2014 Bridge Inspections

Town of Gananoque

- October 2014 –

Keystone Bridge Management Corp.

Contents

Introduction

Keystone Bridge Management Corp. was retained by the Town of Gananoque to provide bridge assessments for all of its bridges. The field work was completed on August 15 2014 by Messrs. John Landry, and Harold Kleywegt, P.Eng. A total of eight bridges were inspected of which three were road bridges and the remainder pedestrian bridges.

Biennial inspection of bridges and culverts with a span equal to or exceeding 3.0 metres is mandated by provincial statute in Ontario. The legislation is found in the Public Transportation and Highway Improvement Act. Most municipalities in Ontario comply with this legal requirement. Municipalities seeking provincial funding for structure capital improvements are required to demonstrate their bridges receive a biennial inspection. Increasingly, the government is expecting municipalities to have an asset management plan as well.

A biennial bridge inspection is prescribed to follow the Ontario Structure Inspection Manual, OSIM. However the regulations (O.Reg.104/97) allow variations from OSIM where:

(a) the variation is not a marked departure from the Ontario Structure Inspection Manual; and
(b) the variation does not adversely affect the safety and mobility of people and goods. O. Reg. 472/10, s. 2.

Keystone Bridge Management Corp. has created a significant improvement to conventional OSIM reporting. Keystone's proprietary approach complies with the spirit and intent of the Regulation, but takes bridge inspection and management an order of magnitude beyond that contemplated in OSIM. Keystone has eliminated most of the subjectivity associated with the Excellent, Good, Fair, Poor rating system of OSIM. Keystone utilizes a deterministic depreciation model to describe the transition of a bridge from excellent to fair, and supplements this by noting damage and defects in components at the time of inspection. This approach complements modern asset management practises. It is something that OSIM on its own cannot do.

Capital Needs

The capital needs were estimated with an estimating tool contained in the Keystone Bridge Management System. This utility covers common items that include deck replacement, expansion joint replacement, barrier wall replacement, waterproofing and paving. The utility provides guidance for traffic management costs. All costs are marked up 20% to account for contingencies and engineering. Contract administration costs are not included.

The Capital Needs for the Town of Gananoque are summarized in a separate included report appended at the end of this Report.

The **Capital Needs Report** is organized from the most immediate needs to the less immediate needs by the Recommended Year sub-headings. Two capital needs pictures are graphically presented at the end of the Report. A Grand Total of **$6,084,000** is the projected capital need from the present to 2025.

The capital needs identify four structures that ideally should be replaced in the next ten years or so. This is described further in the following sub-headings.

Rail to Trail Bridge

This bridge is located immediately upstream of the dam. It consists of three spans of a railway bridge that was converted to pedestrian use. The girder ends at the piers and abutments are exhibiting severe corrosion with perforation. The west end of this bridge is experiencing web crippling of the girders and is slowly failing.

The bridge is still safe for pedestrian use but could “settle” due to girder web failure, and result in alarm to the public. It would be prudent for the Town to not risk losing the public’s confidence in this trail bridge by replacing it before the girder webs fail much further.

Power Canal Pedestrian Bridge

This small bridge crosses the power canal between the dam and City Hall. The bridge is poorly detailed and it is not constructed to any obvious design standard. The support at the east side is precarious.

This bridge should be replaced with a more robust structure that is wide enough to satisfy modern accessibility standards.

Hudson Bridge

The Hudson Bridge was recently load tested. Further information regarding this bridge is provided in the load testing report.

The Hudson Bridge is exhibiting severe corrosion and rust perforation of its primary structural components such as the floor beams and truss compression members. As it continues to corrode it is becoming increasingly structurally unreliable. It should not be relied on to carry traffic of any description after 2030. Until then it can be managed by load posting. However, the Town is assuming some risk by continuing to maintain the bridge open to traffic. Ideally the bridge should be taken out of service and replaced with

a modern bridge. The recommended year of 2020 is flexible and represents a reasonable time for the Town to respond and obtain funding for a replacement bridge.

The historical attributes of this bridge could be retained by repurposing the bridge as a pedestrian bridge. However the bridge would require significant reworking and restoration before it is repurposed as anything other than a museum artifact.

King Street Pedestrian Bridge

This bridge is located immediately downstream of the King Street Bridge. It is a two span railway through-plate girder bridge repurposed as an exceptionally wide pedestrian bridge. Although the top of the bridge has been cared for, the remainder of the bridge has been largely neglected and is in a state of very poor repair. There are gaping holes from corrosion in parts of the bridge's floor system. When this level of severe corrosion is visible from standing beneath the bridge, one has to wonder how severe the corrosion is in other less visible areas of the bridge.

This bridge deserves a very comprehensive detailed inspection to more fully assess the condition of inaccessible areas of the bridge. Only a detailed assessment such as this can be relied on to better determine the fate of the bridge.

In the absence of better information, it is recommended that the Town plan on replacing the King Street Pedestrian Bridge by not later than 2025.

The capital needs groupings in the Capital Needs Report suggests relative priority, but other considerations such as traffic demand, risk of failure, and combining projects should also be considered to establish actual priorities.

The capital estimates provided are very approximate. Environmental considerations, difficult foundations, dewatering requirements, and traffic management costs can be very significant variables that can only be estimated accurately at the preliminary design stage.

Bridge Maintenance

Detailed maintenance needs are captured in the **Bridge Maintenance Report** appended at the end of this Report.

Bridge cleaning is widely recognized as an important maintenance activity. Ideally spring maintenance should include a thorough sweeping of the bridges' horizontal surfaces, and power washing of the bridge seats especially where expansion joints are open or the seal is compromised. Early sweeping removes brine laden winter sand from the bridge decks. This greatly helps forestall the onset of corrosion of the reinforcing

steel. Expansion joints should be cleaned of debris caught inside the gaps in the spring and fall of each year.

The Hudson Bridge is in urgent need of a very thorough cleaning in order to reduce the present rate of corrosion.

Performance Deficiencies

The various components in and around a structure all have a purpose or functionality. Where the purpose or functionality is compromised, it is recorded as a performance deficiency. Appended at the end of this report is a Performance Deficiencies Report.

These deficiencies are often difficult or expensive to remedy. Ideally, a replacement structure should address the present performance deficiencies. These deficiencies should be reviewed when prioritizing the capital program.

Performance Deficiencies require risk management strategizing by the owner.

Triple-D Inspections

The individual bridge inspection reports are provided separately from this Summary Report. The reports are a slight departure from OSIM Reports in that the field inspection effort is directed at identifying deterioration and performance issues as explained below.

Keystone's approach to Bridge Management is fundamentally different from all others anywhere in the world. Keystone models bridge assets in terms of their **D**epreciation, **D**efects, and **D**amage. This "**Triple-D**" approach is unique to Keystone, and is the soundest and most reliable method ever conceived to accurately ascertain or predict the condition of a bridge.

The "**Triple-D**" approach is imbedded in a highly sophisticated MS Access database application developed by Keystone. The design of the database easily facilitates porting the data to any other application, and is highly customizable to any client.

Every bridge is modeled in terms of its components. Each component has a life expectancy and value based on its material and geometric properties. As a bridge ages, the components depreciate in accordance with a simple depreciation function that is client specified. Either a straight-line or parabolic depreciation function is recommended. The overall depreciation of a structure is expressed in terms of the sum of the depreciation of all the components.

This deterministic approach to assessing the condition of a bridge provides an extremely reliable, reproducible and predictable approach to stating the condition of not only a bridge, but an entire bridge inventory.

Imagine a municipality that was incorporated in 1900. Every year on its anniversary it builds an identical bridge, for 100 years running until 2000. For simplicity, presume each bridge is constructed of only one component, and the deemed life of that component is exactly 100 years. From this example, it is easy to see that the oldest bridge constructed in 1901 has completely depreciated and now has zero value. Whereas, the centennial bridge constructed in 2000 would on its completion retain its full value. If straight line depreciation is assumed, the centennial bridge would be depreciated to 91% of its original value in 2009. In 2001, the depreciation of the entire bridge inventory of 100 bridges would be 50% assuming straight-line depreciation. It is this simple straight-forward approach that Keystone has adopted.

Defects are any relatively benign but unintended changes to a bridge that cannot be attributed to normal wear and tear, or aging. Mild to moderate scaling of a concrete surface is an example of a **D**efect. Early alkali-aggregate reactivity in concrete is another example of a **D**efect. **D**amage is any change to a structure that reduces the section properties or intended performance of a structural component. **D**amage includes spalling, delamination, disintegration or severe cracking of concrete; plastic deformation or gouging of steel, or decay of timber.

Defects and **D**amage are detected, quantified, qualified and recorded when the bridge is inspected. The **D**epreciated value of a component is adjusted to account for **D**efects or **D**amage. Keystone recommends that any component that is more than 20% **D**amaged is considered as fully **D**epreciated. Ten percent **D**efects is equal to one percent **D**amage.

The concept of **D**efects and **D**amage is very easily understood and applied as compared to the more traditional subjective ratings of Excellent, Good, Fair or Poor. Consequently, the information resulting from bridge inspections is an order of magnitude more reliable and accurate.

Understanding the Inspection Forms

Inspection reports are headed **Bridge Inspection Report or Culvert Inspection Report**. In the top-right of each form is a general arrangement photograph of the structure taken on the day of inspection.

In the top-left box is basic tombstone data as follows:

- Name of the bridge in large bold font
- The type of bridge or culvert
- The road the structure is on
- Name of the Owner
- Structure Location Information

- The Owner specified Structure Identification Number (Site ID)
- District
- Year of original construction per legacy information.
- Length of the Bridge per legacy information
- Width of the Structure per legacy information
- Number of spans
- The span arrangement is shown in metres for bridges only.

In the next box down is recorded the date of inspection, principal inspector, assistant inspector, the weather for the entire day, and the approximate temperature range on the day of inspection.

In the small box under the General Arrangement photograph is shown the AADT per legacy information, (or updated as the case may be), the number of available traffic lanes crossing the structure, the structure skew angle in degrees, and the general direction of the road that crosses the structure, for example E-W means East to West. Accompanying this information are the Latitude and Longitude at the centre of the structure expressed in decimal degrees. Also include is data where applicable or available for the road width, percent trucks, and any load posting.

The Component Inspection Information is recorded next. The number of components varies based on the complexity of the structure. In the left column for each component is listed:

- Component name in bold with the component count in parenthesis.
- The general category for the component in Italics.
- The Length, Width, Diameter, & Height of the component in metres based on legacy information, or field measure, and as appropriate.

Please note that measurements for substructure items are approximate only.

The second column of the Component Inspection Information captures the actual field inspection information for each component. Information is generally recorded on an exception basis. If there are no annotations it can be safely assumed that the component is generally in satisfactory condition for its age. The following sub-headings explain in detail the inspection information:

Defects

Defects are relatively benign changes to a bridge component that cannot be attributed to simple aging. They result from a material Defect or lack of required maintenance. The amount of Defects is estimated to the nearest five percent based on visual inspection of all similar components included in the component count. For example, bridges have typically four wing walls, so the estimated defects are applied over all four wing walls.

The Defects are characterized with a qualifying comment that is computer generated from drop-down lists in the Keystone Bridge Management System. Where Defects exceed 10% they are highlighted in Yellow.

Damage

Damage is any change to a structure that alters its structural form, strength, or function. Damage may result from untended Defects. The Damage is estimated and reported analogous to Defects, except a level of accuracy of plus or minus 2% or better is maintained. Where Damage equals 5% to 10% it is highlighted in Amber. When Damage is equal to or greater than 10% it is highlighted in Red.

Red and amber flags appear to the right if damage is considered as critical or major respectively. This way an otherwise small amount of damage is brought to attention if the severity warrants it.

Maintenance

Maintenance recommendations are selected from a component specific drop-down menu in the Keystone Bridge Management System. Up to two maintenance recommendations can be selected and reported.

Capital Recommendation

Capital Recommendations are selected from a list of three options; Do Nothing, Repair, or Replace. The number of years in the future the Capital investment should take place is based on the inspector's best judgement, without considering the optimal timing for a comprehensive rehabilitation or replacement.

Performance

If a component has a functional impairment, this may be noted in the Performance comment. The Performance comment is created through a context sensitive drop-down menu. The performance comment only appears when a performance defect has been identified.

Note

Where the above categories are insufficient to capture the inspection information, Keystone adds an unlimited comment at the bottom of the second column.

Capital Needs Cost Estimate Breakdown

At the end of each Inspection Report is a section titled as per the above.

Capital costs estimates are automatically generated by the Keystone Bridge Management System for standard items which include:

- Deck Replacement
- Deck Concrete Overlay (O'Lay)
- Barrier Wall Replacement (B/Wall)
- Waterproof & Pave (WP&P)
- Expansion Joint (X-Jnt)

Unit prices for the above work are based on MTO and client supplied data and extensions are based on geometric data residing in the KBMS database. The unit costs are indicated on the form.

The Contract Administration & Contingencies is a straight 20% mark-up. The Estimated Traffic Management & Civil Items is usually included and is based on experience and the nature of the capital work.

Recommendations for additional investigations are included on the same page as the Capital Needs. A summary comment regarding the structure is included under the Inspection Comments heading.

At the bottom of the last page of each inspection report the BCI number, Straight-Line Depreciation percentage and Parabolic Depreciation percentage is expressed.

Inspection Images

All of the photographs taken at the time of inspection are displayed six per page in the section immediately following the Inspection Report. The Image Number is displayed in the top-left corner of each photo. A brief caption is provided below each photo. For a more detailed look at a photo, the original images are provided with this report in digital format, in separate folders for each structure.

Digital Copy

This entire report is reproduced in PDF format together with all of the image files in DVD discs shipped with this report. Individual inspection reports are included in their own folder together with reduced images.

The original images are provided in folders on a DVD disc. The folder names correspond to the date of inspection. Keystone will maintain one copy of the original images on their file server for two years following the date of inspection.

Limitations

Keystone Bridge Management Corp. endeavours to provide valuable bridge asset management services that help its clients to prioritize and fund their bridge and large culvert capital and maintenance needs. Furthermore we advise of structural performance deficiencies and attendant risks. In short, we help our clients sustain the life of their road structure inventory commensurate with economic and risk management considerations.

Keystone provides these services in a fiercely competitive business environment. Our business value in terms of completing a routine biennial bridge inspection is to provide a competent highly experienced lead inspector and a student assistant. Our explicit attitude for the field work is “it takes as long as it takes.” The Client needs to understand however the following caveats with respect to the reporting provided herein:

1. Field measurements are only to an accuracy that reasonably supports depreciation modelling of the structure and should not be relied upon for any other purpose.
2. The inspection is mostly visual in nature and thus components of the structure that are not reasonably accessible due to depth of water, height, and the like will have a compromised assessment.
3. Ambient lighting and debris can hide or disguise defects and damage.
4. Heavy traffic will preclude a thorough inspection of deck surfaces.
5. Latent defects are not normally discoverable in a routine inspection.
6. There will always be inherent subjectivity when assessing defects and damage.
7. Cost estimates are based on average historical information and are not necessarily current or suitable for local conditions.
8. Where in our opinion the conventional visual inspection is insufficient to adequately and responsibly assess the structure we will recommend follow-up investigations such as boat or ice access inspections, bridge deck condition surveys, and other enhanced inspection methods.

Closing

Keystone Bridge Management Corp. is pleased to report on the condition of the Town of Gananoque vehicle and pedestrian bridges. Should there be any lingering concerns or additional information required with respect to this assignment, then Keystone will be happy to respond.

We trust the services rendered are complete, and in full keeping with the Terms of Reference. It is Keystone's sincerest desire that the recommendations stemming from this work will be helpful to the Town of Gananoque in keeping their structural inventory, safe, sound, serviceable, and sustainable. Keystone strives to help you get the most out of your road structure assets.

Harold Kleywegt, P.Eng.
Managing Director
Keystone Bridge Management Corp.

Capital Needs Report

Year *2016*

Bridge ID	Name	Route	WORK	Cost $
4	Rail to Trail Bridge	Gananoque Waterfront Trail	Replace	$660,000

Sum for Year	***$660,000***
Percentage of Grand Total	***10.8%***

Year *2018*

Bridge ID	Name	Route	WORK	Cost $
5	Power Canal Ped Bridge	Gananoque Waterfront Trail	Replace	$132,000

Sum for Year	***$132,000***
Percentage of Grand Total	***2.2%***

Year *2020*

Bridge ID	Name	Route	WORK	Cost $
3	Hudson Bridge	Machar St	Replace	$3,972,000

Sum for Year	***$3,972,000***
Percentage of Grand Total	***65.3%***

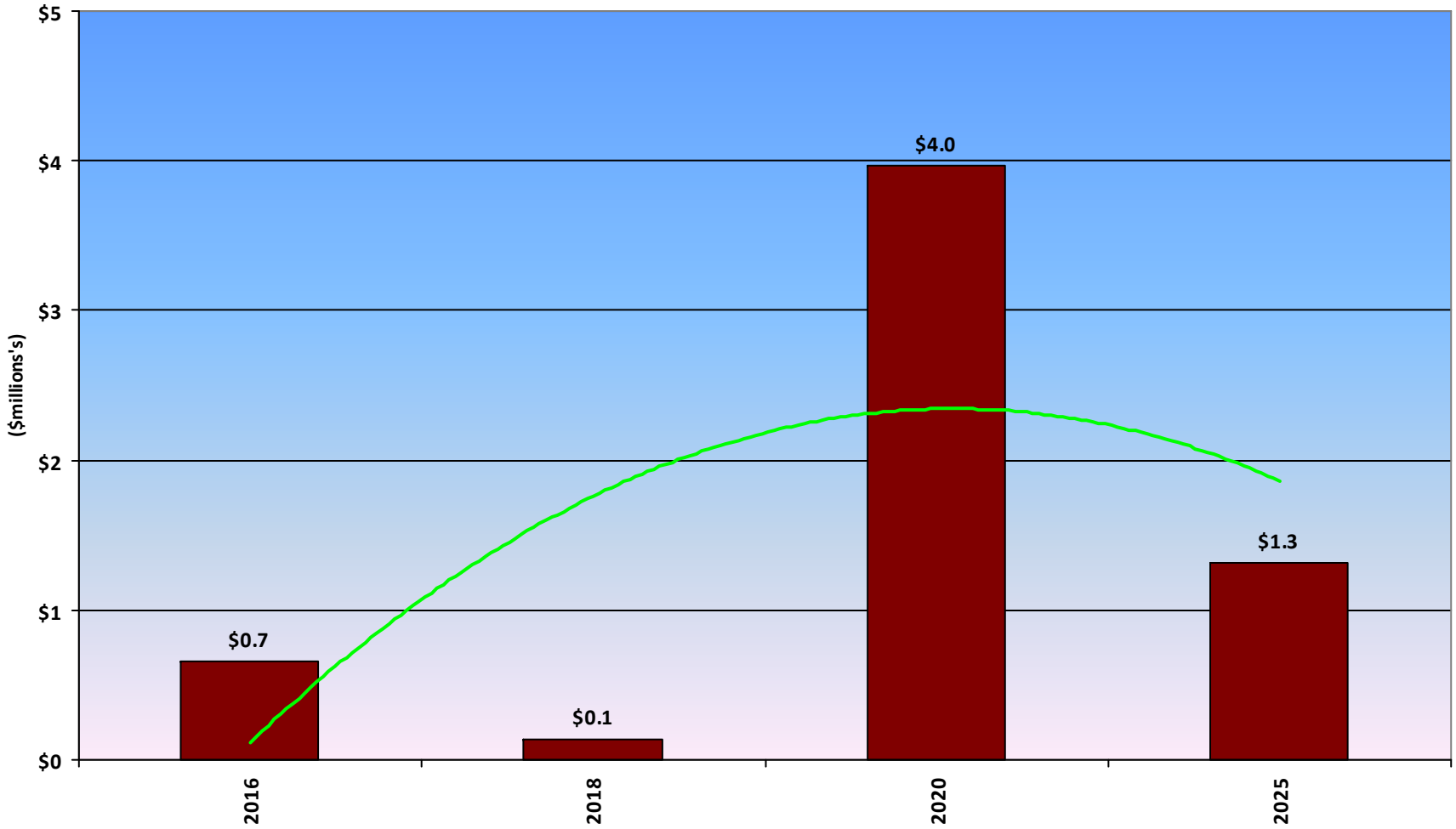
Year *2025*

Bridge ID	Name	Route	WORK	Cost $
7	King Street Pedestrian Bridge	Gananoque Waterfront Trail	Replace with truss type pedestrian bridge.	$1,320,000

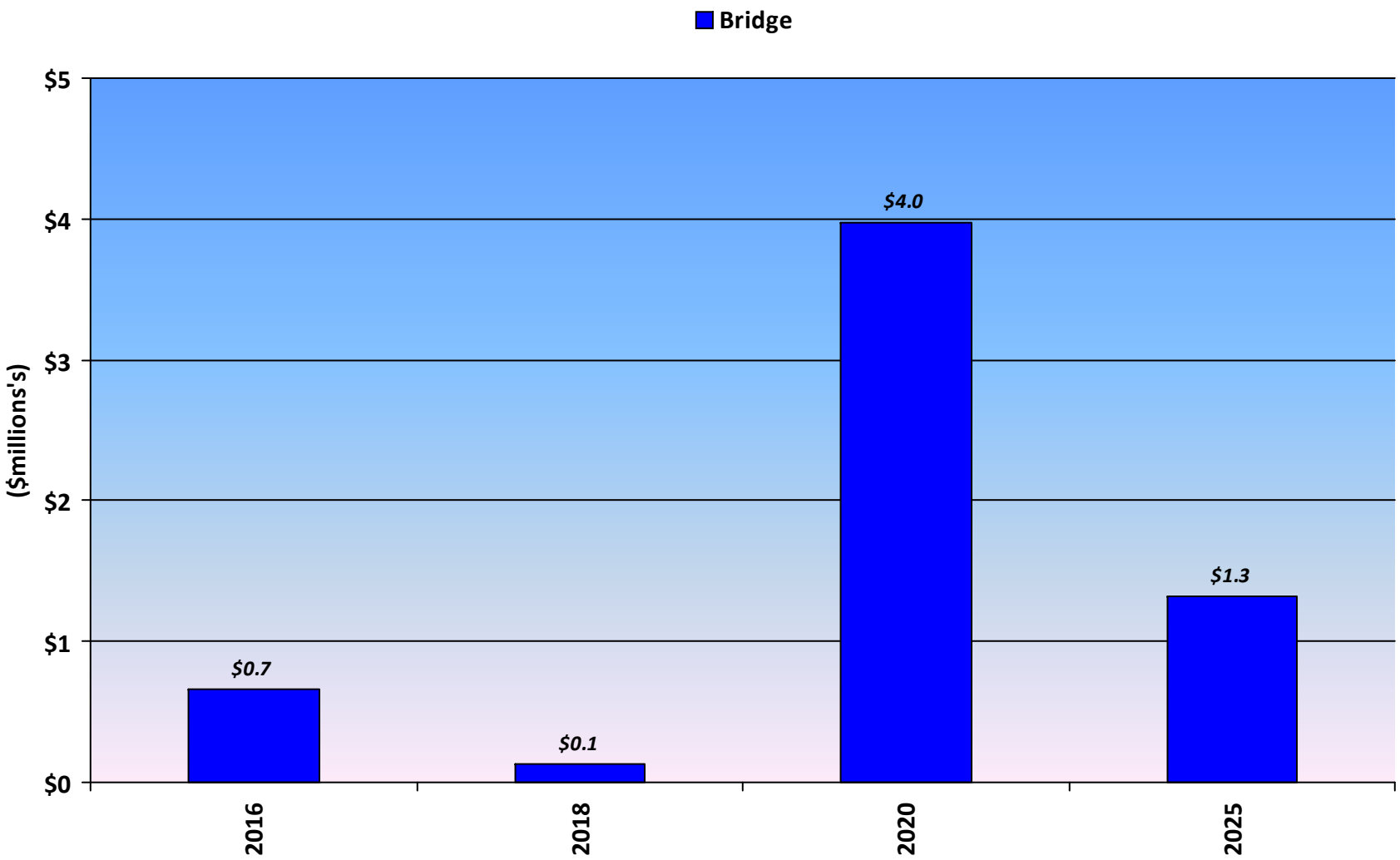
Sum for Year	***$1,320,000***
Percentage of Grand Total	***21.7%***

Total Capital Needs ($m's) **$6,084,000**

Capital Expenditure by Year



Capital Expenditure by Structure Type



Bridge Maintenance Report

Bridge ID	Name	Road	Component Desc	Maintenance Requirements
1	Black (Snappers) Bridge	Gananoque Waterfront Trail	Truss Diagonal/Post/Hangar	Remove debris
Comment:	Debris collected at bottom chord gussets.			
			Truss Diagonal/Post/Hangar	Remove debris
Comment:	Debris collected at gussets at bottom chord.			
			Truss Half Through or Pony	Remove debris
Comment:	Good condition except for debris at gusset locations.			
			Embankment Embankment	Slope revetment
Comment:	Southeast retaining wall has failed. Excessive erosion should be repaired.			
3	Hudson Bridge	Machar St	Wear Surface Timber Wear Surface	Local repair
Comment:	Asphalt protection is worn through and should be replaced to help preserve timber.			
4	Rail to Trail Bridge	Gananoque Waterfront Trail	Barrier Wood Post Wood Rail	Replace Bracing
Comment:	Cleats supporting rakers exhibit decay and require spot replacement. Railing system is secure.			

Bridge ID	Name	Road	Component Desc	Maintenance Requirements
6	King Street Bridge	King St. East	X-Joint X- Joint Conventional	Remove Debris

Comment: Good condition.

7	King Street Pedestrian Bridge	Gananoque Waterfront Trail	Embankment Embankment	Remove Brush/Trees

Comment: Extremely dirty under west span. Infilling is preventing good air circulation under west span.

Performance Deficiencies Report

Bridge ID	Name	Component	Component Description	Performance Deficiency
3	Hudson Bridge	Diagonal/Post/Hangar	Diagonals/Hangars	Connection
		Steel Sliding Plate	Abutment Bearings	Seizing
4	Rail to Trail Bridge	Steel-Rolled	Girders	Sagging