

To: Board of Directors
From: Doug Kelsey, Chief Operating Officer
Date: June 17, 2014
Subject: Pattullo Bridge Rehabilitation and Condition Monitoring Update

PURPOSE

This report provides an information update on the current status of the Pattullo Bridge Rehabilitation Project. Information new since the **March** 2014 update report is highlighted in **yellow**.

The Pattullo Bridge Condition Monitoring Report is attached to this document as Appendix A.

BACKGROUND

A bridge assessment in late 2012 confirmed it was technically feasible to rehabilitate the Pattullo Bridge. As a result, TransLink is moving forward with the site investigation and preliminary design of the rehabilitation of the Pattullo Bridge as outlined in the TransLink 2014 Base Plan. **A phased approach is being used to maximize flexibility and establish the appropriate level of rehabilitation pending confirmation of a funded replacement solution consistent with Vision adopted by the Mayors.**

DISCUSSION

As one of the oldest bridges in the Lower Mainland, the 77-year old Pattullo Bridge faces a number of challenges, including:

- susceptibility to collapse from a moderate earthquake;
- river scour threat to the stability of the bridge foundations;
- a delaminating bridge deck;
- concrete and steel structural elements reaching the end of their functional life;
- spalling concrete from the underside of the deck and from the piers creating a falling debris hazard;
- narrow travel lanes;
- no median barrier;
- the bridge has not been designed to withstand a vessel impact;
- poor pedestrian/cycling facilities, including an absence of suicide prevention measures.

Efforts to identify a solution to the aging Pattullo Bridge have been underway in various forms since 2006. The recently adopted replacement solution outlined in the Mayors' Vision document will address the above-described challenges. The replacement solution requires confirmation and funding approval, to be followed by a six to eight year design and construction period. The rehabilitation project will continue to reduce the magnitude of the prevailing risks, and will be scaled in accordance with the certainty of the replacement solution.

Rehabilitation phases and schedule

The rehabilitation of the bridge will be performed in three phases:

Phase 1: Site investigation

This phase involves retaining design contractors and performing a detailed site investigation program, which includes geotechnical, environmental and archaeological investigation. This phase is currently underway. The site investigation work commenced in Q2 2014.

Phase 2: Preliminary and detailed design

Phase 2 involves the preliminary and detailed design of the rehabilitation to meet the current practice for seismically rehabilitated bridges in the region. The work will include:

- Deck and structural rehabilitation of the steel bridge spans and the concrete approaches.
- Structural seismic retrofit to meet current practice of seismically rehabilitated large bridges in the region.
- Geotechnical seismic retrofit to mitigate the consequences of liquefaction to achieve a bridge seismic performance consistent with other large bridge retrofits in the Lower Mainland.
- Functional Improvements to the bridge including traffic and pedestrian barriers, improved pedestrian/cycling facilities, reinstatement of existing traffic counting and monitoring system and determination of appropriate roadway configurations to meet roadway design guidelines for a new bridge built today.
- Offshore works consisting of further scour assessment and pier improvements for ship collisions.

The preliminary design work is underway and scheduled for completion in Q3 2014. The outcome of the preliminary design and the level of certainty of a funded replacement solution will be used to make an informed decision on the scope and timing of the rehabilitation work including the detailed design and construction of the bridge upgrades.

Phase 3: Phased construction

Phase 3 involves the phased implementation of the rehabilitation work to ensure the Pattullo Bridge remains safe for all users.

- Phase 3a will consist of structural seismic upgrades to be constructed in 2015.
- Phase 3b will consist of a deck replacement or rehabilitation to be constructed in 2016.
- Phase 3c will consist of ground-level seismic upgrades and pier strengthening to be constructed in 2017.

If a funded replacement solution is confirmed prior to fall 2015, Phase 3b will be scaled back to a deck rehabilitation (rather than a deck replacement), and if a funded replacement solution is confirmed prior to fall 2016, Phase 3c will be cancelled.

The major milestones of the rehabilitation are summarized in Table 1.

Table 1. Major milestones schedule

| Phase | Completion date |
|---|-----------------|
| 1. Site investigation | 2014 |
| 2. Preliminary design | 2014 |
| 3. Detailed Design Phase 3a: structural seismic upgrades | 2014 |
| 4. Construction Phase 3a: structural seismic upgrades | 2015 |
| 5. Detailed Design Phase 3b: deck replacement or rehabilitation | 2015 |
| 6. Construction Phase 3b: deck replacement or rehabilitation | 2016 |
| 7. Detailed Design Phase 3c: ground level seismic upgrades and pier strengthening | 2016 |
| 8. Construction Phase 3c: ground level seismic upgrades and pier strengthening | 2017 |

The total cost for Phase 1: Site Investigation and Phase 2: Preliminary and Detailed Design is currently estimated at approximately \$25 million. On May 17, 2013, the Capital Review Committee (CRC) provided Specific Project Approval (SPA) for \$3 million to initiate Phase 1: Site Investigation. On January 22, 2014, \$3.5 million was approved by CRC for the preliminary design portion of Phase 2.

Base Plan cost provisions

A total funding envelope of \$299 million is included in the 2014 Base Plan for the Pattullo Bridge Rehabilitation Project. Of this amount, \$25 million is allocated to be spent in 2014, \$78 million in 2015, \$77 million in 2016 and \$119 million in 2017. This information will be updated at the end of the Preliminary Design phase. If a funded replacement solution is confirmed prior to fall 2015, it is expected that the rehabilitation project can be scaled back to a scope of approximately \$100 million.

NEXT STEPS

Preliminary design work has begun with completion scheduled for Q3, 2014. Detailed design work for the structural seismic upgrades will begin in Q3 2014, with procurement in late 2014 and construction of the structural seismic upgrades commencing in 2015.

APPENDIX A

Pattullo Bridge Condition Monitoring Report

PURPOSE

This attachment is presented to the Board's Major Capital Projects (MCP) Committee for information. The report summarizes the on-going activities to monitor the condition of the Pattullo Bridge. New information since the last report is highlighted in **yellow**.

BACKGROUND

The Pattullo Bridge is 77 years old. Most of the structural components have passed the predicted design life and are reaching the end of their useful life. The deterioration of the bridge condition is a dynamic event, with conditions generally degrading over time. Weather, temperature fluctuation, rainfall, wind, river action, live traffic loads and aging of the steel and concrete components all contribute to the degradation of the bridge condition.

To ensure that all the necessary inspection and monitoring activities are being identified and implemented, TransLink regularly consults with experienced bridge engineers working in the private and public sector in Metro Vancouver.

With responsibility for the safety and operations of the bridge, TransLink monitors the condition of the bridge structure closely through regular inspections of the bridge components. TransLink then performs maintenance and repairs in response to the findings of the inspection reports.

DISCUSSION

Recent inspection reports commissioned by TransLink and received in 2013 are listed in Table 1. In addition to the inspection reports listed in Table 1, TransLink's Manager, Bridge Operations and the Pattullo Bridge's maintenance contractor, Mainroad Contracting Ltd., also perform regular inspections of the Pattullo Bridge. A synopsis of the most recent inspection findings is provided below the table.

Table 1. 2013/2014 Pattullo Bridge Inspection Reports

| APPENDIX REFERENCE | REPORT TITLE | PREPARED BY: | DATE |
|--------------------|--|---|--------------------|
| 1 | 2012 Concrete Deck Condition Survey | Levelton Consultants Ltd. | January 4, 2013 |
| 2 | 2013 Spring Freshet Monitoring Summary | Northwest Hydraulic Consultants | September 25, 2013 |
| 3 | 2013 Winter Monitoring Summary | Northwest Hydraulic Consultants | January, 2014 |
| 4 | 2013 Winter Monitoring Summary | Northwest Hydraulic Consultants | February 7, 2013 |
| 5 | 2012 Pattullo Bridge Management Strategy Study | Associated Engineering | February 28, 2013 |
| 6 | 2013 Maintenance and Rehabilitation Prioritization Recommendations – Pattullo Bridge | Buckland & Taylor | April 18, 2013 |
| 7 | 2013 Pattullo Bridge Project: Seismic Vulnerability Assessment | Delcan Corporation | May 2013 |
| 8 | 2013 Pattullo Bridge Inspection Reports | Ministry of Transportation and Infrastructure | July 2, 2013 |
| 9 | 2013 Concrete Failure Mitigation Options | Buckland & Taylor | August 8, 2013 |

A summary of each of these reports and the resultant actions by TransLink is provided as follows:

1. 2012 Concrete Deck Condition Survey by Levelton Consultants Ltd.

The survey found that the condition of the inspected deck areas varied between fair and poor, with considerable areas of delamination (disconnection of the concrete from the steel), localized patching, and surface spalls. While deck patching and repaving have been undertaken in recent years, these repairs are considered viable in the short-term only. It is expected that the corrosion and its related damage will occur at an increasing rate, requiring bridge maintenance closures to occur at increasing frequency and for longer durations.

There have been several instances during the current and previous deck repair programs where removal of the deteriorated concrete from the top surface of the deck resulted in small holes through the deck, usually less than approximately 100 mm in diameter. The frequency and size of these full-thickness damage events should be expected to increase over time. At this time, the possibility of a localized full thickness deck failure (a small or large but deep pothole that could cause damage to vehicles) cannot be ruled out. As such Levelton recommended that TransLink conduct periodic reviews of the deck riding surface and the soffit at least once every

year or more frequently if evidence of concrete deterioration visually manifests by disruption of the asphalt riding surface. In addition, Levelton also recommended that a comprehensive deck rehabilitation or deck replacement strategy be considered.

Resultant action by TransLink

1. Annual spot repairs are conducted to repair delaminated areas. In the summer of 2013, spot repairs were undertaken over three weekends. **Additional spot repairs are now scheduled over two weekends for the summer of 2014.**
2. A full deck rehabilitation is part of the scope of the rehabilitation design work starting in 2014.
3. The budget for a full deck rehabilitation is included in the 2014 Base Plan.

2. 2013 Spring Freshet Monitoring Summary by Northwest Hydraulic Consultants

Twice a year, Northwest Hydraulic Consultants Ltd (NHC) surveys the scour impacts of low/high river discharges and large tidal variations, which generate reverse flow and large localized river velocity at the Pattullo Bridge. Generally the freshet survey is scheduled to take place one or two weeks after the peak discharge to capture lowest bed levels. The May 2013 Freshet survey recommended that no maintenance or upgrades are required at this time, and that continued monitoring is recommended.

3. 2013 Winter Monitoring Summary by Northwest Hydraulic Consultants

The 2013 winter survey was completed in December, 2013. **We received the report from Northwest Hydraulic Consultants in Q1, 2014. No new concerns are raised by the survey.**

4. 2012 Winter Scour Monitoring Summary by Northwest Hydraulic Consultants

The 2012 winter survey, which was conducted following the two lowest winter tides of the year, identified that there was no unusual or significant bed level changes in the area near the piers. The existing scour protection at the Pattullo Bridge piers appeared effective. The report recommended that continued bi-annual monitoring for the Bridge be performed.

Resultant action by TransLink for items 2, 3, and 4

The rip-rap deployed by TransLink to stabilize the piers is functioning as planned, with regular monitoring. Resolving the scour issue with a longer term solution is a component of the seismic resiliency upgrade within the bridge rehabilitation project.

5. 2012 Pattullo Bridge Management Strategy Study by Associated Engineering

In 2012, Associated Engineering identified the key issues and risks for the Pattullo Bridge related to condition, structural capacity, seismic capacity, and user safety, and established mitigation measures to reduce the risks of each of the items identified.

Resultant action by TransLink

The mitigation measures identified in this report have been included in the scope of the rehabilitation project. **Design work is underway.**

6. 2013 Maintenance and Rehabilitation Prioritization Recommendations – Pattullo Bridge by Buckland & Taylor

Buckland & Taylor confirmed that the Pattullo Bridge is currently facing seven types of structural deficiencies. A severity classification was assigned to each type of deficiency, which found that the items in highest priority for repair are the concrete delaminations and spalls over roads and railways.

Resultant action by TransLink

1. Loose concrete was removed by work crews from the piers and the underside of the deck in 2013.
2. “Falling Debris” warning signs have been installed under the south approach structure (Surrey).
3. **Debris netting was installed under spans that cross other transportation routes (SFPR, rail tracks etc.), with the work completed in June 2014.**
4. The other issues and mitigation measures identified in this report have been included in the scope of the rehabilitation project. **Design work is underway.**

7. 2013 Pattullo Bridge Project: Seismic Vulnerability Assessment by Delcan Corporation

This Delcan study concludes that the current condition of the Bridge is significantly deficient in terms of withstanding a seismic event due to the inadequate ductility of the pier columns. The bridge does not meet seismic standards for a new bridge built today and is vulnerable to damage from a moderate earthquake.

Resultant action by TransLink

The budget for improving seismic resiliency was included in the 2013 Base Plan, **and design work is underway.**

8. 2013 Pattullo Bridge Inspection Reports by the Ministry of Transportation and Infrastructure

Each year, the BC Ministry of Transportation and Infrastructure inspectors perform a condition inspection of the Pattullo Bridge that consists of walkthroughs and visual observations, with the aid of a “snooper truck.” During the 2013 inspection, it was reported that delaminations below the deck and on the piers may cause concrete to break off, resulting in a falling debris hazard. It was also noted that the steel railings and the down pipes used for drainage are heavily corroded and are in need of repair. Frequency of use of the snooper truck for inspections has now been increased from every three years to annual.

Resultant action by TransLink

1. Annual spot repairs are conducted to repair delaminated areas. In the summer of 2013, spot repairs to the upper bridge deck surface were undertaken over three weekends. **Additional spot repairs are planned for two weekends in the summer of 2014.**
2. Loose concrete was removed by work crews from the piers and the underside of the deck in 2013.
3. "Falling Debris" warning signs were installed in 2013.
4. **Debris netting was installed along key sections by June 2014.**
5. The other required repairs identified in this report have been included in the scope of the rehabilitation project.

9. 2013 Concrete Failure Mitigation Options by Buckland & Taylor

This 2013 Buckland & Taylor report found that the introduction of weight restrictions is not expected to be effective in slowing or eliminating the development of potholes. Potholes are developing as a result of the deck delamination, and are not directly caused by the amount and weight of traffic on the Bridge. With respect to debris netting to catch spalling concrete, it was recommended that a netting system be installed over Columbia Street, Front Street, the railway tracks, and over the South Fraser Perimeter Road to protect the safety of the public.

Resultant action by TransLink

1. No weight restrictions (truck prohibitions) are needed at this time.
2. Annual spot repairs are conducted to repair delaminated areas. In the summer of 2013, spot repairs were undertaken over three weekends. **Additional spot repairs are scheduled for 2014.**
3. Loose concrete was removed by work crews from the piers and the underside of the deck in 2013.
4. "Falling Debris" warning signs have been installed.
5. **Debris netting was installed along key sections by June 2014.**

Other ongoing inspections and actions

Two/three times a month, the TransLink Bridge Operations Manager performs inspections of the underside of the bridge deck to monitor the condition of concrete spalls, by walking along the catwalk underneath the structure, where access is available. Pieces of spalled concrete have been found on the surface of the catwalk, ranging in size from 5mm to 50mm. Recent introduction of warning signs under the south approach structure in Surrey and the installation of debris containment netting under spans crossing other transportation routes will mitigate the risk. **The netting installation was completed in June 2014.**

Since July 2013, Mainroad Contracting Ltd. has been performing weekly inspections of the bridge deck asphalt surfacing to detect the formation of potholes. Recent potholes that have been identified were repaired as part of the deck repatching/repaving work that was undertaken during the summer of 2013. When new potholes are identified, they are repaired

in accordance with the terms of the bridge maintenance contract. Underlying deck delaminations that are causing the potholes to occur will be again be repaired during 2014.

TransLink engineers are in contact with Professor Nemkumar (Nemy) Banthia, Canada Research Chair in Infrastructure Rehabilitation at the University of British Columbia, to discuss the latest bridge condition monitoring technology, including the use of electronic sensors to detect minute structural changes. TransLink is exploring whether this technology is appropriate and feasible for the Pattullo Bridge.

CONCLUSION

TransLink will continue to closely monitor and inspect the condition of the Bridge, and maintain the Bridge accordingly.