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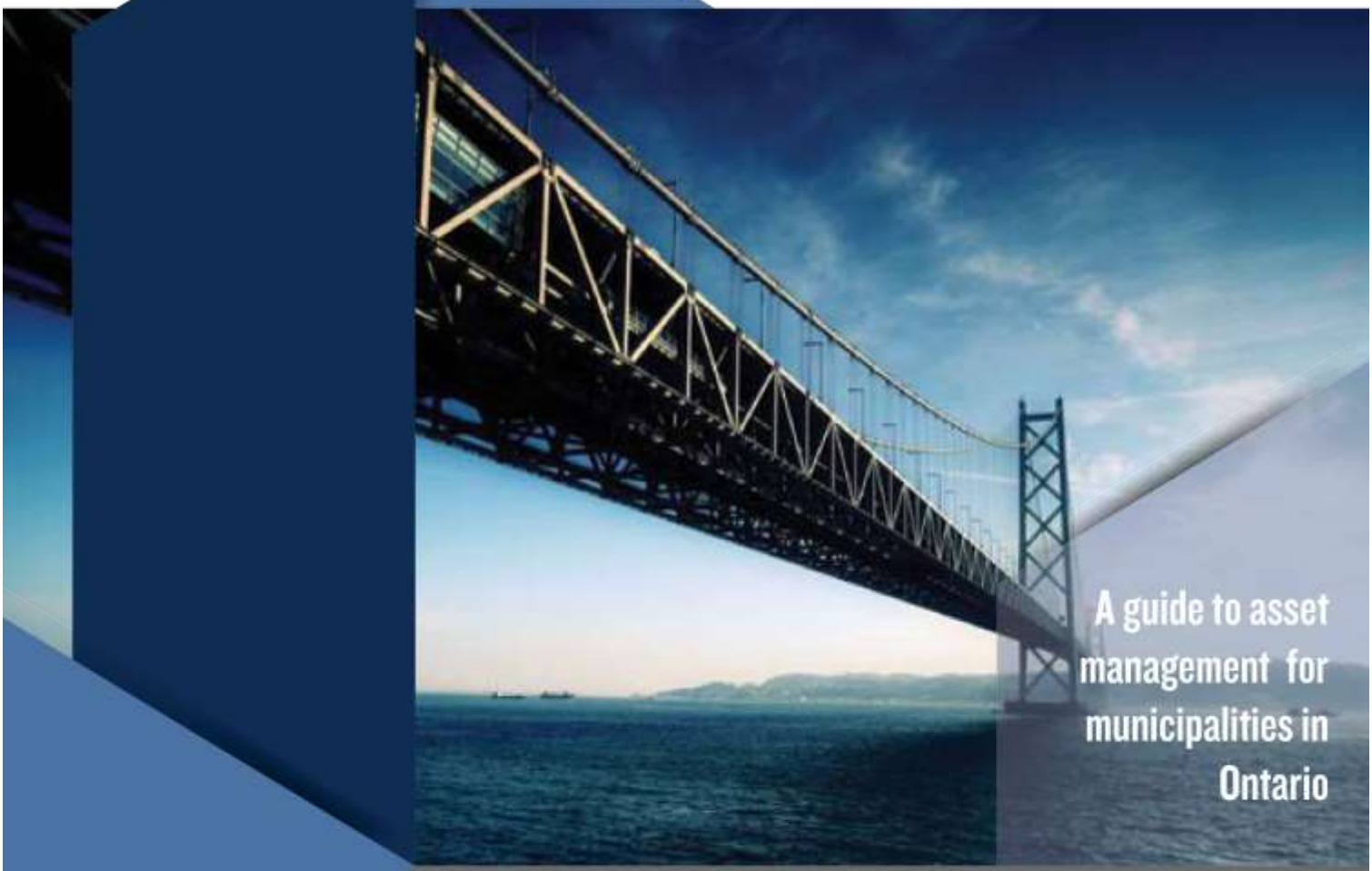


A guide to asset management for municipalities in Ontario

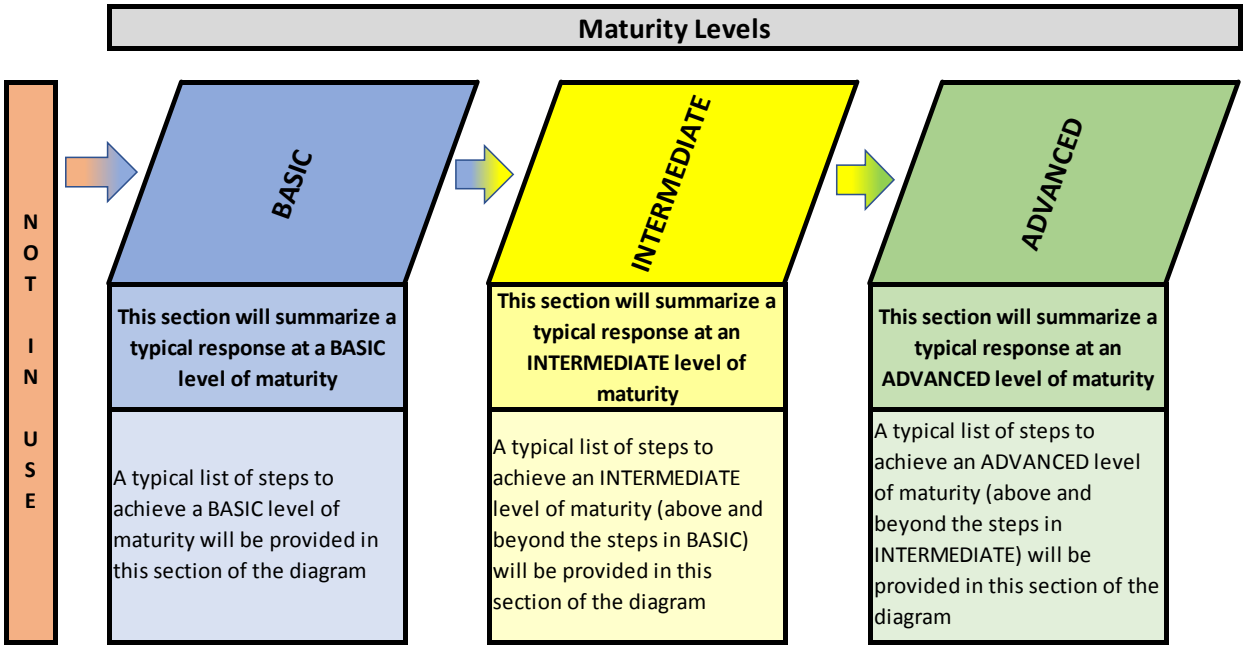
ASSET MANAGEMENT FRAMEWORK

This publication was made possible through funding from the Province of Ontario, MFOA and its members

5 Lifecycle Management Strategy

5.1 Using this Framework

This framework is intended for municipalities of all sizes and maturity levels. The use of the maturity diagrams within this framework can help municipalities identify their current levels of maturity for each AM area. In addition, the diagrams provide possible approaches for municipalities to undertake in order to move to a higher level of maturity over time. Adaptations of the following diagram are used throughout this document to summarize maturity levels according to the themes and questions explored in each chapter:



This document is intended to help municipalities make progress on their asset management planning. By enhancing the readers' understanding of asset management maturity, they can more accurately determine their current, and work toward achieving the desired or appropriate, level of maturity for their municipality.

The asset management framework can be likened to a continuum, whereby municipalities should aim to implement the components described in a subsequent maturity level. For example, municipalities that are not practicing asset management should strive to meet components at the *basic level*, and likewise, municipalities that currently meet the *basic* or *intermediate* levels should strive to advance their practices to meet the components of the next level. However, it should be noted that during this

self-assessment process a municipality may decide to skip over maturity levels (i.e. move from basic to advanced, skipping intermediate). This is perfectly acceptable. Further, not every municipality will need to strive for the highest level of maturity in every area. For example, it may not make sense for a small municipality to meet certain advanced level components.

Readers can use the following descriptions of the maturity levels to guide their assessment throughout the various sections of this framework:

Municipalities that are not undertaking the components described in a particular section of this framework should focus on meeting the *basic leve*l requirements outlined in the maturity level diagram.

At the **basic level of maturity**, a municipality is undertaking the components of asset management shown in blue and will take steps to advance their asset management by implementing the components described under the *intermediate level* heading.

At the **intermediate level of maturity**, a municipality is currently meeting the requirements shown in yellow and to advance their asset management will take steps to implement the components described under the *advanced level* heading.

At the **advanced level of maturity**, a municipality is currently meeting the requirements shown in green.

These maturity framework visuals are found throughout this document. Preceding all maturity level diagrams is a self-assessment question for the reader to consider to help determine where their municipality best fits within the framework.

5.2 Overview

The Ontario “Building Together Guide for Municipal Asset Management Plans” defines an asset management strategy as:

> *The set of planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest lifecycle cost.*

Moving forward, the “asset management strategy” will be referred to as the “lifecycle management strategy”, which provides a more accurate description of the requirements in this section. The actions defined and identified within the lifecycle management

strategy detail how assets should be maintained, renewed/rehabilitated, replaced, disposed, or expanded upon. All strategies considered will attempt to move the municipality towards expected levels of service in an efficient and effective manner.

Lifecycle Costing

Lifecycle costing is defined by IIMM as:

> *The total cost of an asset throughout its life including planning, design, construction, acquisition, operation, maintenance, rehabilitation and disposal costs.*

A "lifecycle management approach" in asset management planning not only includes estimating future lifecycle costs, but also an overview of how the asset performs over its life while providing affordable services. This is a more holistic perspective than the consideration of cost projections alone.

Within this is the true challenge of public infrastructure management which is:

> *To ensure that the assets we have now and those that will be created in the future provide suitable levels of service at a cost the community can afford.*

Lifecycle costing is comprised of the following costs over an asset's useful life:

- Acquisition or construction;
- Operating;
- Maintaining;
- Rehabilitating;
- Replacing;
- Disposing; and
- Non-infrastructure solutions.

All of the cost elements above should be considered when determining the true cost of an asset over its useful life. The resulting cost profile may look something like the following figure.

Figure 5-1
Sample Asset Cost Profile

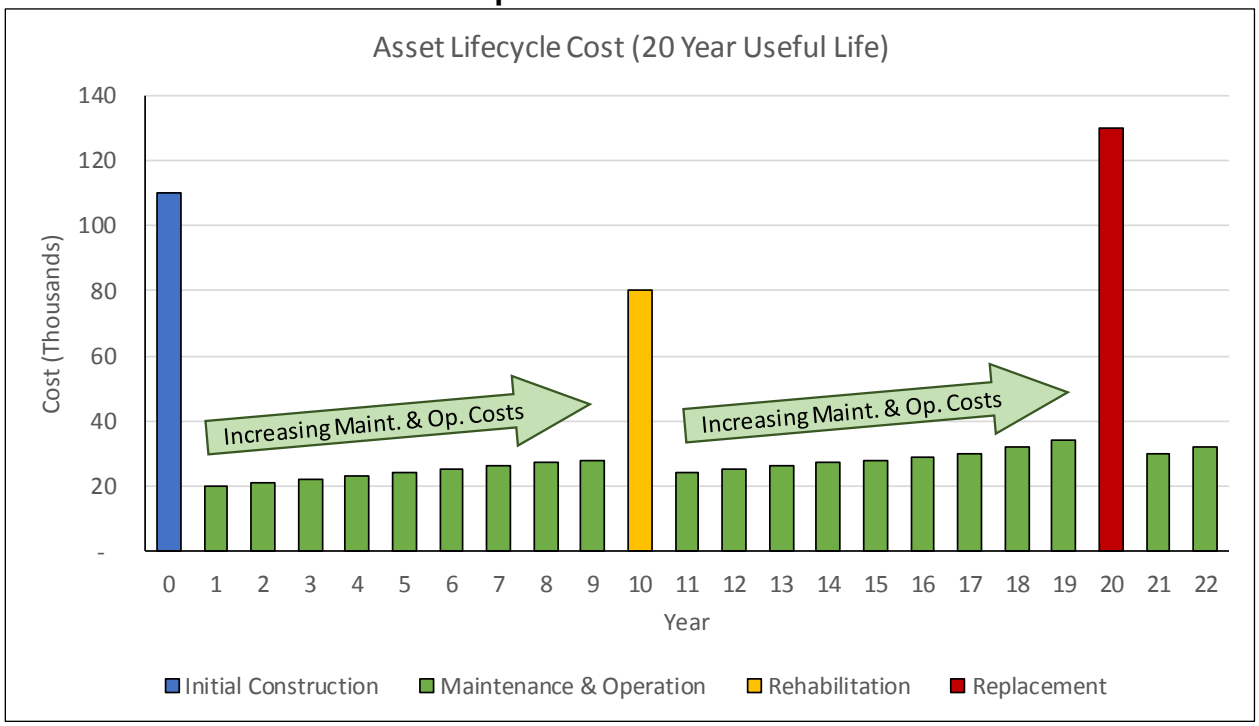


Figure 5-1 (above) illustrates:

- Initial construction of the asset occurs in year 0;
- Maintenance and operational costs are incurred annually, increasing as the asset deteriorates (from year 1 to 9);
- Rehabilitation of the asset is shown in year 10, which has the result of extending the remaining useful life of the asset and reducing annual maintenance and operational costs;
- Maintenance and operational costs are incurred annually, increasing as the asset deteriorates (from year 11 to 19);
- Complete asset replacement occurs in year 20; and
- Annual maintenance and operational costs continue forward on the new asset.

Maintenance and other interventions undertaken to sustain asset integrity and service levels occur over the life of an asset (as illustrated in Figure 5-1). Over time, these costs can outweigh the initial cost of the asset. The lifecycle management strategy helps municipalities plan for these maintenance costs over a forecast period. Because the majority of assets currently managed by a municipality are already part way through their lifecycle, the task of planning for lifecycle costs over a shortened lifecycle period can become difficult.

Using the example in Figure 5-1 (above), the existing asset could be at any point along the "time" axis, regardless of its actually age. The asset's location on the time axis can be determined by an understanding of its behaviour as well as an interpretation of data, such as condition assessments. Age alone is not an accurate indicator of an asset's position in its lifecycle. The timescale in the Figure 5-1 is based on an "estimated useful life" and assumes certain interventions such as maintenance and rehabilitation. This underscores why condition assessments play a key role in the lifecycle analysis. Assets will deteriorate faster or slower than expected depending on whether the asset is maintained. The condition assessment information provides a more accurate indication of lifecycle needs.

Asset managers strive to achieve the lowest lifecycle cost for all assets. The example described above provides an indication of the total lifecycle cost by summing all annual costs over the asset's life. Comparing alternative lifecycle scenarios, such as alternative interventions and frequencies, allows municipalities to experiment with the impact of differing lifecycle forecasts on the assets themselves and the services being provided. This methodology will be expanded upon further in later sections within this chapter.

Infrastructure for Jobs and Prosperity (IJPA) Act and O. Reg 588/17 Requirements

O.Reg 588/17 outlines the following requirements with respect to the Lifecycle Management Strategy:

Every municipality shall prepare an asset management plan in respect of its core municipal infrastructure assets by *July 1, 2021*, and in respect of all of its other municipal infrastructure assets by *July 1, 2023*.

A municipality's AM plan must include the following (for each asset category):

a) The lifecycle activities that would need to be undertaken to maintain the current levels of service for each of the 10 years following the year for which the current levels of service are determined and the costs of providing those activities based on an assessment of the following:
    i. The full lifecycle of the assets.
    ii. The options for which lifecycle activities could potentially be undertaken to maintain the current levels of service.
    iii. The risks associated with the options referred to in subparagraph ii.
    iv. The lifecycle activities referred to in subparagraph ii that can be undertaken for the lowest cost to maintain the current levels of service.

b) For municipalities with a population of less than 25,000, as reported by Statistics Canada in the most recent official census, the following:
    i. A description of assumptions regarding future changes in population or economic activity.
    ii. How the assumptions referred to in subparagraph i relate to the required lifecycle activities described above.

c) For municipalities with a population of 25,000 or more, as reported by Statistics Canada in the most recent official census, the following:
    i. With respect to municipalities in the Greater Golden Horseshoe growth plan area, if the population and employment forecasts for the municipality are set out in Schedule 3 or 7 to the 2017 Growth Plan, those forecasts.
    ii. With respect to lower-tier municipalities in the Greater Golden Horseshoe growth plan area, if the population and employment forecasts for the municipality are not set out in Schedule 7 to the 2017 Growth Plan, the portion of the forecasts allocated to the lower-tier municipality in the official plan of the upper-tier municipality of which it is a part.
    iii. With respect to upper-tier municipalities or single-tier municipalities outside of the Greater Golden Horseshoe growth plan area, the population and employment forecasts for the municipality that are set out in its official plan.
    iv. With respect to lower-tier municipalities outside of the Greater Golden Horseshoe growth plan area, the population and employment forecasts for the lower-tier municipality that are set out in the official plan of the upper-tier municipality of which it is a part.
    v. If, with respect to any municipality referred to in subparagraph iii or iv, the population and employment forecasts for the municipality cannot be determined as set out in those subparagraphs, a description of assumptions regarding future changes in population or economic activity.
    vi. For each of the 10 years following the year for which the current levels of service are determined, the estimated capital expenditures and significant operating costs related to the lifecycle activities required to maintain the current levels of service in order to accommodate projected increases in demand caused by growth, including estimated capital expenditures and significant operating costs related to new construction or to upgrading of existing municipal infrastructure assets.

By *July 1, 2024*, every asset management plan must include the following additional information:

a) A lifecycle management and financial strategy that sets out the following information with respect to the assets in each asset category for the 10-year period:
    i. An identification of the lifecycle activities that would need to be undertaken to provide the proposed levels of service described in paragraph 1, based on an assessment of the following:
        A. The full lifecycle of the assets.
        B. The options for which lifecycle activities could potentially be undertaken to achieve the proposed levels of service.
        C. The risks associated with the options referred to in sub-subparagraph B.
        D. The lifecycle activities referred to in sub-subparagraph B that can be undertaken for the lowest cost to achieve the proposed levels of service.
    ii. An estimate of the annual costs for each of the 10 years of undertaking the lifecycle activities identified in subparagraph i, separated into capital expenditures and significant operating costs.
    iii. An identification of the annual funding projected to be available to undertake lifecycle activities and an explanation of the options examined by the municipality to maximize the funding projected to be available.
    iv. If, based on the funding projected to be available, the municipality identifies a funding shortfall for the lifecycle activities identified in subparagraph i,
        A. an identification of the lifecycle activities, whether set out in subparagraph i or otherwise, that the municipality will undertake, and
        B. if applicable, an explanation of how the municipality will manage the risks associated with not undertaking any of the lifecycle activities identified in subparagraph i.

b) For municipalities with a population of less than 25,000, as reported by Statistics Canada in the most recent official census, a discussion of how the assumptions regarding future changes in population and economic activity informed the preparation of the lifecycle management and financial strategy.

c) For municipalities with a population of 25,000 or more, as reported by Statistics Canada in the most recent official census,
   i. the estimated capital expenditures and significant operating costs to achieve the proposed levels of service as described in paragraph 1 in order to accommodate projected increases in demand caused by population and employment growth, as set out in the forecasts or assumptions referred to in paragraph 6 of subsection 5 (2), including estimated capital expenditures and significant operating costs related to new construction or to upgrading of existing municipal infrastructure assets,
   ii. the funding projected to be available, by source, as a result of increased population and economic activity, and
   iii. an overview of the risks associated with implementation of the asset management plan and any actions that would be proposed in response to those risks.

5.3 Non-Infrastructure Solutions – Introduction

Incorporating non-infrastructure solutions, such as demand management and integrated infrastructure planning, into the lifecycle management strategy can introduce cost efficiencies and/or extend asset useful life.

To what extent are non-infrastructure solutions incorporated into the lifecycle management strategy?

Background

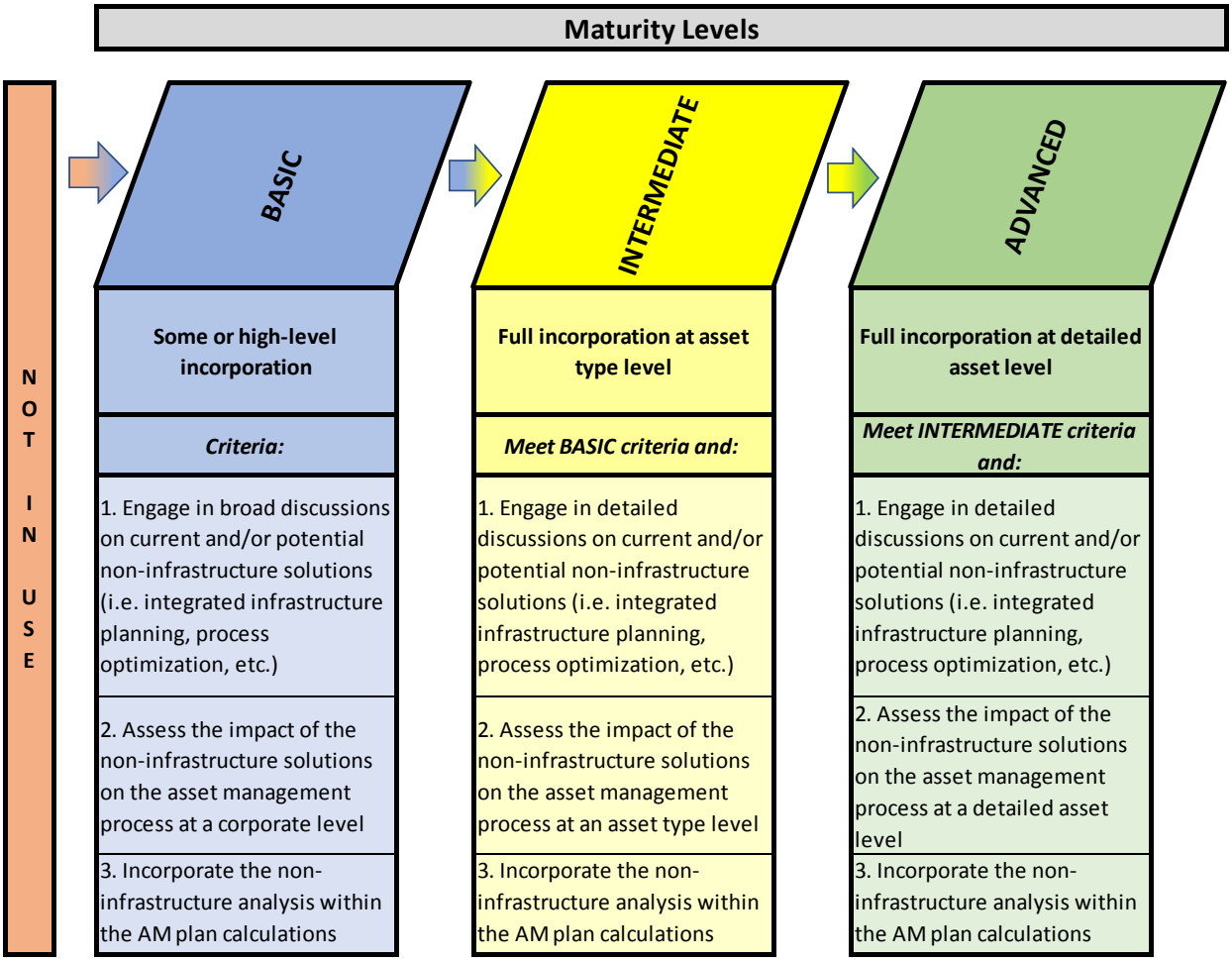
Cost reduction is a consistent driver across most municipalities, and the same is true for asset management. Investment in municipal assets is subject to limited funding, so if the same outcome can be produced at a lower cost, more can be done with the funding

that is available. At the same time, care must be taken to ensure that a cost reduction today does not result in a cost escalation in the future.

Non-infrastructure solutions are actions or policies that are not capital in nature, which result in the lowering of costs and/or extend the useful life of an asset.

Levels of Maturity

To what extent are non-infrastructure solutions incorporated into the lifecycle management strategy?



At the **basic level of maturity**, non-infrastructure solutions are incorporated into the lifecycle management strategy to some extent. Municipalities may engage in broad discussions on current and/or potential non-infrastructure solutions. The impact of these solutions on the asset management process would be assessed at a corporate level. Finally, the non-infrastructure analysis are incorporated within the asset management plan calculations.

At the **intermediate level of maturity**, non-infrastructure solutions are incorporated fully into the lifecycle management strategy at the asset level. Municipalities may engage in detailed discussions on current and/or potential non-infrastructure solutions. The impact of these solutions on the asset management process is assessed at an asset level. Finally, the non-infrastructure analysis is incorporated within the asset management plan calculations.

At the **advanced level of maturity**, non-infrastructure solutions are incorporated fully into the lifecycle management strategy at a detailed asset level. Municipalities may engage in detailed discussions on current and/or potential non-infrastructure solutions. The impact of these solutions on the asset management process is assessed at a detailed asset level. Finally, the non-infrastructure analysis is incorporated within the asset management plan calculations.

Non-Infrastructure Solutions Introduction

Non-infrastructure solutions include policies, processes, or strategies that:

- Reduce asset related costs (i.e. operating, maintaining, rehabilitation, replacement, expansion); and/or
- Improve asset performance (resulting in lower costs and/or extended life).

Achieving cost reduction can come down to effective and efficient non-infrastructure solutions for asset management:

- Effectiveness involves “doing what should be done”, in terms of policies, processes, or strategies. This can come from best practices, legislation, or direction provided by policy, process, or strategy.
- Efficiency involves utilizing the policies, processes, and strategies in the best possible way.

Examples of non-infrastructure solutions include:

Table 5-1
Sample Non-Infrastructure Solutions

Solution	Example
Integrated Infrastructure Planning	Layering road, water, wastewater, and stormwater capital forecasts together. This ensures newly paved roads don’t have to be dug up for main replacements.
Land Use Planning	Manage the development of land within the municipality, ensuring an efficient use of land and the efficient construction of assets.

Solution	Example
Demand Management	Manage and forecast the demand for services within the municipality (e.g. introduce HOV lanes, offer discounts for using facilities at non-peak hours, etc.). Prepare a Development Charge Background Study to manage growth.
Insurance	Minimize unforeseen and uncontrollable asset costs through the use of insurance policies.
Process Optimization	Optimization of asset management related processes, such as "levels of service impacts" and "determining a capital forecast". Optimizing these processes not only minimizes the time and resources required to complete them, but also generates more accurate and "real time" results. Undertake Water/Wastewater/Storm Rate Study.
Managed Failures	Use of asset condition, risk assessments, and levels of service to manage and plan for where assets are "allowed" to fail, allowing available funds to be used in more critical areas.
Procurement Policies	Streamline purchasing policies/by-law to increase the receipt of competitive bids for asset purchase or construction, including the ability to tender for "build/own/operate" agreements or "public private partnerships". Streamlined purchasing policies assists municipalities in getting more for the funding that is available (i.e. pave 5 km of roads per year rather than 4 km, for the same price, given the competitive bid environment).

Non-infrastructure solutions can be implemented at a high (corporate) level, at the asset type level, or at the detailed asset level. The level at which the solutions are implemented depends on the municipality's level of asset management maturity as well as the type of solution being implemented. Examples of non-infrastructure solutions are shown in Table 5-2 (below):

Table 5-2
Non-Infrastructure Solutions Implementation Levels

Maturity Level	Implementation Level	Non-Infrastructure Solution Example
Basic	Corporate (High Level)	Strategic Plan (asset management section), outlining corporate mission, goals, and action items from an asset management perspective.
Intermediate	Asset Type Level	Setting an enhanced procurement policy specifically for roads-related projects.
Advanced	Detailed Asset Level	Asset Condition/Needs Study outlining specific actions by detailed asset, asset segment, or asset component.

5.4 Non-Infrastructure Solutions – Approach

Detailed consideration of non-infrastructure solutions within the lifecycle management strategy can help municipalities accurately estimate the benefits and costs associated with these solutions.

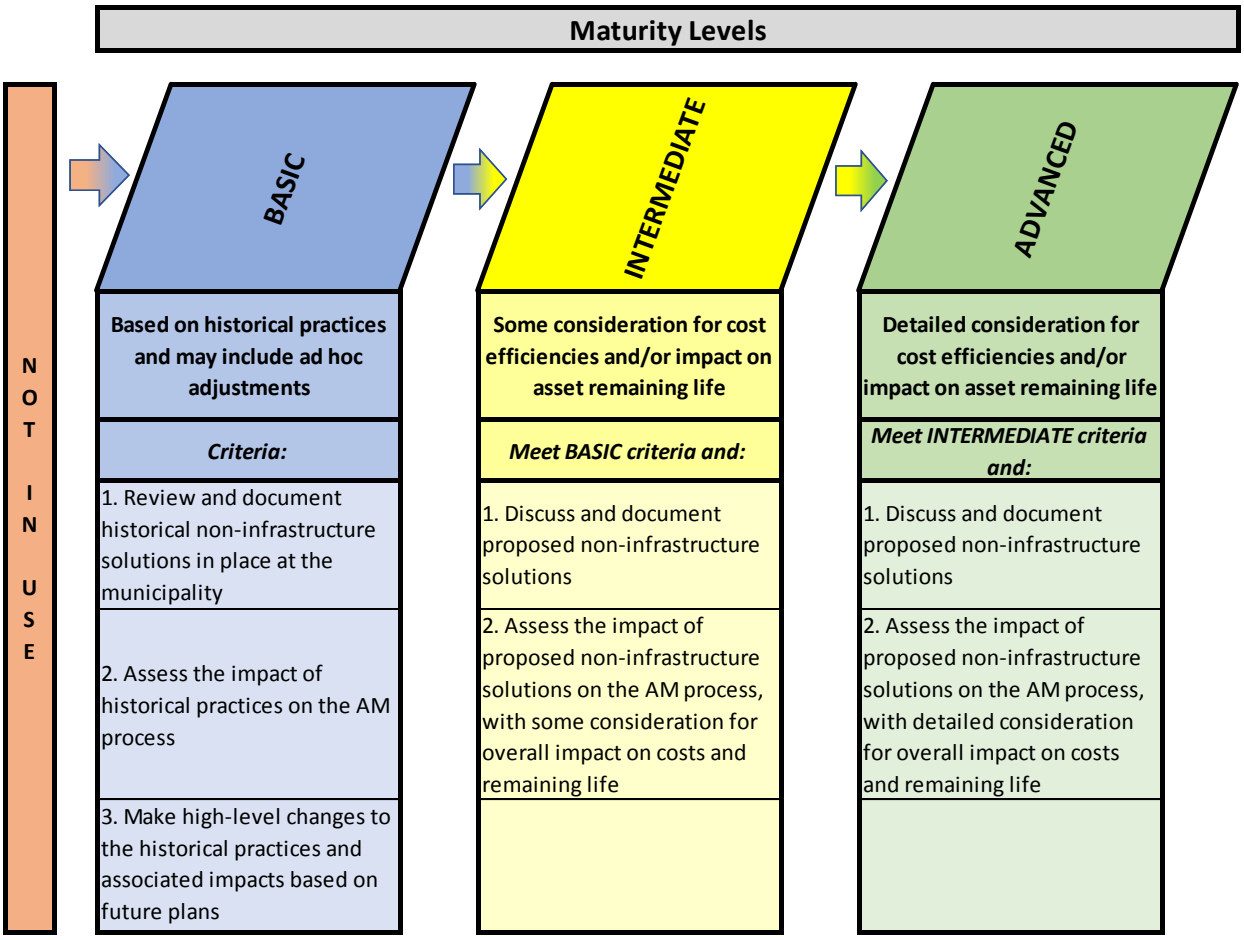
What method is used to incorporate non-infrastructure solutions into the lifecycle management strategy?

Background

Non-infrastructure solutions may be incorporated into the lifecycle management strategy based on past historical practices or a more forward-looking approach where consideration of cost efficiencies and/or impact on asset remaining life is factored into the chosen solution(s).

Levels of Maturity

What method is used to incorporate non-infrastructure solutions into the lifecycle management strategy?



At the **basic level of maturity**, municipalities will review and document historical non-infrastructure solutions that are in place. Municipalities will tend to incorporate non-infrastructure solutions into the lifecycle management strategy based on historical practices and may include subsequent ad hoc adjustments based on expected revisions to historical practices. The impact of these practices on the asset management process are assessed.

At the **intermediate level of maturity**, municipalities give some consideration to the impact of non-infrastructure solutions on cost efficiencies and/or impact on asset remaining life. Proposed non-infrastructure solutions are discussed and documented at a staff level. The impact of these solutions on the asset management process are assessed, with some consideration for the overall impact on costs and remaining life.

At the **advanced level of maturity**, municipalities give detailed consideration for cost efficiencies and/or impact on asset remaining life within a comprehensive non-infrastructure solutions analysis. Proposed non-infrastructure solutions are discussed and documented within this analysis. The impact of these solutions on the asset

management process is assessed, with detailed consideration for the overall impact on asset-related costs and remaining life.

Non-Infrastructure Solutions Methodology

Section 5-3 (above) introduced non-infrastructure solutions with the following examples:

- Integrated infrastructure planning;
- Land use planning;
- Demand management;
- Effective use of insurance;
- Process optimization;
- Managed asset failures; and
- Procurement policies.

This section discusses the process and methods of incorporating non-infrastructure solutions into the asset management planning process. There are two impacts of non-infrastructure solutions for municipalities to consider:

1. Projecting the cost of implementing the non-infrastructure solution; and
2. Projecting the cost savings or extended asset life due to implementing the non-infrastructure solution.

Table 5-3 (below) provides examples of how non-infrastructure solutions can be summarized from cost and savings perspectives.

From a cost perspective, many non-infrastructure solutions will have ongoing and/or periodic costs throughout a forecast period, such as study or staff costs to implement integrated infrastructure planning or process optimization. If these costs are required every few years then the long-term forecast should reflect this need.

From a savings or asset life perspective, an estimation of the potential savings of each non-infrastructure solution is needed. This could be a one-time savings, but it’s likely to have a more long-term impact.

Table 5-3
Sample Non-Infrastructure Solutions – Cost/Savings

Non-Infrastructure Solution	Cost	Savings
Managed Asset Failures: Condition and Risk Assessments for all Assets	$50,000 every 3 years	10-year capital forecast decreases from $50 million (inflated) to $45 million (inflated) Pick-up Truck useful life extended from 7 years to 10 years
Procurement Policies: Introduce processes to increase the number of competitive bids received	$20,000 one-time study cost in 2018 $5,000 annual increase in advertising	Pave 5 km roads per year vs. 4 km per year currently 5% reduction in salt and sand contract
Process Optimization: Automate and optimize the capital forecast, using asset management software	$70,000 one-time cost for implementation and training, plus $20,000 annual software fee	Remaining service life (avg.) of assets increases from 34 years to 48 years Infrastructure gap anticipated to be eliminated in 7 fewer years than anticipated

Once this costing analysis is completed, the results can be used to inform the overall lifecycle management strategy and be combined with other lifecycle costs anticipated over the forecast period.

5.5 Maintenance Solutions – Introduction

Incorporating planned maintenance solutions into the lifecycle management strategy ensures that these activities are funded at an appropriate level, enabling assets to reach their full service potential.

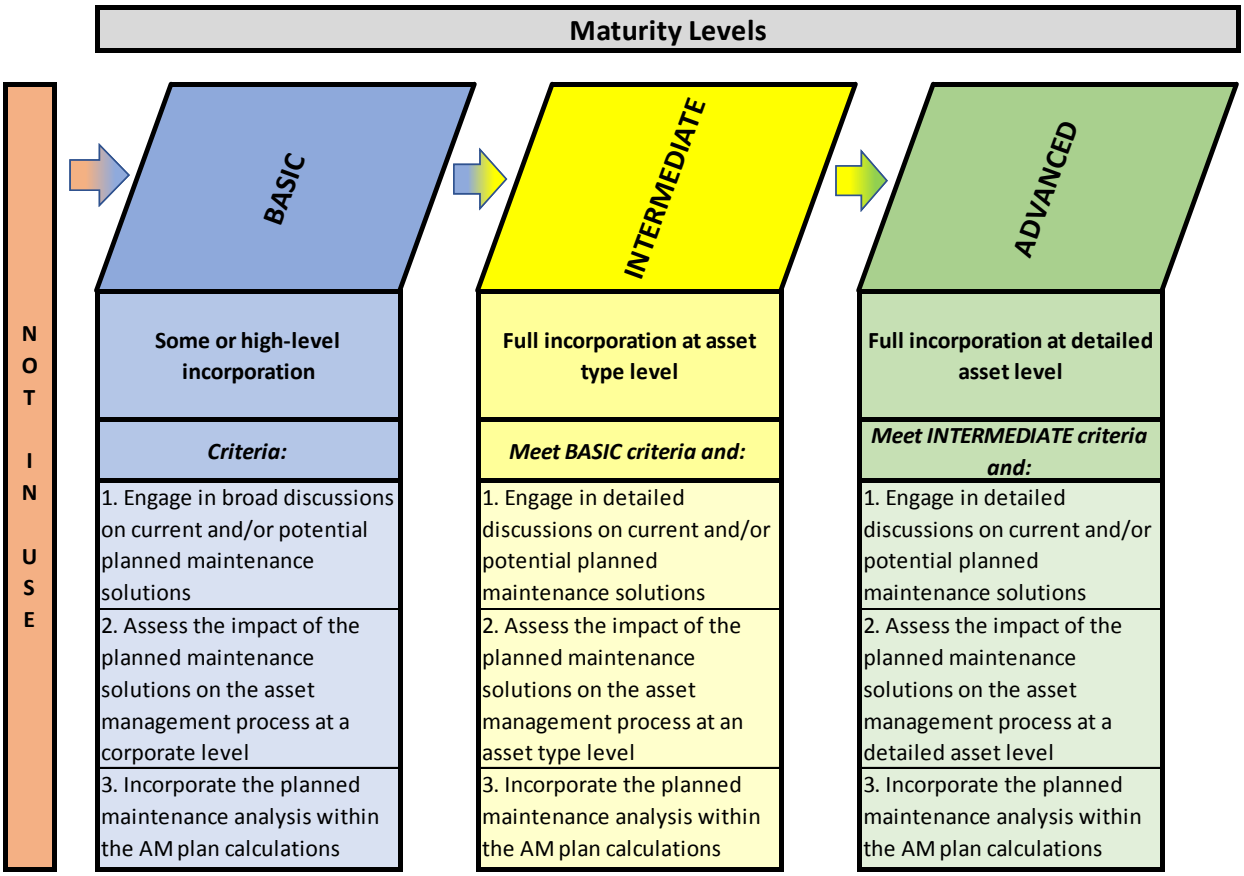
To what extent are planned maintenance solutions incorporated into the lifecycle management strategy?

Background

Municipalities will approach planned maintenance solutions in a number of ways. Some might base their plans on historical practices or broad discussions at the corporate level (i.e. more high level), while others might engage in more detailed discussions with a focus on maintenance by asset type, or possibly at a detailed asset level.

Levels of Maturity

To what extent are planned maintenance solutions incorporated into the lifecycle management strategy?



At the **basic level of maturity**, there will be some incorporation or high-level incorporation of planned maintenance solutions into the lifecycle management strategy. Municipalities engage in broad discussions on current and/or potential planned maintenance solutions. The impact of these solutions on the asset management process is assessed at a high level. Finally, the planned maintenance analysis is incorporated within the asset management plan calculations.

At the **intermediate level of maturity**, there will be full incorporation of planned maintenance solutions into the lifecycle management strategy by asset type. Municipalities engage in detailed discussions on current and/or potential planned maintenance solutions at a staff level. The impact of these solutions on the asset management process is assessed by asset type. Finally, the planned maintenance analysis is incorporated within the asset management plan calculations.

At the **advanced level of maturity**, there will be full incorporation of planned maintenance solutions into the lifecycle management strategy at a detailed asset level. Municipalities engage in detailed discussions on current and planned maintenance solutions over a long-term forecast period. The impact of these solutions on the asset management process is assessed at a detailed asset level. Finally, the planned maintenance analysis is incorporated within the asset management plan calculations.

Maintenance vs. Rehabilitation

Maintenance solutions from an asset management perspective includes regularly scheduled costs to inspect or maintain assets, or in some cases, one-time repair costs that don't meet the definition of capital/rehabilitation. Section 3150 of the PSAB handbook provides an approach to identify repairs and maintenance versus rehabilitation or "betterments" as follows:

Non-Complex Network Assets (Facilities, Vehicles, Equipment, Land Improvements):

Service potential is enhanced (i.e. costs should be capitalized as rehabilitation) when:

- There is an increase in previously assessed output or service capacity;
- Operating costs are lowered;
- Useful life is extended; or
- The quality of output is improved (if applicable).

Complex Network Assets (Roads, Watermains, Wastewater mains, Stormwater Mains):

Service potential is enhanced (i.e. costs should be capitalized as rehabilitation) when:

- There is an increase in previously assessed output or service capacity. This may or may not increase the useful life of the applicable assets.

To reiterate, the maintenance activities for complex network assets – which are assets that form a network pattern – are those that maintain the predetermined service

potential of the applicable assets. This practice is in place to ensure a maintenance activity (such as road-related pothole filling or crack sealing) is recorded as maintenance, rather than recorded as rehabilitation (i.e. capital). Even though pothole filling and crack sealing can increase the remaining life of a road, these types of activities do not increase the previously assessed service capacity.

Historical Maintenance

Municipalities might first review historical maintenance data as they begin to consider the appropriate level of planned maintenance to undertake over a forecast period. The historical data may lead to a number of question related to spending patterns, such as:

- Is this the correct level of spending?
- Should spending levels be higher or lower, and if so, on which criteria should these decisions be based?
- Where should the focus be for planned maintenance spending?
- What has been the impact of historical maintenance on our assets?

If a municipality can assess the impact of current maintenance activities on service levels (through asset condition and risk), it can be determined whether the extent of those maintenance activities is acceptable going forward over the forecast period, or if changes are required. This will be discussed further in the next section.

The collection of historical maintenance data within the asset register (see Chapter 3) can provide key data to assist in developing future maintenance strategies. Areas of concern can be uncovered, providing a basis for developing priorities. For example, assets may be identified that required high maintenance historically, or the assets are experiencing increasing maintenance costs over time, which may be supported by a declining condition rating. It is incumbent upon municipalities to identify these types of assets in order to be in the best position to direct resources and attention where most needed. For example, a decision might be made to continue to maintain the asset, which may require increasing the maintenance budget. Conversely, a decision might be made to rehabilitate or replace the asset, which could reduce future projected maintenance.

Maintenance Impact on Assets

The decision to revise historical maintenance levels should be made following an analysis of all lifecycle costs and expected levels of service. For example, if an asset is

not meeting expected levels of service, the municipality will need to determine the lifecycle costs necessary to reach those expected levels. These costs might include maintenance adjustments and, potentially, other lifecycle costs (such as rehabilitation and replacement). Based on a municipality's maturity level, this can be done using a more high-level (corporate) approach, a more intermediate asset type approach, or a more detailed asset approach. Examples are provided in Table 5-4 (below).

Table 5-4
Sample Maintenance Solutions – Levels of Maturity

Maturity Level	Levels of Service Comments	Maintenance Impact
Basic	Assets as a whole are not meeting expected service levels	Increase all maintenance by 5% per year and monitor impact on service levels annually
Intermediate	One particular asset type is not meeting expected service levels	Increase maintenance programs from $500,000 to $1.2 million over 10 years to provide expected levels of service (can be increases to existing programs or new programs)
Advanced	One particular asset is not meeting expected service levels	Increase maintenance programs from $5,000 to $12,000 over 10 years to provide a specific expected service level (can be increases to existing programs or new programs)

5.6 Maintenance Solutions – Approach

A detailed analysis of the relationship between maintenance levels and asset condition and risk will ensure that the proposed maintenance solutions are aligned with expected levels of service.

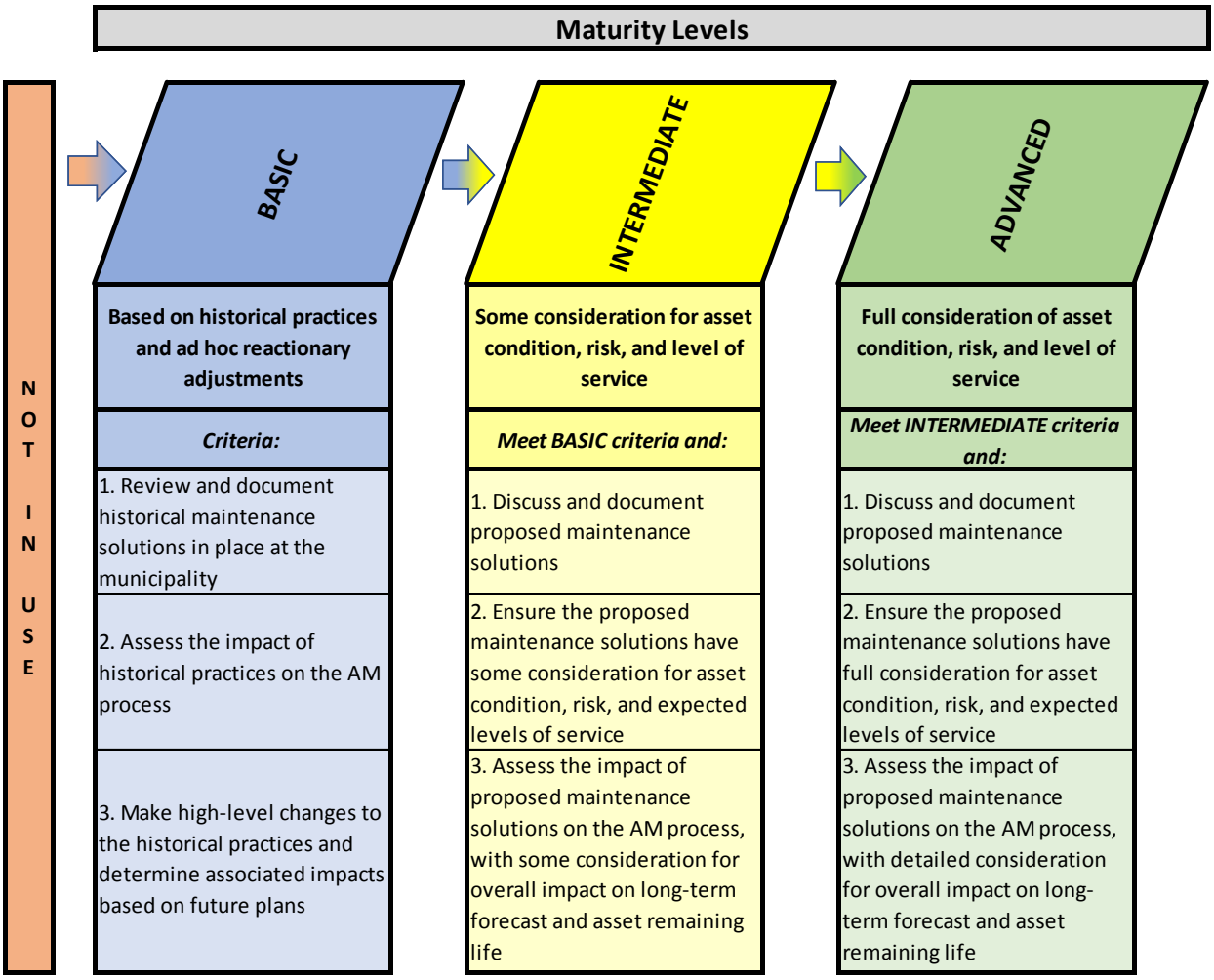
What method is used to incorporate planned maintenance solutions into the lifecycle management strategy?

Background

Municipalities engage in a number of approaches to determine how much maintenance should be carried out in a given year. A simple approach may be to base maintenance spending on prior years' operating budgets, apply an inflationary increase, and adjust for any necessary ad hoc adjustments for 'out of the ordinary' or 'new' spending. Other municipalities will undertake a more detailed approach, taking into account the condition of their assets, risk levels, and desired levels of service to be provided.

Levels of Maturity

What method is used to incorporate planned maintenance solutions into the lifecycle management strategy?



At the **basic level of maturity**, municipalities will tend to incorporate planned maintenance solutions into the lifecycle management strategy based on historical practices and may include subsequent ad hoc adjustments. These municipalities will review and document historical maintenance solutions that are in place. The impact of these practices on the asset management process is assessed. Past practices are updated with any high-level changes included in future maintenance plans. The associated impacts of these changes is determined and considered for use in the budgeting process.

At the **intermediate level of maturity**, municipalities incorporating planned maintenance into their lifecycle management strategy give some consideration to asset

condition, risk, and levels of service. Proposed maintenance solutions are discussed and documented. Municipalities ensure the proposed maintenance solutions will lead to some improvement in asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with some consideration for the overall impact on the long-term forecast and the assets' remaining life.

At the **advanced level of maturity**, municipalities incorporating planned maintenance into their lifecycle management strategy give full consideration to asset condition, risk, and levels of service. Proposed maintenance solutions are discussed and documented. Municipalities ensure the proposed maintenance solutions fully take into account impacts on asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with detailed consideration for the overall impact on the long-term forecast and the assets' remaining life.

Planned Maintenance Strategy

This section introduces the concept of a "planned maintenance strategy", which identifies the role of planned maintenance in the asset management planning process. Maintenance decisions should be made in consideration with other lifecycle costs (i.e. rehabilitation and replacement), and be based on factors such as:

- Asset condition;
- Asset risk; and
- Expected levels of service.

Through this decision-making process the municipality will need to answer:

Does maintenance provide an improvement in asset condition, a mitigation of risk, and/or a movement towards expected levels of service in an efficient and effective manner?

And,

Does maintenance defer other lifecycle costs to the point where savings are projected?

These questions become more complicated when other lifecycle costs are brought into the equation. Finding the optimal level of maintenance, rehabilitation, and replacement lifecycle costs over a forecast period is the definition of lifecycle optimization. Weighing the lifecycle costs against the potential improvement in condition, mitigation of risk, and

movement towards expected service levels becomes the ultimate goal within the lifecycle management strategy.

While *planned* maintenance should be integrated into the asset management process, *unplanned* maintenance should be discussed as well. Significant and dramatic increases in asset risk, even to the point of asset failure, can represent a need for unplanned maintenance. While one of the objectives of asset management planning is to minimize these events, they are not completely avoidable. In the case of asset failure, municipalities will need to assess whether the best strategy is to:

- Perform maintenance work;
- Rehabilitate;
- Replace the asset;
- Apply non-infrastructure solutions; or
- Do nothing (i.e. allow the asset to continue to fail).

While considering the strategies above, municipalities need to decide whether to base planned maintenance on historical trends or develop new maintenance strategies that take risk and/or asset condition into account. Either way, lifecycle costs should be quantified as part of the lifecycle management strategy as well as the impact on the assets themselves. (i.e. useful life, condition, risk, etc.).

5.7 Rehabilitation Solutions – Introduction

Asset rehabilitation often extends service life and/or improves level of service, at a fraction of the cost of asset replacement. Relative to a simple replacement analysis, incorporating asset rehabilitation solutions into the lifecycle management strategy is a more accurate way of predicting future lifecycle costs.

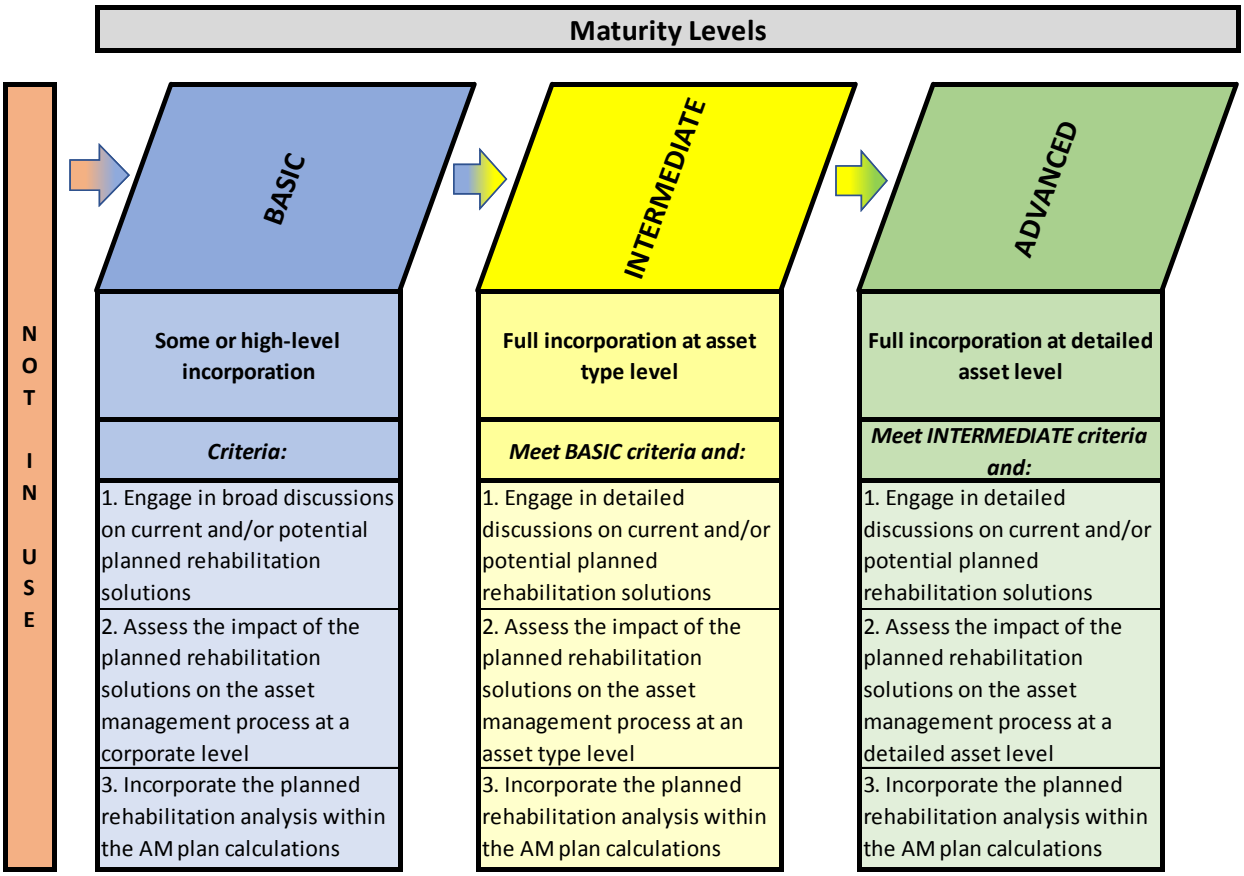
To what extent are planned rehabilitation solutions incorporated into the lifecycle management strategy?

Background

Municipalities will approach planned rehabilitation solutions in a number of ways. Some will base their plans on broad discussions at the corporate level, whereas others will engage in more detailed discussions with a focus on the asset type, or even at a detailed asset level.

Levels of Maturity

To what extent are planned rehabilitation solutions incorporated into the lifecycle management strategy?



At the **basic level of maturity**, there will be some high-level incorporation of planned rehabilitation solutions into the lifecycle management strategy. Municipalities at the basic level of maturity engage in broad discussions on current and/or potentially new planned rehabilitation solutions. The impact of these solutions on the asset management process is assessed at a corporate level. Finally, the planned rehabilitation analysis is incorporated within the asset management plan calculations.

At the **intermediate level of maturity**, there will be full incorporation of planned rehabilitation solutions into the lifecycle management strategy at the asset type level. Municipalities engage in detailed discussions on current and potential planned rehabilitation solutions to be incorporated over the forecast period. The impact of these solutions on the asset management process is assessed at the asset type level. Finally,

the planned rehabilitation analysis is incorporated within the asset management plan calculations.

At the **advanced level of maturity**, there will be full incorporation of planned rehabilitation solutions into the lifecycle management strategy at a detailed asset level. Municipalities engage in detailed discussions on current and potential planned rehabilitation solutions. The impact of these solutions on the asset management process is assessed at a detailed asset level. Finally, the planned rehabilitation analysis is incorporated within the asset management plan calculations.

Rehabilitation vs. Maintenance

Rehabilitation from an asset management perspective includes significant repairs that, in many cases, extend asset life. Section 3150 of the PSAB handbook provides an approach to identify rehabilitation (or "betterments") versus repairs and maintenance, as follows:

Non-Complex Network Assets (Facilities, Vehicles, Equipment, Land Improvements):

Service potential is enhanced (i.e. costs should be capitalized as rehabilitation) when:

- There is an increase in previously assessed output or service capacity;
- Operating costs are lowered;
- Useful life is extended; or
- The quality of output is improved (if applicable).

Complex Network Assets (Roads, Watermains, Wastewater mains, Storm Mains):

Service potential is enhanced (i.e. costs should be capitalized as rehabilitation) when:

- There is an increase in previously assessed output or service capacity. This may or may not increase the useful life of the applicable assets.

To reiterate, complex network assets – which are assets that form a network pattern – rehabilitation activities increase the predetermined service potential while maintenance activities simply maintain the predetermined service potential of the applicable assets. This practice is in place to ensure rehabilitation activities such as the lining of wastewater mains are recorded as rehabilitation (i.e. capital). Conversely, maintenance activities such as road-related pothole filling or crack sealing, should be recorded as maintenance, rather than be identified as rehabilitation (i.e. capital). Although pothole

filling and crack sealing could increase the remaining life of a road, these solutions do not increase the previously assessed service capacity.

Historical Rehabilitation

Municipalities might first review historical rehabilitation data as they begin to consider the appropriate level of planned rehabilitation to undertake over a forecast period. The historical data may lead to a number of question related to spending patterns, such as:

- Is this the correct level of spending?
- Should spending levels be higher or lower, and if so, on which criteria should these decisions be based?
- Where should the focus be for planned rehabilitation spending?
- What has been the impact of historical rehabilitation on our assets?

If a municipality can assess the impact of current rehabilitation practices on service levels (through asset condition and risk), it can determine whether the extent of those rehabilitation practices is acceptable going forward over the forecast period, or if changes are required. This will be discussed further in Section 5.7.

As discussed in Section 5.5, the collection of historical maintenance data within the asset register (see Chapter 3) can provide key data to assist in developing future rehabilitation strategies. Areas of concern can be uncovered, providing a basis for developing priorities. For example, assets may be identified that required high maintenance historically, or the assets are experiencing increasing maintenance costs over time, which may be supported by a declining condition rating. It is incumbent upon municipalities to identify these assets and be in the best position to direct resources and attention where most needed. For example, the decision could be made to continue to maintain the asset, which requires increasing the maintenance budget. Conversely, the decision could be made to rehabilitate or replace the asset, which could reduce future projected maintenance.

Rehabilitation Impact on Assets

The decision to revise historical rehabilitation levels should be made through an analysis of all lifecycle costs, based on expected levels of service. For example, if an asset is not meeting expected levels of service, the lifecycle costs needed to reach those levels must be determined. This could include rehabilitation and, potentially, other lifecycle costs (such as maintenance and replacement). Based on a municipality's

maturity level, this can be done using a more high-level (corporate) approach, a more intermediate asset type approach, or a more detailed asset approach. Examples are provided in Table 5-5 below:

Table 5-5
Sample Rehabilitation Impacts

Maturity Level	Levels of Service Comments	Rehabilitation Impact
Basic	Assets as a whole are not meeting expected service levels	Increase all rehabilitation programs by 5% per year and monitor impact on service levels annually for impact
Intermediate	One particular asset type is not meeting expected service levels	Increase rehabilitation from $1.0 million to $2.0 million over 10 years to provide expected levels of service (can be increases to existing programs or new programs)
Advanced	One particular asset is not meeting expected service levels	Increase rehabilitation on specific asset over forecast period to provide a specific expected service level (can be increases to existing programs or new programs)

5.8 Rehabilitation Solutions – Approach

Rehabilitation solutions embraced in the lifecycle management strategy should be driven by asset condition, risk, and expected levels of service. This will enable an accurate assessment of their impact on the assets in the long-term forecast.

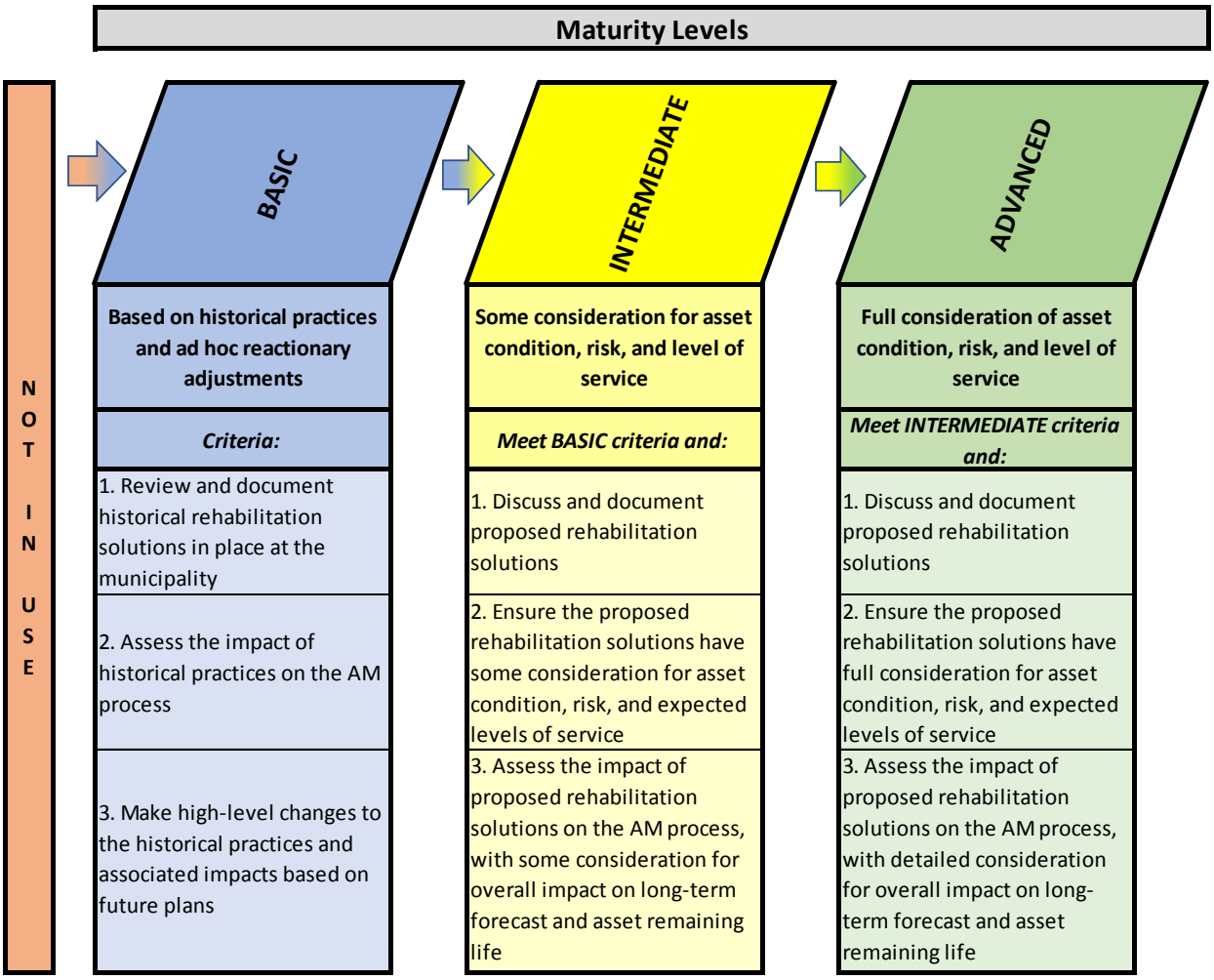
What method is used to incorporate planned rehabilitation solutions into the lifecycle management strategy?

Background

Municipalities engage in a number of approaches to incorporate planned rehabilitation solutions into the lifecycle management strategy. A simple approach may be to base rehabilitation solutions on historical practices, then incorporate any necessary ad hoc adjustments for unexpected situations as they arise. Other municipalities may undertake a more detailed approach, taking into account the condition of their assets, risk levels, and desired levels of service to be provided.

Levels of Maturity

What method is used to incorporate planned rehabilitation solutions into the lifecycle management strategy?



At the **basic level of maturity**, municipalities will tend to incorporate planned rehabilitation solutions into the lifecycle management strategy based on historical practices and may include subsequent ad hoc reactionary adjustments. Municipalities will review and document historical rehabilitation solutions that are in place. The impact of these practices on the asset management process is assessed. Past practices are updated with any high-level changes included in future rehabilitation plans. The associated impacts of these changes is determined and considered for use in the budgeting process.

At the **intermediate level of maturity**, municipalities incorporating planned rehabilitation into their lifecycle management strategy would give some consideration to

asset condition, risk, and levels of service. Proposed rehabilitation solutions are discussed at a staff level and documented. Municipalities ensure the proposed rehabilitation solutions lead to some improvement in asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with some consideration for the overall impact on the long-term forecast and the assets' remaining life.

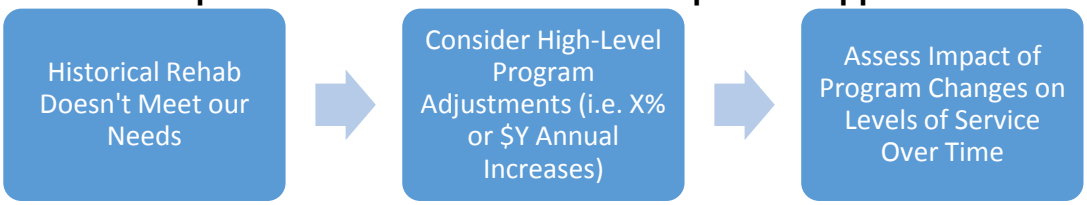
At the **advanced level of maturity**, municipalities incorporating planned rehabilitation into their lifecycle management strategy give full consideration to asset condition, risk, and levels of service. Proposed rehabilitation solutions are discussed at a staff level and documented. Municipalities ensure the proposed rehabilitation solutions take into account asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with detailed consideration for the overall impact on the long-term forecast and the assets' remaining life.

Planned Rehabilitation Solutions - Approaches

Rehabilitation of certain assets can be appropriate when the asset is not maintaining or moving towards expected service levels but is not at a point in its lifecycle where replacement or maintenance is the optimal course of action. To determine appropriate planned rehabilitation solutions for the future, municipalities can follow different approaches. There are generally three broad categories for rehabilitation:

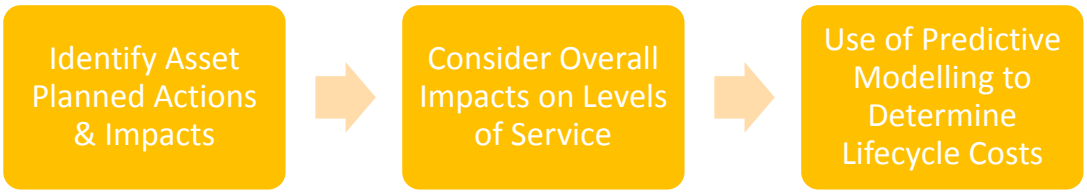
1. Top down
   Under the top down approach, historical rehabilitation programs would be used as a guide for future capital works. For example, municipalities may initiate "shave and pave" programs for some of their roads at a budgeted annual cost and would forecast continuing the program for a number of years. Similarly, a wastewater main relining program may be undertaken over a number of years. Taking these programs into account, municipalities would consider any adjustments to the programs or whether to add new programs. The municipality should assess the impact of these programs on the impacted assets' remaining useful life, replacement timelines, and the service being provided over time as the program adjustments take effect. Example:

Figure 5-2
Sample Rehabilitation Solutions – Top Down Approach



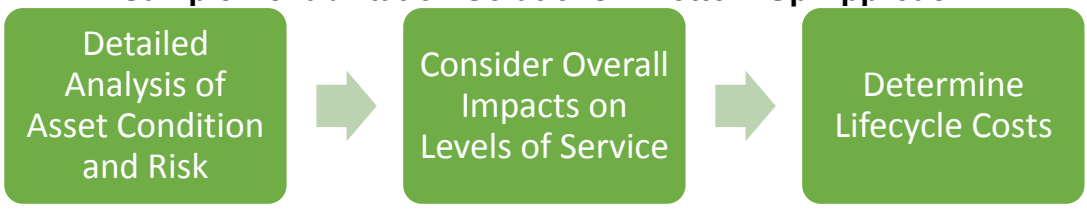
2. Predictive modelling
   The predictive modelling approach can be undertaken by municipal staff through an analysis of a set of planned actions that account for predicted effects on the assets and levels of service. This can be done at a broad level (by asset type) or at a detailed level (by detailed asset). While this can be attempted in spreadsheet format, asset management software would make this approach easier to implement. See Chapter 9 for further discussions on software as an asset management tool.

Figure 5-3
Sample Rehabilitation Solutions – Predictive Modelling Approach



3. Bottom up
   The bottom up approach is dependent on the identification of specific assets that require attention (i.e. consider specific asset risk ratings, condition ratings, and service levels). Assets identified would be scheduled for rehabilitation, with the impacts on the assets' remaining useful life and replacement timelines once again considered. Complex predictive modelling can assist with this process but is not required.

Figure 5-4
Sample Rehabilitation Solutions – Bottom Up Approach



To put these categories in context of asset management maturity:

Table 5-6
Sample Planned Rehabilitation Approaches – Level of Maturity

Maturity Level	Categories	Approach
Basic	Top Down Approach at Corporate Level	High-Level Rehabilitation Analysis (Corporate Level) Increase rehabilitation on all assets by 10%
Intermediate	Top Down or Predictive Modelling at the Asset Type Level	Rehabilitation at the Asset Type Level Increase rehabilitation on local roads by 10%
Advanced	Bottom Up or Predictive Modelling at the Detailed Asset Level	Rehabilitation at the Detailed Asset Level Increase rehabilitation on Smith St. by 10%

5.9 Replacement Solutions – Introduction

Incorporating replacement solutions into the lifecycle management strategy is important because asset replacement is often the most significant component of an asset's lifecycle cost.

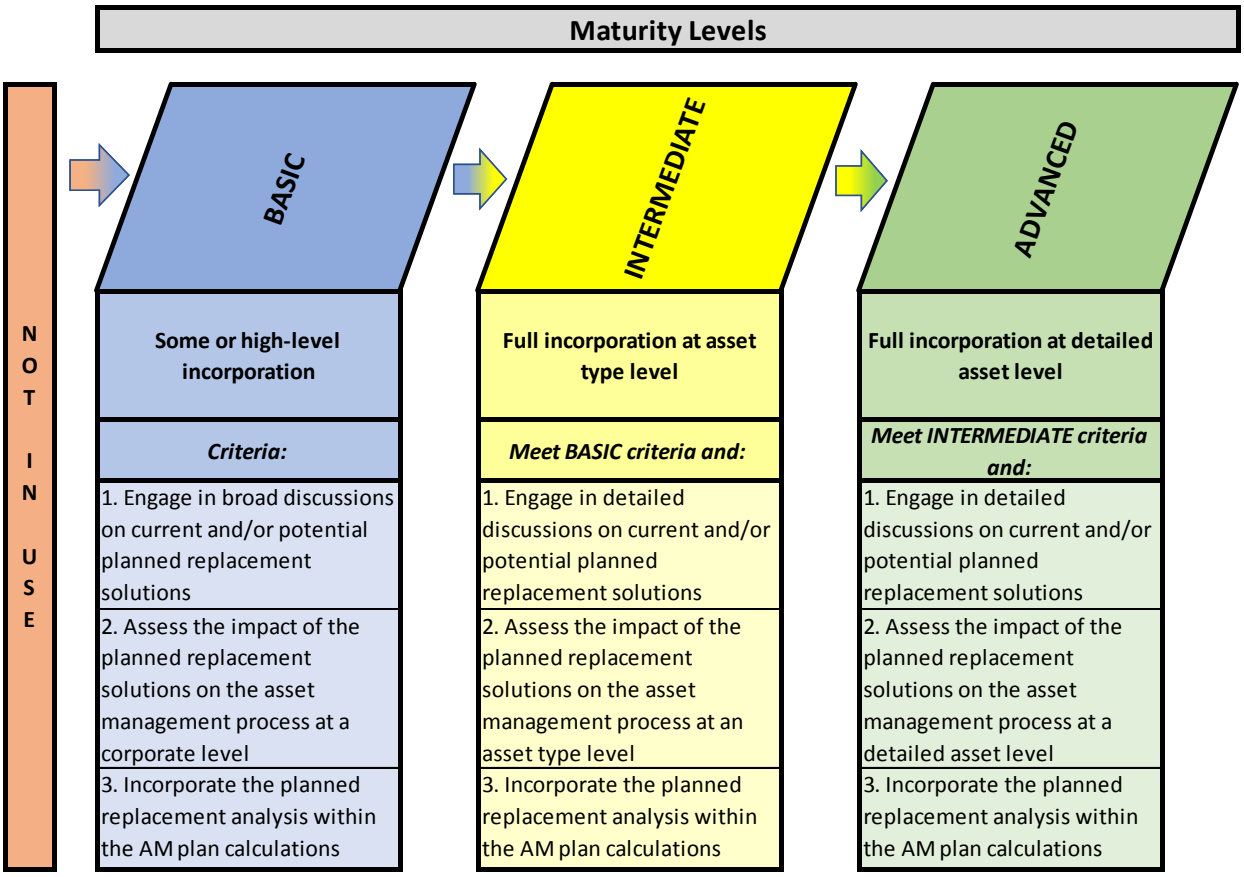
To what extent are planned replacement solutions incorporated into the lifecycle management strategy?

Background

There are a number of ways that municipalities can approach planned replacement solutions. Some may base their plans on broad discussions at the corporate level, while others may engage in more detailed discussions with a focus on the asset type, or even at a detailed asset level.

Levels of Maturity

To what extent are planned replacement solutions incorporated into the lifecycle management strategy?



At the **basic level of maturity**, there will be some high-level incorporation of planned replacement solutions into the lifecycle management strategy. Municipalities engage in broad discussions on current and potentially new planned replacement solutions to incorporate into the forecast. The impact of these solutions on the asset management process is assessed at a corporate level. Finally, the planned replacement analysis is incorporated within the asset management plan calculations.

At the **intermediate level of maturity**, there will be full incorporation of planned replacement solutions into the lifecycle management strategy at the asset level. Municipalities engage in detailed discussions on current and potential planned replacement solutions. The impact of these solutions on the asset management process is assessed at an asset type level. Finally, the planned replacement analysis is incorporated within the asset management plan calculations.

At the **advanced level of maturity**, there will be full incorporation of planned replacement solutions into the lifecycle management strategy at a detailed asset level. Municipalities engage in detailed discussions on current and potential planned replacement solutions. The impact of these solutions on the asset management process

is assessed at a detailed asset level. Finally, the planned replacement analysis is incorporated within the asset management plan calculations.

Replacement Program

Contrary to maintenance and rehabilitation identification, the recognition of an asset being replaced is relatively straightforward. With maintenance and rehabilitation, it will need to be determined whether the predetermined service potential should be changed to classify a cost as maintenance *or* rehabilitation (see Sections 5.5 and 5.6). Asset replacement simply entails replacing one asset with another. The replacement asset will either provide the same service potential or a completely different service. Please refer to the discussion in Chapter 3 regarding the difference between the reproduction cost and replacement cost of an asset.

Municipalities might first review historical replacement levels undertaken over a forecast period. The historical data may lead to a number of questions related to spending patterns, including:

- Is this the correct level of spending?
- Which criteria should drive decisions regarding spending levels?
- Where should the focus be for planned replacement spending?
- What has been the impact of historical replacement spending on our assets?

If a municipality can assess the impact of current replacement practices on service levels (through asset condition and risk), a determination can be made regarding whether that level of replacement is acceptable going forward over the forecast period, or if changes are required. This analysis can also happen at the specific asset level, assessing replacement needs on an asset-by-asset basis. This will be discussed further in the next section.

As discussed in Sections 5.6 and 5.7, the collection of historical maintenance data within the asset register (see Chapter 3) can provide key insights to assist in the development of future replacement strategies. Areas of concern can be uncovered, providing a basis for developing priorities. For example, assets may be identified that required high maintenance historically, or the assets are experiencing increasing maintenance costs over time, which may be supported by a declining condition rating. It is incumbent upon municipalities to identify such assets and be in the best position to direct resources and attention where most needed. For example, the decision could be made to continue to maintain the asset, which requires increasing the maintenance

budget. Conversely, the decision could be made to rehabilitate or replace the asset, which could reduce future projected maintenance.

Replacement Impact on Assets

The decision to update historical replacement levels or patterns to suit present and future needs should be based on an analysis of all lifecycle costs and expected levels of service. For example, if a particular asset is not meeting levels of service expectations, the lifecycle costs to be incurred to move that asset towards providing expected service levels will need to be determined. This could include replacement and potentially other lifecycle costs (such as maintenance and rehabilitation). Based on the maturity level of the municipality, this can be done using a more high-level (corporate) approach, a more intermediate asset type approach, or a more detailed asset approach. Table 5-7 provides examples of replacement impacts.

Table 5-7
Sample Replacement Impacts – Level of Maturity

Maturity Level	Levels of Service Comments	Replacement Impact
Basic	Assets as a whole are not meeting expected service levels	Increase all replacement programs by 5% per year and monitor impact on service levels annually
Intermediate	One particular asset type is not meeting expected service levels	Increase replacement program from $5.0 million to $9.0 million over 10 years to provide an expected level of service
Advanced	One particular asset is not meeting expected service levels	Increase replacement on specific asset over forecast period to provide a specific expected service level

5.10 Replacement Solutions – Approach

A detailed consideration of asset replacement solutions within the lifecycle management strategy will enable the impact of these solutions to be measured and accounted for in the long-term forecast.

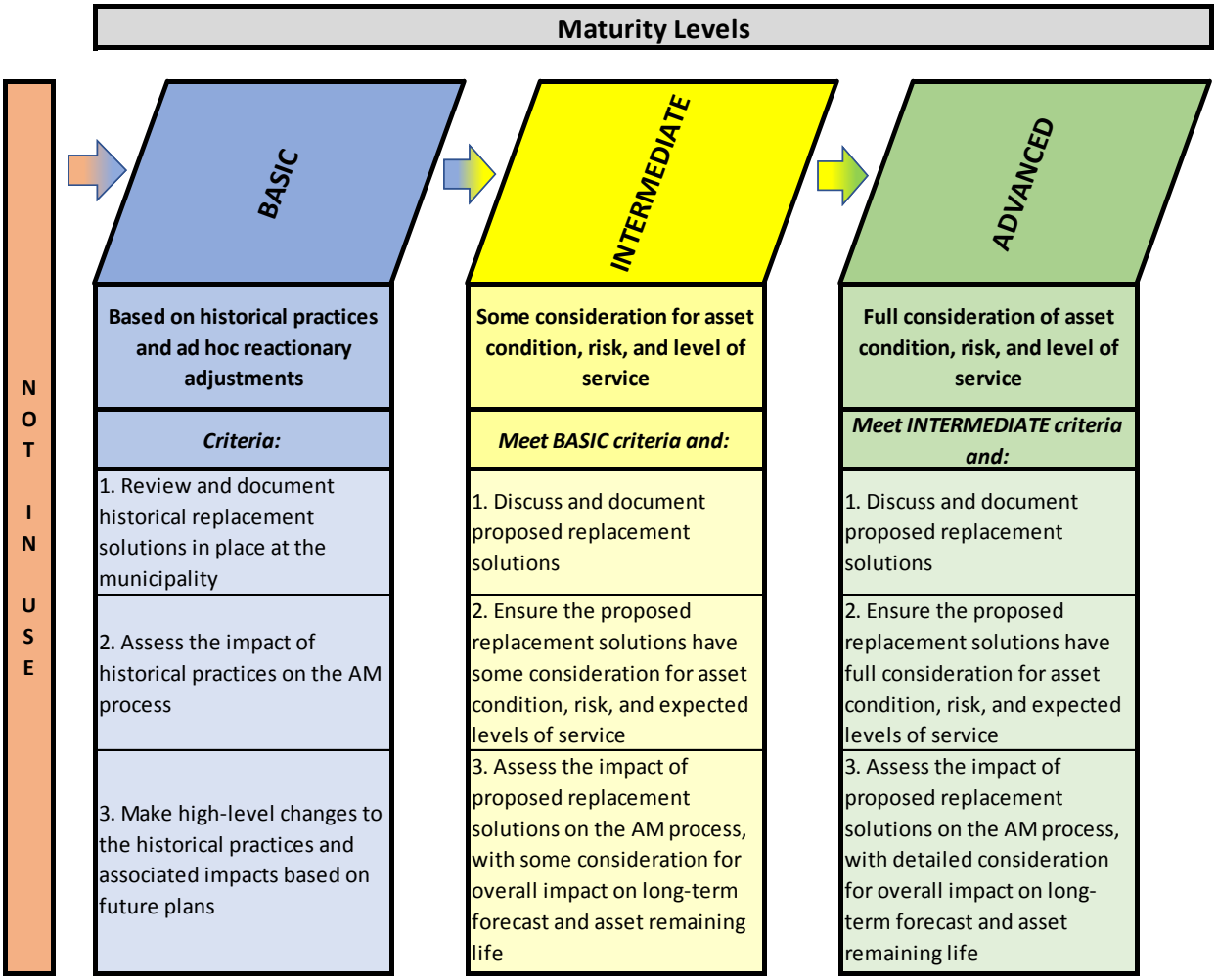
What method is used to incorporate planned replacement solutions into the lifecycle management strategy?

Background

Municipalities engage in a number of approaches to incorporate planned replacement solutions into the lifecycle management strategy. A simple approach may be to base replacement solutions on historical practices, with any necessary ad hoc adjustments for unexpected situations as they arise. Other municipalities may undertake a more detailed approach, taking into account the condition of their assets, risk levels, and expected levels of service to be provided.

Levels of Maturity

What method is used to incorporate planned replacement solutions into the lifecycle management strategy?



At the **basic level of maturity**, municipalities will tend to incorporate planned replacement solutions into the lifecycle management strategy based on historical

practices and may include subsequent ad hoc reactionary adjustments. Municipalities will review and document historical replacement solutions that are in place. The impact of these practices on the asset management process is assessed. Past practices are updated with any high-level changes included in future replacement plans. The associated impacts of these changes is determined and considered for use in the budgeting process.

At the **intermediate level of maturity**, municipalities incorporating planned replacement into their lifecycle management strategy would give some consideration to asset condition, risk, and levels of service. Proposed replacement solutions are discussed at a staff level and documented. Municipalities ensure the proposed replacement solutions lead to some improvement in asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with some consideration for the overall impact on the long-term forecast and the assets' remaining life.

At the **advanced level of maturity**, municipalities incorporating planned replacement into their lifecycle management strategy would give full consideration to asset condition, risk, and levels of service. Proposed replacement solutions are discussed at a staff level and documented. Municipalities ensure the proposed replacement solutions have full consideration for asset condition, risk, and levels of service. The impact of these solutions on the asset management process is assessed, with detailed consideration for the overall impact on the long-term forecast and the assets' remaining life.

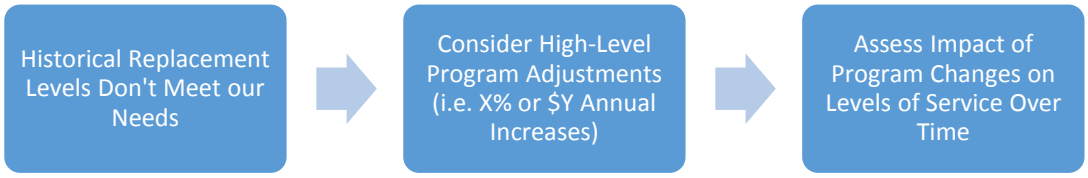
Planned Replacement Solutions - Approaches

Replacement of assets can be appropriate when the asset is not maintaining or moving towards expected service levels and has reached a point in its lifecycle where rehabilitation or maintenance are no longer optimal courses of action. In determining appropriate planned replacement solutions for the future, municipalities can follow different approaches (similar to the approaches identified for rehabilitation solutions above). There are generally three broad categories:

1. Top down
   Under the top down approach, historical replacement programs would be used as a guide for future capital works. For example, municipalities may initiate a road surface replacement program for their roads at a budgeted annual cost, and would forecast continuing the program for a number of years in the forecast. Similarly, a wastewater main replacement program may be undertaken over a

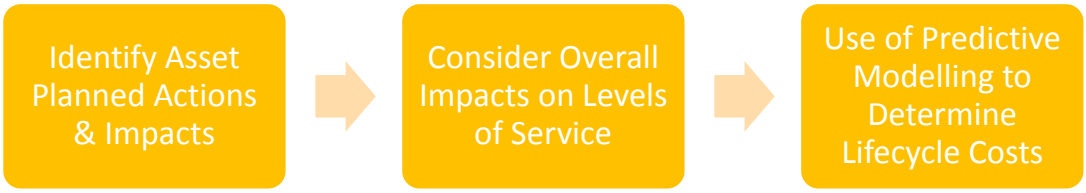
number of years. Taking these programs into account, municipalities would consider any adjustments to the programs or whether to add new programs. The municipality should assess the impact of these programs on the impacted assets' remaining useful life, replacement timelines, and the service being provided over time as the program adjustments take effect. Example:

Figure 5-5
Sample Replacement Solutions – Top Down Approach



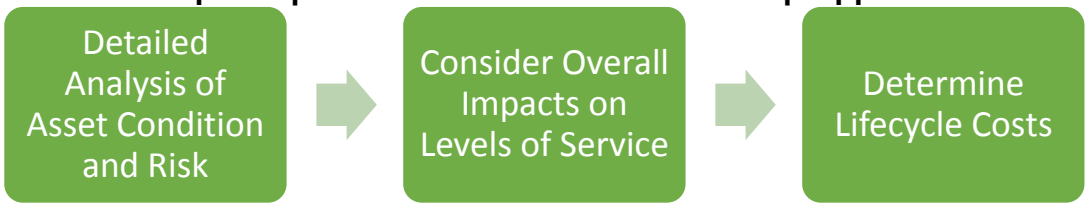
2. Predictive modelling
   The predictive modelling approach can be undertaken by municipal staff through an analysis of a set of planned actions that account for predicted effects on the assets and levels of service. This can be done at a broad level (by asset type) or at a detailed level (by detailed asset). While this can be attempted in spreadsheet format, asset management software would make this approach easier to implement. See Chapter 9 for further discussions on software as an asset management tool.

Figure 5-6
Sample Replacement Solutions – Predictive Modelling Approach



3. Bottom up
   The bottom up approach is dependent on the identification of specific assets that require attention (i.e. consider specific asset risk ratings, condition ratings, and service levels). Assets identified would be scheduled for replacement, with the impacts on the assets' remaining useful life, and replacement timelines once again considered. Complex predictive modelling can assist with this process but is not required.

Figure 5-7
Sample Replacement Solutions – Bottom Up Approach



To put these categories in context of asset management maturity:

Table 5-8
Sample Planned Replacement Solutions – Level of Maturity

Maturity Level	Categories	Approach
Basic	Top Down Approach at Corporate Level	High-Level Replacement Analysis (Corporate Level) Increase replacement on all assets by 10%
Intermediate	Top Down or Predictive Modelling at the Asset Type Level	Replacement at the Asset Type Level Increase replacement on local roads by 10%
Advanced	Bottom Up or Predictive Modelling at the Detailed Asset Level	Replacement at the Detailed Asset Level Increase replacement on Smith St. by 10%

5.11 Asset Expansion

Incorporating growth into the lifecycle management strategy ensures that the additional lifecycle costs associated with newly constructed/acquired assets and/or new services are accounted for in the long-term forecast.

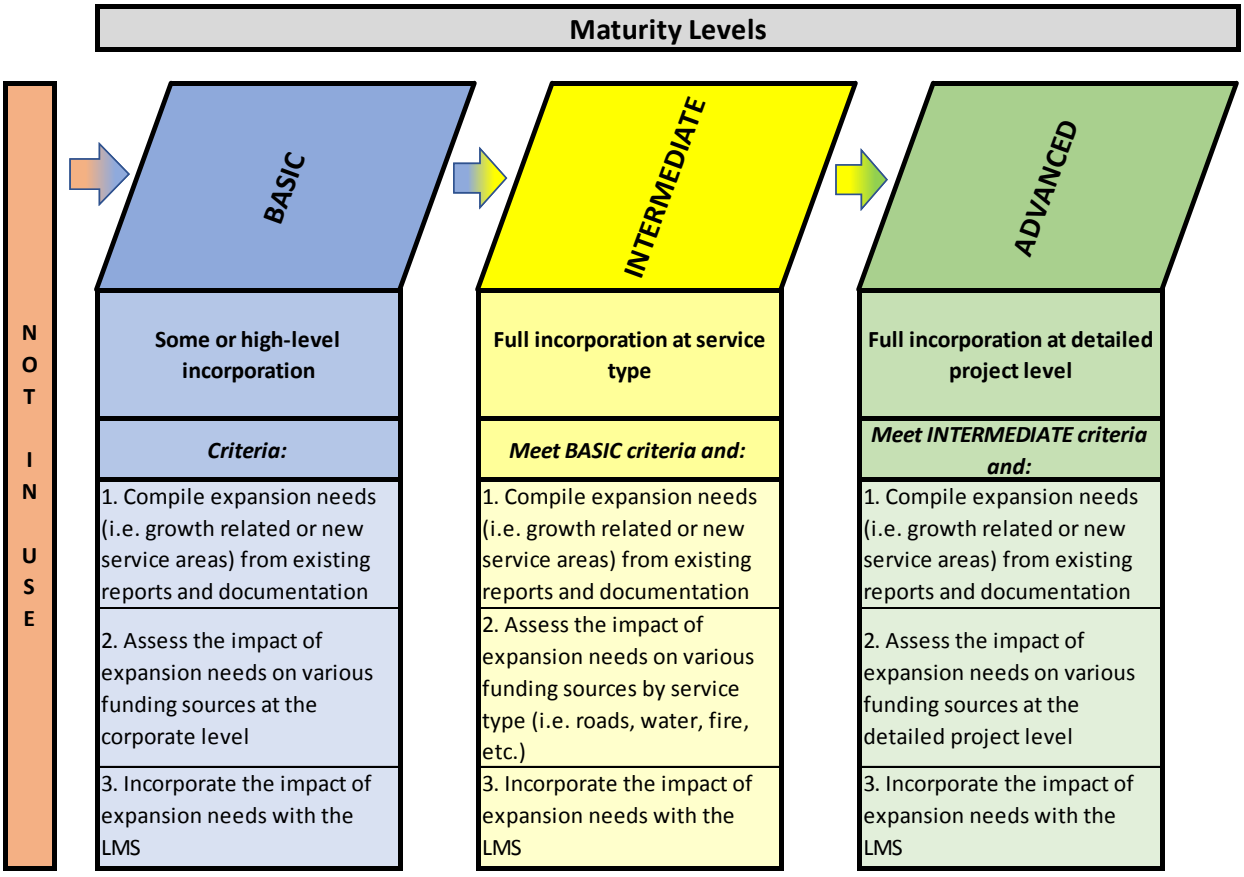
To what extent are growth and/or new service areas incorporated into the lifecycle management strategy?

Background

Municipalities can approach the incorporation of growth and/or new service areas in a number of ways. After compiling expansion needs from existing reports and documentation, some will assess the impacts on funding sources but only at the corporate level; some may take it a step further by assessing impact on funding sources by service type area; whereas others will go further still and assess impact on funding sources at the detailed project level.

Levels of Maturity

To what extent are growth and/or new service areas incorporated into the lifecycle management strategy?



At the **basic level of maturity**, there will be some incorporation or high-level incorporation of growth and/or new service areas into the lifecycle management strategy. Municipalities compile expansion needs (i.e. growth related or new service areas) from existing reports and documentation. The impact of these expansion needs

on various funding sources is assessed, but generally at a high level only. The impact of the expansion needs are incorporated into lifecycle management strategy.

At the **intermediate level of maturity**, there will be full incorporation of growth and/or new service areas into the lifecycle management strategy by service type. Municipalities compile expansion needs (i.e. growth related or new service areas) from existing reports and documentation. The impact of these expansion needs on various funding sources is assessed by service type (i.e. roads, water, fire, etc.). The impact of the expansion needs is incorporated into lifecycle management strategy.

At the **advanced level of maturity**, there will be full incorporation of growth and/or new service areas into the lifecycle management strategy at the detailed project or asset level. Municipalities compile expansion needs (i.e. growth related or new service areas) from existing reports and documentation. The impact of these expansion needs on various funding sources is assessed at the detailed project level. The impact of the expansion needs is incorporated into the lifecycle management strategy.

Assets Expansion

Previous sections have detailed elements of lifecycle costing of existing assets within the context of the lifecycle management strategy. This section explores how to handle new and/or expanded assets in regards to upgrading, creating, purchasing, constructing, or receiving contributed assets (with contributed assets discussed more fully later in this chapter). As municipalities grow, become more complex, and receive demands from residents, expansion-related asset needs become a mechanism for allowing growth to occur and to provide new or expanded services.

Sources of New and Upgraded Assets

The demand for new assets, or the requirement to upgrade assets, can come from multiple sources, including:

1. **Future Growth Planning**: A process which can identify the need for new or expanded assets to meet increasing demands of providing existing services to an expanding population. For example:
    - A requirement to increase the stormwater drainage capacity in a high growth development area; or
    - The need to increase a two-lane road to a four-lane road due to traffic congestion as a result of an increase in residents and housing in the area.

2. **Gaps in the Levels of Service Provided**: When comparing current service levels to expected service levels,it may be determined that new or expanded assets are necessary. For example:
    - The proposed level of service is to maintain parks every week. Currently, parks are maintained every 2 weeks. To increase service levels, an additional mower is needed.
3. **Decision to Provide a New Service**: A municipality may decide that a new service is required within the municipality (or a previously contracted service may become a direct municipal service), resulting in the need for new or expanded assets to support this service. For example:
    - A municipality may decide to run and operate their water and wastewater systems, which was previously a contracted service. This requires additional vehicles and equipment.

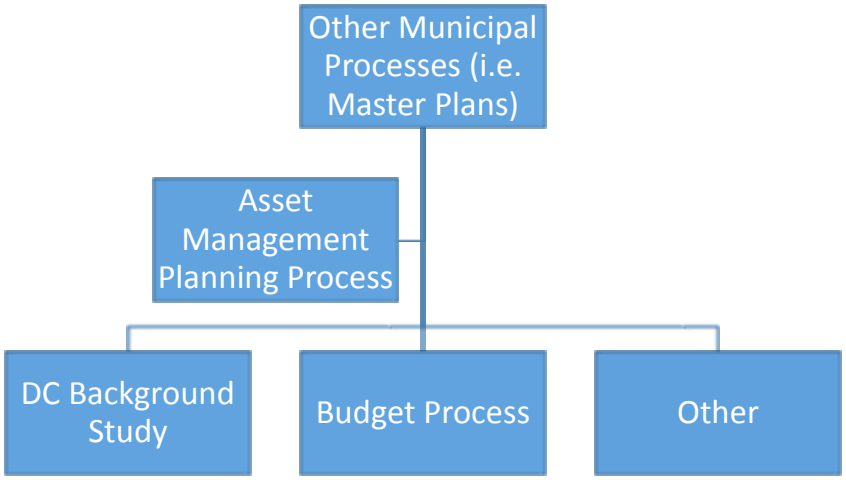
Determining Expansion Needs

Additional assets may be required as a result of the following expansion-related circumstances:

1. **Growth Planning and New Services**: Typically, these expansion needs are determined outside of the asset management planning process. Municipalities will have other various plans, policies, and strategies that deal with the concept of how that particular municipality is to grow. This can include:
    - Strategic Plans;
    - Official Plans;
    - Secondary Plans;
    - Master Plans; and
    - Other (i.e. Capital Plans).

    As illustrated in Figure 5-8 below, these plans, policies, and strategies feed growth planning and new service needs into the asset management process, as well as other processes, such as preparing a Development Charge (DC) Background Study. It is, then, these other processes, such as the DC Background Study, that can assist in determining allowable funding sources within the Financing Strategy (see Chapter 6).

Figure 5-8
Growth Planning and New Services Process



2. **Gaps in Levels of Service**: These expansion needs can come from the asset management planning process (such as the levels of service analysis – see Chapter 4), or can be supported by other municipal processes such as organizational reviews or efficiency/effectiveness reports.

5.12 Contributed Assets

Incorporating contributed assets into the lifecycle management strategy ensures that the additional lifecycle costs associated with these assets, beyond initial acquisition/construction, are accounted for in the long-term forecast.

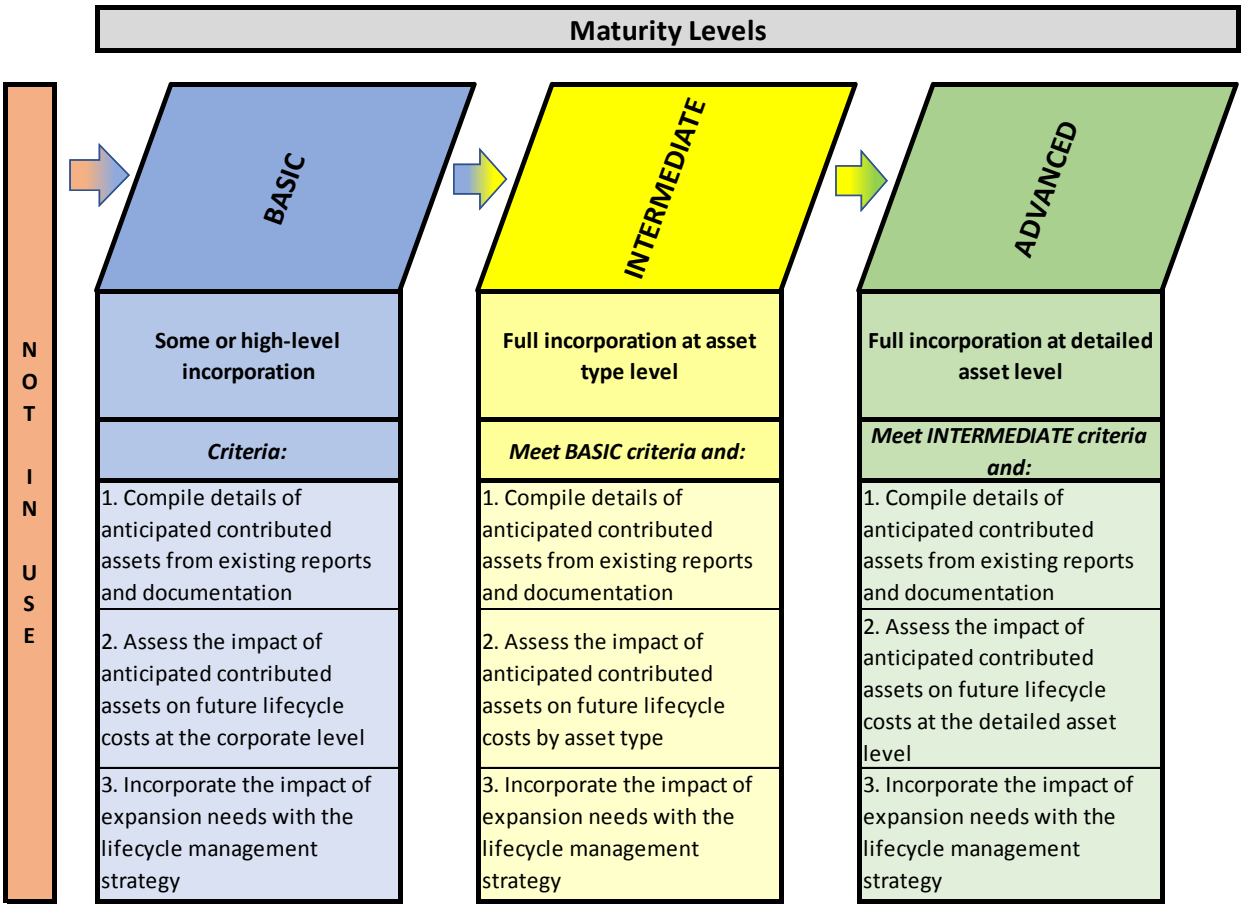
To what extent are contributed assets incorporated into the lifecycle management strategy?

Background

Municipalities can approach the incorporation of contributed assets in a number of ways. After compiling details of anticipated contributed assets from existing reports and documentation, some municipalities will assess their impact on lifecycle management costs at the corporate level, whereas others will focus on their impact on the lifecycle management costs by asset type, or even at a detailed asset level.

Levels of Maturity

To what extent are contributed assets incorporated into the lifecycle management strategy?



At the **basic level of maturity**, there will be some incorporation or high-level incorporation of contributed assets into the lifecycle management strategy. Municipalities at the basic level of maturity will compile details of anticipated contributed assets from existing reports and documentation. The impact on future lifecycle costs of these anticipated contributed assets is assessed, but generally at the corporate level only. The impact of the expansion needs is incorporated into the lifecycle management strategy.

At the **intermediate level of maturity**, there will be full incorporation of anticipated contributed assets into the lifecycle management strategy at the asset type level. Municipalities at the intermediate level of maturity will compile details of anticipated contributed assets from existing reports and documentation. The impact of these

expansion needs on future lifecycle costs is assessed by asset type. The impact of the expansion needs is incorporated into the lifecycle management strategy.

At the **advanced level of maturity**, there will be full incorporation of anticipated contributed assets into the lifecycle management strategy at the detailed asset level. Municipalities at the advanced level of maturity will compile details of anticipated contributed assets from existing reports and documentation. The impact of these expansion needs on future lifecycle costs is assessed at the detailed asset level. The impact of the expansion needs is incorporated into the lifecycle management strategy.

Contributed Assets

Contributed assets can include:

- Assets assumed by a municipality, built by a developer (i.e. completion of a subdivision where roads, stormwater, water, wastewater, parks, etc. were included in the construction); and
- Assets donated to a municipality (i.e. a community group), or a community group agreeing to pay for a portion of an asset's purchase or rehabilitation.

The future lifecycle impact of contributed assets should be accounted for within the asset management planning process. While the municipality may not be responsible for the initial purchase or construction of the asset, other lifecycle costs such as operations, maintenance, and future rehabilitation or replacement will likely be the responsibility of the municipality.

Each municipality should identify a consistent approach to accounting for contributed assets from an asset management perspective. While, for accounting purposes, these assets don't have to be recorded until the date of assumption, asset management consideration can occur before this event, if desired. If the municipality has the ability to estimate the assets being contributed (in terms of asset types and date of contribution), these estimates can be used to start planning for future lifecycle costs within the lifecycle management strategy (long-term forecast). The municipality's approach to determine the specific point in time to account for contributed assets in the asset management process should be consistently applied, considering options such as:

- As soon as the municipality learns of the contributed assets;
- The year (or year before) the contributed asset is anticipated to be received/assumed; or

- As soon as the contributed asset is recorded for accounting purposes (typically date of assumption/receipt).

For this process to work, effective communication is needed between municipal departments to ensure future contributed assets can be identified in an appropriate manner, and at the right point in time.

5.13 Risk Assessments within the Lifecycle Management Strategy

Developing a framework for assessing risk can help municipalities to set priorities and appropriate treatment intervention points for specific assets.

How are risk assessments used within the lifecycle management strategy?

Background

The previous sections of this chapter dealt with the lifecycle cost categories that make up the lifecycle management strategy. This section will explore how risk assessments are used to identify areas for focus and priorities within the lifecycle management strategy. This will allow a municipality to effectively mitigate risk while moving towards expected levels of service from an asset management perspective.

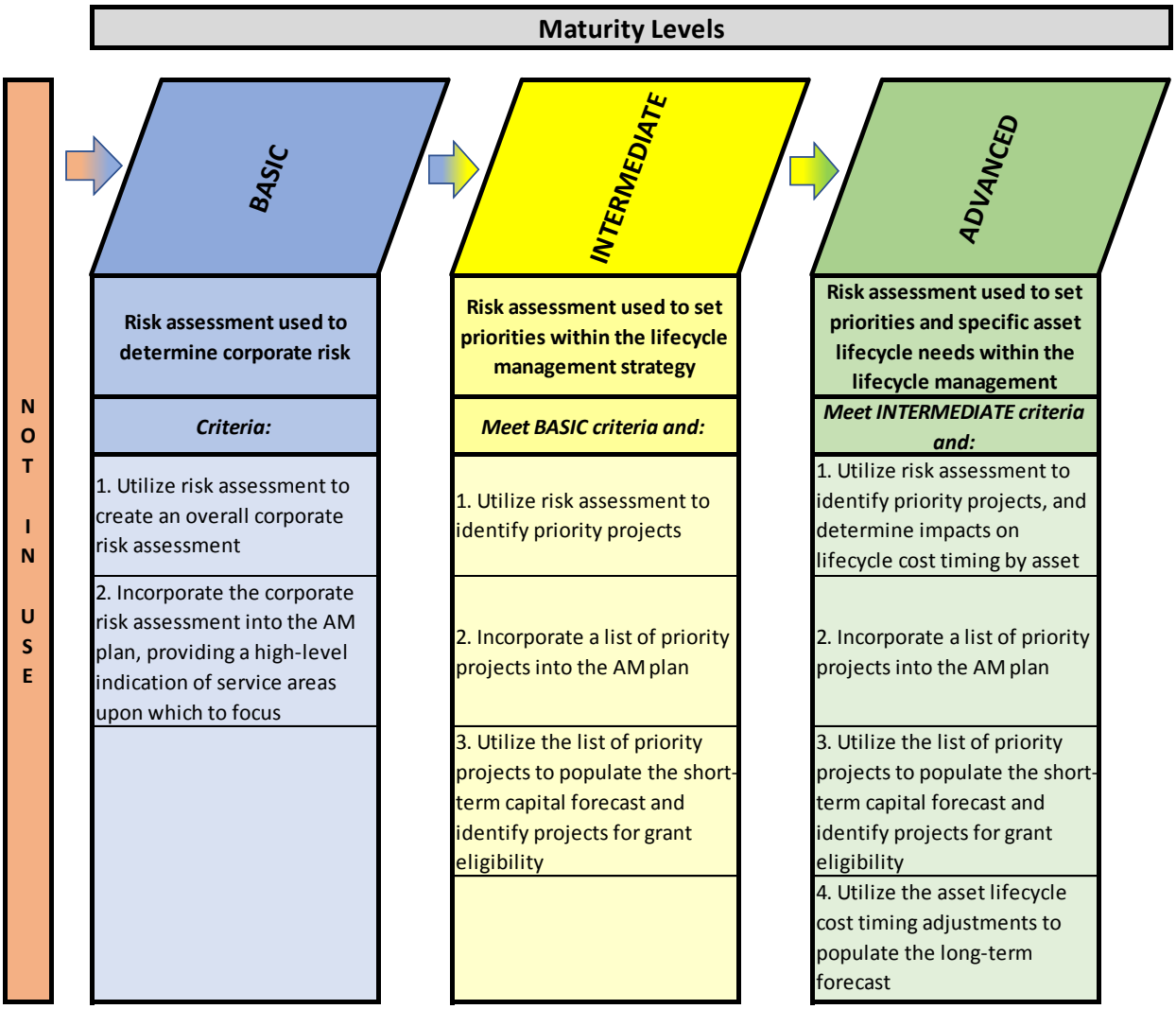
During the management and maintenance of assets there is an inherent risk associated with each activity. ISO 31000 – Risk management defines risk as:

"The effect of uncertainty on objectives"

Acknowledging risks and managing them appropriately helps to mitigate any implications associated with that risk, which enables municipal staff and Council to make informed decisions around how to manage infrastructure assets and their associated risks.

Levels of Maturity

How are risk assessments used within the lifecycle management strategy?



At the **basic level of maturity**, municipalities use risk assessment to determine corporate risk by service area. The resulting corporate risk assessment is incorporated into the asset management plan, providing a high-level indication of service areas upon which to focus in the lifecycle management strategy.

At the **intermediate level of maturity**, risk assessments are used to set priorities within the lifecycle management strategy. This is accomplished by utilizing risk assessment to identify priority projects, and then incorporating the list of priority projects into the lifecycle management strategy. The list of priority projects is utilized to populate the short-term capital forecast and to form the basis for determining grant eligibility.

At the **advanced level of maturity**, risk assessments are used to set priorities, as well as specific asset lifecycle needs within the lifecycle management strategy. Municipalities utilize risk assessments to identify priority projects, and determine the

related impacts on lifecycle cost timing by specific asset. The list of priority projects is incorporated into the lifecycle management strategy. The list of priority projects is also used to populate the short-term to medium-term capital forecast and form the basis for determining grant eligibility.

Risk Management Approach

A risk management approach essentially defines what risk management means to the organization.

For the purposes of asset management, there are two types of risk:

1. **Corporate Risk**: The corporate level risk assessment looks at risks that affect the organization as a whole.
2. **Asset (Service) Risk**: The activity level risk assessment looks at risks affecting the management of a service and any associated infrastructure. This level of risk assessment also considers corporate risk and is the level most relevant to asset management.

One of the first steps in risk management is to understand the organization and define the risk context. Factors that influence risk management are identified through this process and a risk tolerance can be defined.

Three steps can be followed for this process.

1. Conduct a review that identifies internal and external factors that need to be considered when managing risks corporately.
2. Determine the organization's risk tolerance, which can be expressed from the perspective of the organization, or for different types of services/risk.
3. Develop an overall risk management policy statement that is supported by staff and Council.

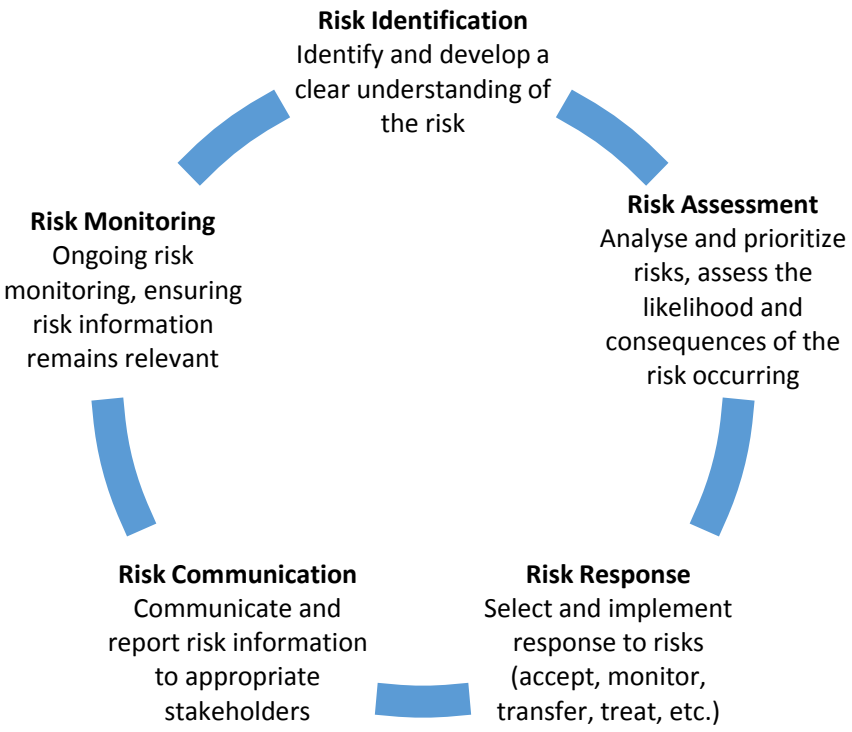
In understanding the organization from a risk perspective, a municipality should be able to describe the risk drivers affecting each service area. As discussed in Chapter 3, this includes determining the probability of assets failing as well as the consequence of assets failing, which results in services "failing". For services that utilize assets with a high probability and/or consequence of failure, the minimization of risk can become a significant objective of asset management planning. Please refer to Chapter 3 for details on assessing asset risk.

Risk Management Process

A risk management process is usually established as a procedure and should be referred to in the asset management planning process and be integrated into decision-making to assist in mitigating risk.

A risk management process is a series of inter-related steps that guide the identification, assessment, response, communication, and monitoring of risks. The risk management process outlined in the Treasury Board of Canada Secretariat's (TBS) *Guide to Integrated Risk Management* (Section 4.6) is summarized in Figure 5-9 (below).

Figure 5-9
Risk Management Process



Uncertainty, from a risk perspective, results from a lack of information or some degree of unpredictability; while an effect is the change in expected outcomes as a result of something happening. To be effective when analyzing risks, both the possibility of risks occurring and the uncertainty of an organization meeting their objectives should have risk treatments applied to manage risk effects. Actions to minimize negative impacts should be included in an initial risk assessment to manage effects from possible risks and uncertainties.

Essentially, this recognizes that whenever one tries to meet an objective there's a chance that things won't go according to plan. There is always an element of risk and the outcomes are generally uncertain. A municipality can attempt to mitigate this and reduce uncertainty as much as possible through risk management.

Risk Assessment

Once the risk management process has been defined, the next step is to assess which risks are the most severe. An organization can then determine the level of exposure to each risk, and from there, the actions necessary from a lifecycle costing perspective to mitigate that risk. From an asset management perspective, since service levels are directly tied to assets, risk is applied to specific assets, depending on both probability and consequence of failure.

As described in Chapter 3, risk can be assessed using a risk matrix as detailed in Table 5-9 (below), whereby:

$$Probability\ of\ Failure\ \times\ Consequence\ of\ Failure\ =\ Asset\ Risk\ Score$$

There are also various deviations from this calculation (as described in Chapter 3), but all approaches focus on probability and consequence factors.

Table 5-9
Risk Assessment Matrix

Probability of Failure	Consequence of Failure				
	Insignificant	Minor	Moderate	Major	Significant
Rare	Low	Low	Medium	Medium	High
Unlikely	Low	Medium	Medium	Medium	High
Possible	Low	Medium	Medium	High	Extreme
Likely	Medium	Medium	High	High	Extreme
Almost Certain	Medium	High	High	Extreme	Extreme

Setting Priorities Using Risk

In previous sections, it was discussed that risk management and informed decision making are inherently linked. The simplest way to use risk to set priorities is through a risk matrix similar to the one shown above. The suggested steps to incorporate risk into the lifecycle management strategy include:

1. Identify the probability of asset failure;
2. Identify the consequence of that failure;
3. Combine the probability and consequence factors to obtain a risk ranking;

4. The asset or project with the highest risk should be attended to first through some type of lifecycle activity (non-infrastructure solutions, maintenance, rehabilitation, replacement, or expansion); and
5. Lifecycle activity costs identified are included in the lifecycle management strategy.

Please refer to Chapter 3 for more details on this calculation.

The *International Infrastructure Management Manual* (IIMM) provides a good illustration of this process from another perspective, shown below in Figure 5-10:

Figure 5-10
Work Prioritization Based on Risk – IIMM

(i) Probability of Failure

Failure Likely	Probability
Within 1 year	0.9
Within 2 years	0.7
Within 3 years	0.4
Within 4 - 5 years	0.2
Within 6 - 10 years	0.1
Within 11 - 20 years	0.05
Within 20 years plus	0.02

(ii) Consequence of Failure

Costs of Repair	Impact of Failure/ Customer Hours Affected			
	Less than 2,000	2,000 - 20,000	20,000 - 200,000	Over 200,000
Less than $10,000	0	2	4	6
$10,000 - $50,000	2	4	5	7
$50,000 - $500,000	5	7	8	9
Over $500,000	8	8	9	9

(iii) The probability and consequence factors are combined to rank each risk

Example	Probability	Consequence of Failure	Risk	Priority
1	0.05	9	0.45	3
2	0.9	2	1.8	2
3	0.4	7	2.8	1

Figure 3.4.9: Work Prioritisation Based on Risk

5.14 Multiple Lifecycle Management Strategy Scenarios

Developing and accessing multiple lifecycle management strategies ensures that an appropriate balance of costs and service levels can be achieved. In addition, multiple scenarios can assist municipalities in finding the most cost effective approach to providing the desired levels of service.

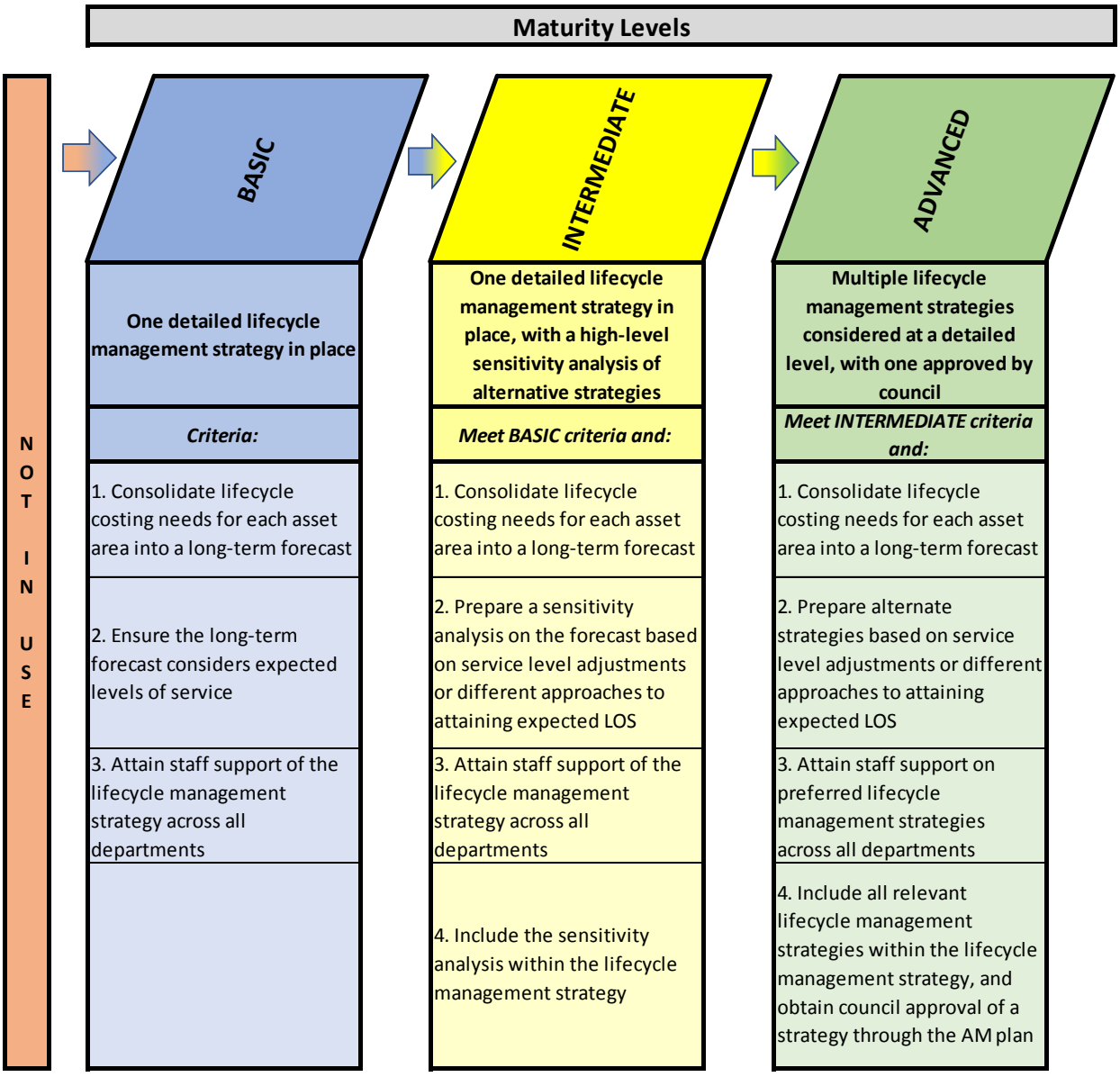
Has the municipality considered multiple lifecycle management strategy scenarios within its asset management plan?

Background

Municipalities can benefit from considering multiple lifecycle management strategy scenarios within their asset management plan. Comparing lifecycle cost forecasts versus asset performance (or service levels) over time for alternative strategies can assist municipalities to ensure that the most beneficial strategies are implemented.

Levels of Maturity

Has the municipality considered multiple lifecycle management strategy scenarios within its asset management plan?



At the **basic level of maturity**, municipalities will typically have one detailed lifecycle management strategy in place. Lifecycle costing needs for each asset area are consolidated into a long-term forecast. The long-term forecast is developed with consideration for expected levels of service. Staff support for the lifecycle management strategy should be attained across all departments.

At the **intermediate level of maturity**, municipalities will have one detailed lifecycle management strategy supplemented by a high-level sensitivity analysis of alternative strategies. Lifecycle costing needs for each asset area are consolidated into a long-term forecast. A sensitivity analysis on the forecast is prepared based on service level adjustments, or alternative lifecycle costing approaches to achieving expected levels of

service. Staff support for the lifecycle management strategy should be attained across all departments. The sensitivity analysis will form part of the lifecycle management strategy.

At the **advanced level of maturity**, multiple lifecycle management strategy scenarios are considered at a detailed level. Alternative strategies are prepared based on service level adjustments, or alternative lifecycle costing approaches to achieving expected levels of service. Lifecycle costing needs for each asset area are consolidated into long-term forecasts (one for each scenario). Staff support for the preferred lifecycle management strategy should be attained across all departments. All relevant strategy scenarios is included within the lifecycle management strategy, and Council approval of preferred scenarios should be obtained through the asset management plan.

Determining Lifecycle Management Strategy Scenarios

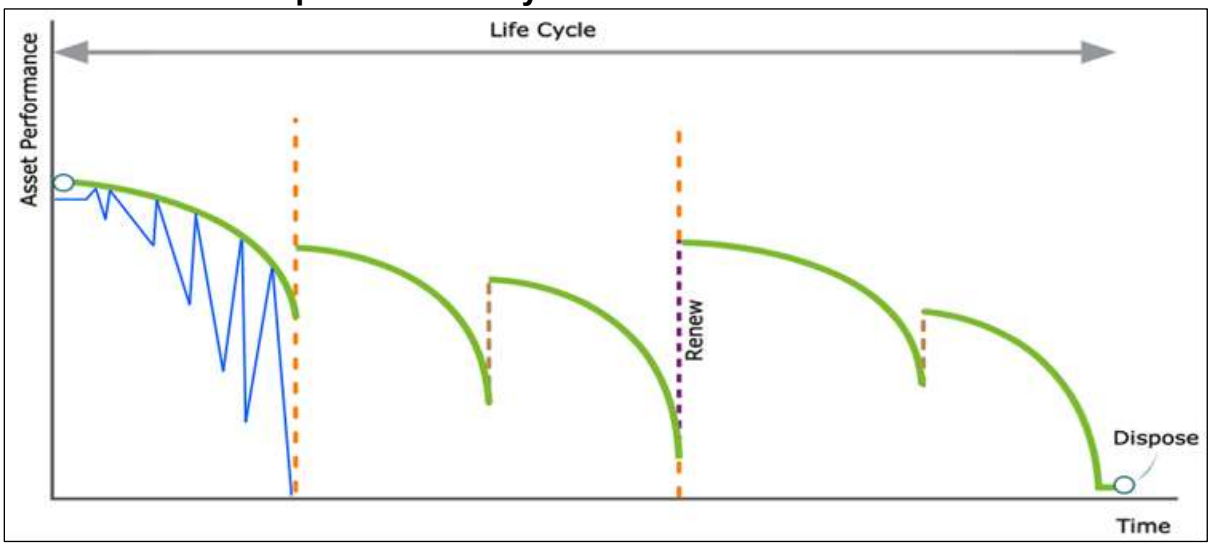
An optimal lifecycle management strategy would entail finding the most efficient/effective approach to managing assets throughout their life. The assets should be used in such a manner as to be as cost effective as possible (considering lifecycle costs), while delivering expected levels of service and mitigating risk. To facilitate this strategy, municipalities need to predict what lifecycle costs are needed, and when, including:

- Non-infrastructure solutions;
- Maintenance and operations;
- Rehabilitation;
- Replacement and disposal; and
- Expansion.

The lifecycle management strategy is the set of planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest lifecycle cost

Figure 5-11 (below) represents a sample asset's lifecycle. The degradation line (green) depicts the performance/ condition levels at various stages throughout the asset' life. As expected, the performance/condition of the asset reduces as time passes. Scheduled condition assessments can provide important insights into the degradation curve.

Figure 5-11
Sample Asset Lifecycle with Planned Intervention



The blue line represents maintenance completed in the first segment of the graph (in reality this would continue over the entire life of the asset). The length of the blue lines represents the amount of maintenance required as the asset deteriorates. As the degradation curve slopes down on the *Asset Performance* axis, the total amount of maintenance increases.

The dashed lines (orange) represent asset renewal and rehabilitation. These types of activities enhance the asset's performance and service life. This is evidenced by the position of the degradation curve immediately following the dashed lines along the *Time* axis. By actively managing the lifecycle management strategy for this asset, it has had its performance and service life maximized. However, eventually, the asset is disposed of and replaced. Creating an optimal lifecycle management strategy entails this type of analysis for all assets of the municipality.

Table 5-10 (below) outlines a number of approaches available for municipalities, when considering how to manage a particular asset's lifecycle needs.

Table 5-10
Sample Lifecycle Management Scenarios

	Strategy	Considerations
Asset Based Solutions	Do nothing	Always consider 'doing nothing' as an option. This position would be the baseline against which other options are compared. In some cases, risk levels or levels of service requirements offer 'do nothing' as a legitimate alternative.
	Operational procedures	Operational management changes to limit peak demand, such as minimizing leakage (i.e. water), or modifying schedules for use of an asset, could be employed. Contingency plans can improve recovery times and reduce impacts of failure.
	Maintenance procedures	The level and timing of maintenance can improve asset performance and/or extend its useful life.
	Asset rehabilitation/renewal	Depending upon where an asset is on its lifecycle, rehabilitation may be an option to maintain service levels, or extend service life.
	Expansion	Where demand exists, investment may be required to create new assets, or to augment/enhance existing ones.
	Asset replacement/disposal	An asset which is no longer providing adequate service levels may have to be disposed of and replaced, or reconfigured to meet alternative business needs.
Non-Asset Based Solutions	Reduce demand for service	Strategies to reduce demand can be employed such as pricing incentives and provision of alternative services (i.e. promote several parks).
	Reduce levels of service	Accept lower levels of service for certain identified assets (i.e. pavement surfaces could be allowed to deteriorate to a lower condition level for certain local roads).
	Educate customers	Use communication/information to allow customers to manage their use of assets (i.e. carpooling or water conservation) and their expectations of asset performance and failure rates.

Comparing Lifecycle Scenarios: Net Present Value

With multiple lifecycle management scenarios possible within an asset management plan, a methodology is required to compare these scenarios to determine the scenario with the “lowest lifecycle cost”. One possible methodology is a *net present value* analysis.

The timing and cost of interventions and maintenance, and therefore the real lifecycle costs, are impacted by the time value of money. In simple terms, this means that to be able to have $1.00 to spend in the future, you would have to invest less than $1.00 today. As a result, to compare future expenditures over a lifecycle, the value of all expenditures need to be discounted back to a current-day value. This is called Net Present Value (NPV), also known as Net Present Worth (NPW).

The formula for NPV is:

$$\sum_{n=0}^{N} \$C_n \left[\frac{1}{(1+r)^n}\right]$$

Where:

- $0 =$ year 0 of the analysis period;
- $N =$ the number of years in the analysis period;
- $\$C_n =$ the cost in year n;
- $r =$ the discount (inflation) rate as a decimal (e.g. 0.03 for 3%); and
- $n =$ the number of years into the future from year 0.

NPV is used to compare strategies that have the same duration (i.e. 2 scenarios that cover a 20-year forecast period). Applying the concept of NPV assists in determining the scenario with the lowest lifecycle cost. From a common-sense point of view, this approach is taking the inflated lifecycle costs in each year of the forecast and deflating them to put all into current year terms. In the example below, Table 5-11, scenario 1 and scenario 2 have the same inflated lifecycle costs over the 5-year forecast ($400,000), however scenario 2 has a lower NPV.

Table 5-11
Sample Net Present Value Scenarios

year	0	1	2	3	4	5	TOTAL
Scenario 1 Inflated		50,000	65,000	80,000	95,000	110,000	400,000
Scenario 1 NPV (yr = 0)		48,544	61,269	73,211	84,406	94,887	362,317
Scenario 2 Inflated		40,000	45,000	60,000	130,000	125,000	400,000
Scenario 2 NPV (yr = 0)		38,835	42,417	54,908	115,503	107,826	359,490

Therefore, creating and selecting lifecycle management scenarios entails looking at many objectives, such as:

- The levels of service provided;

- The risk being mitigated; and
- Minimizing lifecycle costs in current year dollars (i.e. through NPV calculations).

Why Optimize?

Municipalities must make good decisions as to how, where, and when they spend the limited funds available for infrastructure (capital and operating). This means gaining the most benefit from capital expenditure and minimizing maintenance costs without compromising service or risk levels over a long period. Therefore, a primary objective of asset management planning is to achieve the best cost versus service outcome.

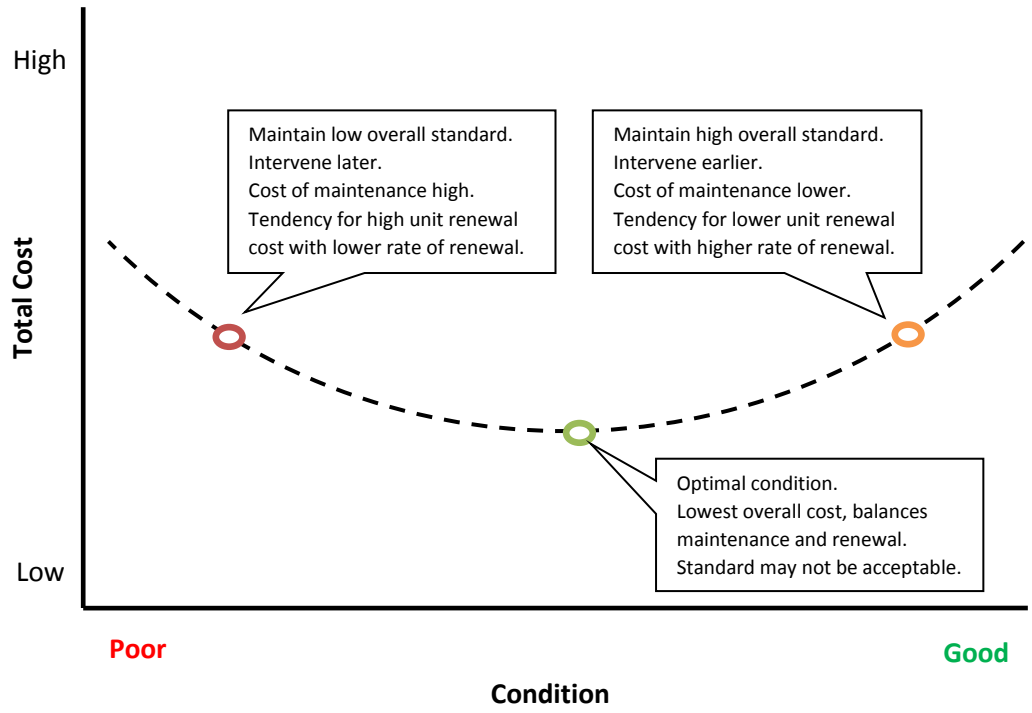
There are numerous asset management software packages that use deterministic, and/or probabilistic, techniques to model asset behaviour to predict future capital and operating budgets as well as asset condition. Many asset management software packages also include the ability to optimize aspects such as cost, risk, and other benefits. Concepts of modelling optimization are dealt with in more detail in Chapter 9.

What is Optimal?

Optimal outcomes for asset managers can mean different things. In previous sections of this chapter, lifecycle costing types were discussed. The lowest lifecycle cost could be termed as an optimal outcome from a finance point of view. If, however, the lowest lifecycle cost strategy does not deliver satisfactory levels of service, it would be a sub-optimal outcome from the customer's point of view.

This is demonstrated by Figure 5-12 below. The figure is based on the theory used by most modelling tools that costs are high to support a network in poor condition due to higher maintenance costs. Further, maintaining a network in very good condition also leads to high costs due to the need for more frequent renewal. Under this concept, the optimal cost level will be at some point between good and poor condition (the lowest point of the curve). The condition that correlates to that cost, however, may not be acceptable. So, a sub-optimal cost would be arrived at for the desired condition.

Figure 5-12
Lifecycle Management Scenarios – Optimal



Essentially, what asset managers should be striving for are levels of service that are either at the optimal point, or somewhere to the right of optimal, based on the example above.

Optimization is often constrained by available funding. For instance, it is not possible to fully optimize a condition outcome if funds are insufficient for the total maintenance and capital required. In these circumstances, the optimization will likely be the achievement the best all-round service outcome with the limited funding and involves balancing maintenance and capital costs with a number of benefits related to condition, risk, and other service aspects.

Typically, when using predictive modelling tools and optimization, a number of scenarios should be developed to evaluate differing funding levels and timing, differing service targets, and trade-offs between funding and service. After evaluation, a final scenario will be adopted as the preferred lifecycle management strategy.

5.15 Identifying Capital Priorities

Clear identification of capital priorities, spanning multiple years of the forecast period allows municipalities to outline critical projects within the asset management plan. It also provides a mechanism for determining projects eligible for grant funding, and provides linkages to key projects within the budget process.

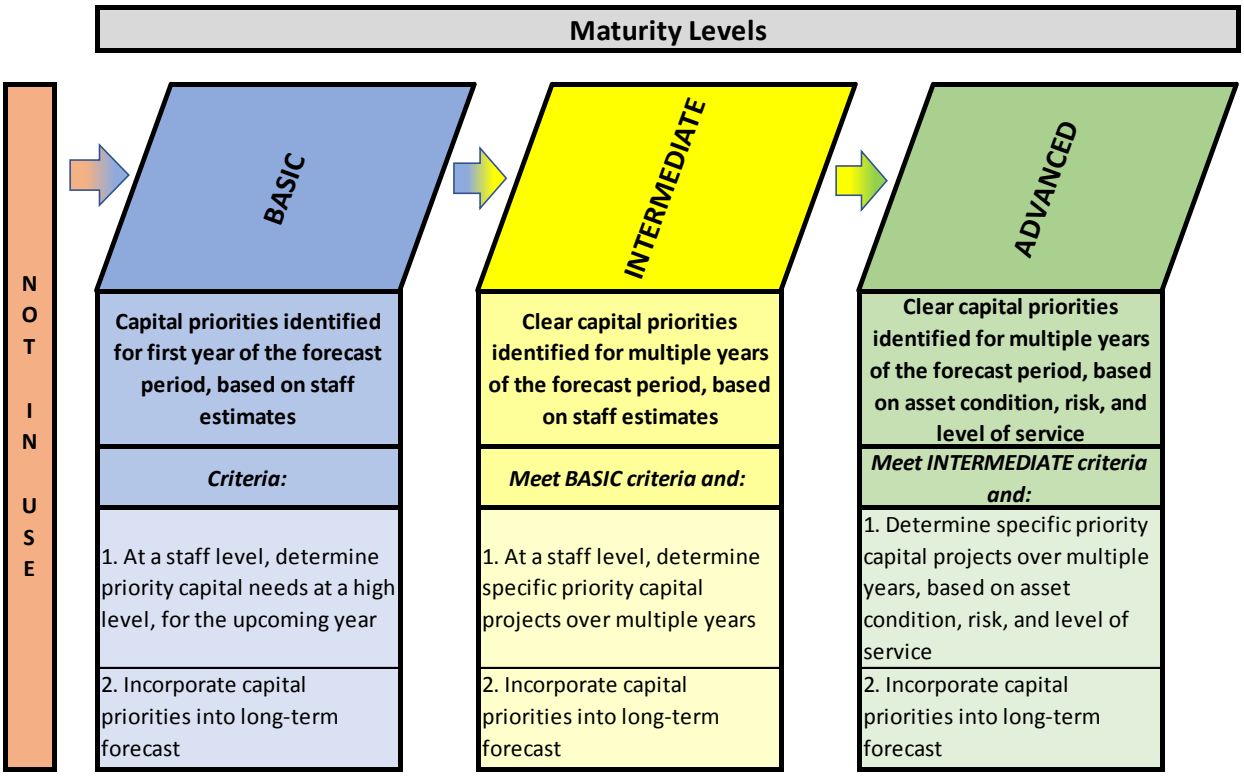
Are clear capital priorities established within the lifecycle management strategy?

Background

Capital investment is typically a combination of capital asset rehabilitations, replacements, and expansions. A methodology was introduced in the risk discussion in the section above that can assist municipalities to establish clear priorities based on a risk management approach. The clear identification of capital priorities is critical for the lifecycle management strategy, as it is a prerequisite for provincial grant funding applications and federal gas tax funding reporting.

Levels of Maturity

Are clear capital priorities established within the lifecycle management strategy?



At the **basic level of maturity**, municipalities will identify capital priorities for the first year of the forecast period only. Typically, at this level of maturity, this is done at a high level, based on staff estimates rather than a more documented and defined approach. The priorities are included in the first year of the lifecycle management strategy and identified as priorities within the asset management plan.

At the **intermediate level of maturity**, municipal staff will clearly determine specific priority capital projects over multiple years. Staff estimates are used as a foundation for the priority capital spending identification, which is documented by project or asset. This process is undertaken based on staff estimates rather than a more documented and defined approach. The priorities are included in the lifecycle management strategy and identified as priorities within the asset management plan.

At the **advanced level of maturity**, specific capital priorities are determined based on an assessment of asset needs in regards to condition, risk, and levels of service (i.e. documented and defined approach, such as risk management based). The priorities are included in the lifecycle management strategy and identified as priorities within the asset management plan.

Identifying Capital Priorities

Capital projects to be identified for current or future attention can come from a number of sources. The following list provides some areas of consideration:

- **Risk Management Assessments**: Identify assets (or service areas) with high risk of failure with the intent of mitigating risk, while providing expected levels of service;
- **Future Expansion Planning**: Identify areas where current asset capabilities will be insufficient to deliver expected levels of service, resulting in the identification of expansion-related priorities;
- **Asset Lifecycle Analysis**: Replacement/rehabilitation scenario models may identify assets as priorities (based on asset condition), in accordance with lowest lifecycle costs;
- **Asset Obsolescence**: Assets that no longer provide levels of service, or can no longer be maintained, rehabilitated or replaced given obsolescence, may be identified as priority projects;
- **Technological Advancements**: Opportunities may arise to deliver better service levels at a lower lifecycle cost;
- **Operational**: Municipal staff may identify potential priority projects to reduce asset operational costs; and
- **Land-use Plan**: Land-use planning may present new opportunities for existing assets or identify priority projects.

Depending on the availability of resources and/or the sophistication of asset management processes and tools, a municipality may prioritize decisions at the individual asset level, or at the asset type level. The latter approach will require some generalized assumptions to be made and followed for all assets of that asset type. This will potentially result in a lesser degree of accuracy than under the individual asset approach. However, making rehabilitation decisions at the asset type level can be appropriate for lower cost assets, where the cost of collecting individual cost information is not warranted, or reasonably attainable.

Examples:

Table 5-12
Asset Priority – Level of Detail

Level	Priority Project
Asset Type Level	Arterial Road Reconstruction Program

Individual Asset Level	Smith Street Reconstruction

From an asset management plan perspective, it is suggested that a subsection of the lifecycle management strategy be dedicated to discussing and identifying priorities. This subsection provides a clear and transparent priority identification for:

- Future budget consideration;
- Gas tax funding consideration; and
- Potential capital grant application process.

5.16 Resources and References

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