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JACQUES CARTIER + CHAMPLAIN
Bridges
Canada

STATEMENT
For immediate release

Status of the Champlain Bridge
Ensuring safety and mobility through rigorous and constant monitoring

Montreal, October 20, 2017 – This morning, at a technical media briefing held jointly with the partners of the New Champlain Bridge Corridor (NCPC) project, The Jacques Cartier and Champlain Bridges Incorporated (JCCBI) gave an update on the status as well as maintenance and monitoring activities of the Champlain Bridge.

"The Champlain Bridge is safe. Our team of experts assigned to this structure is closely monitoring its operation and maintenance to keep this key Montreal transportation and economic corridor open until the new Champlain Bridge is ready," explained Mr. Glen P. Carlin, Chief Executive Officer of JCCBI.

The bridge corridor has remained safe thanks to major reinforcement work as well as strict monitoring—with over 300 sensors that measure the bridge's behaviour in real time—and detailed inspections. JCCBI is vigilantly managing this structure at the end of its service life and has deployed all necessary preventive measures to keep it safe.

JCCBI is also working closely with Infrastructure Canada and Signature on the Saint Lawrence to minimize the impact of the important NCBC project on users. At the government's request, a risk analysis was conducted to assess the possibility of extending the service life of the Champlain Bridge if delivery of the new bridge is delayed. Based on the recommendations of its expert consultant, JCCBI has targeted priority actions and taken steps to plan and conduct preventive work to maintain safety and service standards.

About JCCBI

As a manager of important infrastructure, The Jacques Cartier and Champlain Bridges Incorporated is a Crown corporation established in 1978 that is responsible for the Jacques Cartier Bridge, the Champlain Bridge, the Champlain Bridge Ice Control Structure, the Île des Sœurs Bypass Bridge, the federal sections of Bonaventure Expressway and the Honoré Mercier Bridge, as well as the Melocheville Tunnel. The Corporation manages, maintains, and repairs these important Greater Montreal structures to ensure the safe passage of thousands of users every day. It also ensures that these critical structures remain safe, fully functional and aesthetically pleasing both today and in the future. www.JacquesCartierChamplain.ca

SEPTEMBER 2017
JACQUES CARTIER AND CHAMPLAIN BRIDGES INCORPORATED (JCCBI)

CHAMPLAIN BRIDGE

IMPACTS DUE TO POSSIBLE DELAYS OF NEW BRIDGE OPENING

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APPENDICES

1 Purpose

On July 26th, 2017, Jacques Cartier and Champlain Bridges Incorporated (JCCBI) was informed by Infrastructure Canada that the replacement of the existing Champlain Bridge could be behind schedule. JCCBI has indicated that they are not aware of the current projected delay of the commissioning of the new Champlain Bridge. Infrastructure Canada asked JCCBI to investigate the consequences of two delay scenarios of 12 and 24 months beyond the original planned date of December 1, 2018 for decommissioning the existing Champlain Bridge.

Since 1991, COWI has performed many engineering tasks on the Champlain Bridge for JCCBI. In the last 4 years, COWI has been mandated by JCCBI to assess the structure, be responsible for the overall coordination of JCCBI's risk mitigation program, and along with Stantec, be the engineer of record for the rehabilitation measures aimed at keeping the bridge safe for the public.

With this in-depth knowledge and background of the bridge, JCCBI has asked COWI to assess the impact of the possible delay scenarios, and how it could affect the way the existing bridge is managed. This report summarizes COWI's conclusions and recommendations.

2 Description of Structure

The existing Champlain Bridge was opened to traffic in 1962. It is a 3.4 km long structure comprising seven steel truss spans (collectively referred to as Section 6), and 50 concrete girder spans (Sections 5 and 7). The bridge accommodates six lanes of traffic, three in each direction. See Figure 1 for an overview of the entire bridge. Appendix A includes a more detailed description of the bridge.

Figure 1 General View of Champlain Bridge

3 Risks with the Bridge

In 2011, Delcan performed an assessment of the bridge (JCCBI Ref: 61445) and summarized the condition as follows:

"Overall, our impression of the bridge is that it is in a condition that requires extreme vigilance in order to maintain it safely in service over even a relatively short term. Some of the deterioration which has been observed is very severe. Deterioration such as this tends to progress exponentially, the rate of increase of deterioration increasing itself with time, hence increasing concern with regard to the bridge."

The deterioration of the bridge has become significantly worse in the six years since the 2011 assessment was completed. This was most exemplified by a girder failure that occurred in 2013 that resulted in a partial closure of the bridge for several weeks and required the installation of the Superbeam to stabilize the girder.

There are many different types of spans, and many different bridge components within a span that make up the existing Champlain Bridge. Some of the bridge components are more deteriorated than others and as such, the risks associated with the performance of each component are different. Therefore, this portion of the report is separated into sections that relate to each major component of the bridge. COWI has included an assessment of the risk level for each major component of the bridge and how those risks could change under different delay scenarios in an attempt to give the reader an indication of the severity of each risk.

3.1 Section 6 – Steel Truss Spans

Based on information obtained from the annual inspection of Section 6, the steel truss spans are considered to be in good condition. The trusses have little corrosion, the deck was replaced in the early 1990s and continues to perform well, and the piers were recently repaired and show no major signs of deterioration or distress.

Additional inspections have been undertaken to assess the condition of Section 6 and these inspections are ongoing. In addition, a full load evaluation has been completed by COWI which established that there are no major structural issues with the steel truss spans. Following the completion of the inspections in the fall of 2017, COWI will review the load evaluation and incorporate the effects of corrosion identified during the inspections. Based on the preliminary findings of the inspections already received by COWI, it is not anticipated that the conclusions will change.

Therefore, COWI believes that the risk associated with the performance of any component of Section 6 of the bridge is low. This level of risk is not expected to change if there is a 12 month delay to the new bridge, however under a 24 month delay scenario, it could increase to medium if no additional mitigation measures are taken.

3.2 Sections 5 & 7 – Concrete Spans

Severe deterioration has occurred in Sections 5 and 7 of the bridge. JCCBI has been aggressively repairing and retrofitting these sections of the bridge for many years. In 2013, COWI studied the overall condition of the concrete span edge girders of the Champlain Bridge. At the time, COWI recommended and JCCBI implemented a strategic action plan in order to address the condition of the bridge and maintain an acceptable level of risk to the structure until the bridge is decommissioned. This action plan included:

- Emergency strengthening measures to be completed by the end of September 2013;
- Short-term actions to be completed by the end of 2014;
- A five-year plan to be completed by the end of 2018.

In the last 4 years, the action plan developed in 2013 has been continuously updated and additional measures have been required, due to the exponentially accelerating deterioration in the girders and piers. Figure 2 shows the number of girder interventions per year as well as the total expenditures on the overall repairs to the Champlain Bridge per year since the first interventions in 1986. This figure shows the increase in interventions over time for the girders of the Champlain Bridge that have been required to maintain user safety and keep the bridge open to traffic. This also shows JCCBI's significant investment in rehabilitating the bridge since the failure of one of the edge girders in 2013 due to continued corrosion and deterioration of the structure.

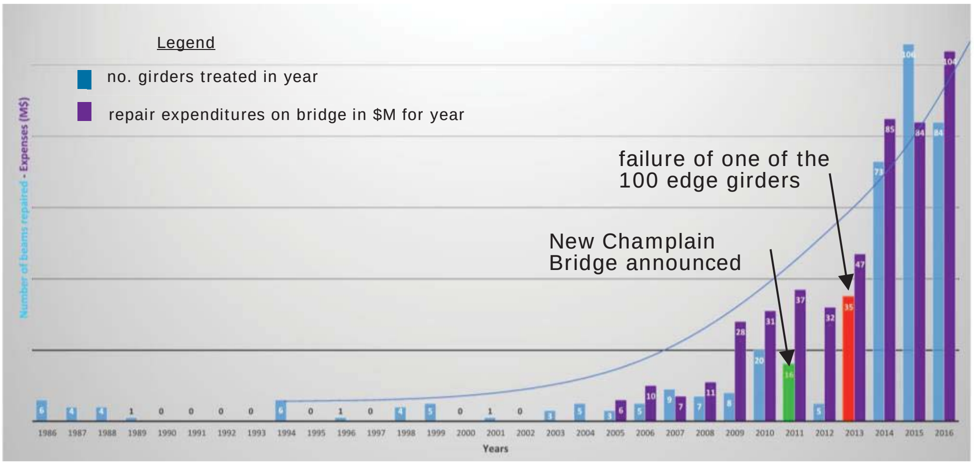

Figure 2 History of Girder Repairs for the Champlain Bridge since First Interventions in 1986

3.3 Sections 5 & 7 – Roadway Deck Slab

The roadway deck slab of the concrete spans is the original post-tensioned concrete deck. It exhibits signs of significant deterioration and given the structural details, there is little that can be done to implement a permanent repair to the severely corroded locations. As such, JCCBI continues to repair the deck locally when signs of deterioration present itself.

Figure 3 shows typical observed signs of deterioration on the soffit of deck infill strips. At some locations, there is evidence of corrosion of the transverse post-tensioning tendons in the deck and these tendons are essential to ensure the transverse integrity of the deck slab.

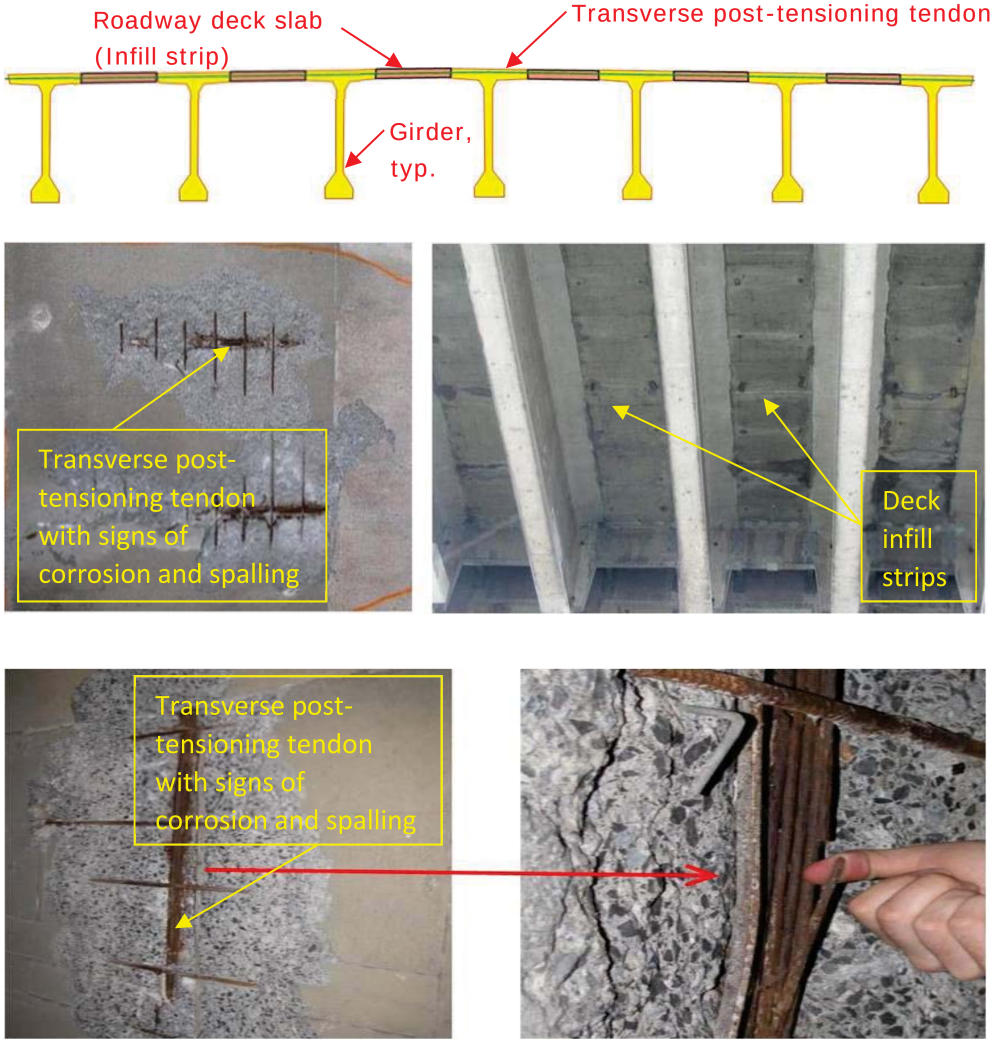

Figure 3 Observed Signs of Deterioration on Soffit of Deck Slab

COWI anticipates that the number of localized deck repairs required per year will continue to increase as time passes.

The risk associated with the deck if a serious problem is not identified by JCCBI's inspection team is a local failure in the deck. The most likely result of a local deck failure would be a short-term closure of one or two lanes of traffic (depending on the extent of the local failure).

Inspections are ongoing for the deck to help manage the risks. COWI believes that the risk of localized failure is low, and is expected to remain low under both 12 and 24 month delay scenarios, however the number of local failures needing repair will increase the longer the new bridge is delayed.

3.4 Sections 5 & 7 – Concrete Girders

There are 350 concrete girders that make up the 50 spans in Sections 5 and 7, and they are among the most seriously deteriorated components of the bridge.

The use of de-icing salts, the lack of proper deck drainage in the first 30 years of service and the absence of a waterproofing membrane, created an environment where salt laden water penetrated into the concrete girders from the deck, or by free drainage over the side of the bridge deck onto the concrete edge girders. The most significant corrosion is in the post-tensioning (PT) inside the girders, which has resulted in severe degradation of the girder concrete and significant loss of strength: in fact in 2013, one of the concrete girders failed and an emergency repair was required to secure the structure.

The initial signs of concrete deterioration and PT corrosion were first observed in the 1980s and over the last 30 years increasing signs of deterioration have been observed, mostly in the edge girders. Figure 7 and Figure 8 show typical signs of girder deterioration observed on many of the 50 concrete spans. Figure 4 shows the severe cracks observed on the surface of the girders that were caused by corrosion of the post-tensioning tendons. Figure 5 shows signs of severe deterioration and spalling on the girder soffit, near mid span. Severe deterioration and failure of some of the PT was also observed through exploratory openings in the concrete girders that were carried out to assess the condition of the PT tendons.

Establishing the amount of PT section loss in a girder is very difficult since only localized openings or surface observations are possible. Although attempts have been made to use non-destructive testing to determine corrosion levels, there is still uncertainty about the actual condition and section loss of the PT tendon and as a result the strength of the girders.

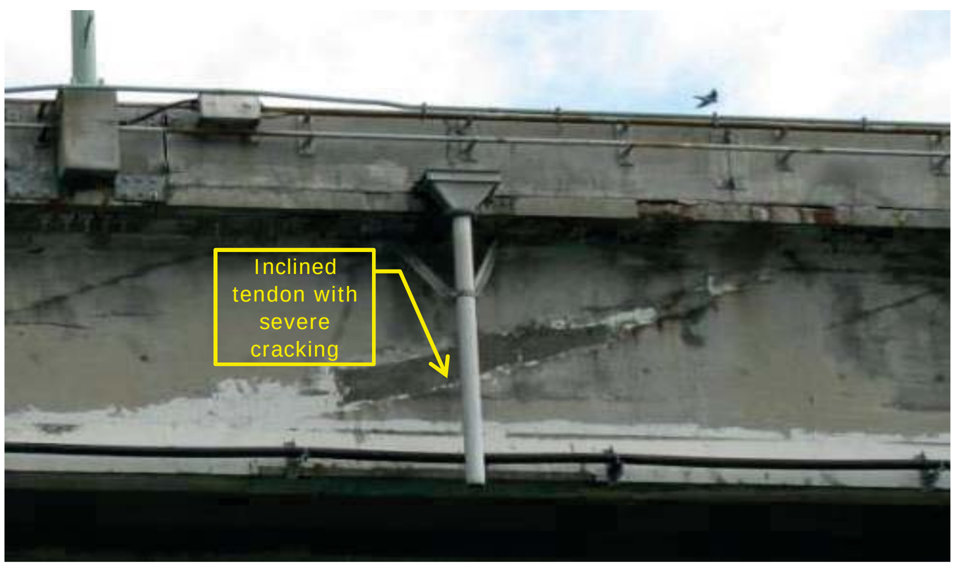

Figure 4 Severe Cracking as Sign of Deterioration of Girder Internal PT

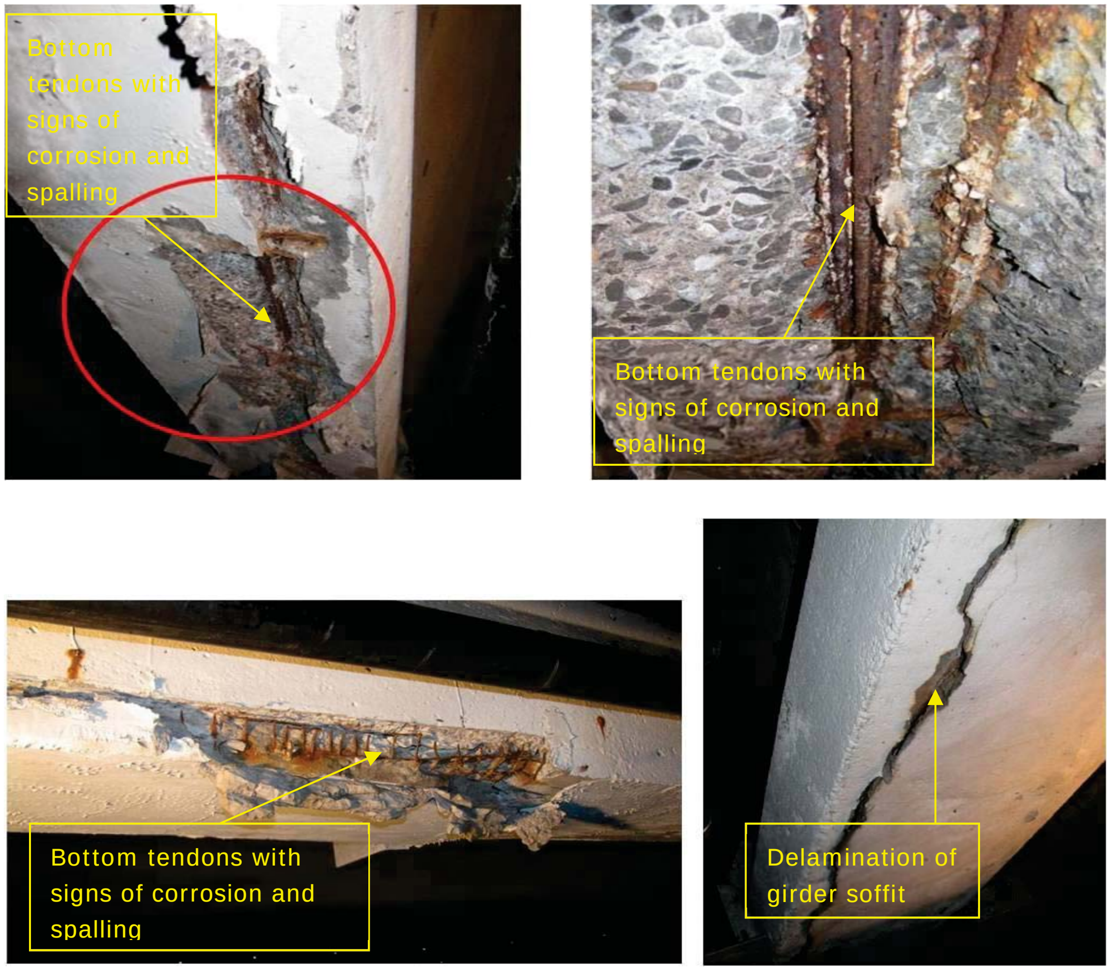

Figure 5 Observed Signs of Deterioration of Edge Girders

3.4.1 100 Concrete Edge Girders

In 2013 a very alarming structural failure occurred to one of the 100 edge girders. Fortunately, as part of JCCBI's proactive approach to managing the deterioration of the bridge, a steel support girder ("Superbeam") had been fabricated in 2009 and stored near the bridge, ready to be used in the event of such a failure. Following this girder failure, JCCBI updated its risk mitigation program and launched a major girder strengthening campaign to ensure structural integrity of all 100 edge girders.

In the last 4 years, support trusses (see Figure 6) have been placed under all concrete edge girders except for four spans where other strengthening systems were more suitable or cost-effective and these trusses have been designed to carry the entire load that would result from an edge girder failure. Since truss installation was completed on all spans in March 2017, the risk of an edge girder failure has been effectively dealt with, and is considered to be very low (and is expected to remain very low under both the 12 and 24 month delay scenarios). However COWI continues to monitor the behaviour of all 100 concrete edge girders on a daily basis using sensors and a sophisticated monitoring system to assess any changes to the girder deformations.

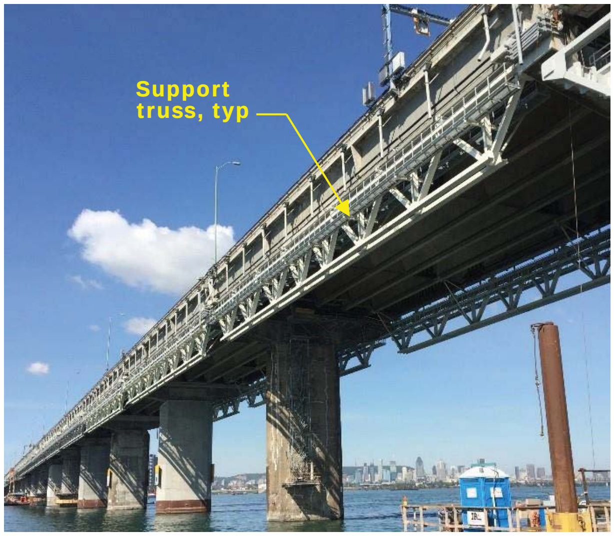

Figure 6 Support Trusses Installed under Concrete Edge Girders

3.4.2 250 Concrete Interior Girders

There are 250 interior concrete girders in Sections 5 and 7. Some interior girders show signs of significant deterioration, and therefore the risk with these girders has to be managed. Strengthening measures have been designed, some of which have been implemented, and some of which will be implemented in 2018. JCCBI has instrumented 31 of the most deteriorated interior girders with strain gauges, and consultants to JCCBI continue to inspect and closely monitor these girders. COWI considers that there is a medium risk of failure of an interior girder, and that if the new bridge is delayed 12 or 24 months, the risk will increase to high if the current mitigation measures are followed. COWI considers this risk will remain medium under the 12 and 24 month delay scenarios if the updated mitigation plan outlined in Appendix A is followed.

In the unlikely event of a major distress in one of the interior girders, JCCBI has fabricated 3 above deck support "Superbeams" and are available to be deployed to secure the distressed concrete girder.

The use of an above deck Superbeam to secure an interior girder would have a significant impact on traffic resulting in the closure of 2 or 3 traffic lanes. In addition, during the time that the Superbeam is on the bridge deck, it is likely that trucks would be banned from the bridge, and that the dedicated bus lane would be unavailable for use. This is acceptable as a temporary strengthening solution, but a permanent below-deck truss would need to be installed under the failed girder to allow the removal of the Superbeam in order to restore traffic.

3.5 Sections 5 & 7 – Concrete Diaphragms

Many of the 1272 concrete diaphragms between the girders in Sections 5 and 7 are in poor condition and show signs of significant deterioration (see Figure 7). At some locations, corrosion of reinforcement, concrete spalling and cracking have been observed. The concrete diaphragms provide load sharing between girders under traffic, and deterioration to these components increase the girder demands and, in turn, the risk. In the last 4 years, many of the diaphragms have been strengthened.

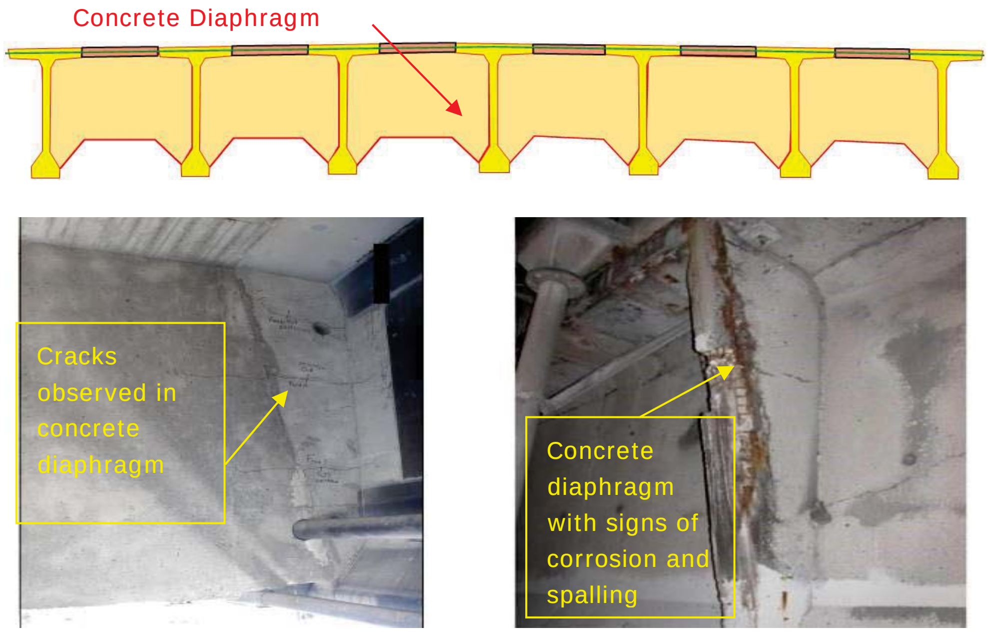

Figure 7 Observed Signs of Deterioration on Concrete Diaphragms

COWI considers that there is a medium risk of failure of a concrete diaphragm and that this will increase to high risk with any delays to the new bridge if the current mitigation measures are followed.

The consequence of a failed concrete diaphragm may require a lane closure on the bridge until it is rehabilitated. JCCBI continues to carry out frequent inspections to closely monitor for signs of distress in the diaphragms so that strengthening measures can be implemented. In the event of a failed diaphragm, JCCBI has tasked COWI with developing concepts for an emergency replacement diaphragm as part of the updated risk mitigation program. As such, COWI considers that the risk of failure of a concrete diaphragm risk will remain medium under the 12 and 24 month delay scenarios if the updated mitigation plan outlined in Appendix A is followed.

3.6 Sections 5 & 7 – Pier Caps

The pier caps of the concrete spans have been retrofitted many times over the years – the most significant interventions were carried out between 2002 and 2013.

At the time, significant deterioration of the pier caps, including structural cracking, was observed. Recent inspections of the pier caps have identified cracks that could be a sign of structural distress (see Figure 8).

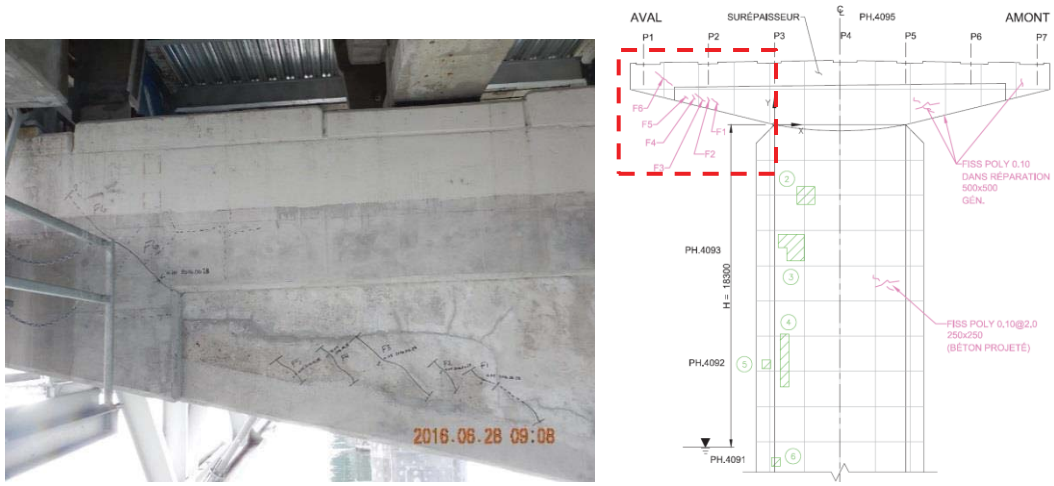

Figure 8 Observed Signs of Deterioration on Pier Caps [redacted] *hown)*

Even with the retrofits and strengthening systems that have been added to the pier caps, they are very highly stressed. In addition, due to the ongoing deterioration there is a possibility that unseen defects exist within the pier caps that would potentially affect their load carrying capacity. Since the pier caps have no redundancy, severe distress of a pier cap would result in a complete closure of the bridge, and a complete failure of a pier cap would result in the collapse of two spans of the bridge.

COWI considers the risk associated with the pier caps to be medium. If the current mitigation measures are followed, under a 12 month delay, this would become high and under a 24 month delay, it would become very high. If the updated risk mitigation plan included in Appendix A is followed, COWI considers that the risk associated with the pier caps will become low by the end of 2018 as all of the pier caps will be retrofitted by then.

Consultants to JCCBI are carrying out frequent inspections and monitoring, as well as detailed analyses of these important components. As a result of the communicated delays of up to 24 months beyond the original commissioning date of the new bridge, JCCBI has made a preemptive decision to implement the additional mitigation measures for the pier caps now, irrespective of whether the delays to the new bridge materialize since the risk is so high and the delays cannot be quantified at this time.

3.7 Sections 5 & 7 – Pier Columns

The columns of the piers have shown some deterioration over the years, and have generally been repaired. However, since the majority of the load on the columns is vertical, corrosion of the reinforcing in the pier columns is not a major concern.

COWI believe the risk associated with the failure of the pier columns is low, but will become medium in the event of any delay to the new bridge. It is noted that this risk level is subject to findings of future inspections and engineering analyses.

3.8 Sections 5 & 7 – Pier Bases and Foundations

The underwater portion of the pier (the pier base) and the foundations of the piers are difficult to inspect, and therefore have only been inspected a few times in recent years. JCCBI is undertaking additional underwater inspections of three of the piers in the fall of 2017 and an additional 11 by mid-2018, and the results of these inspections may result in retrofits being required. However based on the current information, COWI believes that the risk associated with the pier base and foundation is low, and assuming that the current inspections do not identify any issues, will remain low under both a 12 and 24 month delay scenario. It is noted that this risk level could change significantly subject to findings of current underwater inspections.

4 Risk Mitigation Measures

The existing Champlain Bridge was opened to traffic in 1962. Given its relatively young age, it is reasonable to expect that the bridge would be in much better condition than it is. Unfortunately, this is not the case due to design details and concrete material characteristics that have led to premature deterioration – the initial signs of which showed up 25 years after the bridge was opened which is much earlier than expected. In the last 30 years, the level of deterioration has been steadily increasing to the point where the existing Champlain Bridge is considered to be one of the most severely deteriorated major bridges in all of Canada.

JCCBI has been successfully mitigating the risk associated with the bridge for many years, and regularly encounters new issues due to the uncertainties in the nature of the deterioration. However, the design details and concrete material characteristics built into the original bridge do not allow for elimination of the problems, and rehabilitation measures are designed, at best, to reduce the risk. Keeping the bridge open until the original planned commissioning of the new bridge is already a challenge. Extending the life of the bridge past December 2018 will require additional major mitigation measures that are summarized in this report.

The current strategic risk mitigation program is the product of a close cooperation between JCCBI and the consultants responsible for the assessment work (primarily COWI and Stantec) that has permitted a coordinated and proactive approach to maintaining the bridge. The strategic risk mitigation program has been critical to successfully ensuring an acceptable level of public safety and allowing the bridge to remain open to traffic. The risk mitigation planning done to date has all been based on decommissioning the bridge in December 2018. With the possibility of this date being delayed by up to 24 months (to December 2020), additional mitigation measures will need to be implemented immediately. COWI's recommended updated risk mitigation plan is summarized in Appendix B.

As experienced in 2013 with the unexpected failure of an edge girder, the strength of the bridge can change very quickly. Rehabilitation of the bridge is essential to manage the risk and maintain an acceptable level of public safety, however it cannot eliminate the possibility of a structural failure. Therefore, even with continued rehabilitation, substantial risks will remain the longer the bridge is open, including the increased risk of lane closures, the increased risk of long term full bridge closures, and even the increased possibility of a collapse of a portion of the bridge. Due to the fact that these risks will continue to increase the longer the bridge remains open, COWI highly recommends that JCCBI inform Infrastructure Canada that they must do everything possible to eliminate or minimize the delays in opening the new bridge.

5 Conclusions

The existing Champlain Bridge was opened to traffic in 1962. Given its relatively young age, it is reasonable to expect that the bridge would be in much better condition than it is. Unfortunately, this is not the case due to design details and concrete material characteristics that have led to premature deterioration – the initial signs of which showed up 25 years after the bridge was opened which is much earlier than expected.

JCCBI has been successfully mitigating the risk associated with the bridge for many years, and regularly encounters new issues due to the uncertainties in the nature of the deterioration. However, the design details and concrete material characteristics built into the original bridge do not allow for elimination of the problems, and rehabilitation measures are designed, at best, to reduce the risk. Keeping the bridge open until the original planned commissioning of the new bridge is already a challenge. Extending the life of the bridge past December 2018 will require additional major mitigation measures that are summarized in this report.

In 2011, Delcan performed an assessment of the bridge and summarized that the bridge is in a condition that requires extreme vigilance in order to maintain it safely in service over even a relatively short term.

The deterioration of the bridge has become significantly worse in the six years since the Delcan report was completed. In 2013, JCCBI implemented a five-year risk mitigation plan in order to deal with the increasing levels of deterioration, and to maintain an acceptable level of structural safety until the bridge's planned decommissioning in 2018. In the last 4 years, this plan has been updated regularly and implemented effectively, and even dealt with a girder failure that occurred in 2013 resulting in a partial closure of the bridge for several weeks. However, since the new bridge is now potentially delayed 12 or 24 months, a new risk mitigation plan must be developed and implemented in order to maintain an acceptable level of structural safety beyond December 2018.

COWI considers that the existing Champlain Bridge is well beyond its effective service life and is on "life support". The level of deterioration has been steadily increasing to the point where the existing Champlain Bridge is considered to be one of the most severely deteriorated major bridges in Canada.

Given the severely deteriorated condition of the bridge, and the projected exponential increase in the deterioration over time the possibility of needing to keep the existing bridge operational for an additional year or two beyond December 1, 2018 will pose major challenges. Therefore, COWI highly recommends that JCCBI inform Infrastructure Canada that they must do everything possible to eliminate or minimize the delays in opening the new bridge. The longer the existing Champlain Bridge remains open to traffic, the more difficult it is for JCCBI to ensure public safety.

The existing Champlain Bridge has many different components, some of which are more deteriorated than others. The table below summarizes COWI's assessment of the risk level for each major component of the bridge, and how those risks could change under different delay scenarios and different mitigation plans. The "current mitigation measures" are those that were planned and implemented by JCCBI considering the new bridge to be opening in Dec 2018, whereas the "updated mitigation plan" is the plan required to keep the existing bridge open due to the 12 or 24 month delay to the new bridge.

Bridge Component	**Risk Level** (See note 1)			
	Sept 2017	Dec 2018	Dec 2019 12 month delay	Dec 2020 24 month delay
Section 6 - All components (truss spans)				
Current mitigation measures	Low	Low	Low	Medium
Updated mitigation plan	Low	Low	Low	Medium
Section 5&7 - Roadway Deck Slab				
Current mitigation measures	Low	Low	Low	Low
Updated mitigation plan	Low	Low	Low	Low
Section 5&7 – 100 Edge Girders (See note 2)				
Current mitigation measures	Very Low	Very Low	Very Low	Very Low
Updated mitigation plan	Very Low	Very Low	Very Low	Very Low
Section 5&7 – 250 Interior Girders				
Current mitigation measures	Medium	Medium	High	High
Updated mitigation plan	Medium	See note 3	See note 3	See note 3
Section 5&7 – 1,272 Diaphragms				
Current mitigation measures	Medium	Medium	High	High
Updated mitigation plan	Medium	See note 3	See note 3	See note 3
Section 5&7 - Pier Caps (See note 4)				
Current mitigation measures	Medium	High	Very High	Very High
Updated mitigation plan	Medium	See note 4	See note 4	See note 4
Section 5&7 - Pier Columns				
Current mitigation measures	Low	Low	Medium	Medium
Updated mitigation plan	Low	See note 5	See note 5	See note 5
Section 5&7 - Pier Bases and Foundations				
Current mitigation measures	Low	Low	Low	Low
Updated mitigation plan	Low	See note 6	See note 6	See note 6

Notes:

1. Estimates for future risk levels are uncertain as it is not possible to predict the effects of continued deterioration.

2. Risk has been effectively dealt with since truss installation was completed on all spans in March 2017.

3. Risk level remains medium for updated mitigation plan but JCCBI will have tools to secure components in the event of distress to reduce risk beyond Dec 2018.

4. The pier caps are currently considered to be medium risk and with possible deterioration would be considered to be high risk. Currently, the inspection frequency has changed from 6 months to 3months and additional mitigation measures are planned to be implemented given the potential delays to the new bridge. It is noted that the pier caps are currently the most critical components of the bridge given their condition and their consequence of failure.

5. Risk level subject to findings of future inspections and engineering analyses.

6. Risk level could change significantly subject to findings of current underwater inspection.

COWI is of the view that each of the above risks are currently at an acceptable level for JCCBI to keep the bridge open to traffic. Mitigation measures recommended in this report must be implemented including, in particular, strengthening of the pier caps. Should any inspections or monitoring reveal any new structural defects or material deterioration, it may become necessary to close certain lanes or perhaps even the entire bridge for an undetermined period of time.

It is very difficult to estimate the amount of funding that will be required to rehabilitate and strengthen the bridge due to the uncertainties of its current condition and the progression of deterioration until the new bridge opens to traffic. However, COWI recommends that JCCBI have available funding of up to $250 million if the new bridge is delayed by 24 months. If the new bridge is delayed 12 months, an amount of $200 million is recommended.

Following the mitigation plan is essential to manage the risk and maintain an acceptable level of public safety, however it cannot eliminate the possibility of a structural failure. Therefore, even with the continued rehabilitation, substantial risks will remain the longer the bridge is open, including the increased risk of lane closures, the increased risk of long term full bridge closures, and even the increased possibility of a collapse of a portion of the bridge. Closing the bridge would have a devastating impact on both the travelling public and the economy of the Montreal region.

In summary, COWI is of the opinion that that JCCBI must continue to be vigilant in inspecting, monitoring, evaluating, and wherever necessary, strengthening the bridge. Every effort should be made by Infrastructure Canada to eliminate or significantly reduce the delay to the opening of the new bridge.

Appendix A Description of the Existing Bridge

A.1 Description of Structure

The existing Champlain Bridge was opened to traffic in 1962. It is a 3.4 km long structure comprising a cantilever steel truss main span over the Seaway, flanked by two truss spans on each side (collectively referred to as Section 6), and 50 concrete spans (Sections 5 and 7). The bridge accommodates six lanes of traffic, three in each direction. See Figure A9 for an overview of the entire bridge.

Figure A9 General View of Champlain Bridge

A.2 Section 6 - Steel Truss Spans

Figure A10 shows the general arrangement of Section 6, which consists of four under deck truss spans and a three-span truss main bridge. These seven spans are supported by eight concrete piers (4W to 4E).

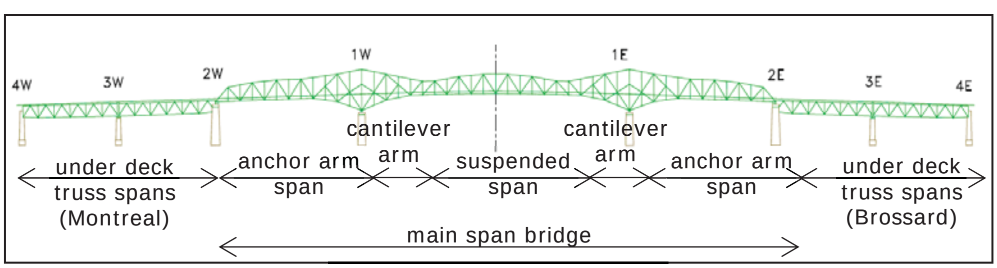

Figure A10 General Arrangement of the Steel Truss Spans in Section 6

Each of the four under deck truss spans (78.0 m for spans 4W-3W, 3E-4E; and 78.5 m for spans 3W-2W, 2E-3E – see Figure A10) consists of four simply supported steel trusses topped by an orthotropic deck that supports the roadway traffic.

The main span bridge consists of three cantilever-type steel trusses, spanning over three spans. Each truss is composed of five separate portions: two anchor arm spans (117.5 m), two cantilever arms (48.9 m), and a suspended span (117.5 m), as shown in Figure A10. The traffic is supported by an orthotropic deck, which is situated near the bottom chord of the trusses.

A.3 Sections 5 and 7– Concrete Spans

Each of the 50 concrete spans in Sections 5 and 7 is a simply supported system and has a cross-section of seven precast post-tensioned (PT) girders (see Figure A11). The deck slab between the top flanges of the girders at deck level is made up of cast-in-place infill strips. There are diaphragms between the girders, both at the bearing locations and within the span. The deck is post-tensioned in the transverse direction in the slab and the diaphragms. The top flanges of the girders together with the cast-in-place infill strips constitute the deck over which an asphalt riding surface is installed. This results in a structure that is highly integrated in both the longitudinal and transverse directions.

Figure A11 Typical Concrete Span in Section 5 & 7

The concrete spans range in length from 51.4 m to 53.7 m. A typical concrete girder is reinforced with 24 internal post-tensioning (PT) tendons. The tendons have a parabolic profile, with 14 tendons anchored on the girder ends and up to 10 tendons anchored on the girder top. Figure A12 shows the bridge deck typical section and an elevation of the girder PT tendon layout.

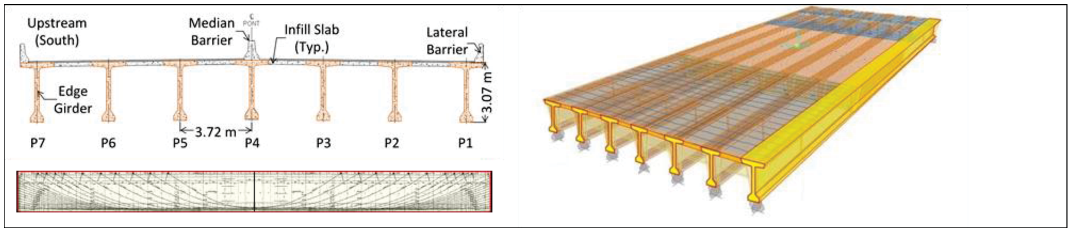

Figure A12 Typical Section 5 and 7 Concrete Span Deck Cross-Section and Elevation of Girder Internal Post-Tensioning System

Appendix B Recommended Updated Risk Mitigation Plan

Due to the possible delay of 12 or 24 months to the opening of the new bridge and in order to maximize the possibility of keeping the bridge open to traffic until the new bridge is open to traffic, COWI recommends that the existing mitigation measures continue as planned, and in addition we recommend the following:

1 Increase the inspection frequency of the most deteriorated interior girders in Section 5 and 7 to twice per year (COWI to define which girders, but this is expected to include about 50 of the 250 interior girders).

2 Increase the inspection frequency of the pier caps in Section 5 and 7 to once every 3 months until retrofit measures can be installed.

3 Immediately design retrofit measures for all of the pier caps in Sections 5 and 7 (target design completion by mid-October 2017).

4 As soon as possible, install the retrofit measures for all of the pier caps in Sections 5 and 7 (target completion by the end of 2018). COWI will establish the priority of installations based on information from inspections and calculations to address the most critical pier caps first.

5 As soon as possible, fabricate a set of retrofit measures that can serve as an emergency repair for the pier caps in Section 5 and 7 in the event that a sudden failure needs to be addressed. Target completion of design by mid-October 2017, and fabrication by end of February 2018.

6 Design and install retrofit measures for the underwater portions of the piers if issues are discovered during the inspections or engineering calculations show a need for repair.

7 As time passes and deterioration accelerates, it may become necessary to install additional measurement devices on more interior girders in Sections 5 and 7 identified by COWI (anticipate to be a total of 50 girders, 31 of which already have instrumentation). Target completion of installation by the end of December 2017.

8 Install instrumentation measurement devices on some of the pier caps in Sections 5 and 7 (target completion of installation by the end of December 2017).

9 Design and fabricate by summer 2018 an emergency standby truss to be installed between piers under an interior girder, if the need arises.

10 Design and fabricate an emergency replacement diaphragm to be installed on a distressed diaphragm, if the need arises.