and to provide them with an additional complementary tool in working toward infrastructure sustainability.

1.2 GLOSSARY

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.

Benchmarking — Measuring performance against a standard of quality (industry sector or technical standard).

Indicator — At its simplest, an indicator is data that identify the condition or state of something being measured. For the purposes of this best practice, there is

a hierarchy of indicators that roughly mirrors the organizational decision-making structure of municipalities (see Figure 2–1). As indicators are aggregated and massaged, they usually combine with related data to form higher levels of indicators, moving from the specific (operational) to more abstract (strategic).

Operational indicators — An operational indicator is generally raw data collected about an infrastructure asset by road or work crews while performing their duties or as part of an asset inventory process. In the case of roads, it will be what is often referred to as “counting cracks.” Operational indicators are often expressed by municipalities as survey results or scorecards. Some indicators can also be a dollar value, expressed as the cost of an individual asset repair.

Functional indicators — Functional indicators result from analyzing different but related operational indicators to obtain an overview of an infrastructure asset’s condition. For example, a number of operational indicators, such as number and types of cracks, smoothness, etc., can be combined to produce an overall pavement quality index (PQI). A functional indicator provides managerial-level municipal decision makers (e.g., city engineer, public works manager) with an overview of an infrastructure asset’s condition, state or value.

Strategic indicators — Strategic indicators are the highest and most abstract type of indicators. They are set and reviewed by the highest level of municipal decision makers. Examples include a measurement of a municipality’s quality of life or meeting an annual infrastructure budget.

Infrastructure —Refers to the physical assets that relate to municipal road, water, wastewater and sewer systems.

Performance measure — A performance measure is an attempt to quantify the success of a best practice in achieving its intended goals or objectives. In the context of municipal infrastructure decision-making support, a performance measure assesses the condition and quality of infrastructure. It can also assess the effectiveness of a particular decision-making process.

2. SCOPE AND FRAMEWORK

2.1 PURPOSE

This framework describes a guide for municipalities in developing and using indicators in support of high-level infrastructure decision making. It also attempts to foster a deeper understanding of the relationship between planning decisions and the state of infrastructure assets.

Canadian municipalities vary considerably in the resources available to them, whether it is financial constraints, staffing issues or varying degrees of technological advancement. Individual constituent elements of this best practice may be found in municipalities, regardless of size and geographic location. It is the intent to provide a framework that allows, to the greatest extent possible, all Canadian municipalities to benefit from this best practice and to participate, to the extent they are able, in developing indicator-based infrastructure decision-making support.

2.2 METHODOLOGY

In creating a methodology that would be useful for municipalities, several considerations became obvious.

First, the people making funding decisions in municipalities often do not have an in-depth understanding of infrastructure engineering considerations. It is therefore important to start by identifying indicators that are meaningful to decision makers.

Level of Indicator	Example
Operational	Number of potholes per kilometre
Tactical	Overall pavement quality index of a particular surface road
Strategic	Backlog value of the infrastructure shortfall (accumulated infrastructure deficit)

There are also different levels of decisions that need to be made when addressing infrastructure planning. For example, the data needed to decide which roadways should be resurfaced during a season are different from the data needed to decide how much of the infrastructure budget should go to road resurfacing. This is again different from the data needed to decide which portion of a municipal budget should be allocated to overall infrastructure maintenance.

The different levels of decisions imply different levels of indicators. For the purposes of this best practice, they have been labelled operational, tactical and strategic. Operational indicators are generally granular data about individual assets that are used to make day-to-day decisions. Tactical indicators concern aggregations of different types of operational indicator data into a “bigger picture” (i.e., overall road condition), and are used to help support decisions made by middle management. Strategic indicators are global assessments of abstract goals or ideals, such as “maintaining an efficient transportation system,”

or a more concrete “reinvesting annually 2% of the replacement value of the infrastructure asset.”

This best practice focuses on indicators and decision making at the tactical and strategic levels. As indicators are aggregated and passed up through each level, there is a value-added element. Raw numbers that are otherwise meaningless to higher-level decision makers begin to take on significance when they are combined with other data. Moving from the specific or micro level to the more abstract or macro view, patterns and relationships emerge that, if interpreted properly, allow decision makers to see the consequences of the different policy, planning and funding decisions open to them.

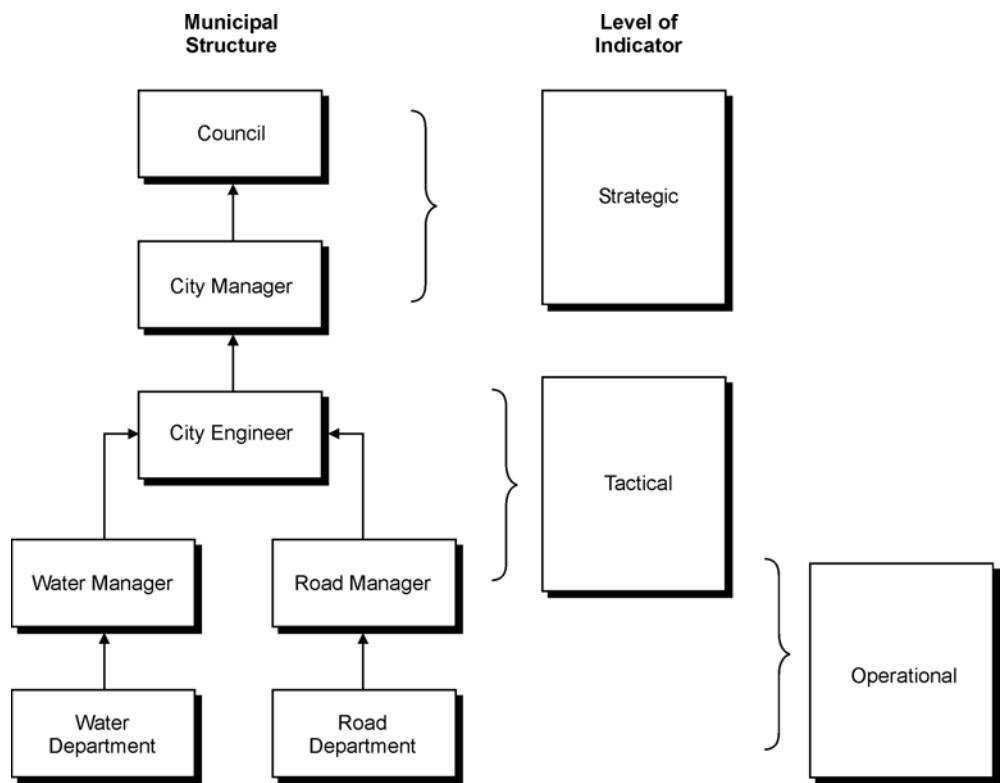


Figure 2–1: Hierarchy of indicators in a typical municipality

3. FIRST PRINCIPLES: CHOOSING INDICATORS

At its simplest, an indicator is a piece of information that provides insight into what you are trying to measure. In the case of municipal infrastructure, it is typically data indicating a condition or state of something being measured.

Indicators provide useful, relevant information to decision makers at all levels, from the operational to the tactical and up to the strategic level of decision making.

To develop and use indicators for decision-making support, several steps are required. The first is the identification of the high-level (strategic/tactical) indicators that would assist your municipality in its infrastructure decision-making process. This consists of determining what you are trying to measure and the information needed to measure it.

In deciding what your municipality would like to measure and track, it is necessary to first determine the goals to be supported by the decision-making process. Common general municipal objectives may include the following.

- Quantify sustainable infrastructure funding requirements.
- Prioritize infrastructure spending from available funds.
- Control costs.
- Foster predictability in the budgeting/spending process, to the extent possible.
- Better understand and manage infrastructure asset life cycles to maximize useful life.
- Determine the optimum time to perform infrastructure asset maintenance to keep it in good repair at the least cost.
- Prevent costly and inconvenient service disruptions due to asset failures.
- Maintain an acceptable level of public safety.
- Maintain an acceptable level of public satisfaction.
- Meet levels of service including those legislatively mandated.

- Meet accountability requirements of funding partners (e.g., federal or provincial infrastructure cost-sharing programs that mandate minimum conditions to be maintained).
- Be accountable to the general public.

These objectives vary considerably in their complexity and, therefore, in the ease by which they can be measured. For example, maintaining an acceptable level of public satisfaction might be measured by counting the number of complaints received about a particular stretch of roadway. Quantifying sustainable infrastructure funding requirements is a higher-level goal requiring the collection and analysis of more indicators and data elements, both simple and sophisticated.

For example, if the goal is to prevent costly and inconvenient service disruptions due to asset failures, a municipality may choose from among operational, tactical or strategic indicators sampled below.

- Operational:
 - number of breaks per kilometre of water pipeline,
 - average time it took to repair the break;
- Tactical:
 - total number of system outages,
 - lost revenue; or
- Strategic:
 - percentage of reinvestment compared to value of system,
 - needs versus budget.

Although these are only a few examples, the concept is clear: identify what you are trying to measure, and then define the necessary indicators.

Determining the usefulness of indicators is a constant, iterative process. If an indicator is too difficult or onerous, or does not produce useful or coherent information, it should be revised or eliminated. Many municipalities initially choose far too many indicators, resulting in data overload and frustration.

In choosing indicators, care should be taken to ensure they are:

- **Manageable:** Is the level of detail sufficient to provide the necessary information? There is a fine balance between not enough data to be analyzed and too much. Quality, not quantity is vital.
- **Relevant:** Do the selected indicators actually measure what is intended? That measurement must have a relationship to the intended outcome.

- **Meaningful:** At the end of the day, does the indicator tell you something? It should fit into the larger picture. If it does not, it should be changed or abandoned.
- **Measurable/quantifiable:** Can the indicator be easily measured? Indicators that cannot be easily or empirically measured will elude meaningful analysis.
- **Well-defined:** Has the indicator been clearly defined? Shifting or unclear definitions will introduce a level of inconsistency that will reduce the reliability of the indicators and, ultimately, result in a loss of confidence in them. Indicators should facilitate comparisons among similar assets and from year to year.
- **Aligned with objectives:** Have objectives been met? Indicators should be developed in those areas that are essential to the stated high-level objectives of the decision makers. Indicators should relate back to the achievement of strategic municipal objectives. In addition, indicators should be repeatable and be prone to tracking over time.

It is important for municipalities to revisit their indicator selection regularly to see if they are actually meeting municipal needs and producing useful information to support decision making. Indicators are dynamic and will shift as circumstances and priorities change.

4. DATA COLLECTION

While raw data collection can be identified as functioning at an operational indicator level and outside the scope of this best practice, it is the essential underpinning of higher-level functional indicators.

After clearly defining objectives and identifying the information that is useful and relevant for high-level decision making, municipalities need to proceed with the indicator data collection.

Almost all Canadian municipalities collect data in varying levels of detail about their infrastructure assets. These typically include:

- **Asset inventory:** This includes the extent and nature of a municipality's road, water, sewer and storm drainage systems, looking at physical location, age and material composition. If a complete inventory is not available, it is possible to proceed with partial or representative assets until more information is available.
- **Estimated current and replacement value of the infrastructure asset.**
- **Assessments of current asset condition:** Condition assessment must be regularly updated, as infrastructure assets change over time.
- **Historical repair and work history data.**
- **Repair and replacement cost data.**
- **Budget allocations.**

Most municipalities already collect much of the data to be used as indicators. The first step then becomes identifying the data already available. This should be a municipality-wide search, as useful data can often be found in other departments. For example, many municipalities already have valuable information concerning their asset inventory, replacement values, repair and replacement histories, repair cost data, public complaints and claims for damages or personal injury.

After a review of a municipality's existing and available data, it is then possible to identify gaps between the data needed for the selected indicators and the data currently available. Once the gaps have been identified, a decision can be made to either collect the additional data or amend the indicator.

If collecting the information is too onerous or, once collected, the data turn out to be incomplete, analysis for decision-making support can begin with available data, and progress as more data become available.

A municipality's data collection process should be optimized to capture supporting data on a continuous basis. As part of this best practice, indicator data capture can be optimized in several ways.

- If possible, data collection should be an integral part of a municipality's day-to-day operational activities. This is true whether the operational activities are done internally by municipal employees in the regular performance of their duties or externally by contract consultants or operators.
- Every contact with infrastructure assets should be treated as an opportunity to capture useful information.
- Co-ordinate with other municipal departments and other external interested entities to optimize data collection (e.g., gas, hydro, cable, fiber optic, telephone).

Making the most of every opportunity can greatly reduce the cost of data collection. Alternately, some municipalities engage an outside contractor to create an initial or base asset inventory.

5. INFORMATION MANAGEMENT

An information management system to contain and make data available for analysis is recommended as part of this framework. This recommendation does not necessarily require municipalities to invest in large, complex or expensive computer systems. Systems or tools should, however, be appropriate to the context of the municipality's needs and resources.

It is important to recognize that data collection is only the beginning of decision-making support. If decision makers are to benefit, the data must be brought together in a way that is useful and easy to understand.

It is also important that municipalities identify a data solution that meets their current (and future) indicator and data management needs and which they have the ability to maintain. At the lowest level, this may include manual systems, such as maps, index cards or spreadsheets. More complex systems may require databases, maintenance management systems (MMS), asset management applications and business intelligence software. A number of software vendors supply municipal infrastructure-specific information and analysis tools.

If a municipality is just beginning to use tools to manage indicators, it should start with mid- to high-level infrastructure indicators. This includes estimated asset inventory and age. The municipality could then continue to develop and expand the system as more data are collected and made available.

Regardless, it is important to select data standards that permit the uniform collection, inputting and sharing of infrastructure data. Uniform data collection and recording methods are necessary to allow for effective and reliable analyses.

When selecting tools or systems, certain functional issues must be considered. An infrastructure information management system should permit collected data to be:

- entered closest to source and stored in one location;
- easily retrieved and shared throughout the municipal government;
- analyzed for cost comparisons;
- weighted to accommodate different or changing priorities;
- aggregated to provide an overall condition assessment for portions of or the entire system;

- analyzed to show change in overall condition over time, including future projections;
- analyzed for life cycle trends and deterioration curves; and
- linked to the budget process.

While indicators, by definition, convey information about, or insight into, the condition or state of an infrastructure asset, sometimes this insight is not immediately obvious. There are volumes of scientific and engineering studies devoted to infrastructure asset behaviour and life cycles. This rich and ongoing field of study attempts to interpret indicator data to guide asset managers in their evaluation and maintenance of infrastructure.

Tools to manage indicators frequently incorporate features to allow asset managers to do trend analysis and analyze data collected. They allow data to be mapped automatically to indicators and budgetary needs, and assist in the funding or planning process by anticipating future needs through projections of asset deterioration and costs.

Although information management systems are designed to contain and sometimes assist in the analysis of indicator data, indicator-supported decision making depends, ultimately, on committed human resources. To ensure the successful deployment of data collection and indicator support, several things are necessary within the municipality.

- Ensure the importance and relevance of infrastructure-indicator collection are understood and valued throughout the municipal government.
- Integrate data collection and indicator-development support into operational activity wherever possible.
- Train staff to manage data collection, input and analyses.
- If warranted and resources permit, hire dedicated staff to manage the indicator data.

Finally, the purpose of any information management system is its ability to convey useful and understandable information to the various levels of decision makers within the municipality. This includes the tactical decision makers (e.g., engineering or public works managers with a knowledge of engineering and asset management issues), as well as strategic decision makers, who do not have the same level of technical knowledge but make critical infrastructure funding and planning decisions.

The results of indicator analysis must be regularly shared with decision makers, so they can better understand the options open to them and the consequences of the decisions they have to make. Sharing is also part of the iterative process to determine whether the indicators are providing decision-making support (i.e., whether the right things are being measured, and whether the results provide valuable guidance).

6. INDICATORS AS DECISION-MAKING SUPPORT

Indicators are only as useful as the information and decision-making support they provide. They are a means to an end — the end being the effective management of assets to provide maximum life and value in a cost-effective manner. They are not an end in themselves.

Several features are common to many Canadian municipalities working toward indicator-supported decision making. In general, the indicators used by a municipality should support the following.

- **Create infrastructure budgets based on projected needs.** In an ideal world, infrastructure should be funded based on demonstrated need. Need should drive funding. In such a case, indicators would support a budgeting process to establish actual need. Unfortunately, few Canadian municipalities have the financial resources to meet their current infrastructure funding needs. Regardless, the establishment of overall infrastructure funding needs is a useful and valuable benchmark even in the absence of the funds required to do the actual work. As a benchmark, a municipality can compare resources against actual needs as a high-level indicator of its accumulated infrastructure funding deficit. It is significant to know, for example, that a municipality is only able to fund 60 percent of its actual need demonstrated by an analysis of indicator data.
- **Prioritize infrastructure projects based on available funds.** This has become the common funding model for most municipalities. In the face of limited or frozen infrastructure budgets, most municipalities work backward from the available funds. Infrastructure spending is frequently allocated based on a determination of which projects require immediate attention. Instead of resorting to an inefficient “worst first” model of funding, the use of indicators assists in making intelligent planning decisions by determining priorities for the most effective use of limited financial resources.
- **Assess the reasonableness of individual infrastructure project costs.** Cost indicators facilitate the easy comparison of project costs as a check on spending and to justify budgets.
- **Show the relationship between overall asset condition and funding levels.** Decision makers need to see the correlation between funding and asset condition or deterioration. Tactical indicators, such as pavement quality indices, attempt to quantify overall condition, which can be monitored from year to year to see the effect of budgetary neglect. Relationships can also emerge through trend analysis to discover if relatively small infrastructure investments can have a significant effect on overall asset quality. Conversely,

it may also be true that significant funding may not have an appreciable effect on a particular infrastructure asset, and the funds might be better spent elsewhere.

- **Develop multiple “what if” scenarios based on different priorities, backlog levels and funding levels.** Municipal infrastructure decision making has become an exercise in choosing among various pressing needs. It is important for decision makers to model or predict the effect of different funding scenarios. As above, funding decisions may not have the expected or intended results; relatively small investments may have large returns, while large ones may not carry great benefit. In making difficult choices, indicator-based modelling can allow decision makers to adjust spending priorities to see the possible outcomes. Adjusting variables, such as percentage reinvestment or percentage backlog, allows decision makers to see the short- and long-term consequences of these choices, and adjust their planning accordingly.
- **Evaluate infrastructure life cycle trends.** Better understanding of asset life cycles and deterioration is an important tool in extending the useful life of assets. An analysis of historical indicator data can provide valuable information regarding the optimal time to invest in infrastructure maintenance to extend useful life at the lowest cost.
- **Conduct a year-to-year budget review.** Indicators assist in providing a clear picture of the accuracy and effectiveness of the budgeting process by allowing for the direct comparison of each year’s spending priorities. An example is the percentage of accomplishment illustrated by the actual financial performance versus the budgeted allocation.
- **Review current municipal practices, priorities and work methods.** As part of a municipality’s continual goal of self-improvement in its efficiencies and business processes, indicators permit the determination of the decisions or solutions that have proven the most effective. Indicators can show whether municipal funding priorities are being met, or whether changes in priorities will yield better results.
- **Exchange information and make comparisons with other municipalities.** While local conditions may make some direct comparisons difficult, the experience of other municipalities in managing their infrastructure assets may provide decision makers with important additional information or possible innovation. Indicators that facilitate easy comparison increase the possibility of benefiting from another municipality’s infrastructure planning experience. An example is the Ontario Municipal Benchmarking Initiative (OMBI) by which a set of consistent and comparable indicators is being developed for Ontario municipalities.

- **Tie into a GIS and other municipal information systems.** Indicators should be seen as integral to a geographical information system (GIS) and other municipal information systems. Sharing data among these systems allows for the greatest possible use of the data throughout the municipality.

It is important to note that the use of indicators is not intended as a substitute for exercising judgment in infrastructure decision making, but is intended as a tool to assist in the decision-making process.

7. CHALLENGES (REAL AND PERCEIVED)

Indicators are becoming increasingly recognized as an important tool in understanding municipal infrastructure conditions and needs. There is an overwhelming trend among Canadian municipalities toward indicator-supported infrastructure planning and decision making.

In the implementation of this best practice, some municipalities may face potential challenges. These could include:

- the real and perceived complexity of indicator development and use;
- the cost, in both human resources and data management systems;
- encouraging engineering/public works departments to see the value of indicator development and use;
- encouraging senior municipal decision makers to understand the value of indicator development and use;
- the widely disparate states of readiness found in Canadian municipalities;
- institutional resistance requiring an adjustment in corporate culture and attitudes;
- recognizing that one size does not fit all, and any system will have to be tailored to meet the individual needs and priorities of the municipality;
- maintaining reasonable expectations (there are no “silver bullets”);
- the difficulty in quantifying immediate economic benefit to the municipality;
- making the data understandable, relevant, useful and valuable to the elected level of municipal government;
- securing commitment to the value of indicator development by engineering/public works departments;
- concern that a review of the data will show the unpleasant reality of the consequences of years of infrastructure underfunding; and
- identifying financing options and alternatives (see best practice for Alternative Funding Mechanisms).

As municipalities that work with indicators have learned, most of these challenges are more perceived than real. Decision makers are grateful for the improved articulation and conveyance of municipal infrastructure needs, and the ability to see the consequences of their decisions. As planning becomes a balancing of priorities with the allocation of scarce financial resources, decision makers are conscious of the impact of poor funding choices. Conversely, engineering and public works departments are happy to be able to quantify their infrastructure needs and justify their spending priorities through empirical, understandable data.

Properly implemented, indicators are an attempt to solve the problem best expressed as “you cannot manage what you do not know.” They also attempt to create a decision-making process based less on personal (although professional) experience of a municipality’s infrastructure assets, and more on measurable conditions and results. This gives decision makers the ability to see more clearly the consequences of their decisions and avoid the many pitfalls that result from making funding decisions with an incomplete understanding of their infrastructure assets and needs.