Norfolk County – Asset Management Plan – Bridges and Large Culverts

An overview of the County's Asset Management Practices based on the Ontario Ministry of Infrastructure's Building Together Initiative

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Sign-off Sheet

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Municipalities are stewards of Community infrastructure. Well-managed infrastructure fosters prosperity, growth, and quality of life for a Community's residents, businesses, and visitors.

Most Canadian municipalities are struggling to maintain existing infrastructure under current tax and rate levels. They continue to deal with downloaded responsibilities and, at the same time, face growing needs to maintain and renew aged and decaying infrastructure.

The subject of asset management has been gaining increasing public awareness as a result of the introduction of Bill 175, the Sustainable Water and Sewage Systems Act in 2002, and the implementation of "Full Cost Accounting" through PSAB. The emphasis is now being placed on not only knowing the true cost of providing services to your customers today, but also understanding what will be required to maintain the services virtually in perpetuity (or as long as they are required), through the use of life cycle costing. In other words, we are moving towards Sustainable Asset Management.

Ontario's Ministry of Infrastructure has also recently released guidelines for the development of Municipal Asset Management Plans, which supports the Province's 10-year infrastructure plan "Building Together". The objective of these guidelines is to provide a basis for the standardization and consistency of asset management practices across Ontario's municipalities.

This document follows the Ministry's guidelines for the development of an Asset Management Plan for the County's bridges and large culverts with a span greater than three metres.

1.0 Introduction

1.1 GOALS AND OBJECTIVES

This Asset Management Plan has been prepared in response to the Ontario Ministry of Infrastructure's *Building Together* initiative, and provides the County with a medium-term business plan for ensuring long-term sustainability of the County's infrastructure.

1.1.1 Scope of Work

The scope and format of this document follows the Ministry of Infrastructure's *Building Together: Guide for Municipal Asset Management Plans*. The Guide outlines the specific elements of a detailed asset management plan, which includes:

1. Summary
2. Introduction
3. State of Local Infrastructure
4. Desired Levels of Service
5. Asset Management Strategy
6. Financing Strategy

The County has developed individual Asset Management Plans following the Ministry's guidelines and suggested format for roads, bridges, and water and wastewater systems. The County is not responsible for social housing, an asset group to be included, if applicable, as per the Ministry's guide.

This document focuses on the County's bridge and large culvert infrastructure.

2.0 State of Local Infrastructure

A State of the Infrastructure report provides the County with an understanding of the true cost of maintaining the infrastructure that is required to provide the services to the Community. The following State of the Infrastructure (SotI) assessment was developed through a Life Cycle Analysis, covering the County's bridges and culverts.

The SotI was based on a high-level analysis of the replacement, rehabilitation, and maintenance needs of the County's bridge and culvert assets. This included the preparation of a report on the current and assumed future state of these assets.

In November 2003, the *National Guide for Sustainable Municipal Infrastructure* published a *Best Practices for Municipal Infrastructure Asset Management*. This publication included a listing of seven questions, which could be used as a framework for an asset management plan. The SotIR employs this framework:

1. What do you have and where is it?
   (Inventory)
2. What is it worth?
   (Costs/Replacement Rates)
3. What is its condition and expected remaining service life?
   (Condition and Capability Analysis)
4. What is the level of service expectation, and what needs to be done?
   (Capital and Operating Plans)
5. When do you need to do it?
   (Capital and Operating Plans)
6. How much will it cost and what is the acceptable level of risk(s)?
   (Short- and Long-term Financial Plan)
7. How do you ensure long-term affordability?
   (Short- and Long-term Financial Plan)

The County's Public Works assets have a replacement value of **$2.2** billion. The breakdown of those replacement values per serviced property or household in the County, are shown in Figure 2.1 below.

It can be noted that the bridges and culverts maintained by the County account for approximately **10%** or **$212** million, of the total asset replacement value for the County's infrastructure.

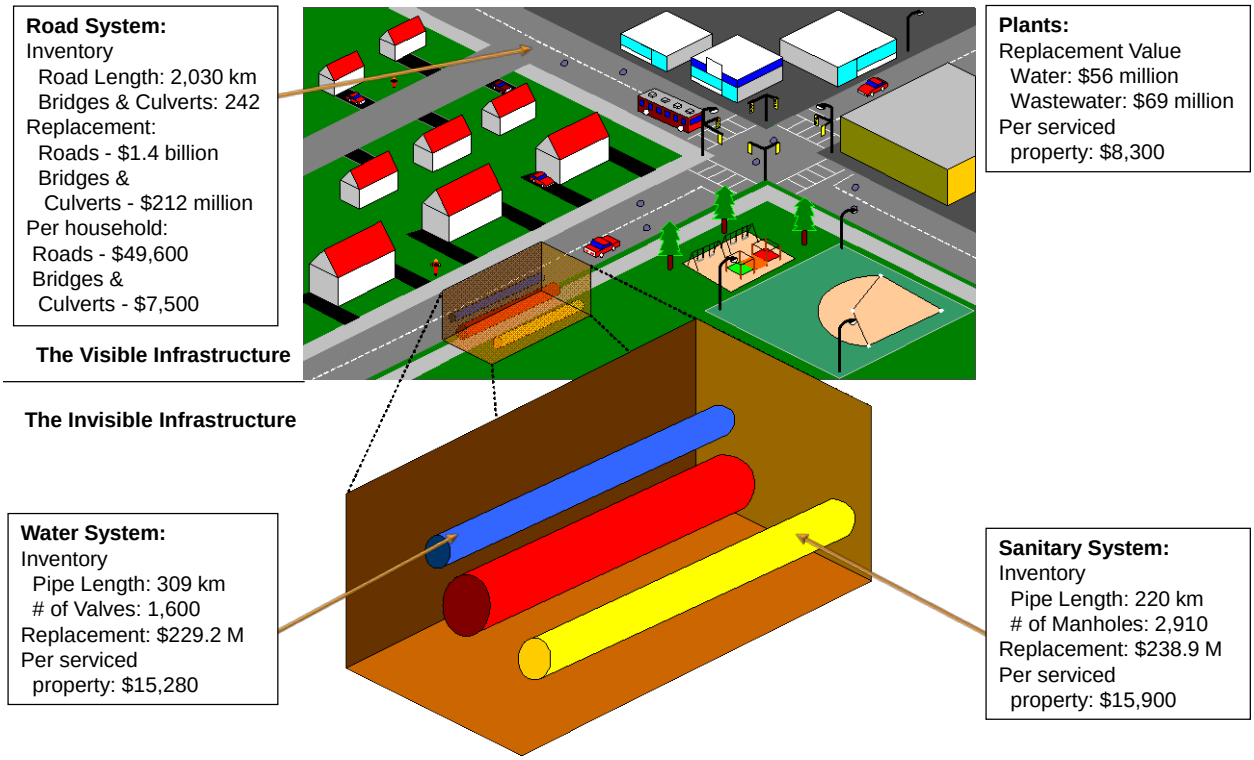

Figure 2.1: Asset Replacement Value per Serviced Property/Household

2.1 VALUATIONS

2.1.1 Financial Accounting Valuation

Based upon the County's 2012 Financial Information Return filed with the Ministry of Municipal Affairs, the Net Book Value of the County's Bridges and Culverts at the end of 2012 was $16.1 million. The assets included in this figure are outlined in Table 2.1 below:

Table 2.1: FIR Schedule of Tangible Capital Assets (Schedule 51)

Asset Type	Asset Component	2012 Closing Net Book Value (million)
Roads	Bridges and Culverts	$16.1

2.1.2 Replacement Cost Valuation

The Total asset value of the County's Bridges and Culverts is approximately **$212 million**. If this total asset value is translated to provide an average value for each of the approximately 28,240 households within the County, then an average household will be responsible for approximately **$7,500** of Bridge and Culvert assets.

The following tables provide a breakdown of the contribution of each of the bridge and long-span culvert assets to the overall system value.

Table 2.4: Bridge & Large Culvert Replacement Values

Asset Type	Quantity	Unit Rate	Total Replacement Cost
Bridges	130	$1,200,000 each	$156,000,000
Culverts	112	$500,000 each	$56,000,000

2.2 AGE AND REMAINING SERVICE LIFE

A useful life span can be assigned to an asset type, such as 70 years for bridges and culverts. However, there are many conditions that can affect the true life of an asset, such as: design, construction, and manufacture quality, maintenance standards, quantity of use, surrounding environment, construction material, and so forth.

The level of intervention on infrastructure will vary significantly over the life cycle of an asset. The process of maintenance, rehabilitation, and failure is a very dynamic system. Therefore, it is essential that we take a life cycle approach to assessing the financial needs for the future.

This dynamic process of asset aging has a significant financial impact attached to it that can be quantified. Therefore, our financial analysis is based upon a life cycle model that identifies upcoming trends in asset replacement and, hence, funding needs.

The following diagram illustrates the age distribution of the County's bridge and culvert asset portfolio based on an estimated useful life of 70 years.

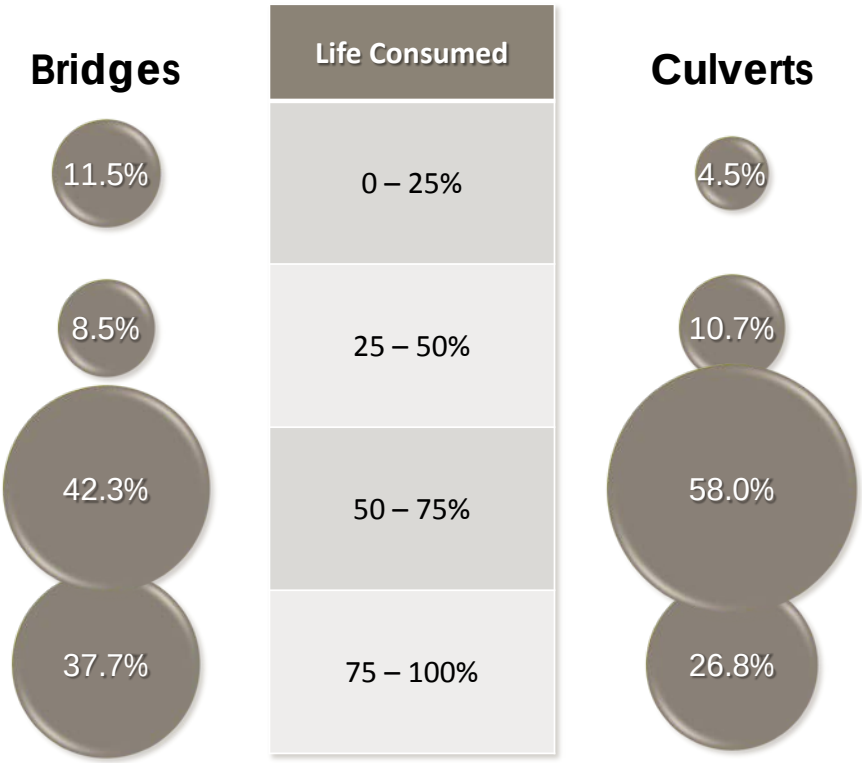

Figure 2.2: Asset Age Distribution (% Life Consumed)

As can be seen from Figure 2.2, over 80% of the County's bridges and culverts are over half way through their expected life; this represents 104 bridges and 95 culverts, which will require rehabilitation or reconstruction within the next few years. The total replacement cost associated with the 49 bridges and 30 culverts in the last quarter of their life is approximately **$74 million**.

Therefore, it is essential that the County continues to assess the condition of these structures on a regular basis, to ensure that any significant defects are addressed as soon as possible.

Figure 2.3 illustrates the projected replacement profile for the County's bridges and culverts.

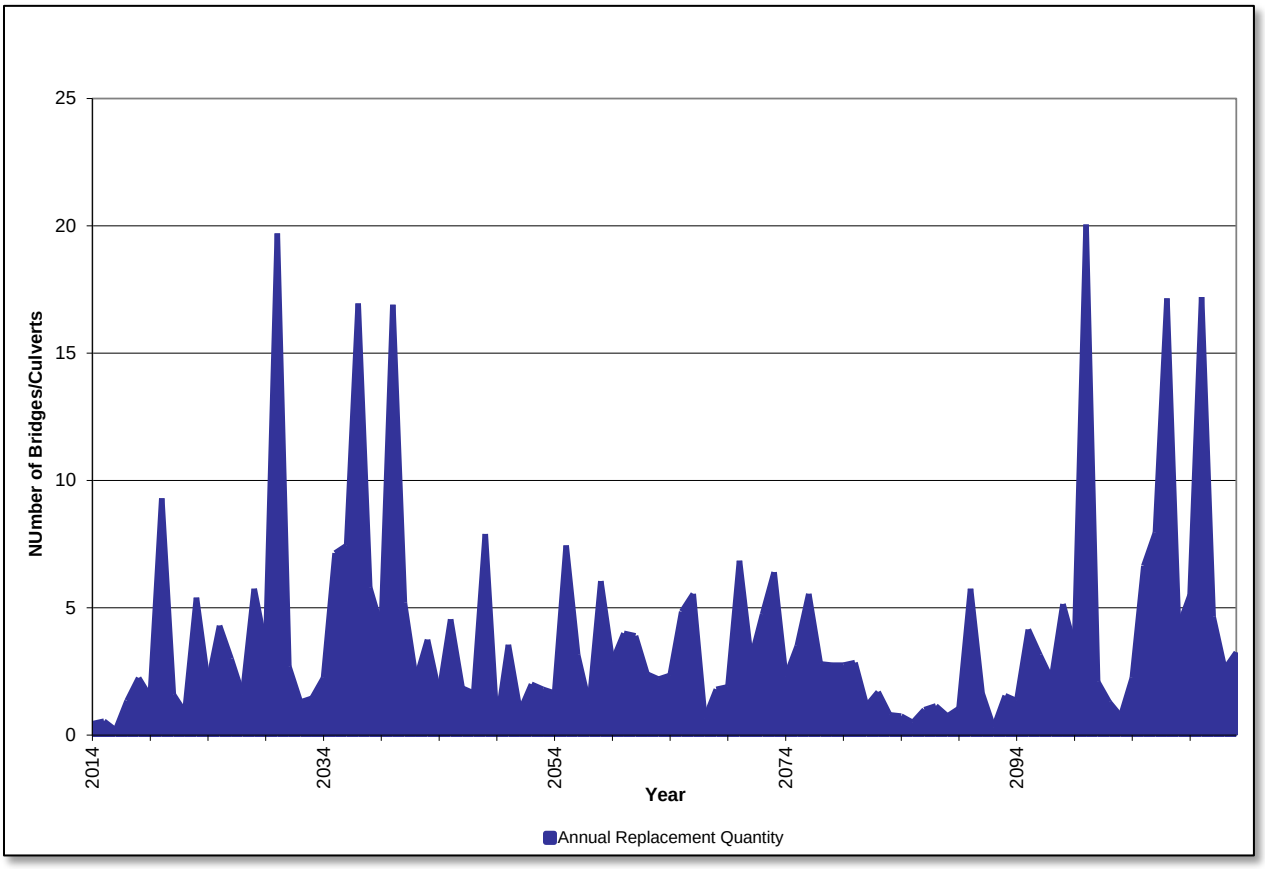

Figure 2.3: Replacement Profile (Bridges and Culverts)

2.3 ASSET CONDITION

Bridge conditions are assessed through inspection, which involves the use of various techniques to assess the physical condition of bridges. Bridge inspection procedures and guidelines are documented in well-developed bridge inspection manuals, such as the Ontario Structure Inspection Manual (OSIM 1989) published by the Ontario Ministry of Transportation. The County currently contracts with structural engineering firms to undertake condition assessments every two years, in accordance with Provincial requirements.

2.4 INSPECTIONS

Activity Name	Comments
Activity Description	Periodic inspections of all bridge components of the structure. Careful and systematic inspection in order to identify areas that require attention before they require major rehabilitation or become potential failures.
Recommended Frequency	Legislated biennial inspection schedule.
Purpose/Benefits	Identification of potential failures before they become major repair problems. Unusual conditions or changes observed during inspection must be reported and will often result in a follow-up In-Depth, Damage, or Special Inspection. Demonstrates regulatory compliance.
Costs/Concerns	Defects identified during inspections require correction.

2.5 BRIDGE CONDITION RATINGS

The bridge condition is evaluated in terms of a Bridge Condition Index (BCI). The BCI is based on the remaining economic worth of the bridge, and ranges from 0 to 100 (Best). This index is a function of the existing condition state of the deck, beams, abutments, piers, and barriers.

BCI = Current Element Value/Total Replacement Value × 100

This index requires that the current condition state of the elements be determined. The governing standard is the OSIM, published by the Ontario Ministry of Transportation (MTO). This visual inspection is used to assess the element condition state and to record the areas that are deteriorated. The material condition state is specified in the OSIM and guidelines are established to evaluate the areas that require rehabilitation and have a reduced economic value. In general, OSIM describes in detail how to rate element distresses in terms of type, severity and extent. The surface condition in terms of surface defects is typically evaluated visually. Material condition states are categorized as Excellent, Good, Fair, or Poor.

The following simplified figure demonstrates that the deterioration is proportional to the age of the structure. The rehabilitation in year 25, is recommended, but will not return the structure to perfect condition, and bridge deck waterproofing and paving should occur at approximately 15 years, to extend the life of the structure. It is recognized that the deterioration will not be linear and the rate of deterioration will vary for each bridge type and location, but this simplified figure serves to illustrate the basic principles at play.

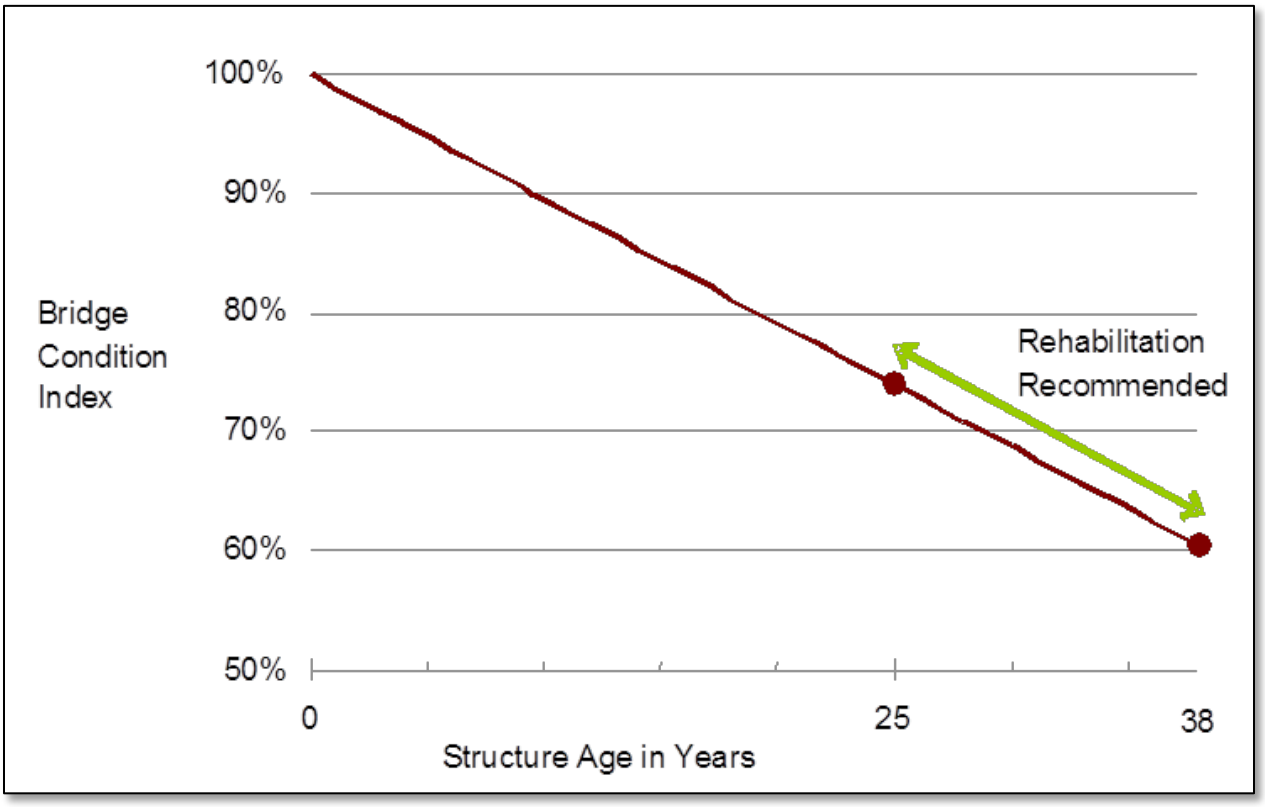

Figure 2.4: Structure Deterioration Model

To date, the data collected during these biennial inspections has not included an assessment of the structure BCI. The next series of inspections will occur in 2014, and will include a requirement for the consultant to calculate the BCI for each bridge and culvert; therefore, future updates to the Asset Management Plan will include a report on overall BCI values for the bridge and culvert asset portfolio.

3.0 Desired Levels of Service

Levels of Service for bridges and culverts are a combination of the Community's expectations and the County's required and desired maintenance and performance targets to meet legislative requirements.

It is important that the County first establish performance objectives for the Asset Management Plan (AMP). Some typical examples of performance objectives are listed below.

- Maintain bridges and culverts to ensure that they remain structurally sound
- Minimize the number of structures with reduced loading requirements
- Perform structure rehabilitation at the optimum point in the deterioration cycle to reduce costs

Performance objectives may be based upon legislative requirements, or industry best practices, and values/goals are agreed upon by the County and Community, through Council policies

Within future iterations of this Asset Management Plan, the County will consider further refining its service level targets for structures. Under consideration will be:

- Exploring options for closing or divesting structures if they are no longer required
- A maximum desired backlog of work
- A determination of funding and service goals for maintenance versus rehabilitation/replacement activities
- Seeking further Community input to further refine expectations and targets

4.0 Asset Management Strategy

A highway bridge is a very expensive, complex structure where the elements of the structure must interact with each other in a unique and efficient way. The operational efficiency of the entire structure can be greatly affected by the malfunction of one element; thus, systematic and continuous maintenance of a bridge will extend its service life as well as reduce its operating expense. Sudden, catastrophic events can be avoided if good systematic, preventive maintenance is practiced. It is also important to carefully and systematically inspect all components of the structure periodically, in order to identify areas that require attention, before they require major repairs.

Strategies related to the maintenance of the bridges and culverts are provided in the following section. The bridge roadway components included in these activities include the deck with or without separately applied wearing surfaces, joints, and deck drainage systems.

Please refer to the *Structure Rehabilitation Manual* by the Ministry of Transportation Ontario, and other applicable publications, for information on the comprehensive maintenance and rehabilitation of all aspects of bridges and culverts.

4.1 CLEANING AND FLUSHING

Activity Name	Cleaning and Flushing
Activity Description	Cleaning and flushing of concrete decks, drains, expansion joints, lower chords, bent caps and other elements. All drainage devices, including curb outlets, pipe drains, floor drains, downspouts, etc., should be adequately cleaned to prevent ponding of water on the deck. Includes cleaning of drainage system to remove items such as bottles, cans, rubbish, debris, etc.
Recommended Frequency	Annual – typically in spring.
Purpose/Benefits	Ponding of water on the deck leads to safety issues for vehicles, such as hydroplaning or skidding on ice in winter. Structural deterioration occurs when water carrying deicing chemicals penetrate the concrete, causing eventual deterioration, especially in cracks and joints. Removal of salt-laden dirt and debris assists in slowing the following distresses: • Scaling of concrete surfaces • Corrosion of reinforcing steel and subsequent spalling of concrete • Deterioration of paint systems and corrosion of supporting members • Corrosion and "freezing" of expansion bearings, which can cause excessive tensile stresses to be transmitted to the concrete under the bearing pad, after sudden drops in temperature, which causes the structure to contract rapidly • Clear deck drainage systems will reduce or avoid ponding water, which can lead to vehicle safety issues such as hydroplaning or skidding on ice. Continued ponding will promote rapid concrete deck deterioration.
Costs/Concerns	It is critical that dirt, debris, and trash be removed from the lower chord and floor beam flanges and connections on truss spans. Failure to do so can lead to loss of section in the steel members at these points. Silt and debris from a deck flushing cannot be discharged directly into the creek; therefore, the local Conservation Authority should be consulted to determine appropriate control requirements. Ensure any drainage that discharges onto supporting members is directed away from these members.

4.2 CRACK SEALING

Activity Name	Crack Sealing
Activity Description	Sealing individual longitudinal, transverse, or random cracks with asphalt or other suitable materials.
Recommended Frequency	As required, or at five-year intervals, whichever is shorter.
Purpose/Benefits	Cracks can be caused when moisture, which carries deicing chemicals, enters the deck cracks. The moisture and chemicals can cause the reinforcing steel to corrode. When the moisture and chemicals swell or expand, the concrete will spall over the reinforcing steel. When the moisture remains trapped in the crack, freezing temperatures or traffic action will also contribute to spall development. Therefore, prevention of moisture and deicing chemicals from entering the cracks will slow the deterioration of the concrete deck. It should be noted that deicing salts in solution can also permeate into the concrete surface, which can cause corrosion and expansion of the embedded steel and subsequent cracking in the concrete.
Costs/Concerns	

4.3 ASPHALT SURFACE TREATMENT

Activity Name	Asphalt Surface Treatment
Activity Description	Asphalt or equivalent sealer can be applied to the surface of significantly cracked or extensively patched decks.
Recommended Frequency	A surface treatment can restore the functional properties of the pavement on the deck, including the smoothness and surface condition. The application of a functional overlay assumes that the structural integrity of the pavement has not been compromised through the various load and environmental conditions. A functional overlay is expected to last from five to eight years.
Purpose/Benefits	Provides protection against the effects of moisture and deicing chemicals for decks that are subjected to frequent freezing and thawing cycles, high moisture, and/or frequent exposure to seawater.
Costs/Concerns	Traffic volume, grade, and bridge alignment should be considered prior to sealing since these factors will greatly influence the successful performance of the seal. Seal the entire bridge deck including the curb outlets (except for inside the curb outlets when the coverstone is broadcast on the deck). It is important to keep the deck expansion devices free of the sealant material since this may interfere with their proper functioning and movement. Remove any material that enters the expansion device promptly and completely. For a short time after sealant application, remove excess coverstone from the deck daily in order to reduce windshield damage and avoid blockage of drains. Remove excess coverstone from the substructure caps and lower chords of the truss spans. This material may be reused for scalping and sealing areas around timber abutments and abutment wings or for sealing gutters at the bridge ends.

4.4 ASPHALTIC CONCRETE OVERLAY

Activity Name	Asphaltic Concrete Overlay
Activity Description	An overlay is a new lift or lifts placed on an existing pavement. The thickness of an overlay varies depending on the severity and extent of the distresses visible on the pavement surface, the roughness of the riding surface, and the structural improvement required to meet the traffic loads. Specific distresses are typically repaired either through milling or patching prior to the placement of the overlay. (TAC 97) Milling can be included prior to the asphaltic concrete overlay where moderate to severe surface distresses on the deck are present. A multiple-course penetration asphalt surface treatment, membrane, or other deck sealer should always be applied prior to an Asphaltic concrete overlay.
Recommended Frequency	An overlay would be considered a functional overlay that restores the functional properties of the pavement on the bridge deck, including the smoothness and surface condition. The application of a functional overlay assumes that the structural integrity of the pavement has not been compromised through the various load and environmental conditions. A functional overlay is expected to last from five to eight years. Milling and replacing the top course of asphalt is expected to last 15 years.
Purpose/Benefits	Provide a smooth riding surface and help reduce damaging impact to the deck. Can be used as a protective wearing surface for penetration asphalt, membrane waterproofing systems, or other deck sealers. End dams should be provided at expansion joints to protect the overlay next to the joint and to keep overlay material out of the joint.
Costs/Concerns	Asphaltic concrete overlays are relatively porous and therefore, do not provide an effective seal. The porosity can entrap salt-laden moisture, which can promote deck deterioration in the absence of an effective deck sealer. A multiple-course penetration asphalt surface treatment, membrane or other deck sealer should always be applied prior to an Asphaltic concrete overlay. Periodic inspection of asphaltic overlays on concrete bridge decks for cracking and debonding from the concrete, commonly found around curbs, expansion joints and at locations where the overlay is cracked. The overlay in these loose areas should be removed and replaced. For good adhesion, the concrete deck must be dry and primed with an effective sealer and bonding agent before placing the asphaltic overlay and all cracks should be sealed to prevent entry of water.

4.5 CLEAN EXPANSION JOINTS AND REPLACE JOINT FILLER

Activity Name	Clean Expansion Joints and Replace Joint Filler
Activity Description	Filled expansion joints should be cleaned of all incompressible materials. Replacing joint filler with asphalt impregnated felt or polyurethane foam topped with poured-in-place rubber asphalt, polyvinyl chloride, polysulfide, neoprene, butyl rubber, or polyurethane, if filler is required.
Recommended Frequency	Replace strip seals after 5 to 15 years and replace the entire joint assembly after 15 to 30 years. As an alternative, when the structure receives a rehabilitation some consideration should be given to conversion to an integral or semi-integral abutment, removing the expansion joint completely.
Purpose/Benefits	Incompressible material such as dirt, sand, coverstone, debris, etc., found in expansion joints will inhibit the expansion and contraction of the bridge. This may cause the concrete deck and/or the girder ends to crack or crush when expanding which can cause undue pressure on the superstructure bearings. This can result in cracking and spalling of a concrete substructure cap. Deterioration of the adjacent deck can also be caused by joints filled with debris, moisture, and deicing chemicals.
Costs/Concerns	

4.6 RECOMMENDED MAINTENANCE STRATEGIES FOR CULVERTS

A culvert is a conduit that can be used to enclose a flowing body of water, which allows water to pass underneath a road, railway, or embankment. The following activities are recommended for the maintenance of culverts.

4.6.1 Inspections

Activity Name	Inspections
Activity Description	Careful and systematic inspection in order to identify areas that require attention before they require major rehabilitation or become potential failures.
Recommended Frequency	Biennial inspections.
Purpose/Benefits	Identification of defects may suggest rehabilitation of culvert based on inspection observations. Inspections are required in order to identify performance deficiencies such as pedestrian and vehicular hazards.
Costs/Concerns	Defects identified during inspections require correction.

4.6.2 Stream Maintenance

Activity Name	Stream Maintenance
Activity Description	Cleaning and removal of items such as bottles, cans, rubbish, debris, etc., from the stream. Redefine stream where meandering and channelization has occurred.
Recommended Frequency	As required
Purpose/Benefits	Ensure stream is clear of obstruction. Ensures stream flow is directed through the channel.
Costs/Concerns	Activities should be reviewed with the respective Conservation Authority to ensure that the risk of potential contamination of the watercourse is minimized.

4.7 DISPOSAL ACTIVITIES

The County will continue to explore the requirements for bridges and assess closure and/or divesting of bridges and culverts, as required.

4.8 EXPANSION ACTIVITIES

The Norfolk County expects modest growth in the foreseeable future. Expansion activities are reflected in the County's master plan.

4.9 PROCUREMENT METHODS

To ensure the most efficient allocation of resources and funds, the County will consider:

- Bundling projects when issuing tenders, to realize cost-benefits of economy of scale

4.10 RISKS

There are several risks that could prevent the County from reaching/maintaining its target level of service for bridges and culverts:

Table 4.1: Risks Associated with Not Reaching Defined Level of Service Targets

Potential Risk	Potential Impact
Required Funding Not Secured	• Bridges and culverts deteriorate further • The condition of the overall asset portfolio decreases • Bridges and culverts deteriorate beyond a condition where rehabilitation is a viable option • Backlog of work increases • More costly treatments and replacements are required • Structures are closed, resulting in increased operating costs for the public and local businesses
Substantial Increase in M&R Unit Costs in Future	• Inability to complete all planned projects with allotted budget levels • The condition of the overall asset portfolio decreases • Bridges and culverts deteriorate beyond a condition where rehabilitation is a viable option • Backlog of work increases • More costly treatments and replacements are required
Environment Change (e.g., severe weather)	• Increased flows in rivers and creeks that require bridges and culverts to be redesigned to accommodate the flows • More costly treatments are required to increase flow capacity and reduce risks from undermining the structure

4.11 ASSET MANAGEMENT PLAN FUTURE UPDATES

The Asset Management Plan for roads is a living document, and will require regular review and refinement. Specifically, the County will:

1. Review the Asset Management Plan annually and confirm validity of assumptions
2. Update the Asset Management Plan every five years
3. Adhere to bridge/culvert inspection regulations (two-year inspection cycle)
4. Update all pertinent attribute and condition data for bridge management purposes
5. Further refine its level of service targets, by engaging in a Community outreach program, to help identify the desired levels of service of County's residents

5.0 Financing Strategy

The County's investment in Bridge and Culvert operations for the period 2011-2012 is summarized in Table 5.1 below.

Table 5.1: FIR Schedule of Operating Expenses (Schedule 40)

Asset Type	Asset Component	2011 [1]	2012 [1]
Roads	Bridges and Culverts	$0	$8,600

[1]Excludes amortization expense & interest on long term debt

This data was derived from the Financial Information Return (FIR) filed with the Ministry of Municipal Affairs and Housing (http://oraweb.mah.gov.on.ca/fir/welcome.htm).

5.1 ESTIMATE OF BRIDGE AND CULVERT CAPITAL AND OPERATING REVENUE REQUIREMENTS

The analysis, which was completed to identify Capital and Operating revenue requirements, was based upon the following assumptions:

1. All values are calculated in current dollars (2013)
2. Replacement costs were based upon unit costs identified within
3. The following allowances were made in the analysis for Engineering (15%), Contingencies (5%), and Overhead & Admin (0%)
4. Operating investments were estimated as 1.1% of the total replacement values of the bridges and large culverts, plus allowances for Overhead and Admin (0%)

Therefore, based upon these assumptions, for the period 2014 to 2113, the average annual revenue required to sustain the County's Bridge and Culvert assets is $6.5 million. Over this same period, and excluding growth, this represents 3.0% of the Bridge and Culvert replacement value of $212 million. Figure 5.1 illustrates the revenue profile from 2014 to 2113, derived from the analysis for all of the Bridge and Large Culvert assets.

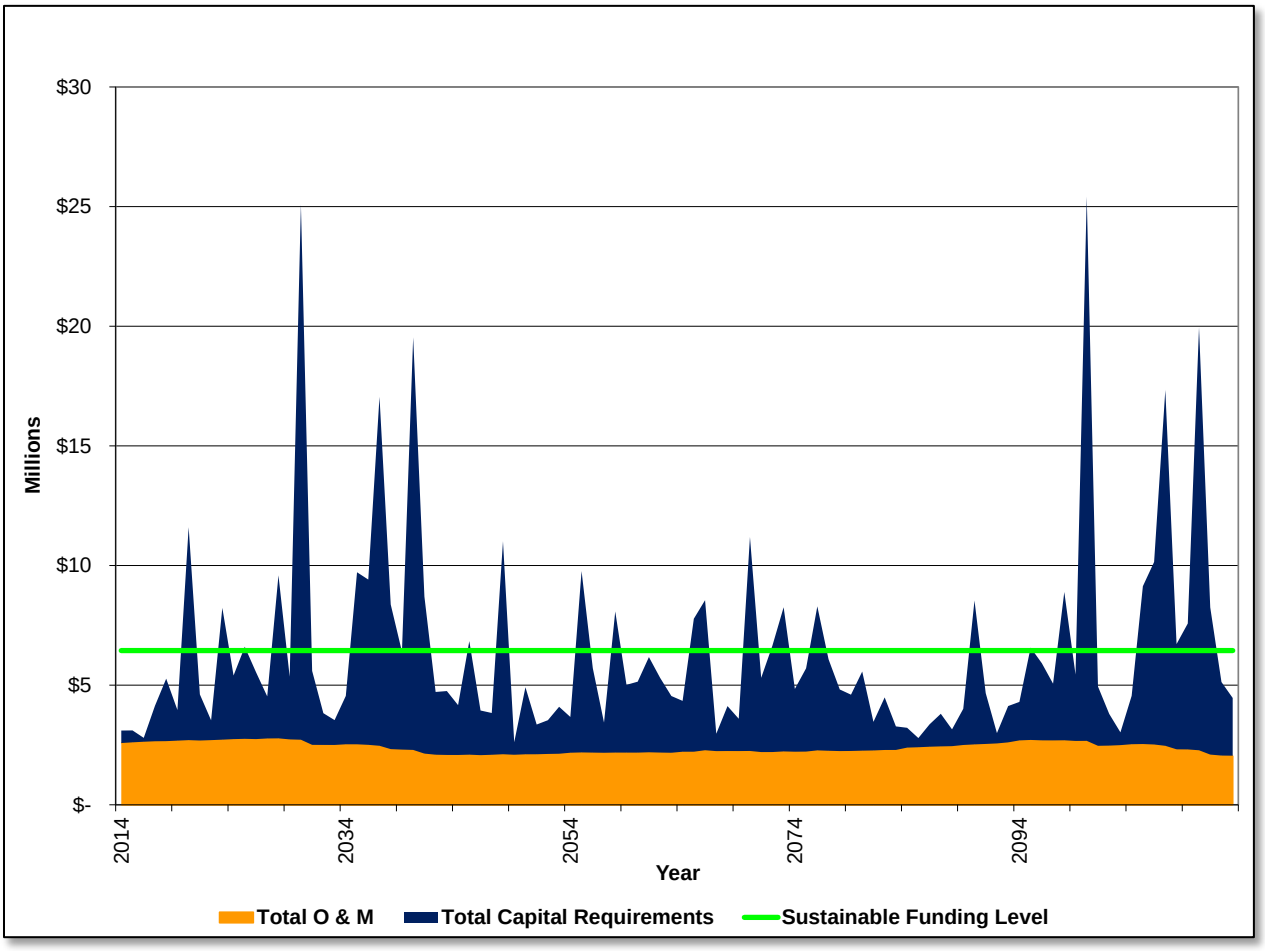

Figure 5.1: Bridge and Culvert Revenue Requirements

Based on the SotI analysis results and a review of the 2014 - 2023 capital funding needs (as supplied by County Staff), the budget for the 10-year period falls short of the sustainable revenue requirements. The table below illustrates the magnitude of this deficit for the County's bridges and culverts. The analysis projects the finance requirements of each program over a 100-year period, to include the full life cycle of each asset type.

Table 5.2: Sustainable Revenue - Capital (Millions)

Program	2014-2023 Projected Revenue (average annual)	Projected Sustainable Revenue[1] (average annual)	Overall Surplus/ (Deficit)
Bridges & Culverts	$1.4	$4.1	($2.7)

1. Assumes no growth in the County's population and infrastructure

5.2 BUDGET PROJECTIONS - CAPITAL

The County's proposed 2014-2023 capital budget shows that approximately $14.385 million will be invested on bridges and culverts over this period. The projected capital investment and associated funding sources for the investment in the County's bridges and culverts is summarized in Table 5.3.

Table 5.3 : Budget Projections & Funding Sources 2014 - 2023

	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Budget (millions)		$.965	$1.410	$1.820	$3.095	$1.165	$1.200	$1.265	$1.000	$1.115	$1.350	**$14.385**
Funding Source	Gas Tax Reserve Fund	-	-	-	-	-	-	-	-	-	-	**$0**
	Other Recoveries	-	-	$0.285	-	-	-	-	$0.250	-	-	**$0.535**
	Provincial Grants	-	-	-	-	-	-	-	-	-	-	**$0**
	Road & Bridge Investment Reserve	-	-	-	-	-	-	-	-	-	-	**$0**
	Roadway Construction Reserve	$0.965	$1.410	$1.535	$3.095	$1.165	$1.200	$1.265	$0.750	$1.115	$1.350	**$13.850**