Public Services and Procurement Canada

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November 2019

LaSalle Causeway Bascule Bridge
2018 Comprehensive Detailed Inspection Report

Project Number: R. 090045.001

PARSONS

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Prepared for:

Public Services and Procurement Canada | Services publics et Approvisionnement Canada

PSPC Project Number: R.090045.001

Prepared by:

PARSONS

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Executive Summary

The LaSalle Causeway (the Causeway), opened since 1917, provides an important transportation link within the City of Kingston, carrying Highway 2, and approximately 28,000 vehicles each day, across the Cataraqui River between the downtown area on the west side of the river and the Barriefield/CFB Kingston area on the east side of the river. The Causeway accommodates a single lane of traffic in each direction and consists of five interconnecting structures: the West Bridge, the West Wharf, the Bascule Bridge, the East Wharf, and the East Bridge. The East Bridge and Bascule Bridge provide marine access to the inner harbour of Kingston and access to the southern entrance of the Rideau Canal. The Bascule Bridge accommodates larger marine vessels and lifts an average of 900 times per year.

The Bascule Bridge is a single leaf Strauss heel trunnion bascule bridge, designed by The Strauss Bascule Bridge Co. of Chicago. Construction of the bridge was completed in April 1917. The structure is supported on two concrete abutments (also known as piers) founded on timber piles. The main leaf (or through) truss span of the bridge consists of a Modified Warren through truss with a span length of 48.77 m and has an open steel deck grating supported by a floor system comprising transverse sills, nine longitudinal stringers, and transverse floor beams located at each panel point. A 1.2 m wide timber plank sidewalk is cantilevered from the exterior of the south truss. The fixed tower truss supports the counterweight truss and the machinery room containing the span drive machinery (brakes, motors, open gearing, etc.) which is located over the roadway. The lower members of the north and south trusses are located directly adjacent to the roadway. The counterweight truss above supports the concrete counterweight, which weighs approximately 550 tonnes (1,220,000 lbs.). The structural steel truss members consist of built-up sections of plates, channels, angles, and lattice. The bridge has undergone numerous rehabilitations since its construction in 1917.

Parsons Inc. (Parsons) was retained by Public Services and Procurement Canada (PSPC) in August 2018 to complete the 2018 Comprehensive Detailed Inspection of the structural, mechanical and electrical components of the Bascule Bridge. The inspection of the structure consisted of a close-up, detailed visual examination of all exposed surfaces of the above-water and above-grade components, including a detailed deck grating inspection. A fatigue inspection was carried out by a team comprising a Parsons engineer, and non-destructive testing specialists who performed magnetic particle and ultrasonic testing of structural steel members and connections, and phased array testing of the trunnion and link pins. The detailed findings of the fatigue inspection and the results of the fatigue evaluation of the Bascule Bridge are included in a separate report, although relevant findings of the inspection have been incorporated into this report. A survey to record the elevation of the east approach slab and east abutment was carried out. An investigation to assess the condition of the concrete counterweight was carried out and comprised localized removal of the metal panels to permit the extraction of concrete cores for materials testing purposes. The inspection of the mechanical and electrical systems and components was carried out by Parsons' sub-consultant Stafford Bandlow Engineering Inc. (Stafford Bandlow) from Doylestown, Pennsylvania. No structural or seismic evaluations or underwater inspection were carried out as part of this assignment.

The key findings of the inspections and recommendations are as follows:

Structural

The fatigue inspection revealed cracks in several leaf truss top chord, bottom chord, and vertical members, in gusset plates at connections, and a lamination defect in the north channel of top chord 3S-5S. A 3 mm crack parallel to the main stress was found at the location of a removed weld near the top of 9S-10S. Cracks were also found in counterweight truss member 21N-27N, tower truss horizontals, and at the top and/or bottom cope in 25 of the 72 stringers, including in six adjacent stringers in bay FB14-FB16. The north and south main trunnion connections exhibit severe localized pitting in the gusset plates, very severe section loss of several rivet heads, perforations in the triangular plates behind FB16, and cracks propagating from perforations at the bottom of the vertical gusset plates between the end of the bottom chord members 14-16 and FB16. Other typical structural steel deterioration noted includes vertical gusset plates at truss nodes with significant section loss in failure planes, perforated structural steel members, gusset plates and batten plates, and rivet heads with severe section loss. Some leaf truss sway bracing members have been damaged by vehicle impact. Welds were noted on several leaf truss members which are typically discouraged on historical steel structures.

Bent and broken bearing and cross bars were observed throughout the steel deck grating, and cracked bar-to-bar and bar-to-sill welds were noted at several locations. The serrated edge has been completely worn away within the wheel tracks in each vehicular lane meaning the grating no longer provides the same slip resistance as designed which could increase vehicle braking distances in poor weather conditions. In February 2017 a section of grating failed and broke off.

Numerous localized defects are evident in the structural steel coating system. The majority of the defects are on the tower truss members at roadway level, the leaf truss floor system and bracing members, and the leaf truss members at and below deck level.

The visible concrete at the edges of the counterweight is mostly in poor condition and exhibits isolated cracks, map cracking, delaminations, scaling and spalling, extensive disintegration, efflorescence deposits and wet stains. The concrete in the extracted cores exhibited numerous cracks and widespread disintegration. The laboratory test results indicate that the compressive strength of the concrete is 11.9 MPa and is considered to be non-air entrained. The chloride ion content was below the threshold required to initiate corrosion. Damp staining, large areas of light corrosion, stalactites, perforations, and impact damage were noted on the metal panels. Approximately 450mm of disintegrated concrete has collected between the concrete and the panels in the northeast corner which should be removed.

The thrie-beam traffic railings on the bridge do not meet current Canadian Highway Bridge Design Code CAN/CSA S6-14 (CHBDC) crash-tested requirements for bridge barriers, and the beams are mounted directly to the road side of the leaf truss members, therefore there is a possibility that vehicle collision along the barrier could subject primary members of the main truss to damage or failure. PSPC should consider accepting the liability of the railings not meeting CHBDC crash-tested requirements following a detailed review of the performance of the railing system based on accident history.

The approach guide rails do not meet current MTO standards and TAC requirements and may not be able to re-direct errant vehicles back onto the roadway which could subject primary members of the tower truss or though truss to damage or failure. The breakaway type timber posts in the southwest guide rail may permit the guide rail to deflect onto the sidewalk in the event of vehicle impact, which is a potential hazard to pedestrians.

The soffit of the mechanical platform concrete slab has widespread deterioration including delaminated areas over traffic lanes which should be scaled as a matter of urgency to prevent them from falling onto traffic below.

There are currently no safety chains or gates at openings in railings or fall-arrest cables at ladders, which are potential safety hazards. A complete Health and Safety review/audit of the stairs and catwalks should be carried out to identify all locations of potential falling hazards.

The current Structural Condition Rating is 3 (Poor). As previously mentioned, the fatigue inspection revealed cracks in several leaf truss members and connections. Cracks were also found in a counterweight truss member, tower truss horizontals, and in 25 stringers. Repairs are required to the main trunnion connections, concrete counterweight, other primary truss members and connections, and the structural steel coating system. Multiple secondary components also require repairs. The 2017 Structural Evaluation Report by Parsons indicates that the structure meets the current CHBDC load cases for live loading requirements in the closed position, although it should be noted that the evaluation has not been updated to account for the additional deterioration observed during the current inspection. It is not known if the structure satisfies the seismic requirements of the current CHBDC. The structure does not satisfy CHBDC special load case requirements for moveable bridges, specifically the operating impact (Io) factor of 20% applied to the maximum dead load effect in all members caused by the movement of the bridge.

In the bridge's current configuration, the Functional Rating is 2 (Inadequate). The clear distance between the timber curbs on the deck does not meet the minimum width requirements of the Geometric Design Guide for Canadian Roads (GDGCR) by the Transportation Association of Canada (TAC), the structure's vertical clearance of 4.2 m is more than 10% below the requirements of the GDGCR, and the minimum width of the sidewalk of 1.2m is below the practical lower limit of 1.5m. The thrie-beam traffic barriers on the bridge do not meet current CHBDC crash-tested requirements, and a vehicle collision could subject primary members of the main truss to damage or failure. The guide rails do not meet current MTO standards or TAC requirements.

Despite the deterioration observed, the service life of the structure can be extended by carrying out repairs to deteriorated elements in the short term. All costs indicated include relevant Cost Amplification Factors as provided by PSPC, and an assumed annual inflation rate of 2%.

Priority U repairs are recommended to: scale the delaminated areas on the underside of the mechanical housing slab ($7k); and removal of the disintegrated concrete that has collected between the counterweight and the metal panels ($7k).

The following Priority S work is recommended: repeat the survey of the east approach slab and abutment in 2019 to determine if there is any ongoing settlement occurring (Priority A, $8k); carry out a complete Health and Safety review/audit of the stairs and catwalks to identify all locations of potential falling hazards (Priority A, $24k); perform a refined analysis of the south gusset plate of 2N to determine the strengthening requirements (Priority A, $26k); monitor the deformation of the floor beams during future inspections (Priority A, $4k); regularly monitor the mechanical housing slab soffit for additional delaminations (Priority A, $3k); measure and monitor the deformation of 12N-13N during future inspections (Priority A, $4k).

Priority A repairs are recommended to: the catwalks and stairs ($35k); drill holes at the ends of the longer cracks and grind out the smaller cracks in the stringer web copes, and replace missing and tighten loose sill bolts ($115k); modify the approach guide rails to meet current MTO standards ($39k); south roadway railing post anchorage modifications, installation of a chain above the south trunnion, and replacement of missing thrie-beam bolts ($8k); repair cracks, perforations, and lamination defects in structural steel members 1N-2N, 3S-5S, 14S-15S, 14S-16S, 15S-18S, 18S-19S, 21S-27N, and 21N-27N, main trunnion connections 15N/16N and 15S/16S, and drill drainage holes in 15-17N,15S-17S and 26N-26S ($316k).

A project to rehabilitate the main trunnion connections and pins is planned to start in early 2019 with construction to commence in 2020. The scope of the project will include a site inspection to take updated detailed measurements of the assemblies in sufficient detail in order to carry out an updated structural evaluation of the assemblies. Structural repairs to the main trunnions are therefore not recommended at this time except for grinding smooth the suspected crack and the perimeter of the perforation in the vertical gusset plates at 16N and 16S.

The repairs to the concrete counterweight should be carried out within the next three years (Priority B, $1.82M), and it is recommended that a major rehabilitation (Priority C, $2.60M) is carried out to address the other major material and performance deficiencies observed, including: mechanical housing soffit concrete repairs; repairs to the structural steel coating system; replacement of the steel deck grating and sills; repairs to structural steel members and connections (including strengthening, and replacement of deteriorated rivets and batten plates); concrete substructure repairs; and removal of welds on truss members. The traffic staging required to complete the major rehabilitation will undoubtedly cause major delays to vehicular traffic, and therefore to minimize disruption as much as possible it may make sense to wait until the Third Crossing is open (currently scheduled for 2022) which would at least provide an alternative route for some vehicles during construction.

The 2017 CDI report stated that a seismic evaluation was in the process of being carried out, but the results of the evaluation have not been made available to Parsons. A provisional allowance for seismic retrofitting and strengthening (based on the recommendations provided in the 2001 preliminary seismic study by McCormick Rankin Corporation) has been included in the structural rehabilitation cost estimate ($878k).

The remaining recommended work is mostly low-complexity work that could be combined into an additional small miscellaneous repairs contract which would include: repairs to the marine structure safety railing posts; approach slab patch repairs; replacement of the deteriorated bolt in the southeast abutment bearing / live load supports; curb and sidewalk repairs; and installation of bolts in FB0 (Priority B, $23k).

Mechanical

The general condition of the Bascule Bridge machinery systems is fair. Many of the primary components are well-maintained and in suitable condition for long term service based on this inspection. However, there are components with unusual wear that should be investigated, a number of tasks that require maintenance activity, and some conditions that require a significant effort to address.

Where appropriate, inspection findings shall be referenced to Section 13 of the CHBDC.

The machinery operated reliably during the inspection. The motors, motor brakes, and span drive control unit were replaced since the previous inspection in November 2017. The machinery operated with no issues and the previously noted mechanical issues concerning these units have been addressed properly.

A significant concern for public safety is that there is not a traffic barrier system installed on the east approach. The warning gates provided are not adequate to prevent a vehicle from leaving the roadway. Note that the CHBDC does not require a traffic barrier but simply states that consideration should be given to providing one. A traffic barrier has been considered by PWGSC and it has been deemed unnecessary at this time.

It was previously reported that the north pinion guide assembly condition was poor. The north pinion and shaft connection had been compromised due to a poor fit between the pinion shaft and the pinion, and poor fits at the two installed keys due to deformation of the keyways and keys. The north pinion guide assembly was repaired in early 2018 with the proper fits restored to the pinion, shaft, and keys. At the time of the inspection there was no movement noted at the north guide assembly.

Disassembly and inspection of the south pinion guide assembly was performed in November 2015. The conditions at the south assembly were found to be similar to the north prior to the 2018 repairs, though not as severe. A failure at this guide assembly would result in a catastrophic loss of control of the structure which may damage the bridge and/or marine vessels as well as cause a lengthy marine outage. If the fit at the south pinion shaft is not restored, it is warranted to monitor the internal condition on an ongoing basis as part of routine yearly inspections and on a monthly basis as maintenance personnel are in the vicinity and an in-depth inspection should be performed every 5 years.

The condition of the structure near the main trunnion bearings is a concern. There is contact between the moving structure and the fixed structure in the vicinity of the main trunnion bearings during operation of the bridge. The contact is at the outboard side at both bearings and may be a result of contraction of the bridge due to temperature. Although it is not anticipated that the contact will result in components becoming overstressed or failing, the contact at these locations should be monitored over varying temperatures. In addition to this contact, four mounting bolts at each main trunnion bearing have failed due to corrosion and should be replaced. Although failure of the structural elements is not anticipated, a study is ongoing to analyze the loading of the structure adjacent to the main trunnions.

At the counterweight trunnion bearings, the sleeve studs that are used to secure the sleeves to the structure are not tight at some locations. This remains unchanged since 2011. There is strong evidence that there is at least one broken stud. Based on paint removal, it appears that there has been an attempt to tighten them, but that this was unsuccessful. Maintenance personnel have previously indicated that they used a hammer to drive one of the north counterweight bearing studs in while operating the bridge. This is an indication that the stud has sheared. All of the counterweight trunnion bearings studs should be tested to determine if they have failed and tightened if they are suitable for continued use. Cracked or failed studs and those that cannot be tightened should be replaced.

There are several machinery systems that do not appear to be used or maintained, including the full open operating strut support rollers and the span over-travel bumpers. Due to the current full opening angle of about 65°, the full open operating strut support rollers are not needed. If the bridge is ever to be opened to the design opening angle of 84°, rehabilitation of the full open operating strut support rollers will be needed.

The lubrication at the time of the inspection was adequate with exceptions. The south counterweight bearing has two leaking lube fittings, a missing lube fitting, and a fitting that is plugged. At the north counterweight bearing one lube fitting is missing. At both second link pins lubrication fittings are not properly piped to ensure proper lubrication. The north second link pin has leaking lube fittings. The counterweight trunnion bearing caps were removed for inspection in November 2015, and water contamination was noted in the lubricant. It is extremely important that these critical bearings receive regular maintenance and that the grooves are flushed with fresh lubricant on an annual basis.

There are several machinery components that have significant wear or excessive clearance including the south inboard operating strut bearing and the lower east operating strut guide roller bushing (from the Stafford Bandlow Engineering 2015 secondary inspection – not verifiable without disassembly of the strut guide assembly). The re-bushing of the south operating strut guide roller should occur in conjunction with rehabilitation of the south pinion guide assembly. The rivets that secure the inboard south operating strut bearing are loose based on cracked paint and fretting at the assembly. The rivets should be replaced with turned bolts as has been done previously at the north.

The span locks are generally in fair condition with minor exceptions. The span locks operated properly at the time of the inspection, however there was a majority of the components that were not fully painted and corroded. The components that were corroding include, the position indication adjustable arms, the motor and reducer mounting bolts, the B3 bearing mounting bolts, the shaft between B3 and B4 bearings, and the front and rear guide mounting bolts. The span lock machinery was rehabilitated in early 2017 and the condition of this machinery indicates that maintenance practices should be adjusted to ensure longevity of the machinery.

The live load supports and buffers are generally in fair condition with minor exceptions. At the time of inspection, the movable leaf was not seated on the live load supports without traffic present. When traffic crossed the span, the live load supports would come in and out of contact. The motors are putting windup torque into the machinery to seat the span, but the buffers are holding the bridge up and preventing firm seating in the live load supports. The strike plate elevation for the buffers should be adjusted to allow firm seating of the span. The underside of the live load strike plate assemblies and the top side of the supports are not fully painted and are corroded, this condition has worsened since the 2017 inspection.

The warning gates are in fair condition and operated reliably. The gate arms on both east warning gates have been painted however the corrosion is visible under the light coating of paint.

Poor bearing alignment and minor damage to some of the span drive gears have all been noted dating back to Stafford Bandlow Engineering's 2011 inspection. There does not appear to be any significant degradation in the bearings or gear wear at this time.

In addition to the above issues, there are a number of other maintenance tasks that are recommended to address paint deterioration, a corroded machinery brake wheel, unpainted fasteners, and similar smaller issues that could affect the machinery installations if neglected in the long term.

Electrical

The electrical power and control system on the Bascule Bridge were inspected per the requirements stated in the Term of Reference.

The condition of the most bridge components has not changed since the last inspection in 2017 except for the replacement of the main drive motors and drive controllers.

As described in the previous inspection report, the bridge electrical power and control system was rehabilitated in 2012 and a new CCTV system was installed during winter of 2014. A standby generator and a manual transfer switch were installed at the bridge to provide a backup source of power for emergency purposes as per CHBDC in the event of electric utility failure. The control system was modified during the same rehabilitation project to include bypass functions, span position and motor speed displays, as well as traffic gate and brake indication lights on the control desk. The rehabilitation project also included replacement of the motor brakes, traffic gates and traffic signals, installation of a new speed switch, and the replacement of junction boxes and installation of a submarine cable.

The most recent electrical rehabilitation project included replacement of the main drive motors and their associated drive controllers. The replacement drive system consists of squirrel-cage induction motors with variable frequency drives. The new drive system provides the bridge with desirable variable speed and torque control for the moving span. The bridge control system was also modified as part of this latest rehabilitation project to remove the manual control of span motion and introduced safety logic to avoid possible human error. Additional interlocks for the traffic control equipment were also added to the existing control system.

The new drive system utilizes two squirrel-cage induction motors configured as redundant units. The two motors can also be configured to be both duty motors to operate the bridge if additional torque is required. A motor selector switch is provided on the control desk allowing the operator to switch between the two drive motors or to use both motors. When both motors are selected, one of the two VFD drives must be switched to follower mode. The modified control system in conjunction with the manual lever switch provides the bridge with safe and automatic control of bridge operation.

The location of the seated limit switches at the toe end is not appropriate and can be affected by the water and wave action during times of high tide and storm conditions. The seated limit switches were found to have water egress inside their limit switches which have in the past and may in the future cause failures.

The recommended actions necessary to achieve continued reliable and safe operation of the bridge in the long term are:

- Some originally installed submarine cables remain at the bridge, it is not clear if these original cables are still in service. If still in service, they should be replaced, if abandoned, they should be removed from the bridge to avoid confusion during troubleshooting or maintenance.

- Repair and replace the corroded seated limit switch parts in the short term and relocate the seated limit switches to a different location to avoid further water damage.
- As it is unclear whether or not an electrical protective relaying study and arc flash study have been performed in the past, it is recommended that both a protective relaying coordination study and arc-flash hazard assessment be conducted to verify the safety and reliability of the current electrical distribution system.
- The existing bridge control system, although functional, has been poorly installed, is overly complicated and is extremely difficult to troubleshoot in the event of a failure. Additionally, the operator control desk is not laid out in a logical manner and is not user friendly. Replace this existing bridge control system and bridge control desk with a modern PLC and HMI based system.

The following table describes the anticipated life expectancy of the existing electrical systems installed at the bridge. It assumes appropriate and regular maintenance will be carried out and no unforeseen incidents or damage occurs to the installation.

COMPONENT	LIFE EXPECTANCY BASED ON PRESENT STATUS OF TECHNOLOGY	REPLACEMENT NOTES
Main Electrical Service	25 to 30 years	Replace existing pad mounted transformer
Generator	25 years	Assuming continued regular maintenance
Main Span Drive Motors and Drives	30 years	Replace with State-of-Art drive technology
MCCs	One rehabilitation or replacement	One rehabilitation or replacement
Bridge Control System, PLC, and UPS	Two rehabilitations or replacements	Two rehabilitations or replacements
Span Drive Brakes	Covered by mechanical replacement of span drive machinery	----
Span Lock Actuators	15 to 20 years	Replace with devices exposed to the harsh environment
Main Control Desk	20 years	Replacement due to obsolescence and no longer supported
Bridge Control System	20 years	Replacement due to obsolescence and no longer supported
Operational Devices	On an as-needed basis	Replacement part of ongoing maintenance
Traffic Control – Gates	15 to 20 years	Replace with devices exposed to the harsh environment
Traffic Control - Lights	15 to 20 years	Replace with devices exposed to the harsh environment
Traffic Control – Horn	25 years	Replace with devices exposed to the harsh environment
Conduit, Junction Boxes, & Cable Trays	30 years	Minor replacements covered by maintenance on an ongoing basis
Submarine Cables	30 years	May require protracted environmental permitting
Lighting	30 years	May require replacement of devices earlier based on energy conservation
Fire Alarm System	20 years	May require upgrade and communications
CCTV	15 years	Replace with State-of-Art drive technology

1.0 Introduction

The LaSalle Causeway (the Causeway) carries Highway 2 across the Cataraqui River within the City of Kingston, providing an important transportation link between the downtown area on the west side of the river with the Barriefield/CFB Kingston area on the east side of the river. The Causeway was constructed in 1916 and is now owned and operated by Public Services and Procurement Canada (PSPC). Approximately 28,000 vehicles cross the Causeway daily. The Causeway consists of five (5) interconnecting structures: the West Bridge, including its west approach (constructed in 1994); the West Wharf (1916); the Bascule Bridge (1917); the East Wharf (1916); and the East Bridge, including its east approach (1968). The Bascule Bridge and the East Bridge both provide marine access to the inner harbour of Kingston and access to the southern entrance of the Rideau Canal, with the Bascule Bridge lifting an average of 900 times per year for larger vessels. The Causeway accommodates one lane of eastbound traffic and one lane of westbound traffic. The 2015 Kingston Transportation Master Plan indicates that Highway 2 at the Crossing is classified as an arterial road. The location of the Causeway is shown on the key plan (Figure 1).

In August 2018 Parsons Inc. (Parsons) was retained by PSPC to complete the following:

- The 2018 Comprehensive Detailed Inspection (CDI) of the Bascule Bridge (including structural, mechanical and electrical inspections);
- The General Annual Inspection (GAI) of the East Bridge and West Bridge.
- An investigation into the condition of the Bascule Bridge counterweight;
- A detailed inspection of the Bascule Bridge steel deck grating;
- Monitoring of the West Bridge abutment bearings;
- A survey of the Bascule Bridge east approach slab and east abutment; and
- A fatigue inspection and fatigue evaluation of the Bascule Bridge.

An underwater inspection of the Bascule Bridge and the inspection of the East Wharf and West Wharf were not part of the current assignment. The data obtained from the east approach and abutment survey, and the findings of the counterweight investigation and detailed grating inspection are included in this report. The findings of the General Annual Inspection of the East Bridge and West Bridge (including the monitoring of the West Bridge abutment bearings) are provided in a separate report. The detailed findings of the fatigue inspection and the results of the fatigue evaluation of the Bascule Bridge are included in a separate report, although relevant findings of the inspection have been incorporated into this report. The inspection of the mechanical and electrical systems and components were undertaken by Parsons' sub-consultant Stafford Bandlow Engineering Inc. (Stafford Bandlow) from Doylestown, Pennsylvania. Parsons and Stafford Bandlow were responsible for carrying out a review of all available information, carrying out the field inspections, and preparation of the inspection report for the Bascule Bridge.

This report documents and summarizes the findings of the visual inspection of all above-water components, provides a condition rating and functional rating of the structure, recommended repair programs, and a 10-year Management plan with Class 'D' cost estimates. Completed PSPC Field Observation Record Forms (MCR/PCR) forms are included in Appendix A. General Arrangement drawings of the structure are included in Appendix B along with deterioration drawings of the marine structures and main trunnion connections. Selected annotated photographs of the existing condition of deteriorated areas and general photos of the structures are included in Appendix C. Photographs from the mechanical and electrical inspection are included in Appendix D and Appendix E, respectively. The laboratory testing results of the counterweight field investigation are included in Appendix F. The bridge deck grating deterioration drawings are provided in Appendix G. The data from the survey field work is included in Appendix H.

Since carrying out a detailed evaluation of rehabilitation alternatives and financial life-cycle cost analysis of the alternatives is outside the scope of this report, the rehabilitation recommendations and cost estimates included within have been developed for the structure to address deficiencies noted in the current and previous inspection and evaluation reports only. The recommended repairs detailed in this report are not intended to serve as an operational review of the Bascule Bridge or Causeway, nor a code and standards requirements review.

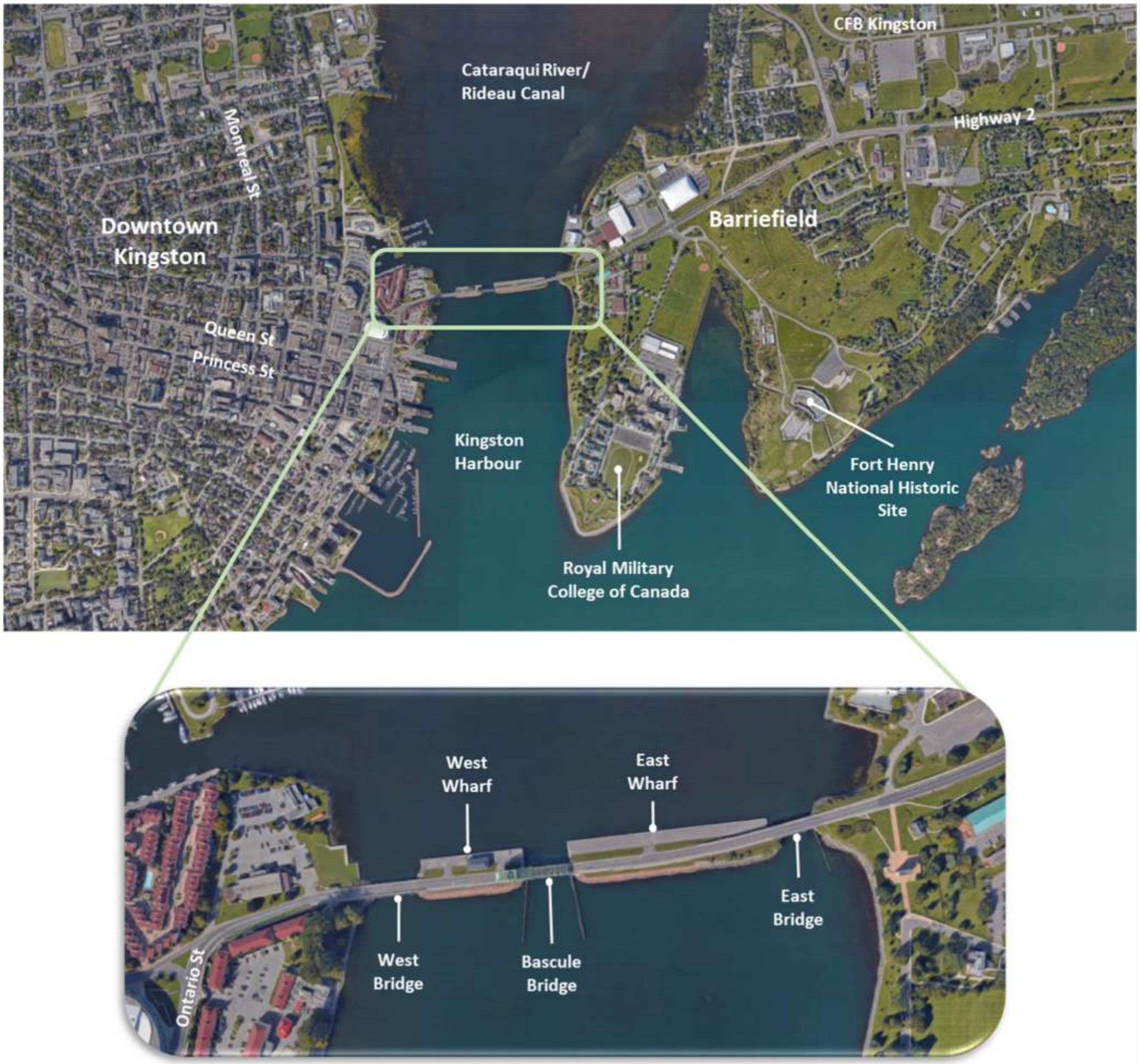

Figure 1: Key Plan (from Google Maps)

2.0 Structure Description

The Bascule Bridge is a single leaf Strauss heel trunnion bascule bridge, designed by The Strauss Bascule Bridge Co. of Chicago (Photos S1 to S8, Appendix C). Construction of the bridge was completed in April 1917. The structure is supported on two concrete abutments (also known as piers) founded on timber piles (based on available original drawings), the front faces of which are protected with steel sheet piling (Photos S9 and S10).

The main leaf truss span of the bridge spans between the East Wharf and West Wharf and consists of a Modified Warren through truss with a span length of 48.77 m (160'). The centre-to-centre truss width is 8.23 m (27') and the centre of bottom chord to centre of top chord height varies from the east to the west end from 6.10 m (20') to 7.92 m (26'). The bridge has a posted vertical clearance of 4.2 m and a vertical clearance above the water of approximately 0.6 m.

The roadway width on the bridge is 7.32 m (24') and carries one eastbound and one westbound vehicular traffic lane on an open steel deck grating (Photo S4). The deck grating is supported by a floor system comprising transverse sills, nine longitudinal stringers, and transverse floor beams located at each panel point. A 1.2 m (4') wide timber plank sidewalk is cantilevered from the exterior of the south truss.

The fixed tower truss supports the counterweight truss and machinery room. The lower members of the north and south trusses are located directly adjacent to the roadway. The counterweight truss above supports the concrete counterweight.

The top chords, bottom chords, verticals, diagonals, cantilevered sidewalk floor beams, sway bracing and struts, top lateral bracing, fixed tower, counterweight link, operating strut, and counterweight truss members consist of built-up sections of plates, channels, angles, and/or lattice. Repairs carried out under previous contracts have strengthened or repaired some deteriorated members and replaced lacing with cut out steel plates on others.

The concrete counterweight weighs approximately 550 tonnes (1,220,000 lbs.) and is suspended from the counterweight truss. The counterweight has an internal steel truss structure and is reinforced at the exterior faces by steel bars and wire mesh. There are steel plates mounted on the north and south faces which are secured in place by threaded steel rods. Two pockets are provided in both the east and top faces of the counterweight, which can accommodate additional dead load required to balance the bridge.

The machinery room containing the span drive machinery (brakes, motors, open gearing, etc.) is located over the roadway and supported within the fixed tower truss. Access to the machinery room, top of the counterweight, bearings and pins is provided by various catwalks, stairs, and access ladders. The operator's control house containing the electrical systems for bridge operations is located to the northwest of the structure on the east end of the West Wharf. The building containing the PSPC office and workshop is located on the West Wharf.

A galvanized steel 3-rail railing system, consisting of HSS sections with woven wire mesh panels, is located on the south edge of the exterior sidewalk. There are galvanized steel railings matching the profile of the railing on the bridge on the southeast and southwest wing walls. Chain link fences have been installed on the southeast and southwest embankments preventing public access to the substructure. Steel beam guiderails are present at the northeast, northwest, and southwest quadrants. There are timber training walls comprising timber piles, walers, and dolphins at the southeast and southwest quadrants. Roadway lighting on the bridge is provided by four LED light fixtures (two per side) and sidewalk lighting is provided by a single LED light fixture, all with the cobra head brackets fixed to the inside of vertical truss members. The lighting supports have been welded to the truss members which is typically discouraged with historical steel structures. A navigation light is bolted to vertical member 7-8 on each side of the structure.

Figure 2: South elevation

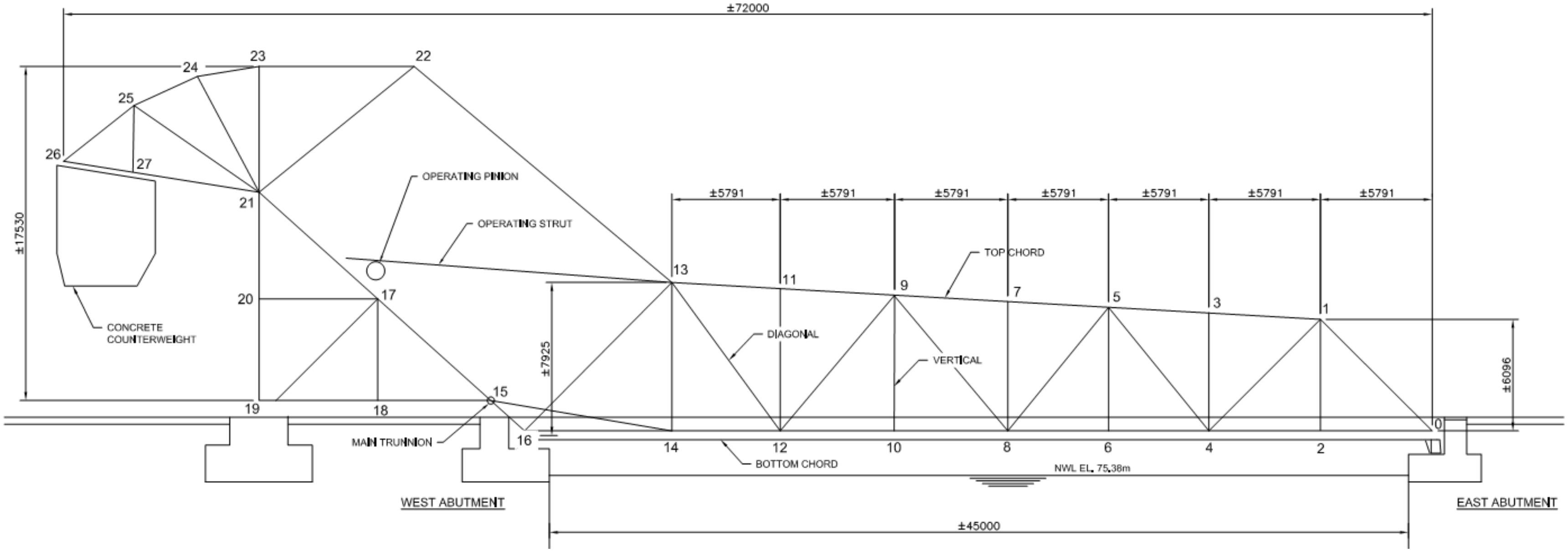

Figure 3: Dimensions and Truss Member Designation

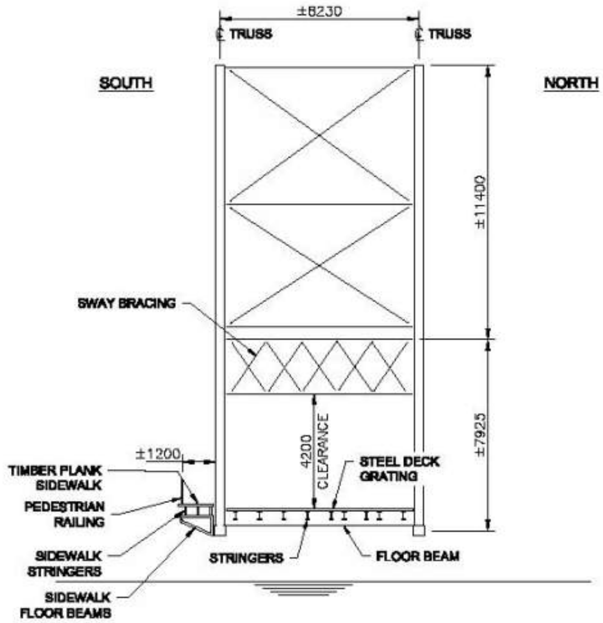

Figure 4: Cross section (looking west).

3.0 Data Collection and Review

The following reference material provided by PSPC or available in Parsons' own files was reviewed and used in the inspection of the bridge and preparation of this report:

1. "LaSalle Causeway – Structural Steel Repairs", Issued for Tender Drawings; Project No. R.09507.060; Parsons Inc.; September 2017.
2. "LaSalle Causeway – Motor Controls"; Issued for Tender Drawings; Project No. R.089507.020; Parsons Inc.; November 2017.
3. "LaSalle Causeway – Bascule Bridge, Guide Assembly - Key Repair"; Issued for Tender Drawings; Project No. R.089507.070; Parsons Inc.; November 2017.
4. LaSalle Causeway – Bascule Bridge – detailed grating inspection; Parsons March 2017.
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13. "Inspection of existing Buffers and existing Span Locks"; Letter; Parsons., New York; April 30, 2014.
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15. “LaSalle Causeway Bascule Bridge – Deck and Sidewalk Concepts Report”; Delcan Corporation, June 2013.
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19. “2010 Level One Underwater Inspection Report for LaSalle Causeway”; McCormick Rankin Corporation; March 15, 2011.
20. “LaSalle Causeway – Bascule Bridge, Repairs and New Coating”; As-Built Drawings S01 to S25; Project No. R.012359.001; McCormick Rankin Corporation; September 16, 2010.
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22. “Kingston Bascule Bridge – Fatigue Review and Rehabilitation of Counterweight Members (Updated After Construction)”; McCormick Rankin Corporation; January 2005.
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24. “LaSalle Causeway, Reconstruction of East Section, North Side, Kingston, Ont.”; Design Drawings; Plan No. 3367, Sheets 1 to 3 of 4; Public Works of Canada; Ottawa, Ont.; March 28, 1949.
25. “Kingston City, Reconstruction of Roadway, LaSalle Causeway, Kingston, Ont.”; Design Drawing, Plan No. 2614, Sheet 1 of 2; Public Works, Canada; Ottawa, Ont.; June 21, 1934.
26. “Strauss Trunnion Bascule Bridge (Patented) over Cataraqui River, Kingston Harbor Improvements for Dept. of Public Works”; As-Built Drawings (1 to 22); The Strauss Bascule Bridge Co., Chicago; January 21, 1915.

4.0 Rehabilitation History

The Bascule Bridge has undergone numerous rehabilitations since its construction in 1917, which according to the available drawings, previous inspection reports, and other documentation includes:

1938: Relocation of the operator’s control house from the bridge to the West Wharf.
1947: Reconstruction of the office and workshop building.
1958: Replacement of the two drive motors.
1966: Renewal of the operating mechanism and span lock gears; repairs to the east abutment / rest pier; renewal of the live load supports.
Between 1971 and 1976: Replacement of the leaf truss floor beams and stringers, sills, deck grating, cantilever floor beam bracing, some bottom lateral bracing angles, and adjustment of front end shoes. Installation of new traffic signals and bridge lighting.
1977: Repairs to portal frame truss 1S-1N and sway bracing members 5S-5N and 9S-9N.
1985: Reconstruction of the operator’s control house.
1991: Repairs to the bottom chord (unspecified location).
1993: Electrical and mechanical upgrades.
1997: Structural steel repairs to 14S-15S, 14N-15N, 14S-16S, 14N-16N, and cantilever floor beam gusset plates, and strengthening of leaf truss vertical members.
2001: Installation of two additional dampers.

2002: Structural steel repairs at node 0S, counterweight truss member 21S-27N, and member 15S-16S; installation of steel beam approach guide rails.
2004: Replacement of rivets in fatigue prone members of the counterweight truss.
2009: Repairs to main trunnion steel plates below roadway level.
2009-2010: Major rehabilitation including the removal of lead paint and application of low VOC protective coating to all structural steel members of the bridge; structural repairs to deteriorating steel members (operating arm, bottom gusset plates, exterior splice plates in the bottom chord); reinforcing certain diagonal truss members; replacing timber sidewalk stringers and deck planks; installation of a new pedestrian railing meeting CHBDC requirements for a combination pedestrian/bicycle barrier; traffic barrier replacement; and replacing wood stairway treads with steel treads.
2011: Addition of steel plates to the west side of the counterweight for balancing purposes.
2012: Roadway and bridge lighting upgrades, and installation of the CCTV system.
2012: Modifications to the pedestrian railing system on the south side of the sidewalk.
2013: Modifications to the motor controls and traffic gate and signals electrical hardware.
2016: Installation of new pedestrian railings on the southeast and southwest wingwalls; repairs to the southeast and southwest training walls; installation of chain link fences on the southeast and southwest embankments and at the westbound traffic barrier.
2017: Replacement of the span locks, the east end of leaf truss bottom chord 0S-2S, and bottom chord gusset plate and bearing plate at 0N; installation of buffers on the east abutment/rest pier; replacement of deck grating panels C and D between FB10 and FB12; and installation of a new armouring angle at the east end of the deck.

5.0 Work Completed Since Last Detailed Inspection

The following work has been completed since the 2017 Comprehensive Detailed Inspection was carried out in November 2017:

November to December 2017: Strengthening of diagonal members 9N-12N and 9S-12S; strengthening at the base of vertical members 13N-14N and 13S-14S.
February to March 2018: Refurbishment of the keyways of the north guide assembly pinion keys and pinion shaft.
March to September 2018: Replacement of the drive motors and modifications to the motor control system.
August 2018: Localized repairs to the deck grating.

6.0 Inspection Methodology

Parsons carried out the Comprehensive Detailed Inspection (including the fatigue inspection, east approach and abutment survey, and detailed grating inspection) of the Bascule Bridge between October 1 and 4, 2018. The counterweight investigation was carried out overnight from October 9 to 10 2018. The mechanical and electrical inspections were carried out by Stafford Bandlow from October 9 to 10, 2018 and from October 31 to November 1, 2018 respectively. The inspections were carried out in accordance with the PSPC *Bridge Inspection Manual* (BIM), the current edition of the CHBDC, the Federal Highway Administration (FHWA) *Inspection of Fracture Critical Bridge Members* supplement, and the AASHTO *Moveable Bridge Inspection, Evaluation and Maintenance Manual*. Safety measures were implemented as per the Occupation Health and Safety Act (OHSA) and the MTO *Safety Practices for Structure Inspection* manual. Prior to the commencement of the field work, a Traffic Management Plan and a Site-Specific Health & Safety Plan were prepared and submitted to PSPC for review. A copy of the plans was kept on site at all times with the inspection team.

Structural Inspection

The structural inspection of the bridge consisted of a close-up, detailed visual inspection of all exposed surfaces of the above-water and above-grade components. Above-deck leaf truss components, main trunnions, tower truss members, operating struts, counterweight, and lower sections of the mechanical room were observed from the deck and sidewalk surfaces and by using an articulated man-lift supplied by Sunbelt Rentals. The inspection of the below-deck superstructure components over water was performed using a motorboat supplied and operated by ODS Marine. The counterweight truss and upper sections of the tower truss were inspected from the stairways, catwalks, and ladders located on the structure, and by Parsons' certified Rope Access Technicians. Additional rope access support and equipment was provided by Team Industrial Services Inc. The fatigue inspection was carried out by a team comprising a Parsons engineer, and non-destructive testing specialists from Brouco NDT Inc. (magnetic particle and ultrasonic testing) and Groupe Mequaltech (phased array testing of pins). The east approach slab and east abutment survey field work was carried out by surveyors from Annis O'Sullivan Vollebekk Ltd.

Traffic control measures for the temporary alternating lane closures (including signage and Traffic Control Persons, i.e. flaggers) required for the inspection and counterweight investigation were implemented in accordance with the requirements of the Ontario Traffic Manual, Book 7, and provided by Beacon Lite. Flood lighting for the counterweight investigation was also provided by Beacon Lite.

The superstructure and substructure components were visually inspected to assess their condition in terms of general damage, deterioration, deficiencies and maintenance issues, with particular attention paid to the fracture critical and fatigue prone components of the bridge. Concrete components were hammer sounded and defects were recorded and mapped. Where possible, surfaces of the structure were inspected at close proximity, i.e. within arms' reach. All other structural and non-structural components were visually inspected, and their conditions were noted. Instruments such as calipers, pit gauges and ultrasonic thickness measuring devices were also used to measure section loss in steel members. Utilities were visually inspected for overall material condition and obvious potential safety concerns only.

The investigation to assess the condition of the counterweight concrete was carried out overnight using two articulated man-lifts supplied by Sunbelt Rentals for access. The investigation comprised localized removal of the counterweight cladding at seven separate locations specified by Parsons Engineers to permit the extraction of concrete cores. Following core extraction, the core holes were patched with high early strength concrete and the cladding repaired. The cladding was removed and repaired by G.A.Wright & Son, and the core extraction and concrete repairs were carried out by Capital Cutting and Coring. The concrete cores were logged on site by Gemtec Consulting Engineers and Scientists (Gemtec) and taken for materials testing. Due to the presence of wire mesh used to reinforce the exterior faces of the concrete, the location of the reinforcing steel bars could not be determined by scanning, and therefore the coring was performed on a trial and error basis. Coring did not proceed if reinforcing bars were encountered. A summary of the laboratory testing results along with photographs of the cores are included in Gemtec's report included in Appendix F.

Observations were recorded in the Field Observation Forms included in Appendix A, with new observations in blue text. Material and Performance Condition Ratings (MCR, PCR) for all elements were assessed using the specified rating criteria outlined in Part 2 – Inspections and Appendix A are summarized in Figure 2.2 of the BIM (see Figure 2 below). Results of the inspection were summarized on the standard BIM Inspection Form (included in the Inspection Summary Form section of each structure), where the rating of the component was based on Part 2 - Inspections, Section 2.2. Priority codes for repairs were assigned in accordance with Section 2.3 of BIM, and the structures were given an overall Structural and Functional Condition Rating in accordance with Section 2.4 (as summarized in Figures 3 and 4).

Mechanical Inspection

The general scope of the mechanical inspection was as follows:

- Visual inspection of components of the mechanical systems for adequacy of lubrication, leakage, cracks, unusual noise, corrosion and wear.
- Visual inspection of drive system, including mounting bolts, machinery supports and anchorages, brakes, bearings, gear teeth, alignment etc.
- Visual inspection of mechanical components that stabilize the movable span when it is in motion and at rest.
- Visual inspection of span locks and drives, centering devices, live load supports, buffers, trunnion bearings and brakes.
- Observation of proper bridge operation, acceleration, deceleration, braking, and seating, including sequence of operation and interlocks.
- Bearings: Perform visual inspection and closely monitor for noise during operation.

Photographs of specific mechanical components and defects recorded by Stafford Bandlow are included in Appendix D.

Electrical Inspection

Every component of the electrical system was visually inspected for condition and adequacy to perform its intended function. The following describes the extent of the electrical inspection services provided:

- Traffic signals, gates & barriers were visually observed during operation. Proper sequencing, all lamps lighted, physical condition of enclosures, gate arms, hardware, wiring, conduits, mounting bolts, internal dirt & debris, corrosion, etc. were checked.
- Navigational lights were visually observed during operation. All lamps lighted, physical condition of housings, lenses, conduit & wiring, attachment bolts & hardware, corrosion were checked.
- Conduit, wiring, junction boxes and enclosures were visually checked for corrosion, adequacy of mounting/attachments, bolts and hardware, spare conductors, weathering of cable jackets and insulation, grounding, water-tightness, etc.
- Drive motors (both AC & DC) were visually checked for mounting bolts, frame movement, noise & vibration, shaft end play during operation, coupling/pulley/sprocket bolts, ventilation openings, dirt and debris build-up, cable connections, brushes, commutators/slip rings, load measurements. The drive motor current, voltage and power parameters were monitored and recorded during operation.
- General purpose motors were visually checked for mounting bolts, frame movement, noise & vibration, shaft end play during operation, coupling/pulley/sprocket bolts, ventilation openings, dirt & debris build-up, cable connections (when visible).
- Brakes were visually checked for overall operation, noise & vibration, wiring, limit switches, corrosion and dirt/debris build-up on electrical components, mounting hardware.
- Locks were visually checked for overall operation, noise & vibration, wiring, limit switches, corrosion and dirt/debris build-up on electrical components, mounting hardware. The lock motor current, voltage and power parameters were monitored and recorded during operation.
- Limit switches were visually checked for overall operation, free movement of lever arms & plungers, wiring, sprockets/chains/gears/couplings, corrosion, mounting bolts & hardware, condition of contacts (when visible).

- Control system (Console, Relay/PLC Cabinets, Speed Controls) was visually checked for condition of enclosures and cabinets, wiring and internal components mountings, dirt debris accumulation, noise, heat, safety (exposed terminals, etc.), grounding, functioning of indicator lights, switches, pushbuttons, and metering. Control system interlocking was tested.
- Submarine cables were visually inspected for their physical condition and quality of installation. Submarine cable junction boxes were also inspected along with the termination of the cables.
- Bridge operation was visually observed for proper operation, acceleration & deceleration, braking, drive motor current draw during operation, seating.

Photographs of specific electrical components and defects recorded by Stafford Bandlow are included in Appendix E.

6.1 COMPONENT CONDITION RATINGS

In accordance with Part 2 – Inspections, Section 2.2 of the BIM, each component has been assigned a Condition Rating. Tables detailing specific material and performance related defects may be found in the same section of the BIM General guidelines for percentage reduction based on the severity and extent of material defects and on the reduction in capacity to perform its intended function are as indicated in Figure 2 below.

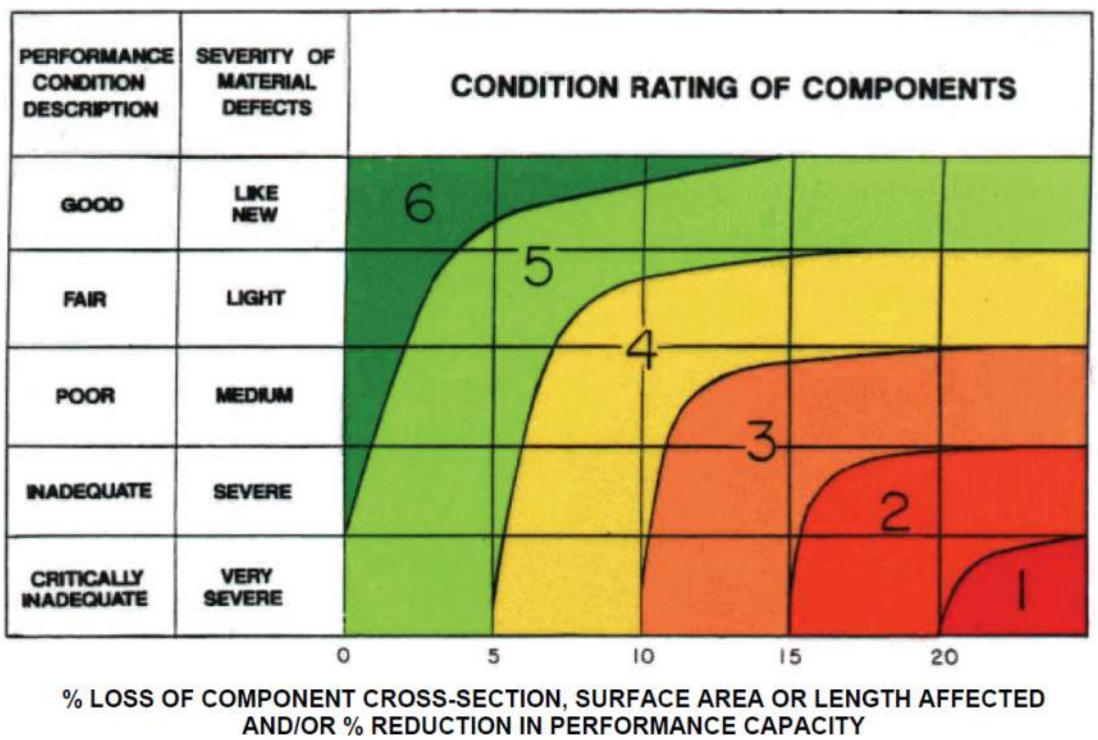

Figure 5: Figure 2.2 of the BIM - Condition Rating of Primary Components

6.2 COMPONENT REPAIR PRIORITY CODES

In accordance with Section 2.3 of Part 2 of the BIM, the Priority Codes assigned to each component used in the rating forms are defined as follows:

Table 1: Excerpt from BIM Section 2.3 - Priority Codes for Component Repairs

CODE	DESCRIPTION
U	Urgent; requires immediate attention and remedial measures to ensure public safety
M	Required work to be done as part of routine annual maintenance
S	Further study/investigation/surveys required prior to initiating repair program
A	Repair and/or replacement to be done in less than 1 year
B	Repair and/or replacement to be done in less than 3 years
C	Repair and/or replacement to be done in less than 5 years
D	Condition to be re-assessed at the next inspection

6.3 STRUCTURAL AND FUNCTIONAL CONDITION RATING

In accordance with Part 2 – Inspections, Section 2.4 of the BIM, the structure has been assigned an overall Structural Condition Rating and Functional Rating in accordance with the criteria in Section 2.4 of the BIM, which are summarized below:

Table 2: Table 2.4(a) from BIM – Overall Bridge Rating: Structural Condition

RATING	CONDITION	OBSERVATIONS
6	Excellent	• New condition, minor imperfections – no repairs warranted; • Structure meets current CHBDC live loading and seismic requirements.
5	Good	• Structure meets current CHBDC live loading and seismic requirements; • Minor repairs required to secondary or auxiliary components; • Known problems relating to primary components but no repairs required; • Minor touch up coating required.
4	Fair	• Structure meets current CHBDC live loading; • Minor repairs required to primary components; • Significant repairs may be required to secondary or auxiliary components; • Minor scour problems; • Significant touch up coating required – no rust holes.
3	Poor	• Structure does not meet current CHBDC live loading; • Posted to within 15% of CHBDC live loading; • Repairs required to primary components and/or load carrying capacity is not compromised; • Medium scour problems; • Rust holes limited to secondary or auxiliary members.
2	Inadequate	• Structure does not meet current CHBDC loading; • Load posted more than 15% below CHBDC loading; • Significant scour problems; • Significant repairs and strengthening required to primary components to reinstate load capacity.
1	Critically Inadequate	• Inadequate to support vehicular loads; • Possibility of imminent failure; • Structure has failed or is closed to traffic; • Public safety is of concern.

Table 3: Table 2.4(b) from BIM – Overall Bridge Rating: Functional

RATING	CONDITION	OBSERVATIONS
6	Excellent	• New condition, minor imperfections – no repairs warranted; • Structure meets current CHBDC live loading and seismic requirements; • Structure meets TAC width and vertical clearance requirements; • Crash tested barriers at bridge and approaches – meet current requirements; • Traffic Capacity Level of Service: C; • Riding quality – excellent; • Approach geometric conditions meet current standards.
5	Good	• Structure meets current CHBDC live loading requirements; • Structure meets TAC width and vertical clearance requirements; • Crash tested barriers at bridge and approaches – meet current requirements, minor repairs required; • Traffic Capacity Level of Service: C; • Riding quality – Good; • Approach geometric conditions: Minor variations from current standards but generally acceptable.
4	Fair	• Structure meets current CHBDC live loading requirements; • Deficiency in terms of bridge width and/or vertical clearance per TAC requirements is less than 10%; • Approach or Bridge barriers do not meet current standards; • Repairs required at multiple locations (<20 percent); • Traffic Capacity Level of Service: D; • Riding quality – Fair; • Bridge or approaches posted at 10 km/hr below the normal highway speed; • Approach geometric conditions deficient in terms of horizontal or vertical alignment.
3	Poor	• Structure does not meet current CHBDC live loading; • Load posted to within 15% of CHBDC live loading; • Deficiency in terms of bridge width and/or vertical clearance per TAC requirements is more than 10%; • Approach and Bridge barriers do not meet current standards; • Repairs required at multiple locations (>20 percent but <50%); • Traffic Capacity Level of Service: E; • Riding quality – poor; • Approach geometric conditions deficient in terms of horizontal and vertical alignment; • Bridge and approaches posted at 20 km/h below normal highway speed.
2	Inadequate	• Structure does not meet current CHBDC loading; • Load posted to more than 15% below CHBDC loading; • Deficiency in terms of width and/or vertical clearance per TAC requirements is more than 20%; • Non crash tested barriers, deficient in terms of original design strength requirements and/or more than 10% in terms of height requirements. Repairs required at multiple locations (>50 percent); • Riding quality – very poor; • Traffic Capacity Level of Service: F; • Approach conditions deficient in terms of horizontal and vertical alignment; • Speed restrictions – posted at more than 30 km/h below normal highway speed.
1	Critically Inadequate	• Inadequate to support vehicular loads; • Possibility of imminent failure; • Structure has failed or is closed to traffic; • Public safety is of concern.

7.0 Structural Inspection Summary Form

NAME:	Bascule Bridge
LOCATION:	LaSalle Causeway, Kingston, Ontario
YEAR CONSTRUCTED:	1917
TYPE OF INSPECTION:	Comprehensive Detailed Inspection

Original Design:	The Strauss Bascule Bridge Co., 1914
Drawings Available:	Yes
Previous Inspection Report Date:	2017 Comprehensive Detailed Inspection Report (March 2018)
Author:	Parsons Inc.
Current Inspection Date:	Structural: October 1 - 4 and 9 - 10, 2018 Mechanical: October 9 – 10, 2018 Electrical: October 31 – November 1, 2018
Inspectors:	Structural: P.Harvey, P.Eng.; J-B.Charron, P.Eng., ing.; C.Waddell, P.Eng.; B.McAuley, P.Eng.; É.Boulay, ing. jr. (Parsons Inc.) Mechanical: M.Denis-Rohr, P.E.; G.Newman EIT (Stafford Bandlow Engineering) Electrical: G.Rees P.E.; Y.Zhang, P.E. (Stafford Bandlow Engineering)
Temperature:	7 to 24°C (variable)
Weather:	Variable
Special Access Equipment:	Work boat; Man-lifts; Rope Access equipment.
Previous Overall Rating: Structural:	4 (*Major rehabilitation of trunnion connections required, and repairs recommended to gusset plates, truss and bracing members*)
Current Overall Rating: Structural:	3 (*Cracks in primary truss members, connections, and stringers; significant repairs required to primary and secondary components, including counterweight and deck grating; structure does not meet current CHBDC special load cases for moveable bridges*)
Previous Overall Rating: Functional:	2 (*Inadequate roadway width and vertical clearance, poor riding surface*)
Current Overall Rating: Functional:	2 (*Approach guide rails do not meet current MTO standards; bridge barriers do not meet current CHBDC crash-tested requirements; roadside and vertical clearances and sidewalk width do not meet TAC requirements; riding quality is poor*)

ELEMENT AND OBSERVATIONS	PREVIOUS CONDITION RATING	NEW CONDITION RATING	NEW PRIORITY CODE
Leaf/Through Truss (P)	3	2	A
Top Chord: 0N-1N has pitting up to 4mm deep in the web near 1N representing an overall 4% loss of cross-sectional area. Impact damage to the south bottom flange of **13N-16N** was found to have a 3mm long crack (which was later ground out). 5mm deep pitting in the top of the south flange 2m above deck level was also noted. **0S-1S** has several locations of localized severe pitting in the north web above and below sidewalk level **(Photo S11),** up to 50% localized section loss of lattice elements, and 40% section loss of rivet heads at bottom plate at 1S. **1S-3S** has very localized medium to severe pitting of the interior of the inner bottom flange at the interface with the web at 1S. Member **3S-5S** has 60mm long lamination defect in the south face of the north channel with a possible crack parallel to the main stress in this primary tension member **(Photo S12).** The diaphragm inside member **11S-13S** near node 13S is perforated and has widespread severe pitting **(Photo S13).** Several small perforations and severe section loss were noted in the bottom batten plate and lower flange of the inner channel of **13S-16S** at 16S. **Bottom Chord:** Severe localized section loss of bottom chord flanges and rivet heads at sidewalk floor beam connections is typical. Member **14N–16N** has a perforation in the south web near node 16N and a section of coating is missing permitting light corrosion to develop **(Photo S14).** There is severe localized pitting and minor			

ELEMENT AND OBSERVATIONS	PREVIOUS CONDITION RATING	NEW CONDITION RATING	NEW PRIORITY CODE
rust jacking in members **14N-15N** and **14N-16N** at the interface between them (**Photo S15**). **The rust-jacking is minor and appears to have been present for a while.** There is severe localized section loss and a perforation in the web of the south channel of member **0S-2S** at node 2S adjacent to the sidewalk floor beam connection (**Photo S16**). Member **46-6S** has severe localized section loss at the base of the south web at the connection to FB4 (**Photo S17**). **14S-16S** deformed prior to the replacement of the lattice members with cut-out plates, though it appears the member may have deformed further following this repair (**Photo S18**). The member has a perforation and a 12mm long vertical crack perpendicular to the main stress in the interior channel web (**Photo S19**). Severe localized pitting and section loss of the flanges where 14S-16S and 14S-15S intersect was noted. 13 rivet heads in the outboard channel connection to 16S have over 75% section loss (**Photo S20**). Member **14S-15S** has two perforations and multiple cracks in the bottom batten plate near node 15S. The cracks range in length from 3mm to 11mm (**Photo S21**). There is severe localized section loss (50 to 100%) and knife-edge corrosion of both bottom flanges over 1m near node 14 where members 14S-16S and 14S-15S intersect. Light to medium active corrosion was also noted in these areas. **Diagonals:** The diagonal members are in generally good condition, but many members at and below deck level have severe localized section loss of flanges (particularly at lattice locations), webs and rivet heads with severe pitting and perforations noted in the members and connecting plates. Member **12N-13N** is deformed into an S-shape in the upper section near 13N (**Photo S123**). Pitting has caused up to 70% localized section loss (6mm deep pitting in 1 flange) of the bottom flange at the base of member **9S-12S**. The upper batten plate of member **12S-13S** near node 13S is deformed (**Photo S22**) and there is localized 6mm deep pitting (up to 50% localized section loss) in the bottom flange at lattice locations in the lower section of the member. **Verticals:** Member **1N-2N** has a suspected crack at a flame-cut hole in the southeast angle (**Photo S23**) and the outstanding leg of the southwest angle is bent above the bottom chord (**Photo S24**). There is a flame-cut hole in the northwest flange of **9N-10N**, but no cracks were found. The flange is deformed below the flame-cut hole (**Photo S25**). Very severe pitting with a small perforation was noted in the south angles above node 10 (**Photo S26**) and impact damage to the member above the railings has bent a portion of the southeast flange (**Photo S27**). Both south flanges of vertical member **11N-12N** near 12N are perforated but the member has been strengthened (**Photos S28 and S29**). Pitting up to 6mm deep of inside flange thickness of **3S-4S** noted at sidewalk level, and up to 50% cross-sectional loss of some lattice and the underside of the angles at lattice locations. **9S-10S** has a 3mm long crack in the top of the southeast flange at a previous weld location (**Photo S30**). **11S-12S** has pitting 6mm deep representing up to 80% localized cross-sectional loss of the flange thickness below sidewalk level. No crack was detected in the flame-cut hole in the northeast angle of **13S-14S** at the bolt approximately 2m above the roadway. Impact damage was also noted to the inboard flanges of vertical members **7N-8N**, **1S-2S**, **5S-6S**, and **7S-8S**. The other vertical members are in generally good condition overall, but many members at and below deck level have severe localized section loss of flanges, webs and rivet heads. *Condition Rating downgraded to reflect presence of cracks in top chord 3S-5S, bottom chord 14S-16S, and verticals 1N-2N and 9S-10S.*			
Tower Truss (P)	3	2	A
The interior of member **15N-17N** has severe corrosion and section loss of the rivet heads at the base at 15N due primarily to the standing water at the base of the member (**Photo S31**). The standing water has also led to 100% section loss of the stiffening angles at node 15N and the bolt heads from the trunnion. Diagonal member **17N-19N** has up to 50% localized section loss of the inner vertical components at 19N. The west interior angle near the base of member **17N-18N** has localized pitting up to 4mm deep. Member **15N-18N** has moderate to very severe pitting of the channel flanges at lattice locations and at the base of the web, a perforation in the inner channel at mid-span, and loss of a section of the north bottom flange at 15N (**Photo S32**). **18N-19N** has severe section loss of the interior channel flanges and rivet heads and perforations in the upper and lower batten plates at node 19N (**Photos S33 and S34**). There is an additional perforation in the inner channel at mid-span. Vertical member **19N-20N** has severe section loss in the rivet heads and web plate at roadway level and deformation			

ELEMENT AND OBSERVATIONS	PREVIOUS CONDITION RATING	NEW CONDITION RATING	NEW PRIORITY CODE
(likely due to impact damage) in the southeast and southwest flanges (**Photo S35**). The lower connection at 15S traps water inside **15S-17S** causing severe pitting in the interior of the members and many of the rivet heads exhibit severe section loss. There is up to 20% localized section loss of the underside of the bottom flange at lattices near base of member and up to 50% localized section loss of the interior of the webs at 15S above the gusset plates. There is a 3mm long crack emanating from a perforation in the south channel of **15S-18S** (**Photo S36**) and areas of up to 80% localized section loss of the bottom flange thickness and up to 70% section loss of rivet heads were noted. There is a 60mm long crack emanating from a perforation in the south channel of **18S-19S** (**Photo S37**). The member also exhibits 5mm pitting in the bottom flange and rivet heads at 18S and localized 10-20% section loss around rivet heads throughout the member. Vertical member **19S-20S** has 70% localized section loss of 6 rivet heads at the base of the member and impact damage to the southeast and southwest flanges above road level. *Condition Rating downgraded to reflect presence of cracks in members 15S-18S and 18S-19S.*			
Counterweight Truss (P)	4	2	A,M
Member **21N-27N** has a crack through the full width of the outstanding leg of the bottom interior angle at 27N (**Photos S38 and S39**). The angle is riveted to the web plate, so the crack cannot propagate into the web of the built-up member. The east bottom batten plate of **22N-23N** has severe pitting along its edges, a perforation and is holding water. **21N-22N** has localized pitting 2mm deep in the north and south bottom angles at the first stiffener, and localized 3mm deep pitting in the batten plate at this location with severe section loss of four rivet heads. **21S-27S** has localized severe pitting up to 12mm deep in the north bottom angle at the west end and 40% section loss of the last rivet head. 2mm deep pitting was noted in the bottom angles of **21S-22S** at the first stiffener. Debris and water are collecting on member **26N-26S** (**Photo S40**). *Condition Rating downgraded to reflect presence of crack in member 21N-27N.*			
Counterweight Links (P)	5	5	D
The counterweight link members **13N-22N** and **13S-22S** are in generally good condition but do exhibit localized pitting in the flanges at some lattice locations.			
Operating Struts (P)	5	5	D
Both the operating struts have been heavily reinforced, and lattice has been replaced with cut-out steel plates. Pitting up to 5mm (**13S-17S**) and 2mm (**13N-17N**) deep was noted at edges of inner web plate but reinforcing plates have been added to outside face to strengthen member. Coating on the top flange and on the web has been damaged by the operation of the bridge.			
Operating Pinion Struts (P)	5	5	D
The transverse struts directly below the operating pinion at both **17N** and **17S** exhibit localized moderate to severe active corrosion on the bottom flanges inside the mechanical room housing (**Photo S41**). Outside of the housing the members exhibit severe pitting and section loss but have been cleaned and coated and therefore no ongoing corrosion.			
Primary Component Connections (P)	2	2	S,A
Main Trunnion Connections: Connections include all gusset plates at nodes 15 and 16 and members 15S-16S and 15N-16N but does not include the trunnion collar plates at 15S/N or the vertical gusset plates connecting Tower Truss members 15S-17S and 15N-17N. The configuration of the connections traps water inside tower truss members 15S-18S and 15N-18N and as a result the head end of the four bolts that secure the trunnion bearings housing to the structure has 100% section loss due to corrosion. **15N/16N**: There is a crack-like initiation propagating from a large perforation at the base of the inside vertical gusset plate between the end of 14N-16N and FB16 at 16N parallel to the shear stress affecting capacity (**Photo S42**). The remaining thickness of the plate above the perforation was determined by UT to be as low as 3mm. The south face of the interior vertical gusset plate has 3mm pitting at the interface with the top flange of 14N-16N. 6			

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rivet heads at the base of the interior face of the south vertical gusset plate between the end of 14N-16N and FB16 at 16N have very severe section loss (**Photo S43**). The interior plate of the south triangular member behind FB16 has three perforations and 10 to 12mm section loss adjacent to the connecting clip angles (**Photo S44**). Severe pitting was also noted in the clip angles. There is a large perforation in the west transverse built-up plate (only visible when the bridge is in the open position) between the vertical gusset plates (**Photo S44**) and very severe section loss in the rivet heads and angle at the base of the exterior face of the south plate (**Photo S45**).

15S/16S: The north vertical gusset plate has a perforation and a 3mm long crack in the east edge immediately above the north top flange of bottom chord 14S-16S (**Photo S46**). The north face of the plate has pitting at the interface with 14S-16S with a remaining thickness as low as 5.7mm. There are perforations at the base of the north and south vertical gusset plates between the end of 14S-16S and FB16 at 16S. 13 rivet heads at the base of the interior face of the south vertical gusset plate at the end of 14S-16S have around 75% section loss, and the base of the gusset plate has severe pitting (**Photo S47**). The exterior face of the south vertical gusset plate has 6mm pitting (50% section loss) at the interface with the top flange of 14S-16S. The exterior plate of the north triangular member behind FB16 has a large perforation at the base of the original plate. Additional perforations have been repaired by the addition of a welded plate. The upper section of the north (roadside) plate adjacent to the trunnion collar has widespread severe pitting. UT measurements indicate remaining thickness generally between 6.6mm and 9.6mm (original thickness was 12.7mm) with one location (at top of plate next to trunnion collar) of 3.3mm (**Photos S48 and S49**). The rivets at the base of the north vertical gusset plate at the end of 14S-16S at 16S have been replaced with bolts, and there is widespread 2mm pitting in the south face of the plate.

Refer to the deterioration drawings in Appendix B for more details.

Leaf Truss Connections: The upper connections of the leaf truss are in generally good condition. At **13S** the upper batten plate and outboard gusset plate connection to 12S-13S are bent, there is a perforation of the end stiffener/diaphragm within the connection, and coating failure on the gusset plate connecting member 13S-13N. The inboard gusset plate of **2N** has delaminated into two segments above the bottom chord on the west and east sides over the full height of the plate. Full-width cracks were identified in both the east and west sides of the gusset plate (**Photo S50**). **12N** has up 60% section loss of the inboard gusset at the top flange of the bottom chord, and 50% section loss on the east side of the inboard gusset plate along the floor beam connection. The interior vertical gusset plate at node Pitting ranging from 1mm to 6mm deep was typically noted in the gusset plates along the top flange of the bottom chord members. Up to 4mm deep pitting noted in clip angle at connection with sidewalk floor beam at **10N**, **2S**, **4S**, **6S**, **8S**, **10S**, **12S** and **14S**.

Tower Truss Connections: The inboard gusset plate at node **15N** has localized pitting between 2mm and 7mm deep representing up to 70% loss of cross-section of the plate, four perforations, and 80% loss of a rivet head at roadway level (**Photo S51**). Water is trapped inside the connection. The short column below 15N (only visible when the bridge is the open position) is in generally good condition. Node **18N** has up to 50% localized section loss of the gusset plates and active corrosion along the top flange of members 15N-18N and 18N-19N with a perforation noted on the inboard gusset plate. Node **19N** has moderate to localized severe pitting representing 30-70% section loss of the plates along the vertical flange of 19N-20N and along the underside of the bottom flange of 18N-19N, plus three perforations. Some rivet heads at the base of the gusset plates have between 50% and 95% section loss. There is active corrosion at the base of the interior face of the inboard gusset plate. The inboard gusset plate at node **15S** has severe pitting with a perforation below 15S-18S. Node **18S** has 40% severe section loss in the interior of the gusset plates along the top flange of members 15S-18S and 18S-19S plus a small perforation.

Counterweight Truss Connections: The counterweight truss connections are in generally good condition.

Rating is based on the PCR of 2N, 15N, 14S, and 18S.

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Floor System (P, S)	1	1	A, S
Floor Beams (P): The roadway floor beams are in generally good condition, however localized deformation of the web of up to 16mm from straight was noted in **FB8**, **FB10**, **FB12**, and **FB14**. Localized light corrosion was noted on FB0. The sidewalk floor beams typically have localized areas of medium to severe pitting of the bottom flange, web, and rivet heads at the connection to the south truss **(Photo S52).** **Stringers (P):** The stringers are in generally good material condition apart from at the floor beam connections where numerous notches/cracks propagating from the 90-degree coping details were noted, some of which appear to have progressed since the 2015 inspection: FB0-FB2: stringers B, E **(Photo S53)**, and F (bottom cope); stringer A (top cope); FB2-FB4: stringers E, F, G, and I (bottom cope); FB6-FB8: stringers F, G, and H (bottom cope); FB8-FB10: stringer E (bottom and top cope); FB10-FB12: stringers E **(Photo S54)** and I (bottom cope); stringer F and H (top cope); FB12-FB14: stringers F and G (bottom cope); stringer E (top cope); FB14-FB16: stringer D (bottom cope) **(Photo S55)**; stringers E **(Photo S56)**, F, G, H, and I (bottom and top copes) **(Photo S57)**. **Sills (S):** The majority of the sills have permanent dead-load deflection **(Photo S58)**. There is a 6mm gap between the sills and stringer F between FB14-FB16 **(Photo S59)**. Several anchor bolts connecting the sills to the stringers were noted to be missing, loose or severely corroded **(Photo S60)**. There is widespread light corrosion on the top flange of the sills where the coating has failed. *The rating of the Floor System is based on the MCR of stringer E between FB0-FB2.*			
Concrete Counterweight and Housing (P)	4	3	U,B
All except the north and south faces of the counterweight are covered with what appear to be corrugated metal roofing panels. Damp staining, large areas of light corrosion, stalactites, and impact damage were noted on the panels on the underside of the counterweight **(Photos S61 and S62)**. Gaps in the panels are permitting smaller pieces of aggregate from the disintegrated counterweight concrete to fall onto the roadway below **(Photo S63)**. The doors to the two lower chambers on the east side of the counterweight are in poor condition and are difficult to open and close. The concrete in the two lower chambers exhibits spalls, disintegration, map cracking, efflorescence deposits and wet stains **(Photo S64)**. Two new small perforations were noted adjacent to the repaired sections of the panels below the chamber doors **(Photo S65)**. The sections of the bottom face of the counterweight visible though gaps in the panels exhibits efflorescence deposits and wet staining **(Photo S66)**. The two upper chambers in the top face of the counterweight contain concrete blocks and catch basin lids used as ballast. The concrete in the upper chambers exhibits spalls, disintegration, and wet areas (**Photos S67 and S68**). The steel plates covering the north and south faces are in good condition overall although some localized areas of deep pitting were noted, particularly in the north plate near node 26N. Some nuts on the ends of the tie rods are loose or are missing. Approximately 450mm of disintegrated concrete has collected between the concrete and the panels in the northeast corner. The cores extracted from the counterweight indicate that with the exception of in the upper sections of the counterweight, the concrete in the outer faces is in poor condition with numerous cracks evident and widespread disintegration **(Photos S69 to S81).** *Condition Rating reduced based on condition of visible sections of counterweight and extracted cores.*			
Structural Steel Coating (P, S)	5	5	B
Although the current coating system was applied during the 2009/2010 rehabilitation, localized defects are evident at numerous locations. Defects noted include cracking (coating-related), under-film corrosion and peeling (adhesion-related), and pinholing, edge defects, runs, and sags (application-related). Physical damage in the form of chips and scrapes was also noted. Small areas of touched-up coating are typical throughout the structure. The			

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coating on the counterweight truss members is in generally good condition, although cracks were noted in the coating on the members and connection between nodes 21-27. The coating on the tower truss members above roadway level is in good condition. Most members at roadway level exhibit localized areas of active corrosion due to the absence of coating. The coating on the upper sections of the leaf truss members, connections, and bracing is in good condition but chips in the coating at locations of impact damage has permitted light corrosion to develop, and some small edge defects were noted. There are many scrapes and chips down to the steel evident in the verticals, diagonals, and top chord members at roadway/railing level. Coating defects noted on members below deck level include cracks (stringers), flaking/peeling (stringers, bracing, and bottom chords (**Photo S82**)), and bleeding and edge defects (bottom chords and connections). Pinholes in the coating over the top half of many stringer webs were noted and the complete loss of coating over a large area of the inboard channel of bottom chord member 14N-16N (**Photo S14**). The poor coating application on the recently rehabilitated span lock mechanisms and live load supports is a contractual deficiency. The areas of coating that were removed to conduct the ultrasonic testing will be repaired during the 2019 Comprehensive Detailed Inspection.			
Deck Grating (P)	5	3	B
The coating of the grating has typically deteriorated, and the steel grating has light corrosion on the vertical faces of the cross bars and bearing bars and medium corrosion along the north and south edges (**Photo S83**). Bent and/or cracked (**Photos S84 and S85**) bearing and cross bars were observed throughout the grating, and broken bars were observed at the west and east ends (**Photo S86**). Cracked bar-to-bar and bar-to-sill welds were noted at several locations (**Photo S87**). Grating panels C and D in bay 10-12 were replaced with new galvanized panels in 2017 but not all bars were welded to the sills. A new armouring angle was recently installed on the east end of the deck grating which eliminated the elevation difference between the deck and the east approach armouring. The serrated edges have been completely worn away within the wheel tracks in each lane (**Photos S85 and S86**), significantly reducing traction and increasing vehicle braking distances. *Condition Rating reduced due to widespread material defects and slippery surface due to worn serrated edges. Refer to the deterioration drawings in Appendix G for more information.*			
Pin and Hanger Bearings (P)	3	3	S
Main Trunnion Bearings: There is contact between the moving structure and the fixed structure in the vicinity of the main trunnion bearings during operation of the bridge (**Photos S88, S89 and S90**). The contact is at the outboard side at both bearings and may be a result of contraction of the bridge due to temperature. Four mounting bolts at each main trunnion bearing have failed due to corrosion and should be replaced. Active corrosion was noted on the back (west) side of the north (**Photo S32**) and south (**Photo S91**) trunnions. The south (roadway) side of the north trunnion (**15N**) and the north (roadway) side of the south trunnion (**15S**) (**Photo S92**) have localized pitting of up to 3mm in the 31mm-thick collar plates, and up to 50% (15N) and 75% (15S) section loss of some rivet heads. No cracks were detected. **Counterweight Trunnion Bearings**: The sleeve studs used to secure the bearing sleeves to the structure are not tight at some locations. There is strong evidence that there are at least two broken studs: the west-most nut on the inboard side of the south trunnion bearing, and the top east stud at the outboard side of the north trunnion. Based on paint removal, it appears that there has been an attempt to tighten them, but that this was unsuccessful. Maintenance personnel have previously indicated that they used a hammer to drive one of the north counterweight bearing studs in while operating the bridge. This is an indication that the stud has sheared. The results of the phased array testing indicate corrosion is present on the upper surface of both the north and south shafts. The south counterweight bearing has a sheared off lube fitting and a second fitting that is plugged. At the north counterweight bearing one lube fitting is missing. **First Link Pin Bearings**: Both the north and south bearing assemblies are inaccessible for hands on inspection as they are surrounded by structural steel. The only accessible portions of the assemblies are the nuts which secure the link pin. Externally the first link pins appear to be in good condition, and lubrication appears to be recent. There			

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is cracked paint between the inboard and outboards nuts and the structure at both link pins, which may be an indication of slight movement. **Second Link Pin Bearings:** The lubrication fittings for the north and south pin are piped together which is not proper practice, and two of the three inboard lubrication ports for the north pin are leaking. As a result, the lubricant is probably not getting to the intended location. Evidence of movement at the inboard bearing for the south operating strut at the second link pin. *See the Mechanical Inspection section of the report for full details.*			
Abutments (P)	5	5	S,C
The majority of the abutment walls are not visible. The bearing seats are in generally good condition but there is an area of severe scaling on the west bearing seat north of the truss and a shallow area of disintegration at the south end. Dirt and debris have accumulated on the east and west bearing seats. Possible differential settlement at the east approach and east abutment may have occurred. A surveying program has been initiated to determine if the settlement is ongoing.			
Foundations (P)	6	6	D
No evidence of foundation performance issues.			
Waterway (P)	5	5	D
No observed flow or navigation obstructions or embankment erosion. The seated limit switches on the east abutment were found to have water egress inside which may be a result of high tide and/or storm conditions.			
Upper Cross Bracing (S)	5	5	D
The upper cross bracing members between the top chords of the leaf truss are in generally good condition, with defects typically limited to localized light pitting of angles near the connections, lower central batten plates, and rivets.			
Leaf Truss Lateral Struts (S)	5	5	D
The lateral struts between the top chords of the leaf truss are in generally good condition, with only localized light pitting of angles, lattice and rivets noted. **1S-1N** has rust jacking between the top cover plate and flanges.			
Leaf Truss Portals (S)	5	5	B
Member **1S-1N** has impact damage to the lower west angle, and six lattices on the bottom and west side of the member are bent (**Photo S93**). The lower angle of **1S-1N** is holding water (**Photo S94**). There is small perforation in the west angle at 1S and very severe section loss of the south batten plate. There is a crack in the weld connecting the vertical clearance sign to the member. Member **13S-13N** has 2mm deep pitting in the bottom chord and cross bracing, small perforations near 13S, localized severe section loss in the bottom gusset plate and south top chord, and many bent lattices in the bottom and top chords.			
Leaf Truss Sway Bracing (S)	4	4	C
The upper sway bracing members of the leaf truss are in generally good condition overall. The rating is based on the MCR of member **5S-5N** which has damage to the bottom angle above the westbound lane which has deformed the angle vertically by 38mm (**Photo S95**). Minor impact damage was noted to the east bottom angle (20mm) and deformation at the north and south ends of the top chord (10mm) of member **9S-9N**. Localized coating failure and light corrosion has occurred at impact locations. There is a perforation in member **13N-13S** at 13S.			
Tower Truss Sway Bracing (S)	4	4	B
Rating corresponds to the MCR of the bracing member between nodes **20N-20S** and between **21N-21S**. The lower-west angle of **21N-21S** has numerous rivets with greater than 50% section loss, and the lower batten plate at the north end on the lower chord exhibits severe pitting and perforations. Member **20N-20S** exhibits 15% loss of cross-sectional area in most angles, 5mm deep pitting in the bottom east angle at 20S, 40% loss of cross-sectional area in angles and up to a 100% loss in batten plates at both the north and south ends. Seven rivet			

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heads on both the east and west sides near 20N have almost 100% section loss (**Photo S96**), and there is very severe section loss of four rivet heads on the east side of the bottom angle near 20S (**Photo S97**).			
Counterweight Truss Lateral Struts (S)	4	4	D
Rating corresponds to the MCR/PCR of the lower strut between **22N-22S**. The west **21N-21S** (21-27 plane) strut has 20% localized section loss of the lower west and east angles over 1000mm at the north and south ends, 30% section loss in 5 rivet heads at the north end and 5 rivet heads at the south end, and up to 20% localized section loss of gusset plates. Although the centre **21N-21S** (21–24 plane) strut exhibits severe deterioration (severe pitting and perforations in the angles, and up to 50% section loss of rivet heads) at the north and south ends, the deterioration appears to have occurred prior to the last coating contract and the member has also been strengthened at these locations. The upper strut between **22N-22S** and the east strut between **21N-21S** (21-22 plane) are in generally good condition with only light localized 1-2mm deep pitting noted. The lower strut between **22N-22S** has 30% section loss of the lower east angle along its entire length with perforations at the south gusset plate connection. **23N-23S** has pitting of up to 2mm deep representing 20% localized section loss of the west angle bottom flange thickness at the north end. **24N-24S** has severe pitting and section loss in the bottom angles at 24S and 24N including a perforation of the east angle. The flanges at the north end of **25N-25S** are bent and pitting and 15% section loss of the angle were noted.			
Counterweight Truss Cross Bracing (S)	2	2	A
The counterweight truss bracing members are generally in good condition. The rating is based on the PCR of lateral bracing member **21S-27N** where a previous repair has not addressed the deficient connection of the lower angle to the gusset plate at 27N. The same member also has a localized area of severe pitting in the south bottom angle at the west end and severe section loss of a rivet head at this location (**Photo S98**). At this location there are also perforations in the lower horizontal lower angle (**Photo S39**). Member **21N-21S** has several perforations in the upper angle at both the north and south end, and large areas of very severe localized section loss in both the angles and rivet heads. Both ends of the member have been strengthened. Several other members have severe localized section loss of both angle legs and rivet heads due to moderate to severe pitting.			
Counterweight Link Lateral Bracing (S)	5	5	D
The counterweight link lateral bracing members are in generally good condition although localized pitting of 1mm deep was typically noted at the connections. The bottom flange of members **13.5N-13.5S** and **22N-22S** has up to 5% section loss of the thickness along the length of the member. The top north and south gusset plates of **13.5N-13.5S** are slightly bent.			
Lower Cross (Bottom Chord) Bracing (S)	5	4	D
The bottom chord bracing members are in generally good condition, however light to moderate pitting was noted at some connections and the underside of bracing members. Rating is based on the condition of bracing member **10N-12S** which is severely deformed (**Photo S99**), including the deformation of the gusset plate at connection 10N and the lug angle at 12S from previous rust jacking. *Condition Rating reduced due to deformation of 10N-12S.*			
Sidewalk Floor Beam Bracing (S)	5	5	D
The sidewalk floor beam bracing members are sagging (**Photo S100**) but are in good material condition.			
Mechanical Platform and Housing (S)	5	4	U,S
The mechanical platform supports the drive motors and machinery and consists of structural steel members embedded in a reinforced concrete slab; the housing walls consist of corrugated steel panels; the flat roof system consists of steel framing members overlain by an asphaltic membrane and has three access hatches. The concrete platform soffit has widespread light to moderate scaling and several localized areas of light honeycombing, plus light to medium spalls (some with exposed reinforcing) and delaminated areas over traffic lanes (**Photo S101**). The top surface of the slab is in good condition with no obvious defects noted.			

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The top flange of the north motor support beam inside the mechanical room has 5mm section loss at the west end caused by water leaking into housing (**Photo S102**). The bottom flange of the east girder below the platform has localized 7mm pitting near the second from south cantilever catwalk support member. There is severe localized section loss and severe rust jacking in some of the other structural steel floor system members outside of the housing. The structural steel roof framing system is in generally good condition. During the inspection water was noted leaking into the housing on the north side (**Photo S103**), centre, and northwest corner (**Photo S102**). There are several perforations in the corrugated steel panels at the northwest corner. *Condition Rating reduced due to the material condition of the concrete slab soffit.*			
Deck Joints (S)	5	4	D
The joints at the ends of the deck are open, permitting dirt, debris and de-icing salts to collect on the substructure and superstructure elements below. The exposed top of the ballast walls typically exhibits moderate scaling and wear at the armoring angle and several transverse wide joints. A new armouring angle was recently installed on the east end of the deck grating which eliminated the elevation difference between the deck and the east approach armouring. Approximately 50% of the length of the west joint armoring sounds hollow, indicating either concrete delamination or a void between the armouring and the underlying concrete (**Photo S104**). *Condition Rating reduced due to inherent performance deficiencies of open joints.*			
Pedestrian Railings (S)	6	6	D
The pedestrian railings on the south side of the bridge sidewalk and on the southeast and southwest approach sidewalks are in good condition with no significant defects noted.			
Operator's House Railings (S)	Not Rated	4	D
The cast iron railings between the Operator's House and the north trunnion were in poor condition at the time of the inspection, as two posts nearest to the trunnion had perforations at the base over at least 60% of the width of the post (**Photo S105**). These posts were repaired in October 2018.			
Roadway Railings (S)	4	4	A
The thrie-beams and lattice railings are in generally good condition, but several bolts are missing from the splices in the thrie beams and there is localized light corrosion at the ends of both thrie-beams and the south railings. The post at the east end of the south railing has been anchored with lag bolts into sidewalk planks. The railings and thrie-beams are discontinuous above the main trunnions. On the south side this could allow pedestrians to fall into the roadway. The existing barriers do not meet current CHBDC crash-tested requirements (in terms of geometry and direct attachment to the truss) and could subject primary members of the main truss to damage or failure during vehicle collision along the barrier. The railings meet the CHBDC minimum height requirements for combination traffic/bicycle barriers.			
Curb and Sidewalk (S)	5	5	M,B
Sidewalk: The sidewalk is in generally good condition but some light to medium end splitting and end checks were observed in the timber planks. Some screw heads are protruding from the planks and should be driven down. Several bolts securing the planks are missing nuts on the roadway side, and the short curb section at the west end is not anchored correctly. The sidewalk is only 1.2m wide at leaf truss member locations, which is 0.3m (20%) less than the minimum practical width of 1.5m specified by the Transportation Association of Canada. **Curb**: The timber curb on the north side of the deck is in generally good condition but there is some minor impact damage to the east end (**Photo S106**) and some narrow and medium splits and checks were noted. The curb is not anchored at the east end and several anchor bolts are missing nuts.			
Ballast Walls (S)	5	5	D

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The ballast walls are in generally good condition, but hairline and narrow isolated vertical cracks are typical. An area of map cracking with wet stains and some efflorescence deposits was noted at the south end of the east ballast wall.			
Wingwalls (S)	5	5	C
The southeast wingwall has extensive light honeycombing and a 10mm wide vertical crack extending onto the east approach sidewalk at the east end in the original concrete (**Photo S107**). The southwest wingwall has a very severe spall (2 m by 2 m) at the base at the east end at the interface with the abutment wall (**Photo S108**).			
Abutment Bearings / Live Load Supports (S)	4	4	B
The two large pedestal bearings (live load supports) on the east abutment typically exhibit light corrosion on the anchor bolts and on some steel plates. The northwest anchor bolt of the south bearing is bent and has medium to severe corrosion on the lower section (**Photo S109**). The bottom of the north bearing is covered in dirt and debris. The north side of the leaf span is not fully seated on the north bearing with a gap of approximately 2mm noted (**Photo S110**). Under live load the span becomes fully seated. Light corrosion was noted on the bearing plates of the buffer supports.			
Approach Slabs (S)	3	3	S,B
The concrete approach slabs do not have an asphalt wearing surface. **East**: The east end of the approach slab and southeast approach sidewalk is lower than the west end, suggesting differential settlement has occurred (**Photo S111**). A surveying program has been initiated to determine if the settlement is ongoing. Two wide transverse cracks near the centre of the slab (**Photo S112**) are at the same location as wide cracks in the curb, sidewalk and southeast wingwall (**Photo S107**). The interface between the slab and the adjacent asphalt wearing surface has opened up (especially on the north side) due to spalls in the slab and cracks and potholes in the adjacent asphalt (**Photo S113**). There is a wide transverse crack at the west end of the slab at the interface with the top of the ballast wall. The slab has widespread abrasion/wear from vehicles. **West**: The concrete slab has longitudinal wide transverse cracks and widespread abrasion/wear from vehicles. The wide gap (up to 35mm) at the interface with the ballast wall is only partially sealed.			
Guide Rails (S)	4	1	A
Northeast: The west end of the guide rail is not (and cannot be) connected to the structure. There is minor impact damage to the east end treatment. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards or TAC requirements and the guide rail may not sufficiently re-direct errant vehicles back onto the roadway. **Northwest**: No significant material defects were noted. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards or TAC requirements and the guide rail may not sufficiently re-direct errant vehicles back onto the roadway, causing the errant vehicle to impact the vertical truss member. **Southwest**: The timber posts are breakaway type posts which may allow the railing to deflect onto the sidewalk in the event of a vehicle impact, which is a hazard to pedestrians. The 7th and 8th posts from the west end of the southwest guiderail have been damaged by vehicular impact (**Photo S114**). There is minor damage to the steel channel. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards or TAC requirements and the guide rail may not sufficiently re-direct errant vehicles back onto the roadway, causing the errant vehicle to impact the vertical truss member. *Rating has been downgraded to reflect serious potential performance deficiencies (PCR of 1).*			
Embankments not Supporting Foundations (S)	6	6	D
The southeast and southwest embankments are in good condition with no significant scour or erosion noted.			

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Slope Protection (A)	6	6	D
The southeast and southwest armour stone slope protection is in good condition with no significant defects noted.			
Marine Structures (A)	5	5	B
Southeast: Several fenders have splits including a severe split in the top east fender at the north end (**Photo S115**). Some nuts are missing or are loose in the bottom fenders (**Photo S116**). **Southwest:** Multiple piles have splits and/or rot. The lower set of steel cables securing the structure to the south dolphin are corroded and loose (**Photo S117**). The fourth and fifth safety line posts from the north end are loose, and the second post from the north end is wooden rather than steel.			
Signs (A)	Not Rated	Not Rated	D
The *Object Marker* signs at the four quadrants are in good condition with no significant defects noted. *Element not rated as per BIM p.A10-1.*			
Utilities (A)	Not Rated	Not Rated	D
Some of the submarine cables were replaced in 2012 and were noted to be in good condition during the 2015 underwater inspection. A number of the original cables are still in place, but it is unclear if they are still in service. *Element not rated as per BIM p.A11-1.*			
Catwalks and Stairs (A)	2	2	S,A
There are no safety chains or gates at openings in railings or fall-arrest cables at ladders, which are potential safety hazards. *Condition Rating is based on PCR of cantilevered platform at 21N.* **Catwalks - 17N-17S:** The east c-channel supporting the catwalk is supported by the tapered cantilevered members below but only 25mm of the bottom flange is actually supported (**Photo S118**). The opening on the west side of the catwalk to the south of the mechanical house is a falling hazard. The 3rd railing post from the north end is cracked. **21N-21S:** A severe perforation in the member supporting the cantilevered platform at the north end has reduced the edge distance of bolts in the connection to almost zero. There are perforations in the east and west supports of the south member. The west railing has two open sections (leading to ladders) which are a potential falling hazard (**Photo S119**). The safety cages at the ladders at the ends of the catwalk are too short which is a potential falling hazard. **22N-22S:** The east handrail is bent at the north end (**Photo S120**), and three are two cracked railing welds at the northeast corner. **21-27:** 3 north railing posts have split vertically over half their height (**Photo S121**). There is no safety chain or gate at the west end of the catwalk preventing access onto the counterweight roof. **Stairs - 17N-21N:** There is 3mm deep pitting in the channels and supporting angles at many steps. The north railing has a cracked weld, there is a perforation in the north support at 17N, and the southwest railing post on the platform below 21N is split. **17S-21S:** There is 3mm deep pitting in the channels and supporting angles at many steps, a split post in the north railing, and the handrail is bent at several locations. **21-22:** There is 3mm deep pitting in the channels and supporting angles at many steps and several perforations (**Photo S121**).			
Chain Link Fence (A)	6	6	D
No significant defects were noted in the southeast, southwest, or east fences.			
Lighting (A)	Not Rated	Not Rated	D
The navigation lights welded to vertical members 7S-8S and 7N-8N and the roadway lights welded to leaf truss verticals 3N-4N and 11N-12N appear to be in generally good material condition. *Element not rated as per BIM p.A11-1.*			

NOTE: P = Primary; S = Secondary; A = Auxiliary

8.0 Mechanical Inspection and Assessment

8.1 INSPECTION FINDINGS

The following sections of this report provide a description of the primary machinery systems, documentation and discussion of the conditions found, and conclusions with appropriate recommendations based on the findings.

Schematic diagrams of the structure, span support machinery, and span drive machinery are presented in the figures below. Photographs were taken of mechanical conditions of interest during the inspection and are presented with detailed captions in Appendix D.

8.1.1 SPAN DRIVE MACHINERY

The span drive machinery comprises bearings, brakes, motors, open gearing, operating struts and operating strut guides. A schematic of the span drive machinery with component designations is presented in Figure 7.

8.1.1.1 Bearings

The span drive machinery has eleven bearings excluding the bearings in the differential and the operating strut supports. The B1 bearings are located outside of the machinery house to support the pinion shafts adjacent to the operating strut supports. The remaining span drive bearings are inside the machinery room. The B1 and B2 bearings have bronze bushings. The remaining bearings are babbitt lined bearings. All of the bearings are secured in split pillow block housings and are grease lubricated.

The bearings are generally in fair condition. The bearings appear to be adequately maintained and were adequately lubricated at the time of the inspection. Noted issues include poor bearing alignment and minor paint deterioration and corrosion on two bearings.

It was previously noted that the clearance measurements and taper in the clearance measurements demonstrate poor alignment at four of the bearings including: B3-S, both B4 bearings, and B5-N-OB. This alignment was visually verified during the inspection to evaluate the condition of the shaft alignment to the bearings. Generally speaking, the misalignment at the bearings will accelerate wear. Given that only light wear had been measured from 2011 to 2016 SBE inspections, adjustments to correct misalignment are not recommended at this time.

At the B1 bearings there is minor paint deterioration and corrosion between the bearing cap and base at the upper split line (Photo M1, Appendix D). This area is difficult to access; however, consideration should be given to removing the corrosion to prevent future deterioration. Note that care must be taken to protect the wearing elements of the bearing during any maintenance work to remove the corrosion.

The bearings associated with the differential assembly were visually inspected to the extent possible. The nature of the assembly limits inspection to some degree. Externally the bearings were in good condition with adequate paint coverage and satisfactory lubrication. No exceptions were noted at these bearings based on a visual external inspection.

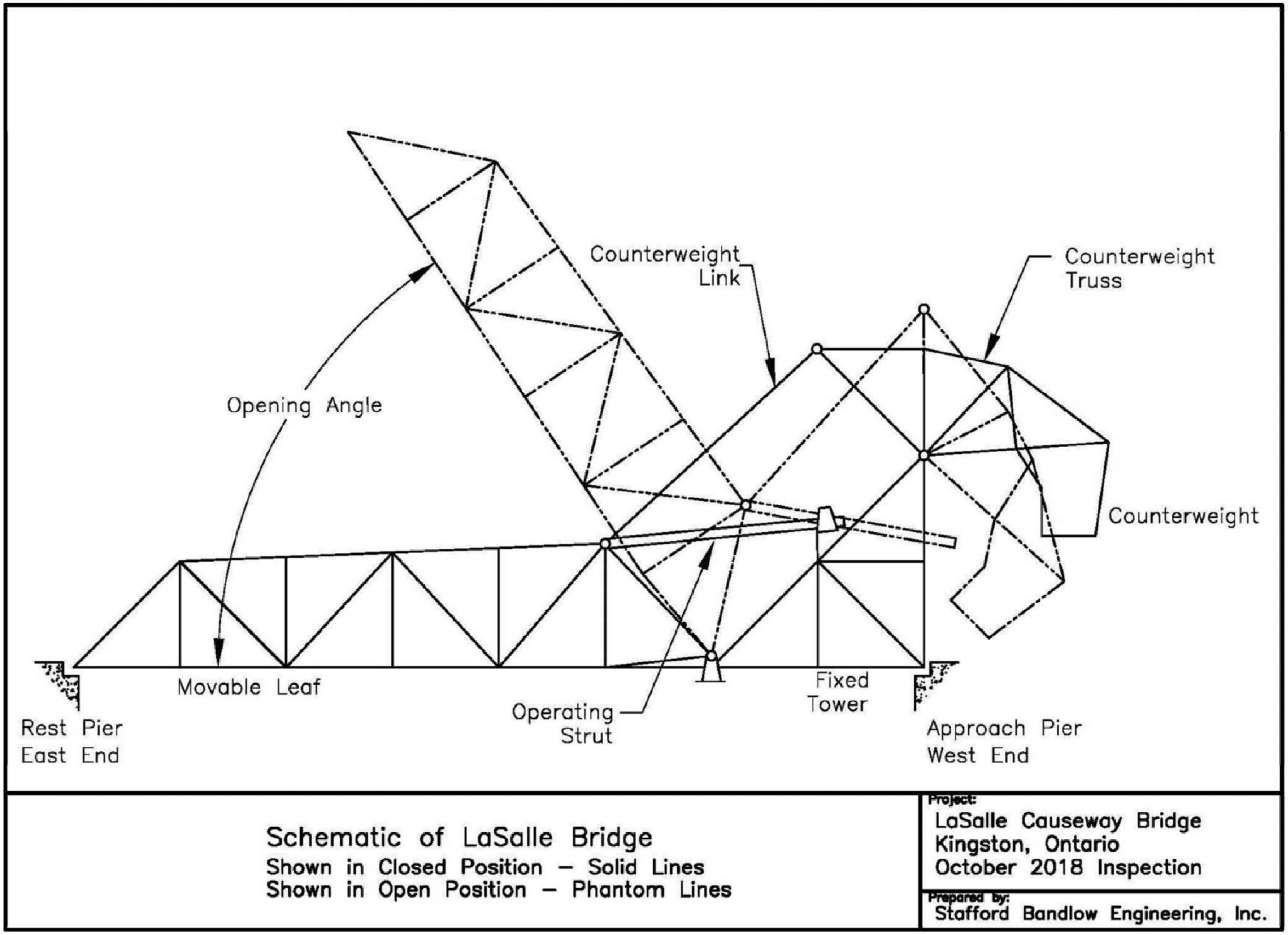

Figure 6: Schematic of Bascule Bridge

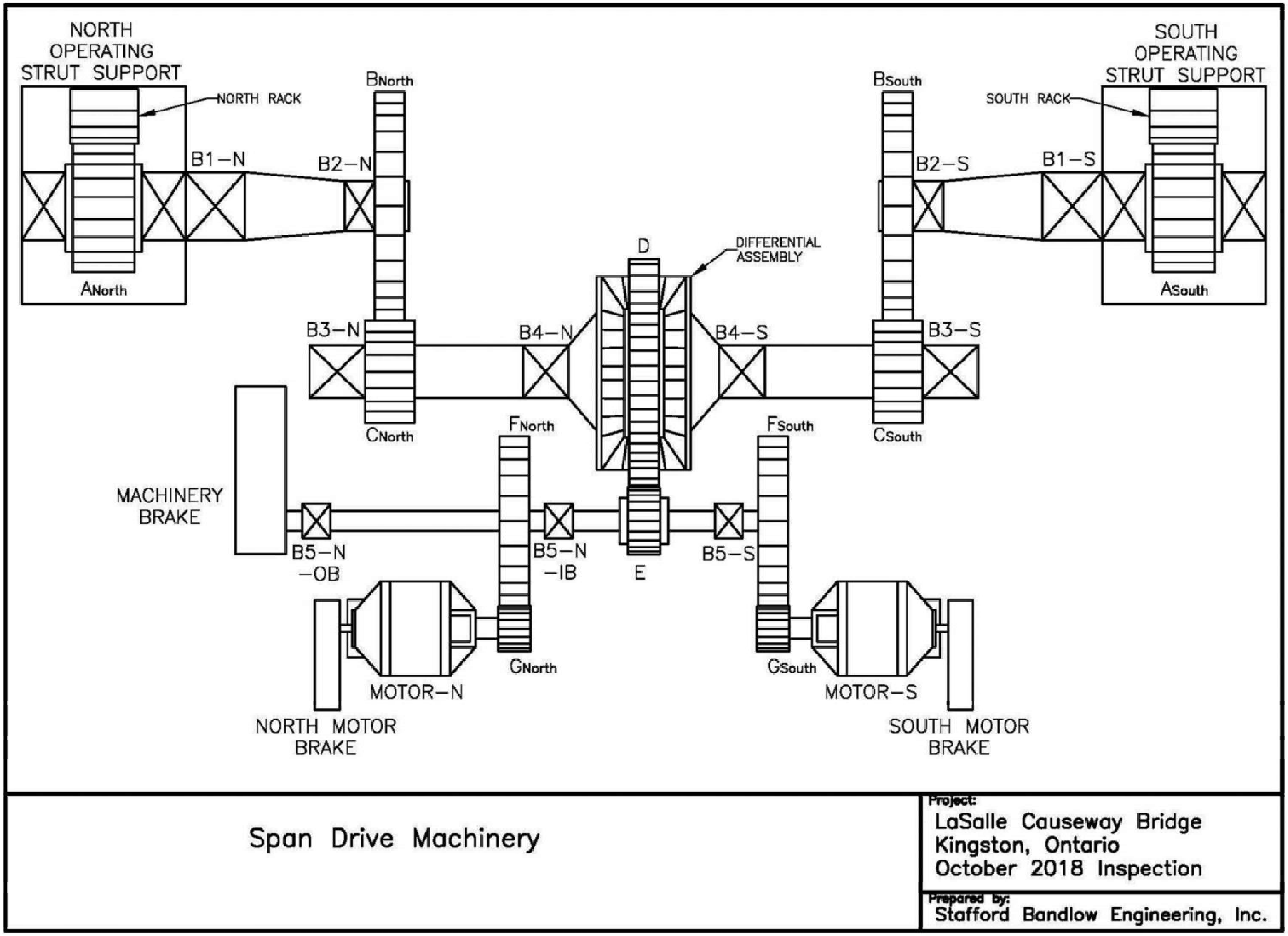

Figure 7: Span Drive Machinery

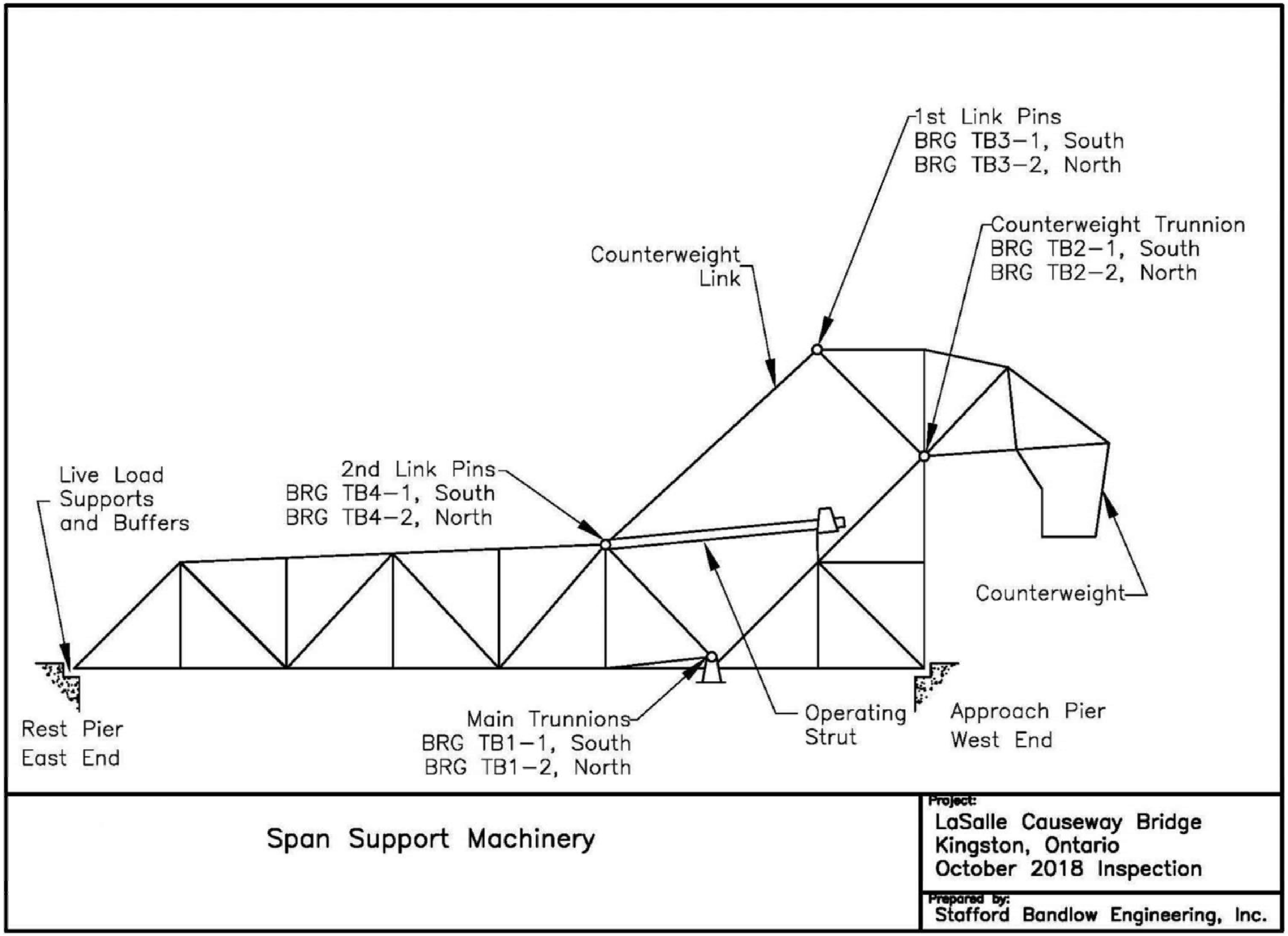

Figure 8: Span Support Machinery

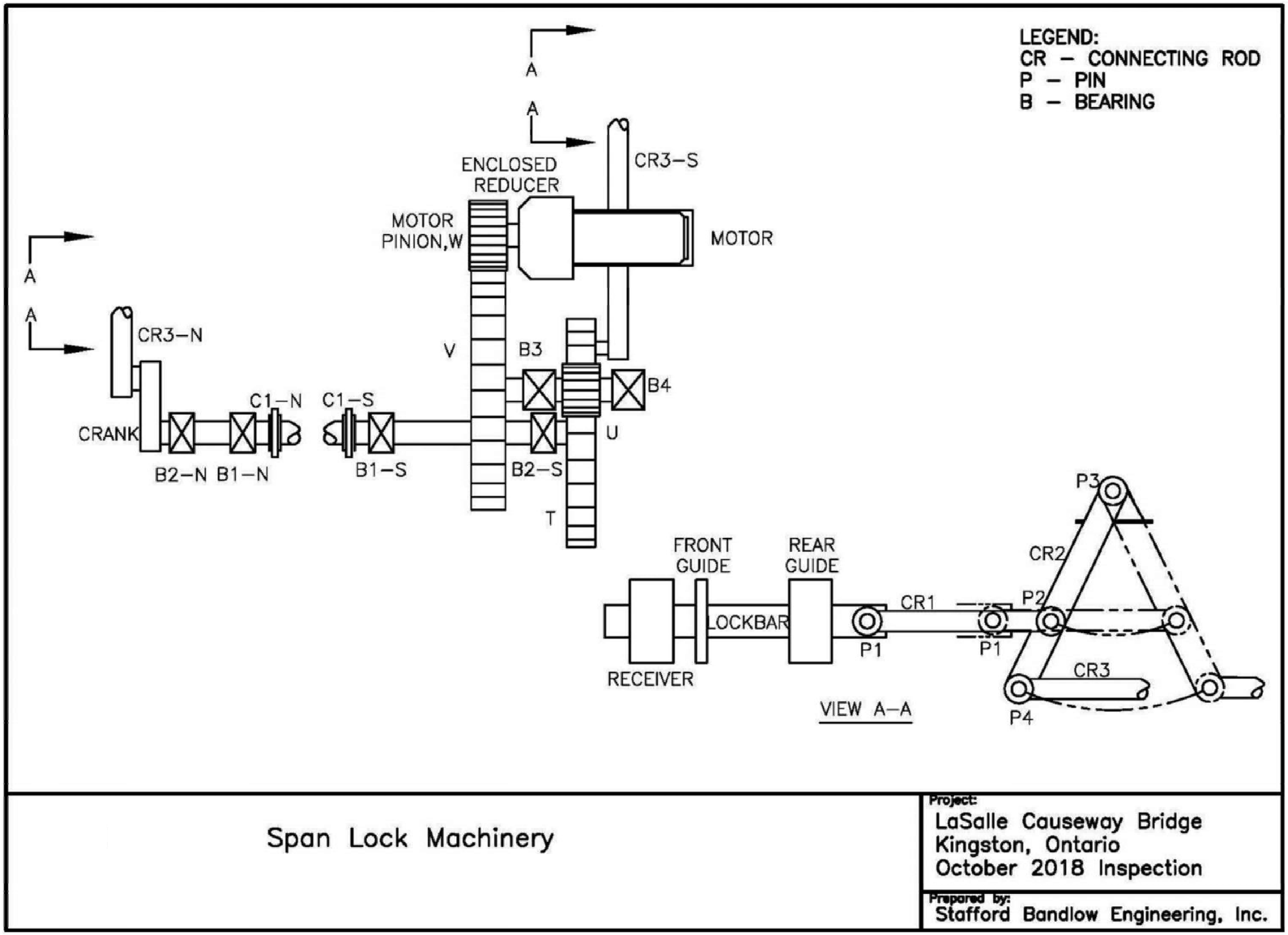

Figure 9: Span Lock Machinery

8.1.1.2 Brakes

The span drive machinery is equipped with three brakes. One motor brake is mounted on each motor shaft extension on its non-driven end. One machinery brake is mounted outboard of bearing B5-N-OB (see Figure 7). All brakes are thrustor released, spring set, shoe type brakes.

Proper installation and maintenance are important to ensure that the brakes provide torque per the design. Factors that commonly affect brake torque are improper brake torque settings, inadequate thrustor gaps, poor contact at the brake shoes, corrosion on the wheel friction surfaces, and contamination of the friction surface from grease or oil.

Based on the provided brake assembly torque scales, the brake settings are:

- South Motor Brake – 1.06 kN-m (780 lb-ft)
- North Motor Brake – 1.07 kN-m (790 lb-ft)
- Machinery Brake – 1.63 kN-m (1200 lb-ft)

The contact between the brake shoes and the brake wheels was checked using feeler gages and compared to the manufacturer's (Magnetek) recommendation of at least 60% contact to decrease the contact pressures and ensure that the provided torque is sufficiently applied to the friction surface. Based on this check, all the brakes satisfy the manufacturer's recommendation.

The thrustor oil level at all brakes was inspected. The oil levels were within an acceptable range at the time of the inspection.

The north east mounting bolt nut on the machinery brake was noted to have poor bearing, this is a previously noted condition that has been monitored by SBE since 2011. No movement was noted during the inspection. The machinery brake mounting bolts and surrounding areas have light corrosion (Photo M2).

At the time of the inspection, the brakes operated properly and reliably.

8.1.1.3 Motors

There are two motors associated with each span drive. The motors were recently replaced in 2018 and are generally in like new condition. The motor mounting supports are sound, and no movement was noted during operation. It was noted however, that the underside of the motor mounting plates is unpainted. There is currently no corrosion on the underside of the mounting plate but should be painted to prevent future deterioration (Photos M3 and M4).

8.1.1.4 Open Gearing

The span drive machinery is provided with seven open spur gear sets excluding the bevel gears and pinions associated with the differential assembly.

Due to the nature of the rack pinion and operating strut guide assembly, many of the machinery interfaces cannot be inspected externally. As part of this inspection the assemblies were visually inspected with limited access in the closed position. The assemblies were observed during opening and closing operations of the span to check for unusual behavior that may indicate a problem. Unusual movement was not noted at the north and south assembly. The north operating strut guide assembly was recently rehabilitated in early 2018. In November 2015, the south operating strut guide assembly was disassembled, and the components were inspected by SBE. The findings are summarized in a January 2016 report. This inspection found deformation at the keys and keyways (2.0 to 2.3 mm clearance) and a poor fit between the pinion shaft and pinion (0.25 mm clearance) but the conditions were not as severe as the north pinion prior to the 2018 rehabilitation. A failure at this connection would result in a catastrophic loss of control of the structure. The fits between the south guide assembly components should be restored in the near term. Until such time that repairs are implemented to restore the fits, it is warranted to monitor the internal conditions on an ongoing basis. An in-depth inspection of the south operating strut guide assembly should be performed on a 5-year basis with the next inspection occurring around November 2020.

The span drive spur gears were cleaned and visually inspected for wear and contact with the exception of the north and south racks and pinions which were inspected using the contact pattern formed by the grease. Based on the visual inspection all gears show minimal to light wear with the exception of the previously noted north and south racks and pinions.

Generally, all the gear teeth are in good condition with light plastic flow and light abrasive wear but with the following exceptions:

- The wear patterns at both B and C gear sets indicate mostly full-face contact with evidence of minor end loading.
- The wear patterns indicate slight end loading on the south side of gear set D and E. There is minor damage on the south side of the opening and closing faces of many of the pinion and gear teeth. Moderate damage was noted on the south side of the closing face of gear D at one location (Photo M5). Similar damage was noted on one tooth at the opening face on pinion E.
- Based on the contact pattern in the lubricant there is full face contact noted at the north and south F and G gear sets. The contact wear pattern at the north G pinion indicates light cross bearing with heavier contact on the north side of the opening face and heavier contact on the south side of the closing face. This condition is expected to wear in as the G pinions were installed in 2018 as part of the motor and drive rehabilitation and wear is dependent on the existing F gears (Photo M6).
- The north and south rack and pinions have moderate wear and are in good condition given their time in service. At both gear sets there is minor metal flow and areas of minor damage to the teeth; many of these locations may be from original casting defects but some appear to be abrasive wear. Based on the wear pattern in the lubrication, the contact between the racks and pinions varies substantially, from 20% of the face up to full contact.

The damage noted at the D and E gearset is likely due to high contact stress. This attributable to the poor alignment noted at this gearset. Previously noted high impact loading to the machinery during the braking operation (prior to the 2012 brake replacement) may also be a factor for damages. Based on a comparison of the current conditions with those recorded in photographs from the 2011, 2016, and 2017 inspections, it does not appear that the condition is worsening.

The gears associated with the differential assembly were visually inspected to the extent possible. The nature of the assembly limits inspection. There were no noted issues with the gearing, lubrication, mounting or fasteners at the time of the inspection.

8.1.1.5 Span Operation

The bridge was operated several times during the inspection. The machinery operated reliably and smoothly during the inspection. The 2018 motor and drives rehabilitation changed operation to PLC based control and the bridge operates well.

It was noted during the inspection that the motors are applying windup torque in the machinery to provide firm seating. However, there is still bouncing at the live load supports because the buffers are preventing the leaf from seating fully. Please see the Live Load Supports and Buffers sections for more information.

8.1.1.6 Auxiliary Span Drive Machinery

The previously noted antiquated auxiliary drive machinery has been removed from the machinery room and is no longer a system on the bridge. As part of the 2018 motor and drive rehabilitation, the bridge is now able to operate from the use of the electricity provided by the generator. The use of the generator to operate the machinery was not observed during this inspection.

8.1.1.7 Operating Strut Guides

The operating strut guides are designed to keep the racks and rack pinions at the correct center distance. Each operating strut guide is equipped with two pairs of lower guide wheels and one pair of upper guide wheels. The lower guide wheels support the dead weight of the rack and operating strut when unloaded. The upper guide wheels limit separation between the rack and rack pinion during span operation due to the separating force. Loading should be equally distributed among all wheels at a given location.

Due to the nature of the operating strut guide assembly, many of the machinery interfaces cannot be inspected externally (Photo M7). The north operating strut guide wheel bushings were replaced as part of the 2018 north guide assembly repair.

The south operating strut guide assembly was disassembled in November 2015 by SBE and the components were inspected as summarized in a January 2016 report. The most significant finding of this inspection is the fits at the pinion assembly; however, the guide rollers were found to have significant bushing wear. The clearance at the bushing for the rollers at the lower east side warrants replacement of the bushing.

As part of this inspection the assemblies were visually inspected in the closed position. The assemblies were also watched during operations of the span to check for unusual behavior. Externally, the operating strut guides are in fair condition and there were no issues during operation.

8.1.1.8 Operating Strut

The front end of the operating strut is pin connected to the top chord of the main truss on the bascule span at the outboard side of the second link pin (see Figure 8). The bearings for the pin connection of each operating strut appear to be receiving regular lubrication and all lubrication fittings were present.

The bearings at the pin connection are difficult to access for inspection. In 2016 clearance measurements were taken at the inboard bearings, the maximum clearances were noted for being outside of the limit used normally to recommend rehabilitation. The clearance at the north operating strut bearing was 0.89 mm (0.035 in) and the clearance at the south operating strut bearing was 1.14 mm (0.045 in). Due to the bearings having no adverse effect on the operation of the bridge, it is not recommended that these being be rehabilitated at this time.

Both the inboard and outboard bearings for the south operating strut move relative to the structure demonstrated by cracked paint and fretting corrosion between the bearing housings and the structure and at the rivets that secure the housings to the structure. This condition was noted at the inboard side bearing in the previous inspections and it is apparent that fretting is actively occurring (Photo M8). At this same bearing at the north side of the bridge the rivets used to secure the bearing to the structure have been replaced with turned bolts and no evidence of significant movement was observed. Additionally, a stiffener on the outboard side bearing of the south operating strut is rubbing on the structure as evidenced by paint removal and fretting (Photo M9). This condition is minor and will be monitored in future inspections.

The rollers that support the operating struts when the bridge is in the full design opening angle of 84° are not used due to the current limited opening angle of about 65°. The studs of the roller assemblies significantly hang down from the supports, indicating the springs are missing or broken preventing the roller assemblies from raising into contact with the struts. Given the poor access and that they are not in use, it is unlikely that the bearings for the rollers are being maintained. Rehabilitation of these assemblies, as well as alterations to the mountings may be required if the strut supports are intended to be utilized.

8.1.2 SPAN AND COUNTERWEIGHT SUPPORT SYSTEMS

The span and counterweight support systems comprise two main trunnion bearings, two counterweight trunnion bearings, two first link pin bearings (counterweight side of counterweight links), and two second link pin bearings (span side of counterweight links). Figure 8 identifies the primary span support components.

During the course of the inspection, each of the bearings was observed during operation. No unusual movements or noises were detected at any of the counterweight trunnion or link pin bearing assemblies.

As previously noted in past inspection reports, the lubrication of the bearings for the span and counterweight supports is marginal. The south counterweight bearing has a sheared off lube fitting and a second fitting that is plugged. At the north counterweight bearing one lube fitting is missing. At the second link pins, the lubrication fittings are piped together which is not proper practice. It is extremely important that these critical bearings receive regular lubrication with fresh grease on a regular basis.

The review of these components was limited to an external visual inspection. This inspection did not include disassembly of the bearings to evaluate the internal wearing components.

8.1.2.1 Main Trunnion Bearings

The movable leaf rotates about the main trunnion bearings. The main trunnion bearings (TB1-1 and TB1-2) are situated between the members who comprise the bottom chord of the bascule truss heel at roadway level. The main trunnions are mounted in the bottom chord (see Figure 8). Access for inspection is limited.

There is contact between the moving structure and the fixed structure in the vicinity of the main trunnion bearings during operation of the bridge. The contact is creating a wear step in the tower leg and wearing away the heads of the rivets in the line of action (Photo M10). Further investigation should be conducted to determine the integrity of the worn tower leg and rivets. In addition to the contact near the main trunnion bearings, the outboard sides of the bridge structure contact the outboard sides of the trunnion support steel at the west abutment. While the contact at the north side is light and appears to be addressed by the applied lubrication, the contact at the south side is heavy and has worn away the paint; the exposed steel is corroded (Photo M11). If the contact is a result of contraction of the bridge with temperature changes then there is no practical corrective action.

The head ends of four of the mounting bolts for the main trunnion bearing have 100% section loss due to corrosion at both the north and south bearings (Photo M12). An excessive amount of standing water was found in the structural cavity covering the head end of the lower two mounting bolts at both locations. In addition, at the north trunnion bearing there is minor fretting corrosion, indicating movement, at the connection interface.

Lubrication of the main trunnion bearings appeared to be recent and adequate. There are three lubrication fittings on the roadway side of the bearing and there is one lubrication fitting on the outboard side of the bearing. All of these fittings are receiving lubrication. In addition, there are three small pipe plugs and one large pipe plug on the roadway side of the bearing. These pipe plugs are typically provided so that the bearings can be purged of old lubricant.

8.1.2.2 Counterweight Trunnion Bearings

The counterweight trunnion bearings are located above and to the west of the span drive machinery room. Access for regular maintenance purposes and external inspection is limited. The construction of the bearing prevents access for clearance measurements.

Each counterweight trunnion bearing includes a trunnion and a sleeve that surrounds the trunnion. The trunnion fits with mating holes in structural steel plates and the sleeve fits around the trunnion and between the structural steel plates. The sleeve is secured to the structure by six turned studs that pass through the structure and the sleeve. The trunnion and the sleeve rotate with the structure as it moves, and the outside of the sleeve is the bearing journal that slides on the bronze bearing bushing.

There is strong evidence that at least one sleeve stud is broken. As previously noted, there is light cracked paint and some fretting corrosion at the interface of the trunnion nut and the structure and also near all of the sleeve studs at both the north and south trunnion bearings (Photo M13). This is an indication of movement between the mating components. At the inboard side of both the north and south bearings there is separation between the structure and nuts for the sleeve studs at multiple locations. At the north trunnion bearing at the inboard side, the top east, top west, and east-most sleeve studs have a 4.76 mm (3/16 in), 9.53 mm (3/8 in) and 1.59 mm (1/16 in) gap respectively. At the south trunnion bearing the west-most nut on the inboard side has backed away from the structure approximately 12.7 mm (1/2 in). Loose nuts are an indication of improperly tensioned or fractured studs. The loose sleeve studs were noted during the previous inspections. Paint removal from the nuts and from the structure makes it clear that there has been an attempt to tighten the studs. The process used to tighten the nuts is not known, however it is clear that the work did not successfully remedy the issue.

During the 2016 inspection an attempt to pry on the most backed off nuts at the south and north trunnions was made. The nuts were pried throughout the range of operation to attempt to find a point at which the studs become loose and to verify if the studs are fractured but none of the studs were able to be moved. Personnel at the bridge have previously indicated that the top east stud at the outboard side of the north trunnion was able to be hammered in slightly. This nut was noted to be backed off about 9.53 mm (3/8 in) during the 2015 inspection and flush during the current inspection with the inboard nut flush against the structure in 2015 and protruding 1.59 mm (1/16 in) currently. This is a good indication that the stud is fractured and separated. Removing and replacing broken studs at these locations may require significant effort as they appear to be seized under dead load.

The caps for the counterweight trunnion bearings were removed for internal inspection of these bearings as part of the secondary mechanical inspection in November 2015. The only issue noted was water in the lubricant. The covers were not removed during this inspection however the lubrication seemed recent and adequate with exceptions.

The original design provided for three lubrication fittings at the inboard and outboard side of each bearing to serve opposite ends of three grease grooves and two lubrication fittings at the top of each bearing. At the north bearing one of the lubrication fittings on the outboard side is missing and there was no sign of lubrication at this location indicating that lubricant is not passing through the entire grease groove. At the south bearing there are two lubrication fittings missing at the inboard side of the bearing. There is evidence of old lubrication leakage at the east most lubrication fittings at the inboard and outboard of the bearing (Photo M14). This leakage may be an indication of a plugged lubrication port or damaged fittings.

Damaged sleeve studs and inadequate lubrication lines are both significant issues that require rehabilitation attention.

8.1.2.3 First Link Pins

The first link pins are used to connect the counterweight frame to the counterweight links. Both the north (TB3-2) and the south (TB3-1) bearing assemblies are inaccessible for hands on inspection as they are surrounded by structural steel. The ends of the pins and the nuts that secure the pins are accessible from the walkway that provides access for lubrication. The only accessible portions of the assemblies are the nuts which secure the link pin.

Externally the first link pins appear to be in good condition. There is a single lubrication fitting at the inboard end of each link pin. Lubrication appeared to be recent. The visible portions of the bearing appear in good condition. There is cracked paint between the inboard and outboards nuts and the structure at both link pins, which may be an indication of slight movement (Photo M15). No corrective action is warranted at this time.

8.1.2.4 Second Link Pins

The second link pins connect the lower end of the counterweight links to the movable span. The bushing and housing for the bushing are bolted to the lower end of the counterweight link and the trunnion and sleeve assembly are secured between two plates which are part of the upper chord of the truss. In addition to the nuts mounted on both ends of the pin, four retaining bolts are used to secure the bearing between the structural steel plates. The retaining bolts pass through to the structural plates and through a sleeve which surrounds the pin. The outer diameter of the sleeve is the bearing journal.

As previously noted, one of the lube fittings at the south second link pin on the outboard side has been replaced with a pipe plug. At the inboard side the three lube fittings are piped together and serviced by one lube fitting (Photo M16). At the north second link pin all the lube fittings are present at the outboard side but, as at the south, three lube fittings are piped together at the inboard side. Two of the three lubrication ports are leaking. Servicing multiple lube ports with one fitting is not good practice because the lube will follow the single path of least resistance. As a result, the lubricant is probably not getting to the intended location(s).

Apart from the poor lubrication practice, the integrity of the second link pins appears good with some light paint cracking and fretting at the outboard and inboard hubs. Additionally, there was a bird nest in the general vicinity of the south 2nd link pin (Photo M16).

8.1.3 SPAN LOCKS

The span lock machinery was recently rehabilitated in 2017 and is generally in good condition with only minor exceptions. The span locks are located under the roadway at the east end of the movable span. Lock bars are driven into engagement with the receivers mounted on the live load supports at the east end rest pier to prevent lifting of the toe end of the span. The system includes an electric motor, an enclosed speed reducer, links and pins at the lock bar connections, and spur gears mounted on shafts supported in plain bearings. Each lock bar is supported in a front and rear guide and engages with a receiver at the approach. The span lock machinery is also equipped with a manual crank that attaches to the non-driven end of the motor for manual operation of the machinery. One lock is located at the northeast corner of the leaf and one is located at the southeast corner of the leaf. Both locks are driven by common drive machinery located at the southeast corner. See Figure 9.

8.1.3.1 Span Lock Drive

The span locks are functional and are generally in good condition. The functional test of hand operation and releasing of the motor brake were satisfactory. There were no issues noted at the time of the inspection with the exception of numerous spots of surface corrosion on various mounting bolts, supports, shafts, pins, and crank arms where paint was not fully applied (Photos M17 through M23). These items included:

- The motor and enclosed reducer mounting bolts, support mounting bolts, and support;
- The “B3” mounting bolts;
- The shaft between “B3” and “B4”;
- The cross shaft bearing housings;
- The north and south adjustable arms for position indication;
- The north and south limit switch crank arm mounting bolts to the lock bar;
- The north and south rotary cam limit switch covers.

8.1.4 LIVE LOAD SUPPORTS, CENTERING DEVICES, AND BUFFERS

8.1.4.1 Live Load Supports

The movable leaf is equipped with two live load supports with one provided at each corner at the toe end of the leaf. Each live load support consists of a live load shoe and a live load strike plate mounted to the rest pier at the toe end of the leaf (Photo M24). The live load shoes are located under the toe end of the lower chords of the main trusses and include a cut-out through which the span lock receiver fits.

The north and south live load supports are in generally good condition and provided good bearing with only minor exceptions. There is corrosion on forming at the underside of the strike plate and the top of the supports (Photo M25).

Under the normal seating process and without traffic on the span, there was about a 3.18 mm (1/8 in) gap at the north live load support and a 1.59 mm (1/16 in) gap at the south. When traffic was on the span, the live load supports close in and out of contact.

8.1.4.2 Centering Devices

There is a tapered centering guide integral to the live load strike plate at both the north and south sides of the toe end of the bridge. The centering guides were in good condition with no contact noted at either guide. At the time of the inspection the gaps at the north and south centering devices were approximately 6.35 mm (1/4 in).

8.1.4.3 Buffers

There are two hydraulic buffers provided at the toe end of the bridge installed in 2016. The buffers are mounted on the movable leaf, and the strike plates are mounted to the pier.

Both of the buffers are in fair external condition with exceptions. The buffer body has widespread light corrosion, the buffer mounting bolts are unpainted and moderately corroded, and the interference at the span and buffer mounting is lightly corroded (Photos M26 and M27).

Before the motor and drive rehabilitation in mid-2018, the buffers were necessary to help assist the operator in smoothly seating the span. As noted in the Span Operation and Live Load Supports sections, currently the motors seat the span with sufficient windup torque, but the span is not fully seated on the live load supports. The buffers are preventing the span from seating firmly on the live load supports. It is recommended that the buffer strike plate elevations are adjusted to allow the live load supports to be in firm contact. Although the new control system provides effective speed control so that the buffers are no longer needed to assist with seating, they do provide some protection against impact damage in the event that control system failure allows the span to reach the seated position without decelerating.

8.1.4.4 Over-Travel Bumper Blocks

There are provisions for over-travel bumpers to be installed on the operating strut to stop the bridge at the fully open limit of travel though there are no stops currently installed. Generally wooden bumper blocks are provided to stop the span in the event of an over-travel condition. Article 13.6.1.3 of the CHBDC requires that bridge stops be provided.

8.1.5 WARNING GATES

The movable leaf is provided with four warning gates, two at each approach. The gates are Chamberlain Liftmaster model BG790-50-53 manufactured by the Chamberlain Group, Inc. The gates are relatively new (identification on the gates indicates a 2013 manufacture) and are in fair condition with no mechanical issues noted. There is spotty corrosion on the gate arm supports at all of the warning gates, efforts have been made to address the previously noted corrosion however it was not fully completed (Photo M28).

8.1.6 BARRIER GATES

The movable leaf approach is currently not provided with barrier gates. While the bridge is in the fully open position, the counterweight provides a barrier for eastbound traffic. There is no barrier for westbound vehicular traffic. Consideration should be given to installing barrier gates at the east end of the span as noted in Article 13.5.6 of the CHBDC.

9.0 Electrical Inspection and Assessment

9.1 GENERAL DESCRIPTION

The inspection consisted of a visual inspection and multiple electrical system chart recording that were sufficient in depth to determine the status of the bridge electrical power and control system and assess the adequacy of the system to perform its intended function. The recorded electrical data will also serve as a baseline for the recent drive and motor replacements.

The inspection work included:

- Information gathering and the review of gathered information in support of the inspection.
- Planning, scheduling of the work with all parties and participation in a worker safety plan including necessary health and safety preparation.
- Inspection of all control and power systems associated with the bridge operating and auxiliary systems. This included a determination of the status and life expectancy of equipment, its installation and its inherent design features that enable the bridge operating system to operate in a safe and reliable manner.
- The inspection was concluded with the submission of this report which documents the findings, provides conclusions and makes recommendations of any actions necessary to meet operating reliability and safety requirements as well as adherence to all prevailing statutory codes.

The electrical inspection and assessment describes all items of equipment defined in the Electrical Inspection Table under the Scope of Inspection section of the report. Items in this report have been arranged in the order of the inspection that begins with the incoming 600-volt electric utility service for the bridge.

9.2 MAIN ELECTRICAL SERVICE

The status and condition of the bridge main electrical service was found to be the same as was reported in the 2017 electrical inspection report. The main electric utility service comes into the bridge from the northwest approach via an underground utility service feeder. The utility service feeder terminates in the main circuit breaker compartment of the Motor Control Centre (MCC) in the operators control house at the northwest corner of the bridge. The service provided to the bridge is a 600 volt, 3-phase, 3-wire, solidly grounded service. The service is provided with a ground fault indication system that consists of three “Wye” connected lights with its “Star Point” grounded. The ground fault indication lights were all illuminated at the time of the inspection which was an indication that the 3-phase feeder is clear of a phase to ground fault (Photo E6, Appendix E). A utility meter is mounted on the side of the MCC enclosure for metering of the control house and maintenance building auxiliary loads (Photo E1).

To determine the balanced condition of the bridge 3-phase electric utility service, the phase-to-phase and phase-to-ground voltages of the incoming service were measured at the motor control centre under no-load condition (only auxiliary loads running) as follows:

Table 4: Phase to phase and phase to ground voltage under no-load conditions

ITEM	DESCRIPTION	VOLTAGE
1	Phase 1-to-Phase 2	613.3 V
2	Phase 2-to-Phase 3	610.1 V
3	Phase 1-to-Phase 3	607.3 V
4	Phase 1-to-Ground	352.0 V
5	Phase 2-to-Ground	354.1 V
6	Phase 3-to-Ground	349.7 V

The measurements of voltage were taken with all bridge auxiliaries operational including an associated office building load. The bridge drive system including traffic gates were switched off during these voltage measurements.

From the above, it can be seen that the no-load phase-to-phase voltages are almost balanced and are within +2% of the mean service voltage of 600 volts.

The phases to ground voltages indicate the voltage being applied to the ground monitoring lights. The minor recorded imbalance indicates that some of the auxiliary loads fed from the lighting transformer are single phase loads and not equally distributed across all three phases, hence causing a slight difference in voltages over the three phases to ground.

No significant physical deficiencies were noted for the bridge utility service at the time of inspection.

In addition to the bridge electric utility service, a 40kW standby generator is installed at the bridge to provide a backup source of power in the event of electric utility failure (Photo E2). This generator was installed in 2015 to comply with the latest version of the Canadian Highway Bridge Design Code. The standby generator was originally not capable of powering the span drive motors to operate the bridge. Part of the goal of replacing the original motors and drive controllers was to be able to operate the bridge using the standby generator. Since the original drives and motors were replaced, the bridge is now capable of being operated using the standby generator but only with one operating drive motor.

The condition of the generator has not changed since the last inspection, both the generator and its housing are in good operational condition. An emergency stop pushbutton is located on the generator housing to stop the generator in the event of an emergency and this was tested and proved to be operational.

Additionally, the standby generator is provided with a load bank breaker, but no load bank for load testing of the standby generator has been provided (Photo E3).

Generator nameplate data was collected and recorded as follows:

Specification	Standby Generator
Model:	GDX-40-3
Manufacturer:	T&T Power Group
Serial:	TTPG728
kW/kVA:	40/50
Phase:	3
Hz:	60
Volts:	600
Amps:	60
RPM:	1800
Ins. Class:	H
Rating:	Standby

As part of the generator installation, a manual transfer switch (MTS) has been provided and installed in the control house. The MTS is of Eaton manufacture and is in excellent condition (Photo E4).

Corrective action is required as follows:

1. Provide a load bank for the existing standby generator to enable it to be exercised under load without operating the bridge.

9.3 DRIVE SYSTEM

The bridge new drive system consists of squirrel-cage induction motors with variable speed drives. This new drive system was installed during the most recent rehabilitation to provide desire variable speed and torque control for the bridge. Dynamic braking resistor is also provided for the VFDs for electrical braking and to control bridge overhauling loads. The new drive system has been developed to allow both drive motors to be operated simultaneously or individually as duty motors. The drive control system now consists of a 7-position lever type master controller with three (3) speed settings for bridge operation, both for the opening and closing cycle of the bridge (Photo E18). These speed settings are also being controlled by the modified control system to automatically limit the bridge speed based on the position of the bridge. A foot switch was also part of the control system to stop the bridge in the event of an emergency situation.

The following describes the bridge sequence of operation:

1. Opening sequence:
   a. Switch the traffic signal to 'RED';
   b. Lower the oncoming traffic gates;
   c. Lower the off-going traffic gates;
   d. Pull the span locks;
   e. Release manual brake;
   f. Raise the span;
   g. Bridge stops at the fully open position. (Note: Bridge speed is automatically limited to creep speed at nearly open position. Operator has the option to run the bridge at a slower speed by adjusting the master controller switch between seated position and nearly open position.)

2. Closing sequence:
   a. Lower the span;
   b. At nearly closed span automatically decreased to creep speed. (Note: Operator has the option to run the bridge at a slower speed by adjusting the master controller switch between full open to nearly closed position.);
   c. Bridge fully seated, enable reduce torque mode and start timer to de-energize system;
   d. Motor brakes set, drive(s) de-energizes;
   e. Set manual brake;
   f. Drive the span locks;
   g. Raise the off-going gates;
   h. Raise the oncoming gates;
   i. Turn the traffic signal 'RED' light off and release the traffic.

No corrective action is required.

9.3.1 MOTOR CONTROL CENTRES

The bridge electrical equipment is controlled from a Motor Control Centre located in the operators control house. The motor control centre is comprised of a main incoming circuit breaker, equipment feeder circuit breakers, motor starters, control relays, lighting transformer and a lighting panel. The Motor Control Centre enclosure is NEMA 12 dust tight rated, 600 A, 3 phase, 3 wire, 60 Hz and is a 2100 Series MCC as manufactured by Westinghouse Canada and was installed in 1994 (Photo E5). The motor control contactors, thermal overloads and associated instrumentation are all appropriately sized and set for the imposed duty and are in good physical and operational condition for continued service in the long term.

The main incoming circuit breaker appears to be in good condition and adequately rated for the prevailing duty. The motor starter for the span locks is provided with motor contactors, three phase thermal overloads and local indication pilot lights to provide the operator and maintenance personnel with starter status. The new VFDs for the main drive motors are located in their respective freestanding enclosures located adjacent to the MCC (Photo E7). The main feeder breakers for the VFD drives are located in the MCC. The cubicles that contain the VFD feeder breakers also contains drive motor temperature monitors that were used for the original span drive motors and are no longer required. The traffic gate motor starters have been installed in the gate enclosures and not in the MCC. The Motor Control Centre contains feeder circuit breakers for the gates. The MCC is also provided with ground fault indication lights for each phase of the 3-phase power. These indication lights were in an operational condition at the time of the inspection, all were illuminated which is a positive indication that the system is free of a ground fault or ground leakage current (Photo E6).

Corrective action is required to:

1. Remove the drive motor temperature monitors as they are no longer in use.
2. It is recommended that low resistance "Ductor" testing be performed at the bridge at a frequency of every 5-years.

9.3.2 MAIN MOTORS AND VFD DRIVE CONTROLLERS

The main drive motors have been recently replaced and are of the squirrel-cage induction type. There are two 50 HP drive motors installed in the machinery space for span drive operation. Both main drive motors have identical electrical characteristics and only differ in the shaft arrangement and their function in operating the bridge. The bridge drive system is provided with two (2) drive motors coupled in parallel (Photo E8). The bridge is either capable of being operated with a single or both motors. Generally, the bridge is only operated using one drive motor and the operator has been directed to alternate between the two drive motors every day. Both single motor operation and dual motor operation were tested at the time of inspection without any noted deficiencies.

The two drive motors are configured as redundant units. A motor selector switch is provided on the control desk allowing the operator to switch between the two drive motors. The selector switch also includes an option for two motor operation in the event that additional torque is required to operate the bridge. When operating with two motors, one of the drives must be set to follower mode. This can be achieved by switching the key switch in front of the drive cabinet from master to follower. The bridge drive system utilizes a heavy duty seven-position mini-master switch via the originally installed but no longer used, rotor resistor switching contactors to vary the speed of the bridge. With the recently modified control system, the span speed is now limited to creep speed at the nearly open position of the bridge when raising and at nearly closed position of the bridge when lowering to ensure safe operation of the bridge. Dynamic braking resistors are provided for each of the VFD drives to provide electrical braking and to overcome any overhauling condition of the bridge during operation. These resistors were installed as part of the new drive installation and are in new condition (Photo E9).

Disconnect switches are provided in the machinery space to disconnect the motors locally and are sized and located in accordance with Canadian Electrical Code requirements (Photo E10).

The new VFD drive controllers are located their respective freestanding enclosures located adjacent to the MCC. They each consist of circuit breaker, control relays, VFD drive, as well as the indication lights, network jack, reset button, keypad and emergency stop button on the enclosure doors. All equipment inside the motor controller compartments are in good operational condition (Photo E7).

Motor nameplate data was collected and recorded as follows:

Specification	Main Span Drive Motor
Type:	Squirrel-Cage Induction rated for Inverter Duty
Manufacturer:	Reuland Electric
SN.:	N18-H0117A-1
Prod. No.:	0500S-VAAN-0004
Frame:	445TZ
Phase:	3
Hz:	60
Volts:	575
Amps:	55.6
Horsepower:	50
Duty:	60min
Speed:	900 RPM

No corrective action is required.

9.3.3 SPAN BRAKES

The bridge drive system is provided with two (2) main drive motor brakes, and one (1) manual/machinery brake. The original motor brakes were replaced with modern thrustor type brakes as part of the 2012 rehabilitation project. The replacement motor brakes are of Magnetek manufacture and are provided with three limit switches (Photo E11).

- Brake released – permissive with drive controller.
- Brake set – status indication.
- Brake hand released – Interlock to prevent bridge operation with the brake hand released.

The bridge manual/machinery brake is also of the thruster type and is provided with brake set and brake released limit switches only; no brake hand released limit switch has been installed (Photo E13).

None of the brakes are provided with covers for protection and no spare brakes or brake parts are held at the bridge.

Local disconnect switches are provided for each individual brake as per code. Wire-nuts have been used inside junction boxes for the motor brake limit switches. The motor brake disconnect switches and starters are housed in the same enclosure in the machinery space and were installed as part of the 2012 rehabilitation. The wires inside the starter/disconnect enclosure for the motor brakes are not properly labelled which could lead to errors during maintenance and troubleshooting (Photo E14).

Motor brake actuator nameplate data was collected and was recorded as follows:

Specification	Motor Brake
Manufacturer:	Eldro
S.N.:	12/0557532
Supply:	575/3/60HZ
Amps:	0.92

Machinery brake actuator nameplate data was collected and was recorded as follows:

Specification	Machinery Brake
Manufacturer:	Mondel Engineering
S.N.:	93/39400
Size:	16MBT/E-ED121/6S
Supply:	575/3/60HZ
Amps:	0.96
Torque:	1.898 kN-m (1400 lb-ft)

Corrective action is required to:

1. Provide a hand released limit switch for the machinery brake.
2. Provide protective covers for all brakes.
3. Replace the wire-nuts inside the motor brake limit switch junction boxes with code compliant splices or terminals.
4. Label all wires inside the starter/disconnect switch enclosure for the motor brakes in accordance with as-built drawings.

9.3.4 SPAN LOCKS

The bridge is provided with a span lock motor on the south side at the toe end of the bridge (Photo E16). The span lock motor and associated machinery equipment is located under the span on the movable structure. A hand crank shaft is provided at the end of the new span lock motor and a means of manually releasing its brake to enable manual operation of the span lock for maintenance and in the event of a total power failure at the bridge. The hand crank mechanism has not been provided with a limit switch to prevent electrical operation of the locks with the hand crank inserted. A local disconnect switch is provided for the span lock motor but it is inaccessible to maintenance personnel due to its location underneath the span (Photo E16). Two span lock rotary cam switches have been installed, one on each side of the span connected to the corresponding span lock linkage for the positive indication and control (Photo E17). The enclosure for the RCLS exhibit signs of corrosion.

The span lock starter is located in the MCC and has been modified to operate both the span lock motor and brake. The span lock starter was originally designed for six (6) speed operation but the current span lock operation is single speed across-the-line only (Photo E15).

A large span lock operator on the control desk is used to operate the span lock motor. This operator was part of the original installation when the span lock motor was multi-speed. The operator still functions with multiple step but its intermediate contacts have been jumpered out. Although the condition of the span lock operator is acceptable and is functional, it is recommended that it be replaced with a modern spring return selector for single speed operation to decrease the chance of contact failure and possible operator confusion with its non-operational multi-steps.

Corrective action is required to:

1. Provide a hand crank limit switch to prevent electrical operation of the locks with the hand crank inserted.
2. Replace the span lock operator with a new spring return selector switch for proper control.
3. Clean, remove corrosion, and apply protective coating on the span lock RCLS covers.

9.3.5 LOAD MEASUREMENT

In an effort to determine the operating characteristic of the main span drive motors their operating load characteristics were measured and recorded under both utility and generator power. The operating parameters (load current, voltage, power, and power factor) were measured during the complete opening and closing operating cycles as shown in Table 5 below. Note all parameters are taken from the output side of the VFD drives.

Table 5: Operating characteristic of the motors.

	PHASE A (AMPS) MAX/AVG	PHASE B (AMPS) MAX/AVG	PHASE C (AMPS) MAX/AVG	PHASE A (VOLTS) AVG	PHASE B (VOLTS) AVG	PHASE C (VOLTS) AVG	REAL POWER (KW) MAX/AVG	POWER FACTOR MAX/AVG	HP/KW RATING
Drive Motor No.1 (utility)	156 / 38	138 / 39	127 / 38	451	454	450	24 / 15.7	0.66 / 0.5	50 / 37
Drive Motor No.2 (utility)	142 / 36	128 / 38	125 / 37	444	442	450	23 / 14	0.56 / 0.45	50 / 37
Drive Motor No.1 (generator)	174 / 38	133 / 39	122 / 38	442	437	441	22 / 14.8	0.66 / 0.5	50 / 37
Drive Motor No.2 (generator)	153 / 37	138 / 39	142 / 38	445	451	452	23 / 13.8	0.6 / 0.5	50 / 37

Note: kW and PF readings are for bridge opening only, these values were very close to zero when lowering the bridge).

The drive motor operating characteristics were recorded using single motor operation over the complete operating cycle of the bridge. From the above results, it can be seen that the average load currents of the main span drive motors are within the nameplate rating of the motors (55.6 Amps). Both motors draw their highest power during the initial opening. This is due to the bridge being span heavy when the highest power draw is required to move the bridge from its stationary closed position. With the new VFD drives operating the bridge we only see a motor load spike during the initial opening and the power quickly stabilizes. This minimizes the impact on the bridge machinery and enables the bridge to be operated on its 40-kW standby generator. The average power consumed by the drive motors during raising of the bridge is about 14 kW. This is well below the rated 37 kW of the motor rating. The motor output power peaked at 23 kW which is also below the maximum rating of the motor. These are indications that the new VFD drives and drive motors are properly sized and effectively minimizes the power needs to operate the bridge.

During bridge lowering cycle, significantly less power is consumed by the drives, this is also an indication that the bridge is span heavy.

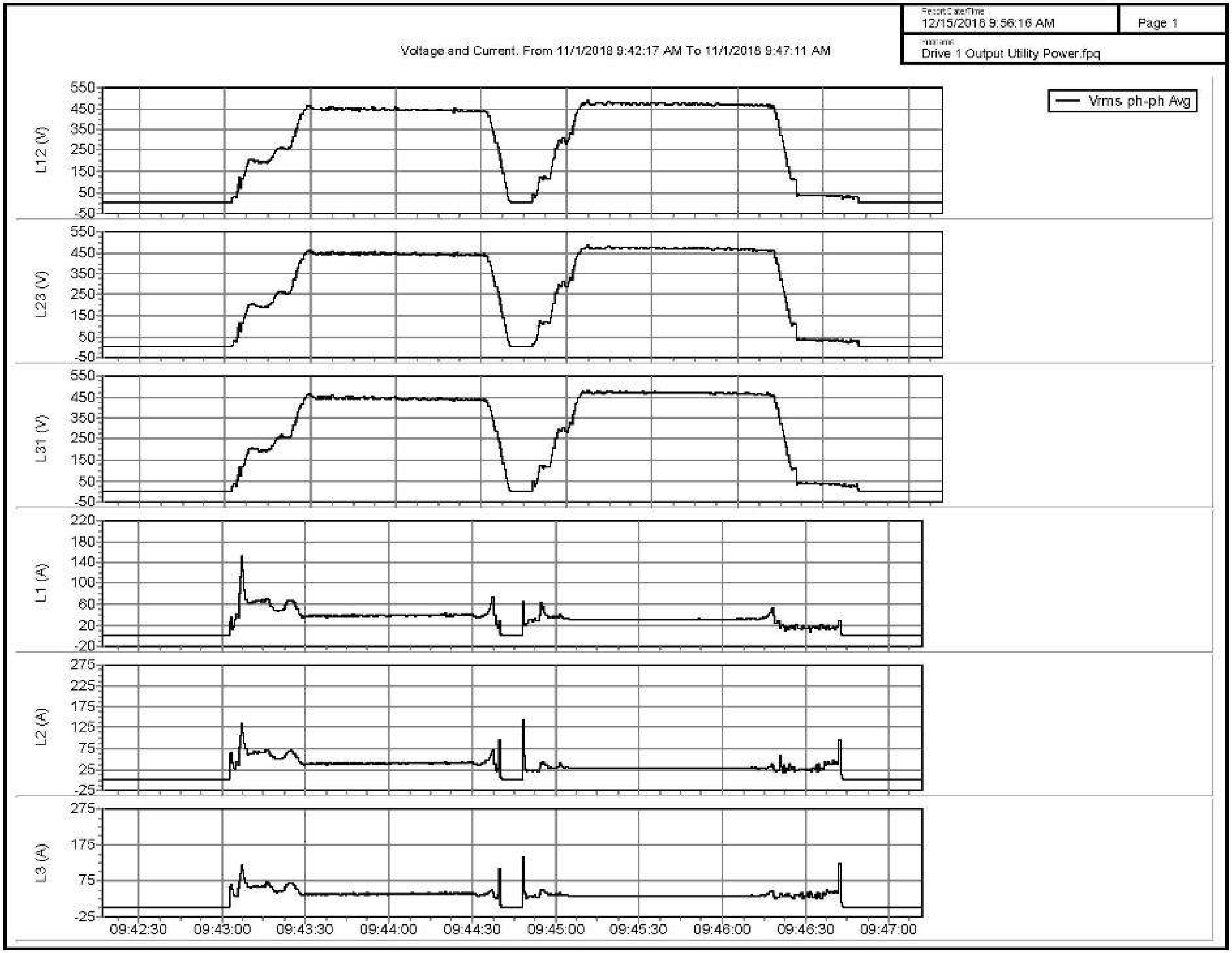

Figure 10: Voltage and Current Parameters (Span Drive Motor 1 Utility Power).

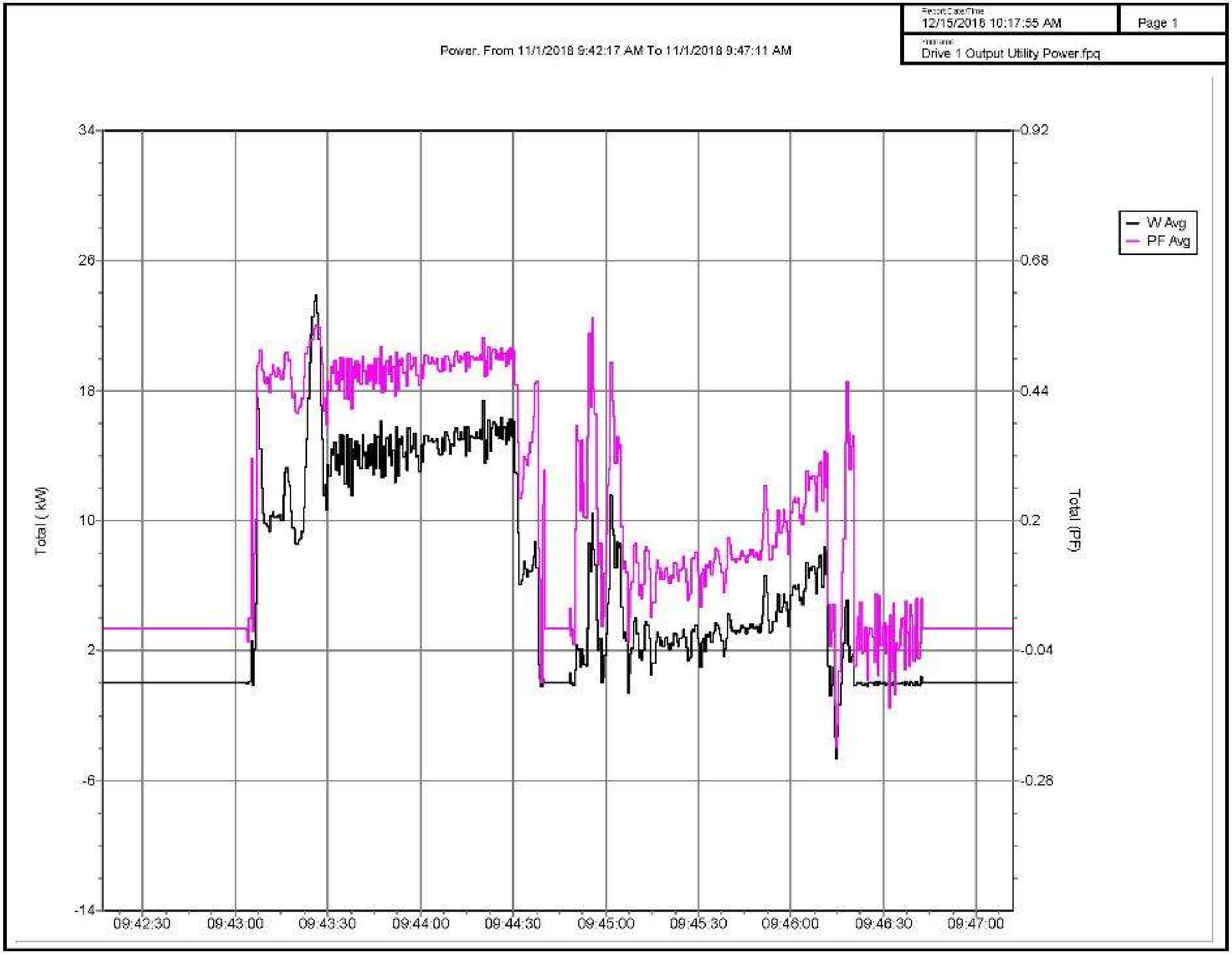

Figure 11: Power Parameters (Span Drive Motor 1 Utility Power).

(Note the motor is drawing more power during raising the span than lowering.)

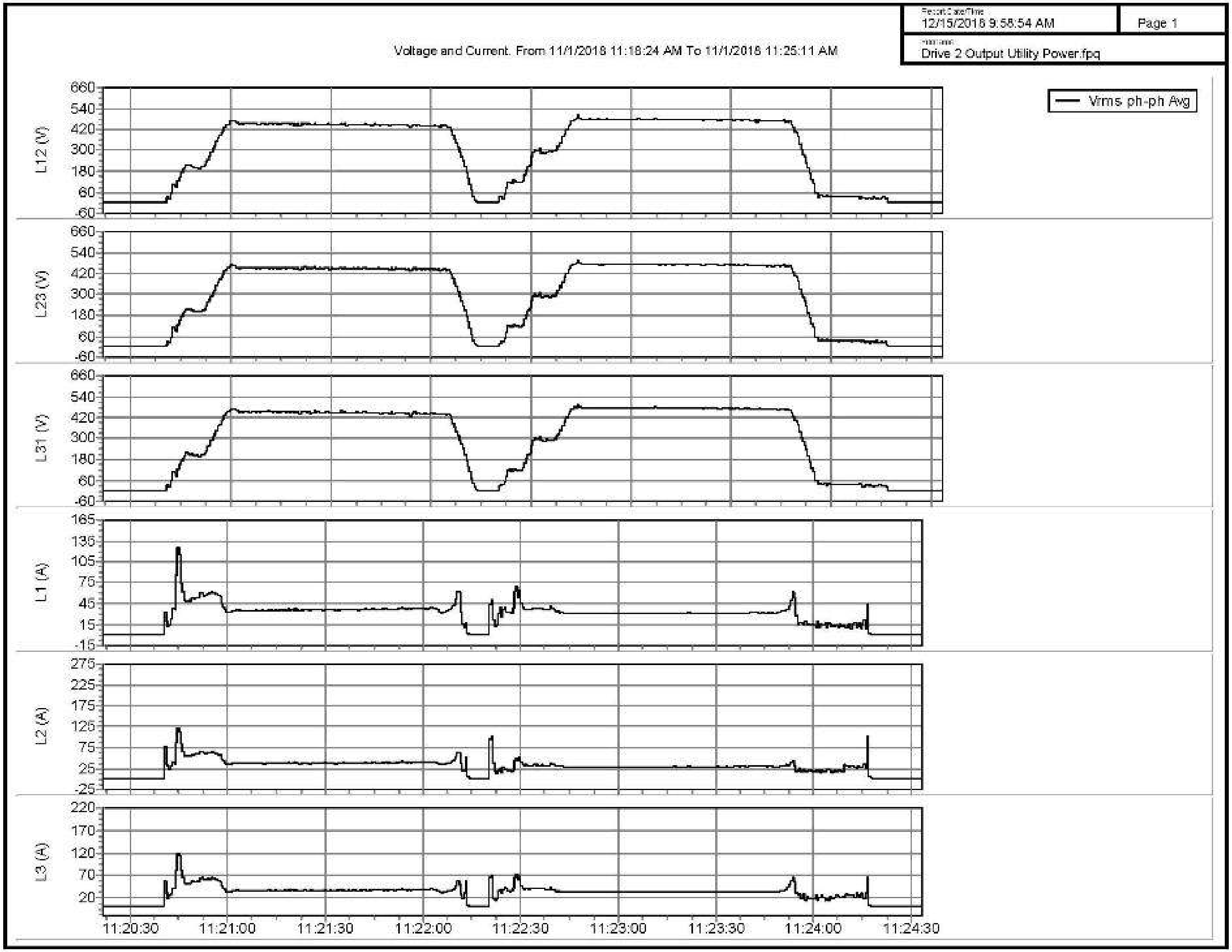

Figure 12: Voltage and Current Parameters (Span Drive Motor 2 Utility Power).

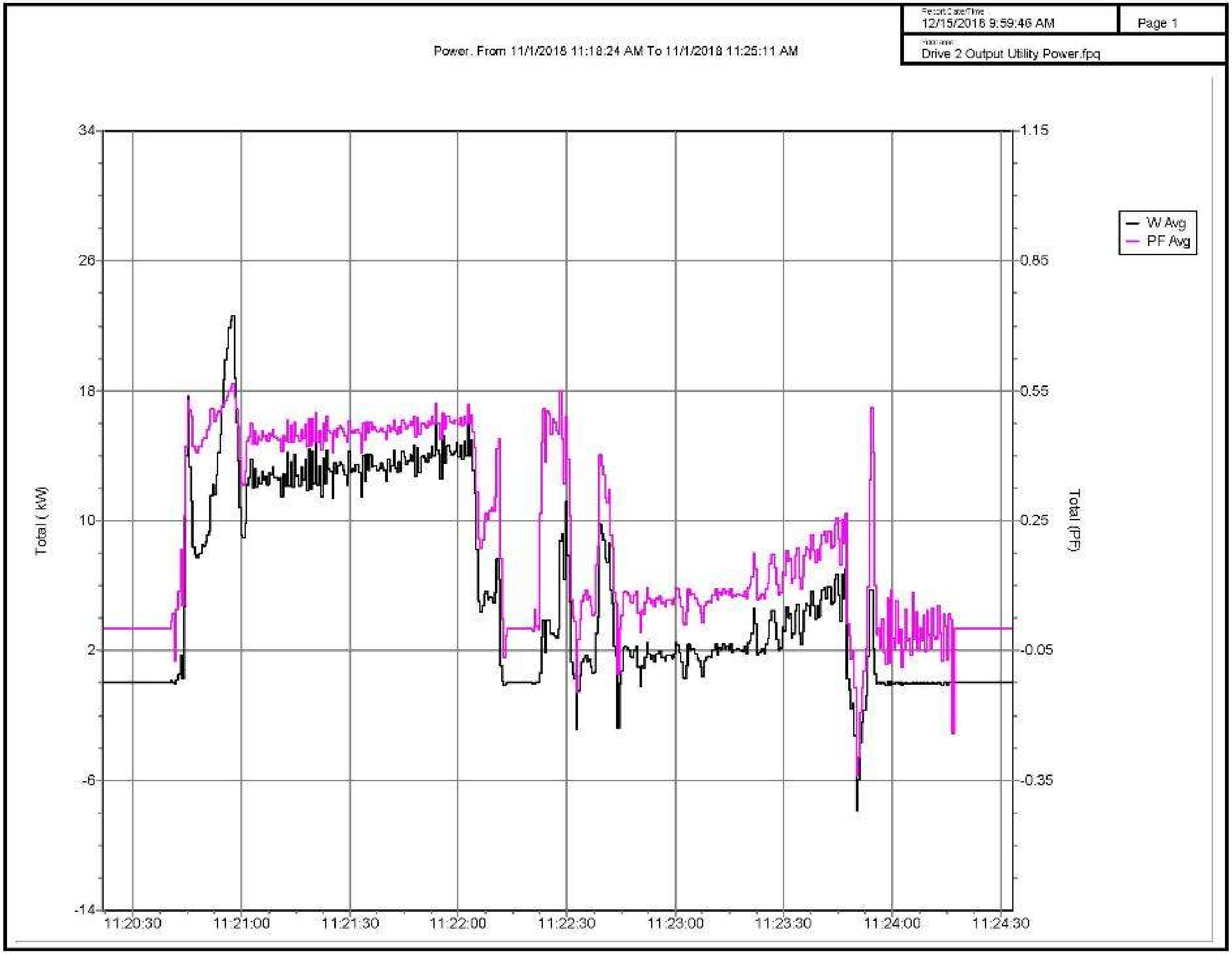

Figure 13: Power Parameters (Span Drive Motor 2 Utility Power).

(Note the motor is drawing more power during raising the span than lowering.)

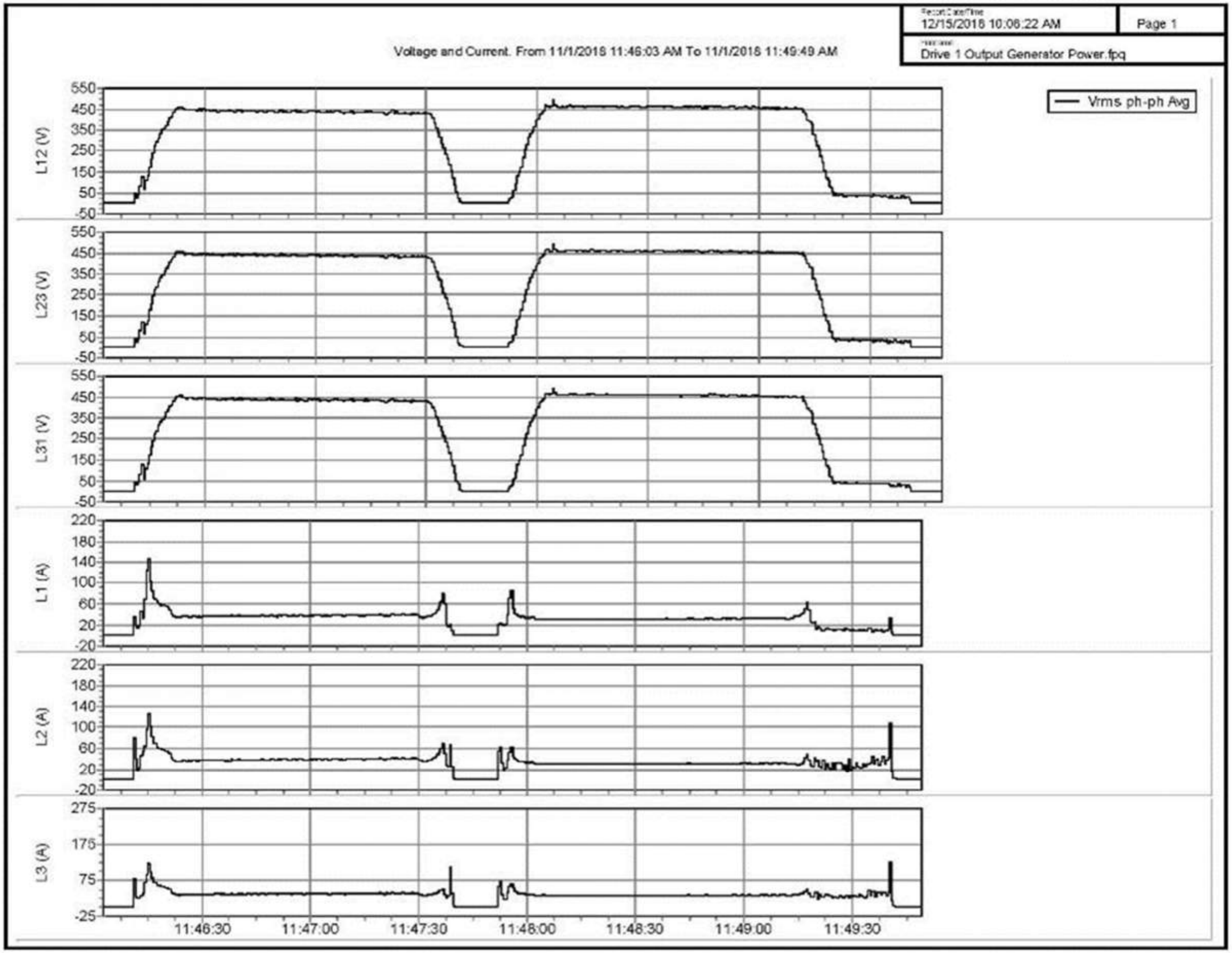

Figure 14: Voltage and Current Parameters (Span Drive Motor 1 Generator Power).

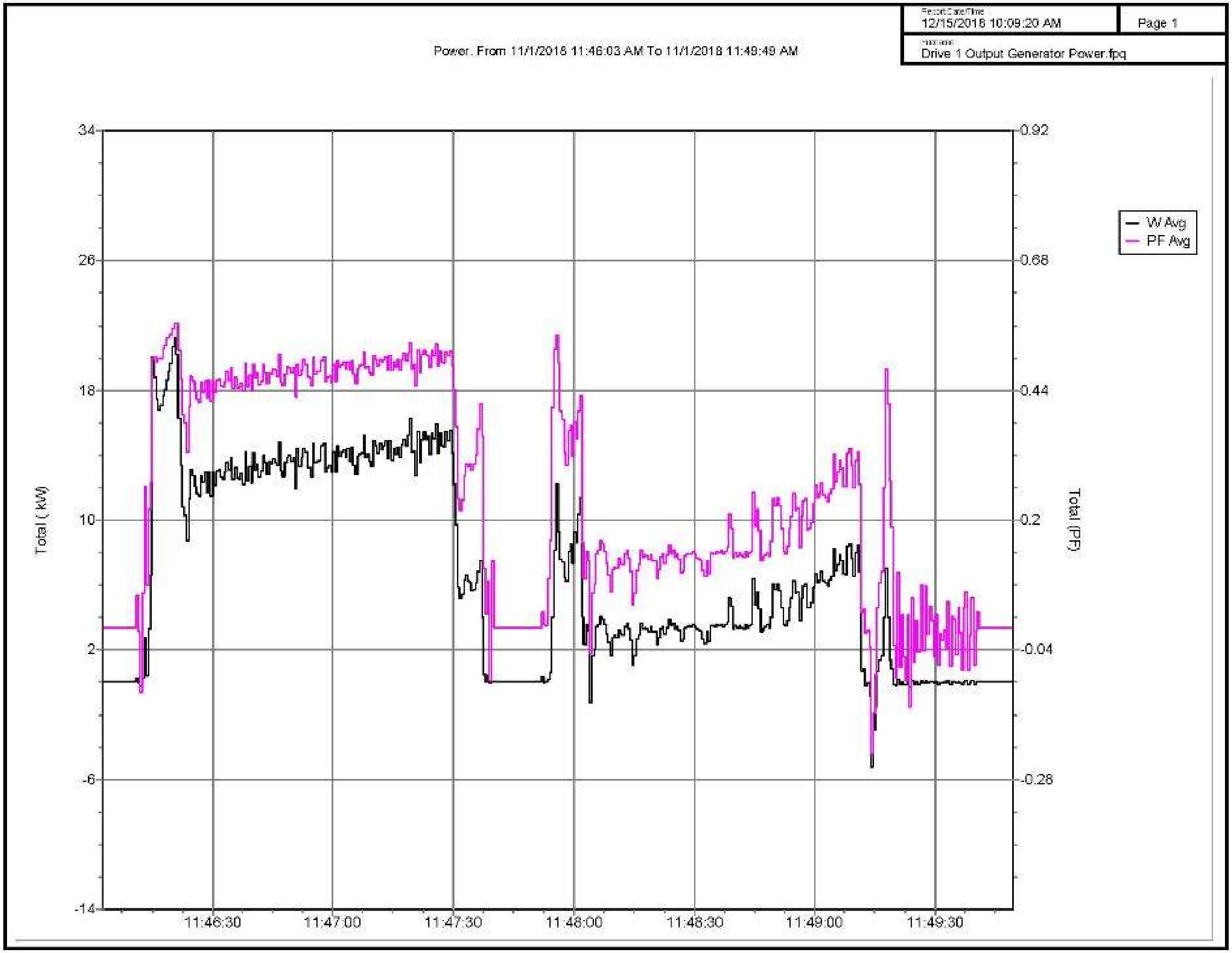

Figure 15: Power Parameters (Span Drive Motor 1 Generator Power).
(Note the motor is drawing more power during raising the span than lowering.)

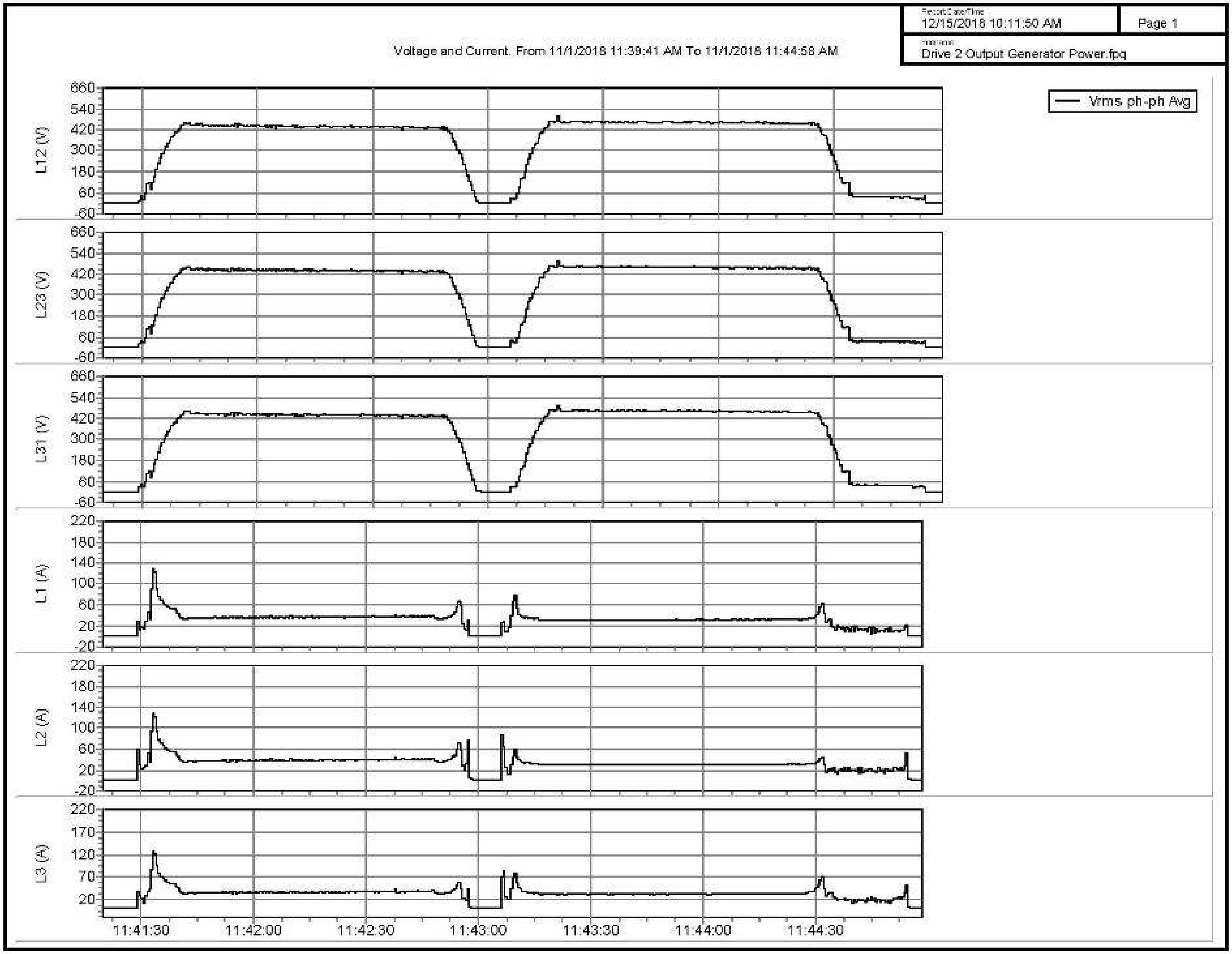

Figure 16: Voltage and Current Parameters (Span Drive Motor 2 Generator Power).

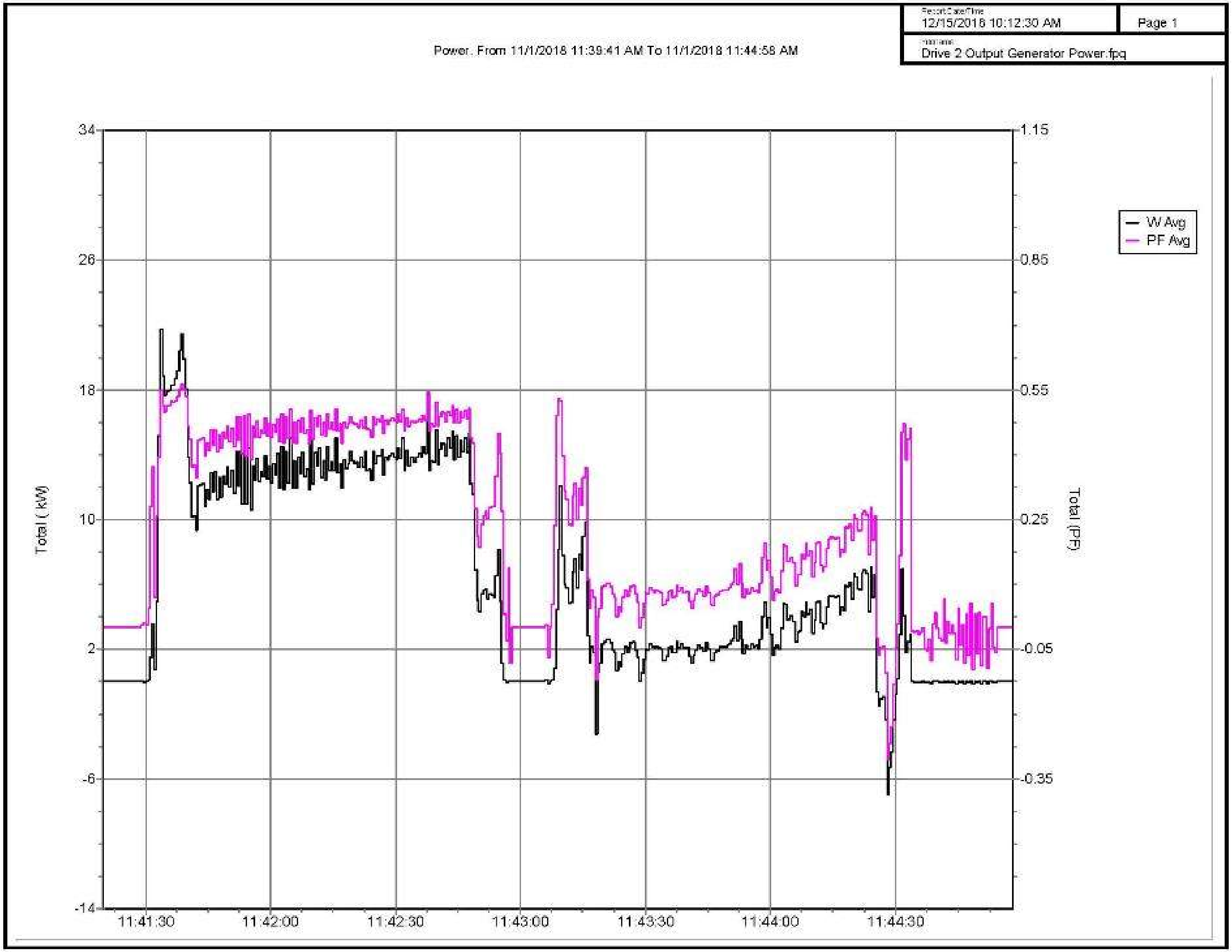

Figure 17: Power Parameters (Span Drive Motor 2 Generator Power).

(Note the motor is drawing more power during raising the span than lowering.)

9.3.6 ELECTRICAL INSULATION TESTING

As part of the electrical inspection the feeder cables and windings of all motor, brakes, and warning gates were insulation resistance tested using a 1,000-volt insulation resistance Megger test set with the following results. The weather conditions during the measurements were overcast and the temperature was approximately 9°C with 80% humidity.

Table 6: Insulation resistance test results

MOTOR/CABLE DESCRIPTION (ALL 3-PHASE)	RESISTANCE TO GROUND
Span Drive Motor No.1	10 GΩ
Span Drive Motor No.2	11 GΩ
Motor Brake 1&2 Feeder Cable	3/3/4 GΩ
Motor Brake 1	9 GΩ
Motor Brake 2	10 GΩ
Manual (Machinery) Brake	2.2 GΩ
Span Lock Motor	16 MΩ
Gate #1 Feeder Cable	78/35/35 MΩ
Gate #2 Feeder Cable	30/30/65 MΩ
Gate #3 Feeder Cable	65/65/65 MΩ
Gate #4 Feeder Cable Phase C	125/125/125 MΩ

From the above results it can be seen that the insulation resistances of all circuits are in good to excellent condition with the exception of the span lock motor that indicates a lower insulation level. Additionally, gate 1 feeders and gate 2 feeders also exhibit lower insulation resistance level, these are still considered sufficient for reliable service in the long term but should be monitor on an annual basis.

Corrective action is required to:

1. Closely monitor the feeder cables for the span lock motor, span lock motor windings, gate 1 feeders and gate 2 feeders, replace as necessary in the long term.

9.4 CONTROL SYSTEMS

The control system is comprised of a main control desk, relay logic controls and a control operator for three speed step control of the span main drive motors.

9.4.1 MAIN CONTROL DESK

The control desk was replaced as part of the bridge electrical rehabilitation in 1994. A number of changes were made to the control desk during the 2012 rehabilitation and some safety interlocks were implemented into the bridge control system. Traffic gate and brake status indicators were added to the control desk as a part of this work. Additionally, a separate bypass control panel and a span position/motor speed indication panel has been added and mounted next to the main control desk. The main control desk is located to provide the operator with complete view of the navigable channel and vehicular and pedestrian traffic approaching from the northwest (Photo E18).

The control desk contains necessary control pushbuttons, switches, indication lights and indicating meters to provide the operator with information and control functions to safely control the bridge. Additionally, a foot switch is provided at the control desk to interrupt operation during emergency situations and for the operator to stop the bridge during normal operation. The control desk is not laid out in a logical sequence and operation of the bridge by operators can be confusing.

As part of the recent span drive motor and motor controller replacement project, a few devices on the control desk were replaced such as switch, button, digital display meter, and indication lights. All replaced devices are in excellent working condition at the time of inspection.

The traffic gate indicator lights consist of mini LED type lights but are not sunlight glare readable. It is difficult to tell if these mini-LED indicators are illuminated under sunlight conditions.

Corrective actions are required as follows:

1. Replace traffic gate indicators with sunlight readable pilot lights in the short term.
2. Replace the operators control desk with a modern desk containing an HMI and logically laid out bridge control devices.

9.4.2 RELAY LOGIC

The bridge logic control consists of conventional relay logic that was installed during the 1994 bridge electrical system rehabilitation and has been modified several times. The control relays are located in a cabinet directly below the main control desk (Photo E19). The control relays are in good operating condition. Some additional relays were added to the relay cabinet as part of the 2012 rehabilitation project. Further modification to the existing relay logic system was implemented as part of the motor/drive replacement project. Additional logic modification alleviated the previous found interlock deficiencies for the traffic control equipment. It also provided safety logic to ensure the span operating sequence is properly automated to eliminate possible causes of human error.

The control system installation in the control desk is generally in poor condition with many wiring changes having been made for the various rehabilitation and upgrade projects that have taken place since the control system was installed. A great deal of the wiring is untagged, “As-Built” drawings are obsolete, and the form of installation is today considered legacy technology. The present system, although operational, is very difficult to follow, has not been installed in a conventional or code compliant manner and maintenance and troubleshooting is extremely time consuming.

A separate E-Stop pushbutton has been provided in the machinery space to prevent electrical operation of the bridge drive system. This allows maintenance personnel to prevent or stop bridge operation when working in the machinery space (Photo E20).

A full-blown interlock test was performed on the traffic control system and the bridge operating system equipment and was found to be properly interlocked.

Corrective actions are required as follows:

1. Properly train all wires in the control desk wiring cabinet.
2. Properly label any wires with missing tags.
3. Replace the existing relay logic control system with a PLC based modern control system with appropriate diagnostics for speedy and accurate troubleshooting.

9.5 OPERATIONAL DEVICES

Operational devices are defined as all electrical devices that contribute to and are part of the bridge operating system.

The operational device group includes the following items:

- Motor Overloads;
- Limit Switches;
- Span Position Limit Switches and Speed Switch.

9.5.1 MOTOR OVERLOADS

The main motor overloads were visually inspected as part of the inspection. The overloads are of the conventional bi-metal heater type that monitor the thermal effect of an overload condition of the motor it protects. The overloads were installed during the 1994 rehabilitation and are in good condition and appropriately sized for their prevailing duty. The new VFD drives have built in overload protection that provide enhanced motor protection and are in proper working order.

No corrective action is required.

9.5.2 LIMIT SWITCHES

Limit switches were inspected as part of the inspection. The following devices were visually inspected: Seated Limit Switches, Span Position Limit Switches, Brake Limit Switches, Span Lock Limit Switches and Over-travel Limit Switches. All switches are operational and in good serviceable condition.

No corrective action is required.

9.5.3 SEATED LIMIT SWITCHES

The bridge is provided with two (2) span seated limit switches, one at each corner of the toe end of the span. These switches are of the plunger type and are used to control and stop the span operation when fully seated. The switches are in good cosmetic condition. However, signs of water were found inside the north fully seated limit switch enclosure at the time of inspection (Photo E21). It was reported that this north fully seated limit switch had previously failed prior to the inspection. The water infiltration appears to be caused by a worn limit switch door gasket and its exposure to water, particularly during stormy conditions.

Corrective actions are required as follows:

1. Investigate the cause of the water infiltration issue for the north fully seated limit switch and repair as necessary to prevent water from getting into the limit switch enclosure.

9.5.3.1 Span Position Limit Switches and Speed Switch

Span position limit switch is used to monitor the span position at discrete bridge leaf positions (fully seated, nearly closed, nearly open, full open and over–travel).

The span position limit switch consists is of obsolete design but is operational and in serviceable condition. It consists of six (6) limit switches mounted in an enclosure in the machinery room with a target attached to a threaded auxiliary shaft to indicate the position of the span as it rotates. The limit switches are of Omron manufacture, they are of the holding type rotating lever switches. These limit switches are used for control and indicating purposes. All limit switches are in good operating condition (Photo E23).

In addition to the span position limit switches, an encoder/speed switch was installed as part of the 2012 rehabilitation project. The speed switch target is mounted on the main driving shaft of the bridge machinery with sensor monitoring the rotational speed of the target. This speed switch module is used to provide a measure of bridge angular position and motor speed at the operator's control desk (Photo E22). An analog signal from the speed switch tachometer module is utilized to feed a Red-Lion panel meter module and provides a second motor speed readout. Note that both modules are providing the read only outputs. Over speed warning and trip functions from this encoder/speed switch have not been integrated into the control system. If an overspeed situation occurs, it is the bridge operator's responsibility to take action manually. The absence of the overspeed trip/stop function is considered a major defect and potentially could cause severe damage to the bridge structure if the motor loses control of the span. Note that each drive is provided with an over speed trip function, but this should not be relied upon for bridge overspeed trip.

Corrective action is required as follows:

1. Integrate the overspeed trip function to the control circuit such that span will be stopped (or E-stopped) if the motor loses the control of the span.

9.5.3.2 Over-Travel Limit Switches

Over-travel limit switches are present at two locations on the bridge. One is located in the span position limit switch enclosure and the second is located on the bridge fixed structure near and above the machinery room. Both are operational, in serviceable condition and perform the desired safety function for the bridge operating system (Photo E24).

No corrective action is required.

9.5.3.3 Span Lock Limit Switches

The Span Lock Limit Switches are located at each span lock and are operated by the lock arm to assure the span locks are pulled. The switches have been recently replaced with the rotary cam switches as part of recent span lock electrical system replacement and are in as new condition but do exhibit signs of corrosion (Photos E16 and E17).

Corrective action is required as follows:

1. Clean, remove corrosion and apply protective coating on the span lock RCLS enclosures.

9.6 TRAFFIC CONTROL

The Traffic Control system consists of Traffic Lights, Roadway Gates and Pedestrian Control.

9.6.1 TRAFFIC SIGNALS AND SIGNS

The traffic light installation consists of one (1) red/amber/green traffic signal suspended over the roadway from a pole mounted cantilevered arm on each side of the roadway at each approach to the bridge. While the bridge is open to vehicular traffic, the traffic signals are GREEN. During a bridge operation the traffic lights cycle to RED. Warning gongs are mounted on the south traffic signal poles. These gongs provide audible indication for the traveling public that the gates are lowering or ready to lower. The traffic signals and poles have been recently replaced and are in excellent condition (Photo E25).

No corrective action is required.

9.6.2 TRAFFIC GATES

The gates and gate electric service feeders were replaced as part of a 2012 rehabilitation project. At the time of the inspection, all traffic gate arms were unable to be raised to their full upright position. The gate mechanism motor starters are housed in the gate enclosures. This location exposes the gate motor starter equipment to the harsh outdoor environment and causes added effort in maintaining and troubleshooting (Photos E26 and E27). The following deficiencies were noted:

- Traffic gate position limit switches are not provided with a protective cover and exhibit moderate to heavy corrosion on the contacts (Photo E28).
- All gates are missing enclosure door limit switches. Although a code compliant sign has been installed to warn that the enclosure is powered and should be disconnected for maintenance this can potentially be dangerous. These switches are normally installed and used to prevent electrical operation of the gates when the doors are open (Photo E27).
- No hand crank limit switch is provided for any of the motor hand crank mechanisms to prevent gate electrical operation when the gate is being operated using the hand crank. This is a major safety concern for operating personnel when hand cranking the gates.
- The hand crank lever of the northwest traffic gate is missing.
- The wiring of the traffic gate motor starters has been poorly installed with wires improperly trained and many wires not properly labelled. This will make maintenance or troubleshooting of the gate starters difficult.
- No barrier gates are provided. CHBDC notes that “consideration” should be given to providing a gate at the toe end of the bridge.

Corrective action is required as follows:

1. Clean gate limit switch contact and provide protective covers.
2. Provide door limit switches and hand crank limit switches for each gate to prevent electrical operation of the gates during maintenance or manual operation.
3. Provide a hand crank handle for the northwest traffic gate.
4. Properly train and label the starter and control wiring inside the gate enclosures.
5. Consider furnishing new barrier gates at each of the bridge approaches. As a minimum, a barrier gates should be provided at the east approach to the bridge.

9.6.3 PEDESTRIAN CONTROL

Pedestrian control devices have been installed to signal pedestrians of bridge operation (Photo E25). They consist of pedestrian signals at the sidewalk approaches and are mounted on the traffic signal poles below the warning gongs. The signals were operating correctly at the time of inspection.

No corrective action is required.

9.6.4 AIDS TO NAVIGATION

The bridge is provided with red and green span navigation lights mounted at the center of the bridge on the truss beam on each side of the bridge for marine traffic signalling. The location of these navigation lights does not provide a clear indication signal to marine traffic due to their location when the span is fully open (Photo E29).

In addition to the span navigation lights, fender navigation lights have also been provided at the bridge piers. These fender lights were recently installed with LED type lights and are in very good operational condition (Photo E30).

Corrective action is required as follows:

1. Install additional pivot type red and green navigation lights mounted near the toe of the leaf for clear indication to marine traffic of the status of the bridge.

9.7 CONDUITS, JUNCTION BOXES, CABLE TRAYS AND SUSPENSION CABLES

The bridge indoor electrical installation generally consists of RGS conduits and termination junction boxes. The installation is generally in good physical condition (Photo E39). The bridge outdoor electrical installation consists of numerous runs of RGS and flexible conduits and junction boxes (Photo E40). The submarine cable junction boxes have many wires that are unlabeled and some unterminated spare wires. Most of the junction boxes and submarine cable junction boxes have been replaced with stainless steel junction boxes as part of the 2012 rehabilitation project.

9.7.1 CONDUITS

The bridge conduits were recently painted. No sign of corrosion or significant physical deficiencies were noted at the time of inspection.

No corrective action is required.

9.7.2 JUNCTION BOXES

Many of the outdoor junction boxes were replaced with stainless steel junction boxes as part of the recent rehabilitation project. These junction boxes appear to be in good physical condition but some of the boxes do exhibit signs of corrosion inside the boxes (Photo E31).

The submarine cable junction boxes also have many unterminated and unlabeled wires (Photo E32). The enclosures are covered with debris.

The junction box near span motor 2 brake is covered with a black plastic bag with traces of water stains being an indication of a roof leak in the machinery space (Photo E12).

Most of the indoor junction boxes are in fair condition. No significant deficiencies were noted at the time of inspection.

Corrective action is required as follows:

1. Properly terminate all spare wires, and properly label wires in the outdoor junction boxes.
2. Repair any water leakage in the machinery space.

9.7.3 SUBMARINE CABLES

Submarine cables are provided for the transition of power and controls to the far side of the bridge for gates, traffic signals and fully seated limit switches. A number of the submarine cables were replaced during the 2012 rehabilitation project along with the replacement of submarine cable junction boxes. However, some originally installed submarine cables were found at the time of inspection (Photo E33). It was unclear if these original submarine cables are still in service or if they have been taken out of service.

Corrective action is required as follows:

1. Investigate and determine if the original submarine cables are still in service. If it is determined that the original cables are not currently in service, they should be removed, or consideration given to maintaining the cable for use as a backup to the existing submarine cables. If this is pursued, ensure that the backup cable does not deteriorate with age. It is recommended that 120V be applied to each conductor within the backup cable, this would maintain a slight differential of temperature within the cable and protect the cable and cable insulation.
2. Properly label all wires inside the submarine cable junction boxes.

9.8 GROUNDING AND BONDING

The inspection included a visual inspection of the bridge grounding and bonding installation. The installation appears to be complete with the structure and the electrical installation grounded and bonded in accordance with Canadian Highway Bridge Design Code and Canadian Electrical Code (Photo E34).

Corrective action is required as follows:

1. Ensure that the ground integrity is maintained throughout the bridge structural steel and electrical system. This should take the form of ground resistance testing and should be performed annually.

9.9 REDUNDANCY

The reliability of operation of the bridge can be greatly improved by introducing a redundant control system.

Corrective action is recommended as follows:

1. A redundant bridge control system is recommended such as providing a PLC controller with relay backup to increase reliability of operation for the bridge. See control system recommendation.

9.10 GENERAL LIGHTING AND FIRE ALARM

9.10.1 GENERAL LIGHTING

The status of the lighting and electrical installation associated with the control house is in good operational condition, with sufficient illumination levels for its function and no signs of corrosion or aging of the equipment and associated junction boxes or conduit installation (Photo E36). The lighting and associated electrical installation are expected to continue to operate in a reliable manner in the long term.

The lighting in the machinery space was recently replaced and provides sufficient illumination level for maintenance and troubleshooting of the machinery equipment (Photo E37).

Emergency lighting is provided in the operators control house, maintenance facility and the machinery space. The emergency lighting in the machinery space and operator's control house was tested and found to be in operational condition at the time of the inspection.

No corrective action is required.

9.10.2 FIRE ALARM SYSTEM

The bridge has been provided with a fire alarm system. The system consists of smoke detectors, horn/strobe unit, pull stations, a remote annunciator panel located in the control house and a fire alarm control panel located at the entrance of the maintenance facility (Photo E35). The fire alarm system was recently installed. All associated equipment is in as new condition. No deficiencies were noted at the time of inspection. A smoke detector and a pull station are also provided in the machinery space and its control is routed back to the annunciator panel in the control house and the main FACP in the maintenance building.

No corrective action is required.

9.11 CCTV SYSTEM

A CCTV system was installed at the bridge in 2014. The CCTV cameras have been strategically located throughout the bridge to monitor the roadway approaches, waterway approaches and the machinery space (Photo E38). The operator can monitor these locations from the office space inside the maintenance facility. The camera installation provides good visual information and has been well installed and was operational at the time of the inspection.

No corrective action is required.

9.12 PROTECTIVE RELAYING AND ARC FLASH STUDIES

It is unclear whether or not an electrical protective relaying study and arc flash study have been performed in the past.

Corrective action is recommended as follows:

1. Conduct a protective relaying coordination study and arc-flash hazard assessment to verify the safety and reliability of the current electrical distribution system.

10.0 Counterweight Investigation Results

A total of six 100 mm diameter cores ranging in depth from 126 mm to 611 mm were extracted from the counterweight at the following locations:

Table 7: Counterweight Core Locations

CORE NO.	LOCATION
#1	West face, north end, bottom.
#2	West face, north end, top.
#3	East face, north end, bottom.
#4	East face, south end, top.
#5	East face, south end, bottom.
#6	West face, south end, bottom.

The number of cores successfully extracted from the counterweight was limited by the location of the reinforcing steel bars, the condition of the concrete, and time constraints for the work. Cores #1, #3, #4 and #6 were identified as having significant concrete deterioration, including cracks, delaminations, scaling and spalling, with very little sound concrete extracted from cores #1 and #3. Cracks were also observed in cores #2 and #5, and core #1 had wire mesh with severe corrosion. The counterweight appears to be generally comprised of Portland cement concrete. The original design drawings specify a mix ratio of “one part cement, three parts sand, and five parts of crushed stone”. The size of the aggregate varies from small pieces of crushed stone to cobbles. In general, the concrete cover to the wire mesh and reinforcing steel seems consistent with the cover of 50 mm specified in the original design drawings. Due to the poor quality of the concrete in the cores extracted, it was only possible to test a single core sample (core #2) for compressive strength. The test result indicates that the compressive strength of the core is 11.9 MPa at an approximative depth of 50 to 255 mm. Part 1, Section 5.4.1 of the MTO Structural Rehabilitation Manual (SRM) indicates that concrete with a compressive strength of less than 20 MPa is of poor quality. The design compressive strength is not shown on the original contract drawings.

A single core (#4) was tested for chloride ion content. The corrected chloride ion content value ranged from 0.000% at an approximative depth of 0 to 30 mm to 0.004% at an approximative depth of 260 to 320 mm by mass of concrete, after subtracting a background chloride ion content of 0.016% as per the requirements of the MTO SRM. It should be noted however that the background chloride ion content is normally the lowest observed in all the cores tested, but as only a single core was tested for chloride ion content, this skews the results. If the background chloride content is ignored, then the chloride ion content values range from 0.016% to 0.020%, which is below the threshold of 0.025% by mass of concrete required to initiate corrosion according to Section 5.4.3 of the SRM.

The air void content test result for core #4 was 2.25 percent at an approximative depth of 130 to 230 mm with a spacing factor of 0.545 mm and a specific surface of 12.56 mm^2/mm^3. Concrete is normally considered properly air entrained if the air content exceeds 3 percent with a spacing factor less than 0.20 mm and a specific surface exceeding 24 mm^2/mm^3 as defined in Part 1, Section 5.4.2 of the SRM. However, Section 5.2.3 of the SRM states that the concrete used in structures before 1958 can be assumed to be non-air entrained.

The results of the laboratory testing of the concrete cores extracted from the counterweight and the visual inspection of the concrete surface at core locations indicate that the concrete at the edges of the counterweight is in poor condition, with the exception of the concrete in core #2 (west face, north end, top) where the concrete is mostly sound but still exhibits cracks.

A copy of the laboratory test results along with photographs of the cores are included in Appendix F.

11.0 Overall Structure Rating

Based on the results of the 2017 Structural Evaluation Report, the draft 2018 Fatigue Inspection and Evaluation Report, and the 2018 Comprehensive Detailed Inspection, the current Structural Condition Rating is 3 (Poor) and is therefore reduced from the rating of 4 (Fair) provided in the 2017 Comprehensive Detailed Inspection Report. The rationalization for this rating is as follows:

- The fatigue inspection revealed cracks in leaf truss bottom chord members 14S-15S and 14S-16S, top chord members 3S-5S and 13N-16N, verticals 1N-2N and 9S-10S, and the gusset plates at connections 2N, 16N, and 16S. Cracks were also found in counterweight truss member 21N-27N, tower truss horizontals 15S-18S and 18S-19S, and in 25 stringers.

- Repairs are also required to other primary components including the main trunnion connections, concrete counterweight, leaf truss bottom chord members, tower truss members and connections, and coating system, and strengthening of the north and south leaf truss vertical members 1-2, 5-6, and 9-10 is recommended. Repairs are also recommended for multiple secondary components including bracing members in the leaf and tower trusses, mechanical platform, curbs and sidewalk, approach slabs, guide rails, marine structures, and catwalks and stairs.
- The results of the 2017 Structural Evaluation Report indicated that except for leaf truss diagonal members 9N-12N and 9S-12S the structure met the current CHBDC load cases for live loading requirements in the closed position. These deficient members were strengthened in 2017/18 so in theory the bridge now meets the live load requirements, although it should be noted that the evaluation has not been updated to account for the additional deterioration observed during the current inspection.
- The 2017 report also indicated that the structure does not satisfy CHBDC special load case requirements for moveable bridges. The special load factor in question is the operating impact (Io) factor of 20% applied to the maximum dead load effect in all members caused by the movement of the bridge. Both the 2017 Structural Evaluation by Parsons and the 2015 Trunnion Evaluation by MMM state that the bridge cannot meet CHBDC special load case code requirements for moveable bridges primarily due to this impact load and to wind loads. The Parsons report also states that: "*It is acknowledged that the code prescribed factors may be overconservative and more applicable to setting the standard for new bascule bridge construction rather than evaluating a structure that has already operated for 100 years.*" As part of the upcoming Trunnion Rehabilitation project strain-gauge testing will be carried out to rationalize the operating impact factor.
- It is not known if the structure satisfies the seismic requirements of the current CHBDC. There have been significant changes to the seismic section of the CHBDC since the preliminary seismic study was carried out by McCormick Rankin Corporation in 2001, and the changes could result in a lower demand on structural elements. The 2017 CDI report indicated that a new seismic analysis was being carried out, but the results have not been provided to Parsons.

In the bridge's current configuration, the Functional Rating is 2 (Inadequate), and is unchanged from the 2017 Comprehensive Detailed Inspection Report. The rationalization for this rating is as follows:

- The clear distance between the timber curbs on the deck is approximately 7.30 m. Chapter 4 of the Geometric Design Guide for Canadian Roads (GDGCR) by the Transportation Association of Canada (TAC) states that for an urban road with a design speed of 60 km/h or less (the Causeway has a posted speed of 50 km/h), the minimum recommended lane width where buses and larger trucks are expected to regularly use a lane is 3.30 m (Table 4.2.3). The minimum distance from the edge of the lane to the inside face of the barrier/curb is 1.4m for bridges less than 50.0 m in length on urban arterial roads (Figure 4.10.3). The overall required width of the lanes is 6.60 m, leaving a clearance of 0.35 m on each side, therefore insufficient roadside clearance is provided.
- Section 3.3.5.5 of the GDGCR states that 5.0m vertical clearance is required for vehicular bridges over travelled lanes and shoulders. The structure's vertical clearance of 4.2 m is more than 10% below this requirement.
- The riding surface quality provided by the deck steel grating is generally poor, especially for cyclists.
- Section 6.3.1.2 of the GDGCR indicates that the practical lower limit of sidewalks is 1.5m. At several locations where the structural truss members pass through the sidewalk at deck level, the width is reduced to 1.2m.
- The existing thrie-beam traffic barriers on the bridge do not meet current CHBDC crash-tested requirements, and the beams are mounted directly to the road side of the through truss members,

therefore there is a possibility that vehicle collision along the barrier could subject primary members of the main truss to damage or failure.

- The northeast, northwest, and southwest approach guide rails do not meet current MTO standards or TAC requirements as the consistent post spacing does not provide a transition section that produces a gradual stiffening between the semi-rigid guide rail and the rigid truss members. This means that in their current configuration the guide rails may not be able to re-direct errant vehicles back onto the roadway which is a safety concern and could subject primary members of the tower truss or though truss to damage or failure. In addition, the timber posts in the southwest guide rail are breakaway type posts which may permit the guide rail to deflect onto the sidewalk in the event of vehicle impact, which is a potential hazard to pedestrians.

12.0 Recommended Rehabilitation and Maintenance Work

Despite the deterioration observed during the inspection, the service life of the structure can be extended by carrying out repairs to deteriorated elements in the short term. The major structural, mechanical, and electrical components recommended for rehabilitation and ongoing maintenance items are discussed in the following sections.

12.1 STRUCTURAL RECOMMENDATIONS

12.1.1 SUBSTRUCTURE

The 10mm wide vertical crack in the southeast wingwall should be repaired once the cause of the approach slab and sidewalk settlement has been identified and rectified. The very severe spall at the east end of the southwest wingwall at the interface with the abutment wall, the area of severe scaling on the west bearing seat north of the truss, and the shallow area of disintegration at the south end should be repaired.

12.1.2 DECK GRATING

According to the As-built contract drawings “LaSalle Causeway – Repairs to Bridges” by C.C. Parker the current steel deck grating was designed in 1973 and installed in 1976, meaning it has been in service for almost 43 years. Approximately 23,000 vehicles cross the bridge per day.

Both the cross-bars and the bearing bars were originally serrated to provide traction for vehicular traffic, but the serrated edge has been completely worn away within the wheel tracks in each vehicular lane, and the bearing bars are worn up to an additional 3mm in between the cross-bars. The steel grating therefore no longer provides the same slip resistance as designed which could increase vehicle braking distances in poor weather conditions.

The coating (assumed to be galvanized) of the grating has typically deteriorated and there is light corrosion on the vertical faces of the cross bars and bearing bars and medium corrosion along the north and south edges.

Bent bearing and cross bars were observed throughout the grating, and broken bars were observed at the west and east ends. Cracked bar-to-bar and bar-to-sill welds were noted at several locations. Most of this deterioration of the grating is suspected to have been caused by impact damage which has caused numerous transverse cross bars to either bend and deform or completely break off at the bearing bar interface. In February 2017 a 370mm wide by 420mm long piece of grating failed and broke off from the remaining grating and the transverse sill beneath. Parsons’s 2017 detailed grating inspection report states that multiple cracks were observed in the piece that broke free and the bearing bars surrounding the opening, with most of the cracks propagating from the notch for the cross-bars and extending to the base of the metal. It appears from the wearing of the base of the longitudinal bearing bars at the sill that the welds had failed between the sills and the bearing bars first which caused the portion of the grating to vibrate which placed additional stress on the bearing bars which caused them to crack and fail.

Given the performance and serviceability issues discussed above it is recommended that capital allowances are made to replace the entire steel deck grating. Localized repairs due to fractures and broken welds can be expected in the interim. Although the CHBDC discourages the use of open-deck systems on moveable bridges due to concerns with salt-laden water causing deterioration to below-deck components, the 2013 *LaSalle Causeway Bascule Bridge – Deck and Sidewalk Concepts Report* by Delcan Corporation did not recommend a closed deck system, mainly due to uncertainty surrounding the performance of innovative technologies that are relatively untested.

12.1.3 STRUCTURAL STEEL

12.1.3.1 Leaf/Through Truss Members and Connections

Top Chord

13N-16N: The crack found at the location of the impact damaged was removed by grinding during the fatigue inspection, but this location should be monitored during future inspections to verify that the grinding was successful in removing the entire crack.

3S-5S: Reinforce the north channel at the location of the 60mm lamination defect (with a possible crack) with a slip-critical bolted connection (Priority A). The defect should be monitored until the member is repaired to ensure the defect/crack does not propagate

Bottom Chord

14N-16N: The perforated inboard (south) channel web near 16N should be strengthened with a slip-critical bolted connection and the missing coating repaired to arrest further corrosion (Priority A).

14S-15S: Grind smooth the multiple cracks and the edges of the perforation in the bottom batten plate near 15S and strengthen or replace the batten plate within 5 years.

14S-16S: Grind smooth the 12mm long crack and the edges of the perforation in the north channel web and strengthen the channel with a slip-critical bolted connection (Priority A). The 13 rivets in the south channel connection to 16S with over 75% section loss of the rivet head should be replaced with bolts (Priority B). The cause of the deformation of the member near 16S is not known, but it should be closely monitored during future inspections.

Diagonals

12N-13N: The cause of the deformation of the member near 13N is not known. The member was strengthened in 2010 and was replaced entirely at some point prior to this. It is recommended that baseline deformation measurements are taken during the 2020 CDI and closely monitored in subsequent inspections.

Verticals

1N-2N: Grind smooth the suspected crack or drill a hole at the end of crack and install a bolt with nut and washer (Priority A). The crack should be monitored until the member is repaired to ensure it does not propagate. The deformation of the outstanding leg of the southwest angle above the bottom chord should be monitored during future inspections.

9S-10S: Remove the sign support angle to enable the grinding out of the 3mm long crack in the top of the southeast flange at the previous weld location, and perform magnetic particle testing to check for additional cracks (Priority B). The crack should be monitored in the interim to ensure it does not propagate.

North and south members 1-2, 5-6, and 9-10: In 2016, cracks were discovered in the interior angles of vertical 13N-14N. Those cracks were repaired in 2017 by the addition of bolted steel elements. The cracks originated from a rivet hole, just above a discontinuity in the web plate of the vertical. Vertical 13S-14S was also reinforced in 2017, even if no cracks were detected in the member. All similar details were inspected during the fatigue inspection and no cracks were detected. However, the detail where cracking occurred in 13N-14N is prone to concentrated stress in the angles and creates a high local stress range when the bridge is open or under vehicular traffic loading. Since the floor beam connects to the interior gusset plate, the interior angles of the verticals most probably take a greater load than the outer angles. Secondary bending in the vertical caused by the connection of floor beams to verticals, shear lag and bending stiffness changes at discontinuities in the web all contribute to concentrating stress in the angles at the location where cracking occurred in 13N-14N. Therefore, it would be beneficial to reinforce the other vertical members with the same detail as 13N-14N and 13S-14S to prevent cracking (Priority C). In the interim, these members should be closely monitored for cracks during future inspections.

Connections

2N: The inboard (south) gusset plate of 2N has multiple laminations through the thickness over the full height of the plate, and full-width horizontal hairline cracks were identified in both the east and west sides of the gusset plate. It is recommended that a refined analysis of the connection is performed to determine the strengthening requirements (Priority A).

The 2017 Structural Evaluation Report incorporated the deterioration observed during the 2015 Detailed Measurements project and the 2016 Comprehensive Detailed Inspection Report (both by Parsons) in calculating the remaining capacity of the leaf truss connections under live load. The connections were not evaluated for special load cases. The report states that it "*was found that even with measured section losses that the connections had sufficient reserve capacity for live loads.*" In general, the deterioration noted at the connections during the current inspection is not significantly greater than the deterioration noted during the previous inspections as the coating is still intact and no active corrosion is occurring, therefore it can be assumed that the connections still have adequate capacity and that no repairs are required at this stage, other than those indicated above.

12.1.3.2 Tower Truss

Members

15N-17N, 15S-17S: Drill drainage holes in 15N-17N and 15S-17S at nodes 15N and 15S respectively to prevent the accumulation of water inside the members which has caused severe corrosion of the members and rivet heads, and the main trunnion bolt heads and stiffening angles (Priority A). It is recommended that the section loss of these members at nodes 15N and 15S is measured and appropriate repair details developed during the upcoming main trunnion rehabilitation project.

18N-19N: The severe section loss of the interior channel flanges and rivet heads and the perforations in the upper and lower batten plates at node 19N should be repaired (Priority B).

15S-18S: Grind smooth the crack and the perimeter of the perforation in the south channel (Priority A) and reinforce the element with a slip-critical bolted connection (Priority B).

18S-19S: Grind smooth the crack and the perimeter of the perforation in the south channel and reinforce the element with a slip-critical bolted connection (Priority A).

19S-20S: The 6 rivet heads with 70% localized section loss at the base of this vertical member should be replaced with bolts (Priority C).

Connections

15N: The severe localized pitting, perforations, and deteriorated rivet head in the inboard gusset plate at roadway level should be repaired as part of the upcoming main trunnion rehabilitation project (Priority B).

18N: The section loss and perforation in the gusset plates along the top flange of members 15N-18N and 18N-19N should be repaired and localized coating repairs carried out to arrest the active corrosion (Priority B)

19N: Repair the perforations and the localized severe pitting in the gusset plates at the interfaces with the vertical flange of vertical member 19N-20N and the bottom flange of horizontal member 18N-19N. The rivet heads with severe section loss at the base of the gusset plates should be replaced (Priority B).

15S: The severe localized pitting and perforation in the inboard gusset plate at roadway level should be repaired as part of the upcoming main trunnion rehabilitation project (Priority B).

The 2017 Structural Evaluation Report states: "*Connections on the counterweight truss and tower truss were found to have a low participation for live load and were excluded from live load evaluation*." The connections were not evaluated for special load cases. It is therefore not known what the exact effect the observed deterioration has on the capacity of the connections, and this should be confirmed prior to the development of design details.

12.1.3.3 Counterweight Truss

21N-27N: The member has a crack through the full width of the outstanding leg of the bottom interior angle at 27N which should be repaired with a slip-critical bolted connection (Priority A). It is recommended that monthly inspections of the affected area are carried out if the bridge is lifted prior to the repair being performed.

21S-27S: The results of the fatigue evaluation indicate that members 21N-27N and 21S-27S have one of the shortest residual lives of all members and given the discovery of the crack in the bottom interior angle of 21N-27N, it is recommended that 21S-27S is carefully monitored for signs of cracking during future inspections.

21S-27N: The northwest end of this bracing member at 27N has 100% section loss over the full width of the horizontal lower leg plus many small perforations, and although the member has been previously strengthened, the angle that was added has not addressed the connection of the lower angle to the gusset plate. It is recommended that the repair detail is modified accordingly (Priority A).

12.1.3.4 Operating Pinion Struts

The exposed sections of struts 17N and 17S inside the mechanical housing should be cleaned and coated to arrest the moderate to severe active corrosion noted.

12.1.3.5 Main Trunnion Connections

The main trunnion connections at nodes 15N/16N and 15S/16S each comprise two large vertical gusset plates connecting bottom chord members 14-16 and 14-15, top chord member 13-16, and member 15-16 to the main trunnion pins. There are cracks propagating from perforations at the bottom of the south vertical gusset plate of 16N and the north vertical gusset plate of 16S between the end of the bottom chord members 14-16 and FB16. Severe localized pitting in the gusset plates is typical and there is very severe section loss of six and 13 rivet heads at 16N and 16S respectively. Perforations were noted in the triangular plates behind FB16. The upper section of the north (roadside) gusset plate of 15S/16S adjacent to the trunnion collar has widespread very severe pitting. A project to rehabilitate the main trunnion connections and pins is planned to start in early 2019 with construction to commence in 2020, and that the scope of the project will include a site inspection to take updated detailed measurements of the assemblies in sufficient detail in order to carry out an updated structural evaluation of the assemblies. Repairs are therefore not recommended at this time except for grinding smooth the suspected crack and the perimeter of the perforation in the vertical gusset plates at 16N and 16S (Priority A). The perforations should be monitored until the members are repaired to ensure the cracks do not propagate.

12.1.3.6 Stringers

All the roadway stingers were constructed with an abrupt 90-degree cope (with no radius) in the top and bottom of the member at the clip angle connection to the floor beams. These copes are a fatigue-prone detail. Magnetic particle testing was carried out at locations where cracks in the coating, crack-like indications, or visible cracks in the stringers were previously documented. The testing revealed cracks have initiated at the top and/or bottom cope in 25 of the 72 stringers, including in six adjacent stringers in bay FB14-FB16. Some of the cracks appear to have progressed since the 2015 inspection. The stringers are in generally good material condition otherwise. In the short term it is recommended that a hole is drilled at the end of the longer cracks to arrest further propagation and bolts with nuts and washers installed in the holes. The smaller cracks could be ground out. Prior to the repairs being carried out it is recommended that the stringers are inspected from the deck grating surface during the monthly inspections by PSPC to ensure that no fractures have occurred. It is likely that additional stringers will develop cracks over time, therefore it is also recommended that additional magnetic particle testing is carried out during future detailed inspections for all remaining stringers. Although the stringers are not fracture-critical members, if further cracks do develop the replacement of the stringers during the recommended steel deck grating replacement could be considered.

12.1.3.7 Sills

The sidewalk ends of some sill members were noted as being deformed, and the majority of the sills below the roadway have permanent dead-load deflection. There is widespread light corrosion on the top surface of the top flange where the coating has failed, and several anchor bolts connecting the sills to the stringers below are missing, loose, or severely corroded. The sills above stringer F between FB14-FB16 have a 6mm gap between the sills and the stringer. In the short term it is recommended that missing bolts are replaced, and loose bolts tightened and gaps between the stringers and sills are shimmed. The deck grating panels are welded to the top flange of the sills and removing these welds when the deck grating is replaced will be labour-intensive and costly. It is therefore recommended that the sills are replaced in conjunction with the deck grating.

12.1.3.8 Roadway Floor Beams

The roadway floor beams are welded plate members and are in generally good condition, however localized deformation over the height of the web of up to 16mm from straight was noted in FB8, FB10, FB12, and FB14. The cause of the deformation is not clear, but it should be closely monitored during future inspections. Bolts should be installed in the 18 holes at the midspan of FB0 relating to the original air buffer mechanism.

12.1.3.9 Leaf Truss Portals

The crack in the weld connecting the vertical clearance sign to leaf truss portal member 1S-1N should be repaired.

12.1.3.10 Leaf Truss Sway Bracing

The damaged and deformed bottom angle above the westbound lane of member 5S-5N should be repaired.

12.1.3.11 Tower Truss Sway Bracing

The built-up sway bracing between 20N-20S and 21N-21S requires repairs to the angles with severe pitting and perforated batten plates at node 20N. Seven rivet heads near 20N and four rivet heads on the east side of bottom angle near 20S require replacement.

12.1.3.12 Welds

Welds were noted on primary truss members 3N-4N, 7S-8S, 9N-10N, 9S-10S, 11N-12N, and at 0N and 0S. It is recommended to grind the welds smooth and perform magnetic particle testing for cracks at these locations (Priority C). In the interim, these locations should be closely monitored for cracks during future inspections.

12.1.4 STRUCTURAL STEEL COATING

Although the current coating system only dates from the 2009/2010 rehabilitation, localized defects are already evident at numerous locations. Defects noted include cracking (coating-related), under-film corrosion and peeling (adhesion-related), and pinholing, edge defects, runs, and sags (application-related). Physical damage in the form of chips and scrapes was also noted. The majority of the defects are on the tower truss members at roadway level, the leaf truss floor system and bracing members, and the leaf truss members at and below deck level. The poor coating application on the recently rehabilitated span lock mechanisms and live load supports is a contractual deficiency and will be repaired in spring 2019. It is recommended that localized repairs to the deteriorated coating system are carried out within 3 years (Priority B) and preferably at the same time as structural steel repair work to save on access costs. All surface preparation and coating repairs should be inspected and approved by an experienced coating inspector. It is estimated that approximately 20 m² of coating requires repair.

12.1.5 PIN AND HANGER BEARINGS

Refer to the Mechanical Recommendations section for work related to the Main Trunnion Bearings, Counterweight Trunnion Bearings, First Link Pin Bearings, and Second Link Pin Bearings.

12.1.6 CONCRETE COUNTERWEIGHT AND HOUSING

It is our understanding that the concrete counterweight originates from the original construction of the bridge in 1917 and is therefore currently over 100 years old. It is not known if repairs have been carried out to the counterweight in the past. All except the north and south faces of the counterweight are covered with what appear to be corrugated metal roofing panels. It is not known what material the panels are fabricated from or when they were installed. While the panels do provide some protection to the underlying concrete from the elements, they are not watertight, and once the concrete gets wet it cannot dry out properly due to the panels hindering evaporation of the water. The panels are starting to corrode (particularly on the underside) and there are several small perforations near the doors in the east face. The doors themselves are in poor condition and require repair. Damp stains, large areas of light corrosion, stalactites, and impact damage were noted on the panels on the underside of the counterweight.

The visible portions of the concrete counterweight surface (including at core locations) exhibit significant deterioration, including isolated and pattern cracks, delaminated areas, scaling, efflorescence, wet and damp areas, spalling, and disintegration. Approximately 450mm of disintegrated concrete has collected between the concrete and the metal panels in the northeast corner. Gaps between the panels are permitting smaller pieces of aggregate from the disintegrated counterweight concrete to fall onto the roadway below. While the concrete in the core extracted from the top of the north end of the west face was found to be mostly sound (but still exhibited cracks), the cores extracted from near the bottom of the east and west faces at the north end contained very little sound concrete. The results of the laboratory testing of the concrete cores extracted from the counterweight indicate that the concrete has a compressive strength of 11.9 MPa and is considered non-air entrained. Although the chloride ion content values were determined to be below the threshold required to initiate corrosion according to Section 5.4.3 of the MTO SRM, severe corrosion of the wire mesh reinforcing was observed at core locations.

The steel plates covering the north and south faces are in generally good condition overall although some localized areas of deep pitting were noted, particularly in the north plate near node 26N. Some nuts on the ends of the tie rods are loose or are missing.

The metal panels do not provide any structural containment for the concrete, therefore in the short term it is recommended that the two metal angles at the base of the counterweight are temporarily removed to permit removal of the disintegrated concrete that has collected between the concrete and the metal panels in the northeast corner (and possibly elsewhere). In the longer term, rehabilitation of the entire counterweight is recommended.

The St. Charles Air Line Bridge in Chicago, IL is a 67 metre-long single-leaf Bascule Bridge designed by the Strauss Bascule Bridge Company and built between 1917 and 1919 which is of very similar design to the LaSalle Causeway Bascule Bridge (Vector Construction, 2015). The two main differences between the St. Charles and LaSalle structures are that the St. Charles bridge carries two Canadian National Railway Company (CN) rail lines instead of vehicular traffic, and it has two 'winged' concrete counterweights (one either side of the rail tracks) rather than a single central counterweight. The twin counterweights were constructed in 1930, and similar to the LaSalle Causeway Bascule Bridge are cast integral with the structural steel of the counterweight truss. Two separate rehabilitation contracts were completed in 2011 and 2014 to repair the exposed concrete of the counterweights which exhibited spalls, delaminated areas, and scaling, which included removing the unsound concrete to depths of approximately 300mm and repairing the areas with shotcrete. To extend the life of the concrete repairs, a surface-applied FRP system was installed on the counterweights.

It is recommended that a similar rehabilitation (i.e. removal of unsound concrete followed by concrete patch repairs) methodology is implemented for the LaSalle Causeway Bascule Bridge. The exact depth of concrete removal required will not be known until the repairs are carried out during construction, and the exact method of concrete placement (e.g. shotcrete vs. forming) will need to be explored further during the design phase. Deeper cores could be extracted from the counterweight in an attempt to determine more accurately the condition of the concrete towards the interior of the counterweight, but this would be difficult given the embedded structural steel members and tie-rods connecting the plates on the north and south faces. If PSPC intends to keep the bridge in service for the foreseeable future, then replacement of the entire counterweight could be considered. This will provide an opportunity to assess the condition of the embedded structural steel and carry out any required repairs, would be less risk in terms of estimating concrete repair quantities, and would ensure the long service life of the new counterweight.

12.1.7 CURB AND SIDEWALK

The missing nuts on the bolts securing the sidewalk planks at the roadway end should be replaced, and the anchorage of the south curb at the west end should be modified. The screw heads protruding from the planks at the west end of the sidewalk should be driven below the surface of the sidewalk. The nuts missing from the bolts on the north curb should be replaced, and the missing anchor at the east end of the curb replaced.

12.1.8 ROADWAY RAILINGS

The existing roadway railings do not meet current CHBDC crash-tested requirements (in terms of geometry and direct attachment to the truss) for bridge barriers and could subject primary members of the main truss to damage or failure during vehicle collision along the barrier. However, on a truss bridge with an open steel deck grating like this one, it has to be recognized that replacing or upgrading the railings to a crash-tested design in accordance with the requirements and loading of the current CHBDC would be difficult. No accident or collision records for the bridge were reviewed as part of the inspection, but it appears that there has been no recent significant damage to the existing traffic railings, which are protected by timber curbs. PSPC should consider accepting the liability of the railings not meeting CHBDC crash-tested requirements following a detailed review of the performance of the railing system based on accident history.

The post at the east end of the south railing is anchored with lag bolts into the sidewalk planks below. This anchorage should be modified.

The south railing currently has a large gap at the trunnion which could allow a pedestrian to fall into the roadway. A chain or railing should be installed to prevent his from occurring.

The bolts missing from the thrie-beam splices should be replaced.

12.1.9 OPERATOR'S HOUSE RAILINGS

The two perforated cast iron railing posts between the Operator's House and the north trunnion were repaired in October 2018.

12.1.10 ABUTMENT BEARINGS / LIVE LOAD SUPPORTS

The bent and severely corroded northwest anchor bolt of the south bearing should be replaced.

The issue with the north side of the leaf span being not fully seated is believed to be related to the elevation of the north buffer strike plate, which will be addressed in an upcoming repair contract. Much of the light corrosion on the steel plates of the north and south bearings is a deficiency from the recent Span Lock project which will be rectified in spring 2019.

12.1.11 APPROACH SLABS

The concrete approach slabs do not have an asphalt wearing surface and widespread abrasion/wear from vehicles is typical. The wide cracks and small potholes at the interface with the exposed top of the ballast walls and at the ends of the slabs should be sealed and repaired respectively.

The east end of the approach slab and the southeast approach sidewalk is lower than the west end, and two wide transverse cracks near the centre of the slab are at the same location as wide cracks in the curb, sidewalk and southeast wingwall suggesting that differential settlement has occurred. If the results of the monitoring program (to be repeated during the 2019 CDI) indicate that settlement is ongoing, then repairs should be carried out or the slab and sidewalk replaced.

12.1.12 GUIDE RAILS

The spacing of the posts in the northeast, northwest, and southwest guide rails is constant along the length of the guide rails. Both the TAC Geometric Design Guide for Canadian Roads and current MTO standards require the post spacing to reduce adjacent to the structure so that a transition section is provided that produces a gradual stiffening between the semi-rigid guide rail and rigid objects such as bridge barriers or in this case the tower truss members. In addition, the timber posts in the southwest guide rail are breakaway type posts which may permit the guide rail to deflect onto the sidewalk in the event of vehicle impact, which is a potential hazard to pedestrians. It is therefore recommended that the existing guide rails are modified (or replaced) to meet current MTO standards and TAC requirements. The 7th and 8th posts from the west end of the southwest guiderail have been damaged by vehicular impact and require replacement.

12.1.13 MECHANICAL PLATFORM AND HOUSING

The soffit of the mechanical platform concrete slab has widespread light to moderate scaling and several localized areas of light honeycombing, plus light to medium spalls (some with exposed reinforcing) and delaminated areas over traffic lanes. The delaminated areas should be scaled as a matter of urgency to prevent them from falling onto traffic below, and the soffit should be regularly monitored for additional delaminations until the slab is rehabilitated. The soffit of the slab should be repaired in the short term. The repair could consist of removals down to sound concrete, mechanically anchoring galvanized wire mesh or reinforcing steel dowels into the slab and casting a new concrete soffit. No repairs are required to the top surface of the slab which is in good condition with no obvious defects noted.

During the inspection water was noted leaking into the mechanical room housing on the north side, near the centre, and in the northwest corner at the west end of the north motor support beam. Repairs to the roofing membrane should be carried out as required.

12.1.14 CATWALKS AND STAIRS

There are currently no safety chains or gates at openings in railings or fall-arrest cables at ladders, which are potential safety hazards. A complete Health and Safety review/audit of the stairs and catwalks should be carried out to identify all locations of potential falling hazards. Following the review appropriate safety gates, chains, and fall-arrest cable systems at ladders should be installed in accordance with current regulatory requirements.

The perforated support members at the north and south ends below catwalk 21N-21S should be repaired, the split and/or cracked railing posts of catwalks 17N-17S and 21-27 should be repaired or replaced, and repairs carried out to the cracked welded railing connections of 22N-22S.

12.1.15 MARINE STRUCTURES

The fourth and fifth safety line posts from the north end of the southwest marine structure that are loose should be secured, and the wooden post near the north end should be replaced with a steel post.

12.1.16 REHABILITATION AND MAINTENANCE SCHEDULE

Given the structural and functional deficiencies discussed in the preceding sections it is recommended that rehabilitation of the structure is carried out to address the required repairs. The 2017 CDI report indicated that a seismic evaluation of the bridge was being carried out in 2017/8 but the results of the evaluation have not been made available to Parsons. Although the recent changes to the CHBDC seismic requirements could actually result in a lower demand on structural elements, a provisional allowance for seismic retrofitting (based on the recommendations provided in the 2001 preliminary seismic study by McCormick Rankin Corporation) has been included in the structural rehabilitation cost estimate.

The exact scope of work for the rehabilitation of the main trunnions scheduled for construction in 2020 will not be known until an additional site inspection and an analysis are carried out later in 2019. Subsequently, other than grinding smooth the suspected crack and the perimeter of the perforation in the vertical gusset plates at 16N and 16S within 1 year (Priority A) additional repairs are not recommended at this time and an associated cost estimate has not been provided. As part of the main trunnion rehabilitation project, testing will be carried out to rationalize the impact loading for movable load cases of the CHBDC. Once the results of this study are known, additional strengthening of the main trunnions may be required.

The timelines for the recommended rehabilitation work and maintenance are as follows:

Priority U (Urgent):

- Mechanical Housing Soffit: Scale the delaminated areas on the underside of the mechanical housing slab.
- Counterweight: Remove and reinstall the two metal angles at the base of the corrugated metal roofing panels to permit the removal of the disintegrated concrete that has collected between the counterweight and the panels in the northeast corner (and possibly elsewhere).

Priority M (Maintenance):

- Curbs and Sidewalk: The screw heads protruding from the planks at the west end of the sidewalk should be driven below the surface of the sidewalk.

Priority S (Studies/Investigations/Surveys):

- East Approach and Abutment Survey: Repeat the survey of the east approach slab and abutment in 2019 to determine if there is any ongoing settlement occurring (Priority A).
- Catwalks and Stairs: Carry out a complete Health and Safety review/audit of the stairs and catwalks to identify all locations of potential falling hazards. Following the review appropriate safety gates, chains, and fall-arrest cable systems at ladders should be installed in accordance with current regulatory requirements (Priority A).
- Structural Analysis: The inboard (south) gusset plate of 2N has multiple laminations through the thickness over the full height of the plate, and full-width horizontal hairline cracks were identified in both the east and west sides of the gusset plate. It is recommended that a refined analysis of the connection is performed to determine the strengthening requirements (Priority A).
- Roadway Floor Beams: Roadway floor beams FB8, FB10, FB12, and FB14 exhibit localized deformation of the web of up to 16mm from straight. As the cause of the deformation is not clear, the floor beams should be closely monitored during future inspections (Priority A).
- Mechanical Housing Soffit: Regularly monitor the soffit for additional delaminations (Priority A).
- 12N-13N: Take detailed baseline measurements of the deformation during the 2020 CDI and monitor during future inspections (Priority A).

Priority Code A (Within 1 Year):

- Catwalks and Stairs: Repair the perforated support members below catwalk 21N-21S, the split and/or cracked railing posts of catwalks 17N-17S and 21-27, and the cracked welded railing connections of 22N-22S.Stringers: Drill holes at the ends of the longer cracks in the stringer web copes and install bolts with nuts and washers. Grind out the smaller cracks. Carry out additional magnetic particle testing during future detailed inspections for all remaining stringers.
- Sills: Replace the missing bolts, tighten any loose bolts, and shim gaps between stringers.
- Approach Guide Rails: Modify the northeast, northwest, and southwest approach guide rails to meet current MTO standards and TAC requirements. In the interim the damaged 7th and 8th posts from the west end of the southwest guiderail should be replaced.
- Roadway Railings: Modify the anchorage of the post at the east end of the south roadway railing, install a chain or similar railing between the sidewalk and roadway above the main trunnion, and replace the missing bolts from the thrie-beam splices.
- Structural Steel Repairs: The following steel repairs are recommended within 1 year:

ELEMENT	MEMBER	DETAILS
Leaf Truss Top Chord	3S-5S	Reinforce the north channel at the location of the 60mm lamination defect.
Leaf Truss Bottom Chord	14S-15S	Grind smooth the multiple cracks and the edges of the perforation in the bottom batten plate near 15S.
	14S-16S	Grind smooth the crack and the edges of the perforation in the north channel web and strengthen the channel.
	14N-16N	Strengthen perforated inboard (south) channel web near 16N.
Leaf Truss Vertical	1N-2N	Grind smooth or drill a hole at the end of the crack and install a bolt with nut and washer.
Tower Truss Members	15N-17N, 15S-17S	Drill drainage holes in members at nodes 15N and 15S respectively to prevent the accumulation of water inside the members.
	18S-19S	Grind smooth the crack and the perimeter of the perforation in the south channel and reinforce the channel.
	15S-18S	Grind smooth the crack and the perimeter of the perforation in the south channel.
Main Trunnion Connections	15N/16N, 15S/16S	Grind smooth the suspected crack and the perimeter of the perforation in the vertical gusset plates.
Counterweight Truss	21N-27N	Reinforce the cracked bottom interior angle at 27N.
	26N-26S	Drill drainage holes in member to prevent the accumulation of water inside the member.
	21S-27N	Modify the repair detail at 27N to address the connection of the lower angle to the gusset plate.

Priority Code B (1 to 3 Years):

- **Mechanical Housing Soffit:** Repair the underside of the mechanical housing slab.
- **Marine Structures:** Secure the loose safety line posts at the north end of the southwest marine structure and replace the wooden post near the north end with a steel post.
- **Approach Slab Patch Repairs:** Repair spalls and seal cracks in the approach slabs.
- **Abutment Bearings / Live Load Supports:** Replace the bent and severely corroded northwest anchor bolt of the south bearing.
- **Curbs and Sidewalk:** Modify the anchorage of the south timber curb at the west end and replace the missing nuts on the bolts securing the sidewalk planks at the roadway, the nuts missing from the bolts on the north curb, and the missing anchor at the east end of the north curb.
- **Counterweight:** Remove the corrugated metal roofing panels from the counterweight and repair the deteriorated areas of concrete.
- **Structural Steel Coating System:** Carry out structural steel coating touch-up repairs to arrest active corrosion and further deterioration of the steel members and connections.
- **Floor Beams:** Install bolts with nuts and washers in the 18 holes at the midspan of FB0.
- **Deck Grating and Sills:** Replace the steel deck grating and sills.

- **Structural Steel Repairs:** The following steel repairs are recommended within 1 to 3 years:

ELEMENT	MEMBER	DETAILS
Leaf Truss Bottom Chord	14S-16S	Replace the 13 deteriorated rivets in the south channel connection to 16S with bolts.
Leaf Truss Vertical	9S-10S	Remove sign support angle, grind out crack in top of southeast flange and perform magnetic particle testing.
Tower Truss	19S-20S	Replace the 6 deteriorated rivets at 19S with bolts.
	15S-18S	Strengthen perforated inboard (south) channel web.
	18N-19N	Carry out repairs at 19N to the severe section loss of the channel flanges and the perforated batten plates and replace deteriorated rivets with bolts.
Leaf Truss Portal	1S-1N	Repair the cracked weld connecting the vertical clearance sign to the member.
Tower Truss Sway Bracing	20N-20S, 21N-21S	Repair the angles with severe pitting and the perforated batten plates at node 20N and replace the 11 deteriorated rivet heads with bolts.
Tower Truss Connections	15N, 15S	Repair the severe pitting and perforations in the gusset plates and replace the deteriorated rivets with bolts at roadway level as part of the upcoming main trunnion rehabilitation project.
	18N	Repair the section loss and perforation in the gusset plates along the top flanges of 15N-18N and 18N-19N.
	19N	Repair the perforations and pitting in the gusset plates at interface with 19N-20N and 18N-19N and replace deteriorated rivet heads with bolts.

Priority Code C (3 to 5 Years):

- **Concrete Repairs:** Carry out repairs to the deteriorated concrete at the east end of the southwest wingwall at the interface with the abutment wall, and the west bearing seat.
- **Welds on Truss Members:** It is recommended to grind the welds on truss members 3N-4N, 7S-8S, 9N-10N, 9S-10S, 11N-12N, and at 0N and 0S smooth and perform magnetic particle testing for cracks at these locations.
- **Structural Steel Repairs:** The following steel repairs are recommended within 3 to 5 years:

ELEMENT	MEMBER	DETAILS
Leaf Truss Bottom Chord	14S-15S	Strengthen or replace the bottom batten plate near 15S.
Leaf Truss Vertical	1-2; 5-6; 9-10	Reinforce the members with the same detail as 13N-14N and 13S-14S to prevent cracking at the web discontinuity location.
Leaf Truss Sway Bracing	5S-5N	Repair the damaged and deformed bottom angle above the westbound lane.

- **Seismic Retrofit and Strengthening (Provisional):** Carry out a seismic retrofit of the bridge based on the results and recommendations of the most recent seismic evaluation. Consider retrofit requirements in conjunction with any steel repairs recommended above.

The traffic staging required to complete the replacement of the deck grating and sills will undoubtedly cause major delays to vehicular traffic, and therefore to minimize disruption as much as possible it may make sense to wait until the Third Crossing is open (currently scheduled for 2022). The 2010 *Engineering Assets Long Term Planning and Options Engineering and Site Analysis* for the Causeway by Opus International Consultants (Canada) Ltd. indicates that while the new crossing will not "eliminate the need for the LaSalle Crossing and would only somewhat mitigate congestion, given the strong orientation of the trips to and from downtown Kingston and CFB Kingston" it would at least provide an alternative route for some vehicles during construction.

To further reduce disruption to bridge users it is recommended that with the exception of the repairs to the counterweight, the repairs identified above within the Priority B and Priority C timelines are combined into a single major rehabilitation (with a Priority B timeline) as follows:

- Mechanical housing soffit concrete repairs;
- Repairs to the structural steel coating system;
- Replacement of the steel deck grating and sills;
- Structural steel repairs;
- Concrete substructure repairs;
- Removal of welds on truss members; and
- Seismic retrofit and strengthening.

The remaining recommended work is mostly low-complexity work that could be combined into an additional small miscellaneous repairs contract which would include: repairs to the marine structure safety railing posts; approach slab patch repairs; replacement of the deteriorated bolt in the southeast abutment bearing / live load supports; curb and sidewalk repairs; and installation of bolts in FB0.

Table 8: Class 'D' Cost Estimate (Structural)

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	QTY	UNIT COST	ITEM COST	COST CONTINGENCY		CONSTRUCTION COST	ENGINEERING		IN-HOUSE COST		RISK		TOTAL COST
1	Scaling Mechanical House Soffit	U	1	$4,000	**$4,000**	15%	$600	**$4,600**	10%	$460	15%	$690.00	10%	$460	**$7,000**
2	Remove Disintegrated Concrete from inside Counterweight Panels	U	1	$4,500	**$4,500**	15%	$675	**$5,175**	10%	$518	15%	$776	10%	$518	**$7,000**
3	Update of East Approach and Abutment Survey	S(A)	1	$4,600	**$4,600**	15%	$690	**$5,290**	10%	$529	25%	$1,323	10%	$529	**$8,000**
4	Health and Safety Review of Access Platforms & Stairs	S(A)	1	$15,000	**$15,000**	15%	$2,250	**$17,250**	0%	$0	25%	$4,313	10%	$1,725	**$24,000**
5	Structural Analysis of Connection 2N	S(A)	1	$15,000	**$15,000**	15%	$2,250	**$17,250**	0%	$0	25%	$4,313	20%	$3,450	**$26,000**
6	Monitoring of Roadway Floor Beams	S(A)	1	$2,500	**$2,500**	15%	$375	**$2,875**	0%	$0	25%	$719	10%	$288	**$4,000**
7	Monitoring of Mechanical Housing Soffit	S(A)	1	$1,500	**$1,500**	15%	$225	**$1,725**	0%	$0	25%	$431	10%	$173	**$3,000**
8	Measure & Monitor Deformation of 12N-13N	S(A)	1	$2,500	**$2,500**	15%	$375	**$2,875**	0%	$0	25%	$719	10%	$288	**$4,000**
9	Repairs to Stairs & Catwalks	A	1	$15,000	**$15,000**	25%	$3,750	**$18,750**	40%	$7,500	25%	$4,688	20%	$3,750	**$35,000**
10	*Stringer & Sill Repairs*	A													
10.1	Mob/Demob/Access to Work Area		1	$6,000	$6,000										
10.2	Drill Holes and Install Bolts or Grind Cracks in Stringers		1	$50,000	$50,000										
10.3	Sill Repairs - Loose and Missing Bolts, Shims		1	$3,000	$3,000										
				Sub-Total	**$59,000**	25%	$14,750	**$73,750**	10%	$7,375	25%	$18,438	20%	$14,750	**$115,000**
11	*Guide Rail Modifications*	A													
11.1	Mobilization/Demobilization/Traffic Control		1	$5,000	$5,000										
11.2	Modify Existing Guide Rails		1	$15,000	$15,000										
				Sub-Total	**$20,000**	25%	$5,000	**$25,000**	10%	$2,500	25%	$6,250	20%	$5,000	**$39,000**
12	*Roadway Railing Repairs*	A													
12.1	Mob/Demob/Traffic Control		1	$2,000	$2,000										
12.2	Modification of South Railing Post Anchor		1	$1,500	$1,500										
12.3	Install Chain above South Trunnion		1	$500	$500										
12.4	Replace Missing Thrie-Beam Bolts		1	$500	$500										
				Sub-Total	**$4,500**	15%	$675	**$5,175**	10%	$518	25%	$1,294	10%	$518	**$8,000**
13	*Structural Steel Repairs*	A													
13.1	Mobilization/Demobilization/Traffic Control/Access		1	$85,000	$85,000										
13.2	Reinforcement of Top Chord 3S-5S		1	$10,000	$10,000										
13.3	Reinforcement of 21N-27N at 27N		1	$11,500	$11,500										
13.4	Modify Previous 21S-27N Repair Detail at 27N		1	$7,500	$7,500										
13.5	Reinforcement of 18S-19S Channel		1	$8,500	$8,500										
13.6	Drill Holes in 26N-26S at Counterweight Truss, 15N-17N and 15S-17S at Trunnions		3	$500	$1,500										
13.7	Strengthen Channel Web at 14N-16N & 14S-16S		2	$5,000	$10,000										
13.8	Grinding of Cracks & Edges of Perforations		5	$500	$2,500										
				Sub-Total	**$136,500**	25%	$34,125	**$170,625**	40%	$68,250	25%	$42,656	20%	$34,125	**$316,000**

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	QTY	UNIT COST	ITEM COST	COST CONTINGENCY		CONSTRUCTION COST	ENGINEERING		IN-HOUSE COST		RISK		TOTAL COST
14	*Miscellaneous Repairs*	B													
14.1	Mobilization/Demobilization/Traffic Control		1	$3,000	$3,000										
14.2	Repairs to Marine Structure Safety Line Posts		1	$2,000	$2,000										
14.3	Repair Spalls & Seal Cracks in Approach Slabs		1	$5,000	$5,000										
14.4	Replace South Live Load Support Bolt		1	$2,500	$2,500										
14.5	Curb and Sidewalk Anchor Repairs		1	$3,000	$3,000										
14.6	Install Bolts in FBO		18	$150	$2,700										
				Sub-Total	**$18,200**	15%	$2,730	**$20,930**	10%	$2,093	15%	$3,140	10%	$2,093	**$29,000**
15	*Counterweight Repairs*	B													
15.1	Traffic Control		1	$100,000	$100,000										
15.2	Mobilization/Demobilization		1	$25,000	$25,000										
15.3	Access to Work Area		1	$150,000	$150,000										
15.4	Counterweight Repairs		1	$600,000	$600,000										
				Sub-Total	**$875,000**	15%	$131,250	**$1,006,250**	25%	$251,563	20%	$201,250	30%	$301,875	**$1,761,000**
16	*Major Rehabilitation*	C													
16.1	Traffic Control		1	$100,000	$100,000										
16.2	Mobilization/Demobilization		1	$50,000	$50,000										
16.3	Access & Environmental Protection		1	$350,000	$350,000										
16.4	Mechanical House Soffit Repairs		1	$40,000	$40,000										
16.5	Structural Steel Coating Repairs		1	$50,000	$50,000										
16.6	Steel Deck Grating & Sills Replacement		1	$600,000	$600,000										
16.7	Structural Steel Repairs		1	$75,000	$75,000										
16.8	Concrete Repairs (Substructure)		1	$12,000	$12,000										
16.9	Removal of Welds From Truss Members & Magnetic Particle Testing		1	$5,000	$5,000										
				Sub-Total	**$1,282,000**	25%	$320,500	**$1,602,500**	15%	$240,375	15%	$240,375	20%	$320,500	**$2,404,000**
17	*Seismic Retrofit (Allowance)*	C													
17.1	Seismic Retrofit		1	$360,000	$360,000										
				Sub-Total	**$360,000**	25%	$90,000	**$450,000**	40%	$180,000	25%	$112,500	30%	$135,000	**$878,000**
						Total Construction Cost		**$3,430,020**						**Total Cost**	**$5,668,000**

Notes: Cost estimate does not include 13% HST

TOTAL COST is rounded up to the nearest $1000

Costs are in 2019 dollars

12.2 MECHANICAL RECOMMENDATIONS

The priority codes for the recommended mechanical work are as follows:

Priority M (Maintenance):

- **Span Drive Motors:** Paint the unpainted areas on the underside of both motor mounting plates (*Motor Controls contract deficiency*).
- **Second Link Pins:** Remove the bird nest from the vicinity of the south second link pin.
- **Warning Gates:** Clean and paint the arms of both east warning gates.

Priority S (Studies/Investigations/Surveys):

- **Main Trunnion Bearings:** Monitor the contact between the main trunnion bearings and the structure through a range of temperatures over a period of time to determine if contraction of the structure is the cause of this condition (Priority A).
- **Counterweight Trunnion Bearings:** Perform Ultrasonic Testing (UT) on all counterweight trunnion bearing sleeve studs to determine if there are any failures. Tighten loose counterweight trunnion bearing sleeve fasteners that have not failed. Replace any fasteners that have failed and any fasteners that cannot be tightened (Priority A).
- **Span Drive Bearings:** Monitor the B3, B4, B5-N-OB, and B6 bearings for accelerated wear due to misalignment. It is recommended that clearance measurements be taken on a biennial basis (Priority D).

Priority Code A (Within 1 Year):

- **Span Drive Brakes:** Install a plate washer at the northeast mounting bolt nut on the machinery brake. Clean and paint the nearby corrosion.
- **Span Drive Bearings:** Clean and paint the corroded area between the B1 bearings cap and base.
- **Main Trunnion Bearing:** Clean and paint the corroded areas of the main trunnion bearings.
- **Span Locks:** Clean and paint the areas of corrosion on the motor and enclosed reducer mounting bolts and support. Clean and paint the “B3” mounting bolts. Clean and paint the shaft between bearing “B3” and “B4”. Clean and paint both adjustable arms for position indication. Clean and paint both front and rear guides east mounting bolts and undersides. Spot clean and paint the cross-shaft bearings. (*Span Locks contract deficiency*).
- **Live Load Supports:** Clean and paint the areas of corrosion on the underside of the strike plates and the top of the supports.
- **Main Trunnion Bearings:** Replace the mounting bolts at the main trunnion bearings that have 100% section loss of the bolt head.
- **Counterweight Trunnion Bearings:** Provide individual lube fittings and piping at each lubrication point to ensure that all grease grooves are receiving lubrication. Replace leaking or missing fittings.
- **Second Link Pins:** Ensure that each bearing grease groove is provided with its own dedicated piping and lubrication fitting. Replace the leaking fittings on the inboard side of the north second link pin.
- **Barrier Gates:** Consider providing a barrier gate at the east approach to the bridge.
- **Open Gearing and Operating Strut Guide Assembly:** Rehabilitate the south pinion and shaft connection and operating guide assembly.
- **Operating Strut:** Secure the south operating strut inboard bearing by replacing the existing rivets with turned bolts.

- **Main Trunnion Bearings:** Open the main trunnion bearings for internal inspection. Clean and paint, or otherwise protect from corrosion, the corroded areas of the main trunnion bearings.
- **Full Open Operating Strut Support:** Provide lubrication piping and/or access to enable periodic maintenance to the rollers that support the operating strut when the bridge is in the fully open (i.e. at 84°) position. Rehabilitate the roller assembly if the strut support is to be returned to service.
- **Buffers:** Adjust the buffer strike plates so that they do not prevent the span from seating firmly on the live load supports. Clean and paint the mounting bolts and areas of corrosion on both buffers.

Priority Code B (1 to 3 Years):

- **Open Gearing and Operating Strut Guide Assembly:** If the fit between the pinion and pinion shaft and the fits between the pinion, pinion shaft, and keys has not been restored on the south guide assembly, perform an in-depth inspection of the south guide assembly in 2020 (Priority B) and 2025 (Priority D).

Priority Code D:

- **Span Drive Open Gearing:** Continue to monitor the D and E gearset for degradation on the teeth.

Table 9: Class 'D' Cost Estimate (Mechanical)

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	QTY	UNIT COST	ITEM COST	COST CONTINGENCY		CONSTRUCTION COST	ENGINEERING		IN-HOUSE COST		RISK		TOTAL COST
1	Paint Underside of Span Drive Motors (*Motor Controls Contract Deficiency*)	M	2	$0	**$0**	0%	$0	**$0**	0%	$0	0%	$0	0%	$0	**$0**
2	Remove Nest From South Second Link Pin	M	1	$500	**$500**	15%	$75	**$575**	10%	$58	15%	$86.25	10%	$58	**$1,000**
3	Clean and Paint East Warning Gates	M	2	$1,000	**$2,000**	15%	$300	**$2,300**	10%	$230	15%	$345	10%	$230	**$4,000**
4	Monitor Main Trunnion Bearing Contact	S-A	1	$30,000	**$30,000**	15%	$4,500	**$34,500**	0%	$0	25%	$8,625	10%	$3,450	**$47,000**
5	Investigate/Replace Counterweight Trunnion Bearing Studs	S-A	2	$150,000	**$300,000**	15%	$45,000	**$345,000**	40%	$138,000	25%	$86,250	30%	$103,500	**$673,000**
6	Install Plate Washer on Machinery Brake	A	1	$500	**$500**	15%	$75	**$575**	10%	$58	15%	$86.25	10%	$57.50	**$1,000**
7	Clean and Paint B1 Bearing	A	2	$500	**$1,000**	15%	$150	**$1,150**	10%	$115	15%	$172.50	10%	$115	**$2,000**
8	Clean and Paint Main Trunnion Bearing	A	2	$1,000	**$2,000**	15%	$300	**$2,300**	10%	$230	15%	$345	10%	$230	**$4,000**
9	Clean and Paint Corroded Areas Around Span Locks (*Span Lock Contract Deficiency*)	A	1	$0	**$0**	0%	$0	**$0**	0%	$0	0%	$0.00	0%	$0	**$0**
10	Clean and Paint Live Load Supports and Buffers	A	2	$1,500	**$3,000**	15%	$450	**$3,450**	10%	$345	15%	$517.50	10%	$345	**$5,000**
11	Replace Main Trunnion Bearing Mounting Bolts	A	2	$20,000	**$40,000**	25%	$10,000	**$50,000**	40%	$20,000	25%	$12,500	20%	$10,000	**$93,000**
12	Replace Counterweight Trunnion Bearing Lube Fittings	A	2	$20,000	**$40,000**	25%	$10,000	**$50,000**	40%	$20,000	25%	$12,500	10%	$5,000	**$88,000**
13	Replace Second Link Lube Piping	A	2	$5,000	**$10,000**	25%	$2,500	**$12,500**	40%	$5,000	25%	$3,125	10%	$1,250	**$22,000**
14	Install Barrier Gate at East Approach	A	1	$100,000	**$100,000**	25%	$25,000	**$125,000**	40%	$50,000	25%	$31,250	10%	$12,500	**$219,000**
15	South Guide Assembly Repair	A	1	$400,000	**$400,000**	25%	$100,000	**$500,000**	25%	$125,000	25%	$125,000	20%	$100,000	**$850,000**
16	Secure South Operating Strut Inboard Bearing	A	1	$150,000	**$150,000**	25%	$37,500	**$187,500**	40%	$75,000	25%	$46,875	20%	$37,500	**$347,000**
17	Open Main Trunnion Bearing for Inspection	A	2	$40,000	**$80,000**	25%	$20,000	**$100,000**	40%	$40,000	25%	$25,000	10%	$10,000	**$175,000**
18	Rehabilitate Full Open Operating Strut Support (*only if bridge opening increased to 84 °*)	A	2	$100,000	**$200,000**	25%	$50,000	**$250,000**	40%	$100,000	25%	$62,500	10%	$25,000	**$438,000**
20	Adjust Buffer Strike Plates	A	1	$10,000	**$10,000**	25%	$2,500	**$12,500**	40%	$5,000	25%	$3,125	10%	$1,250	**$22,000**
21	Perform In-Depth Inspection of South Guide Assembly (*only if repair not performed in 2019*)	B	1	$200,000	**$200,000**	15%	$30,000	**$230,000**	40%	$92,000	25%	$57,500	10%	$23,000	**$403,000**
22	Monitor D and E Gearset	D	1	$0	**$0**	15%	$0	**$0**	0%	$0	0%	$0	0%	$0	**$0**
23	Monitor Misaligned Span Drive Bearings	S-D	1	$0	**$0**	0%	$0	**$0**	0%	$0	0%	$0	0%	$0	**$0**
							Total Construction Cost	**$1,957,350**						**Total Cost**	**$3,482,000**

Notes:

Cost estimate does not include 13% HST

TOTAL COST is rounded up to the nearest $1000

Costs are in 2019 dollars

12.3 ELECTRICAL RECOMMENDATIONS

The priority codes for the recommended electrical work are as follows:

Priority M (Maintenance):

- **Feeder Cables:** Closely monitor the feeder cables for the span lock motor, span lock motor windings, gate 1 feeders and gate 2 feeders, replace as necessary in the long term.
- **Ground Resistance Testing:** Ensure the integrity of the bridge grounding and bonding installation by performing annual ground resistance testing and performing a visual inspection.

Priority S (Studies/Investigations/Surveys):

- **Limit Switch Enclosure:** Investigate the cause of the water infiltration issue for the north fully seated limit switch and repair as necessary to prevent water from getting into the limit switch enclosure (Priority A).
- **Submarine Cable:** Determine condition of the original un-used submarine cable. If found to be usable arrange as a backup submarine cable for bridge operation (Priority A).
- **Relaying Coordination and Arc Flash Studies:** Perform a protective relaying coordination study and arc flash study for the bridge electrical distribution system (Priority A).
- **Machinery Space:** There appears to be water infiltration in the machinery space. Inspect the roof of the machinery space and if leaking, repair (Priority A).

Priority Code A (Within 1 Year):

- **Standby Generator:** Provide a load bank for the existing standby generator to enable it to be exercised under load without operating the bridge.
- **Drive Motor Temperature Monitors:** Remove the drive motor temperature monitors as they are no longer in use.
- **Ductor Testing:** Carry out low resistance "Ductor" testing at the bridge at a frequency of every 5-years.
- **Machinery Brakes:** Provide hand released limit switches on the existing machinery brakes and incorporate into the bridge control logic.
- **Wire Nut Splices:** Replace all wire nuts presently used as splices with permanent and CSA approved splices.
- **Wire Labelling:** Properly label all wires inside the motor brake starter/disconnect switch enclosure.
- **Hand Crank Limit Switch:** Provide a hand crank limit switch to prevent electrical operation of the locks with the hand crank inserted.
- **Span Lock RCLS Covers:** Clean, remove corrosion, and apply protective coating on the span lock RCLS covers.
- **Traffic Gate Indicators:** Replace traffic gate indicators on the main control desk with lights whose status can be seen during times of sun glare.
- **Control Desk Wiring Cabinet:** Properly train all wires and properly label any wires with missing tags inside the control desk wiring cabinet.
- **Control Circuit:** Integrate the overspeed trip function to the control circuit such that span will be stopped (or E-Stopped) if the motor loses the control of the span.
- **Traffic Gate Enclosure:** Provide traffic gate enclosure door limit switches and integrate into the gate operating system such that the gate cannot be operated with doors open.
- **Traffic Gate Hand Crank Limit Switches:** Provide traffic gate hand crank limit switches and integrate into the gate operating system such that the gate cannot be operated with the hand crank inserted.
- **Traffic Gate Limit Switches:** Clean all traffic gate limit switches and provide protective covers over them.

- **Traffic Gate Enclosures:** Perform housekeeping of wiring in the traffic gate enclosures.
- **Northwest Traffic Gate:** Provide a hand crank handle for the northwest traffic gate.
- **Navigation Lights:** The existing pivoting navigation light provides restricted vision for marine traffic. Add an additional red/green pivoting navigation light at the toe end of the moving structure.
- **Outdoor Junction Boxes:** Properly terminate all spare wires and provide label for all wires in the outdoor junction boxes.

Priority Code B (1 to 3 Years):

- **Thrustor Brakes:** Procure and install purpose made covers for all thrustor brakes in the machinery space.
- Replace span lock operator and control switch with a device that is compatible with the present span lock operating function.
- **Control Desk:** Replace the operator's control desk with a modern desk containing an HMI and logically laid out bridge control devices.
- **Bridge Relay Control Logic:** Replace existing bridge relay control logic with a modern redundant PLC based system.
- **Traffic Barriers:** Add traffic barriers to the bridge in accordance with CHBDC guidelines.
- **Operation and Maintenance Manual:** Prepare a formal electrical Operation and Maintenance Manual and utilize for annual inspections and routine maintenance of the bridge electrical systems.

Table 10: Class ‘D’ Cost Estimate (Electrical)

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	QTY	UNIT COST	ITEM COST	COST CONTINGENCY		CONSTRUCTION COST	ENGINEERING		IN-HOUSE COST		RISK		TOTAL COST
1	Closely Monitor Feeder Cables for Span Lock Motor, Span Lock Motor Windings, Gate 1 and Gate 2 Feeders	M	1	$500	$500	15%	$75	$575	0%	$0	15%	$86	10%	$58	$1,000
2	Perform Annual Ground Resistance Testing and Visual Inspection	M	1	$1,000	$1,000	15%	$150	$1,150	0%	$0	15%	$173	10%	$115	$2,000
3	Investigate Cause of Water Infiltration in North Fully-seated Limit Switch and Repair as Necessary	S-A	1	$2,000	$2,000	15%	$300	$2,300	0%	$0	25%	$575	10%	$230	$4,000
4	Determine Condition of Original Un-used Submarine Cable	S-A	1	$1,000	$1,000	15%	$150	$1,150	0%	$0	25%	$288	10%	$115	$2,000
5	Carry out Protective Relaying Coordination and Arc Flash Studies for Electrical Distribution System	S-A	1	$67,000	$67,000	15%	$10,050	$77,050	0%	$0	25%	$19,263	10%	$7,705	$105,000
6	Investigate Water Infiltration through Roof of Machinery Space and Repair as Neccessary	S-A	1	$2,000	$2,000	15%	$300	$2,300	0%	$0	25%	$575	20%	$460	$4,000
7	Provide Load Bank for Existing Standby Generator	A	1	$10,000	$10,000	25%	$2,500	$12,500	40%	$5,000	25%	$3,125	10%	$1,250	$22,000
8	Remove the Drive Motor Temperature Monitors	A	1	$500	$500	15%	$75	$575	10%	$58	25%	$144	10%	$58	$1,000
9	Carry out Low Resistance Ductor Testing every 5 Years	A	1	$3,000	$3,000	15%	$450	$3,450	10%	$345	25%	$863	10%	$345	$6,000
10	Provide Hand-released Limit Switches on Existing Machinery Brakes and Incorporate into Control Logic	A	1	$2,000	$2,000	15%	$300	$2,300	40%	$920	25%	$575	10%	$230	$5,000
11	Replace Wire Nuts with Permanent and CSA-approved Splices	A	1	$5,000	$5,000	15%	$750	$5,750	10%	$575	25%	$1,438	10%	$575	$9,000
12	Properly Label all Wires inside Motor Brake Starter/Disconnect Switch Enclosure	A	1	$2,000	$2,000	15%	$300	$2,300	40%	$920	25%	$575	10%	$230	$5,000
13	Provide a Hand Crank Limit Switch	A	1	$5,000	$5,000	15%	$750	$5,750	40%	$2,300	25%	$1,438	10%	$575	$11,000
14	Clean, Remove Corrosion, Apply Protective Coating on Span Lock RCLS Covers	A	1	$1,000	$1,000	15%	$150	$1,150	10%	$115	25%	$288	10%	$115	$2,000
15	Replace Traffic Gate Indicators on Main Control Desk	A	1	$3,000	$3,000	15%	$450	$3,450	40%	$1,380	25%	$863	20%	$690	$7,000
16	Properly Train All Wires and Label Wires with Missing Tags inside Control Desk Wiring Cabinet	A	1	$1,000	$1,000	15%	$150	$1,150	40%	$460	25%	$288	10%	$115	$3,000
17	Integrate Overspeed Trip Function to Control Circuit	A	1	$2,000	$2,000	15%	$300	$2,300	40%	$920	25%	$575	10%	$230	$5,000
18	Provide Traffic Gate Enclosure Door Limit Switches and Integrate into Gate Operating System	A	4	$1,000	$4,000	15%	$600	$4,600	40%	$1,840	25%	$1,150	20%	$920	$9,000
19	Provide Traffic Gate Hand Crank Limit Switches and Integrate into Gate Operating System	A	4	$800	$3,200	15%	$480	$3,680	40%	$1,472	25%	$920	20%	$736	$7,000
20	Clean all Traffic Gate Limit Switches and Provide Protective Covers	A	4	$1,000	$4,000	15%	$600	$4,600	10%	$460	25%	$1,150	20%	$920	$8,000
21	Perform Housekeeping of Wiring in Traffic Gate Enclosures	A	4	$800	$3,200	15%	$480	$3,680	40%	$1,472	25%	$920	20%	$736	$7,000
22	Provide Hand Crank Handle for Northwest Traffic Gate	A	1	$100	$100	15%	$15	$115	40%	$46	25%	$29	10%	$12	$1,000
23	Add Additional Red/Green Pivoting Navigation Light at Toe End of Leaf Span	A	2	$2,500	$5,000	15%	$750	$5,750	40%	$2,300	25%	$1,438	10%	$575	$11,000
24	Properly Terminate all Spare Wires, and Provide Labels for all Wires in Outdoor Junction Boxes	A	1	$2,000	$2,000	15%	$300	$2,300	40%	$920	25%	$575	10%	$230	$5,000
25	Procure and Install Purpose-made Covers for Thrustor Brakes in Machinery Space	B	3	$2,000	$6,000	25%	$1,500	$7,500	10%	$750	25%	$1,875	10%	$750	$11,000
26	Replace Span Lock Operator and Control Switch	B	1	$500	$500	15%	$75	$575	10%	$58	25%	$144	10%	$58	$1,000
27	Replace Operator's Control Desk	B	1	$30,000	$30,000	25%	$7,500	$37,500	40%	$15,000	25%	$9,375	10%	$3,750	$66,000
28	Replace Existing Bridge Relay Control Logic	B	1	$60,000	$60,000	25%	$15,000	$75,000	40%	$30,000	25%	$18,750	10%	$7,500	$132,000
29	Add Traffic Barriers to Bridge in ccordance with CHBDC Guidelines	B	2	$100,000	$200,000	25%	$50,000	$250,000	40%	$100,000	25%	$62,500	10%	$25,000	$438,000
30	Prepare Formal Electrical O&M Manual	B	1	$40,000	$40,000	15%	$6,000	$46,000	10%	$4,600	25%	$11,500	10%	$4,600	$67,000
						Total Construction Cost		$566,500						Total Cost	$957,000

Notes:

Cost estimate does not include 13% HST

TOTAL COST is rounded up to the nearest $1000

Costs are in 2019 dollars

13.0 10 -Year Management Plan

A 10-year Management Plan for the Bascule Bridge has been developed and is presented in the following tables. The cost management for the structure is presented individually, rather than as an overall strategy for the entire Causeway. The management plan has been developed based on the recommended rehabilitation, maintenance items, and studies for structural, mechanical, and electrical components presented in the preceding sections. The costs include relevant Cost Amplification Factors (Cost Contingency, Engineering Fees, PSPC In-House Costs, and Project Risk) as provided by PSPC, but do not include HST. The costs are presented in 2019 dollars, and an annual inflation rate of 2% has been assumed. Recommendations for structural, mechanical, and electrical components have been presented separately as these are typically performed under separate contracts.

The Class 'D' cost estimates provided in the 10-year Management Plan are at a conceptual level only (i.e. a rough order-of-magnitude estimate used for comparison based on historical costs for similar work) and do not include costs associated with routine maintenance such as maintenance of light fixtures and bulbs, signage, graffiti removal, sweeping and cleaning, and mechanical component lubrication. The items are listed within the time periods considered appropriate due to scheduling and urgency.

The following further studies, investigations, and surveys (Priority S) have been recommended:

Structural

- Repeat the survey of the east approach slab and abutment in 2019 to determine if there is any ongoing settlement occurring.
- Carry out a complete Health and Safety review/audit of the stairs and catwalks to identify all locations of potential falling hazards.
- Carry out a refined analysis of the inboard (south) gusset plate of 2N to determine the strengthening requirements.
- Monitoring of roadway floor beam deformation.
- Monitoring of the mechanical housing soffit for additional delaminations.
- Measuring and monitoring of the deformation of 12N-13N.

Mechanical

- Monitor the B3, B4, B5-N-OB, and B6 span drive bearings for accelerated wear due to misalignment.
- Monitor the contact between the main trunnion bearings and the structure through a range of temperatures over a period of time to determine if contraction of the structure is the cause of this condition.
- Perform Ultrasonic Testing (UT) on all counterweight trunnion bearing sleeve studs to determine if there are any failures.

Electrical

- Investigate the cause of the water infiltration issue for the north fully seated limit switch and repair as necessary to prevent water from getting into the limit switch enclosure.
- Determine the condition of the original un-used submarine cable.
- Perform a protective relaying coordination study and arc flash study for the bridge electrical distribution system.

The capital expenditure required to implement the recommendations of these studies, investigations, and surveys is difficult to quantify at this stage, and therefore a cost estimate has not been provided.

In addition to the recommended structural studies and evaluations listed above, Parsons understands that a renewal options analysis study (by others) is currently underway for the Causeway. The 10-Year Management Plan does not incorporate any capital expenditure required to implement the recommendations of the study.

Table 11: 10-Year Structure Management Plan – Structural

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	10-YEAR MANAGEMENT PLAN COSTS (x $1000)[2,3,4]									
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Costs and Studies												
1	Scaling Mechanical House Soffit	U	7									
2	Remove Disintegrated Concrete from inside Counterweight Panels	U	7									
3	Update of East Approach and Abutment Survey	S(A)	8									
4	Health and Safety Review of Access Platforms & Stairs	S(A)	24									
5	Structural Analysis of Connection 2N	S(A)	26									
6	Monitoring of Roadway Floor Beams	S(A)	4									
7	Monitoring of Mechanical Housing Soffit	S(A)	3									
8	Measure & Monitor Deformation of 12N-13N	S(A)	4									
9	Repairs to Stairs & Catwalks	A	35									
10	Stringer & Sill Repairs	A	115					20				
11	Guide Rail Modifications	A	39									
12	Roadway Railing Repairs	A	8					10				
13	Structural Steel Repairs	A	316									
14	Miscellaneous Repairs	B			30							
15	Counterweight Repairs	B	252	1,570								
16	Major Rehabilitation	C				255	2,342					
17	Seismic Retrofit (Allowance)	C				191	756					
	Yearly Cost		848	1,570	30	446	3,098	30	0	0	0	0

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	10-YEAR MANAGEMENT PLAN COSTS (x $1000)[2,3,4]									
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Typical Repair and Maintenance[1] and Comprehensive Detailed Inspections												
1	Deck Grating Repairs	M		25				15		16		16
2	Timber Sidewalk & Curb Repairs	M		4		4		4		5		5
3	Guide Rail Repairs	M			9				10			
4	Comprehensive Detailed & Underwater Inspections	S	135		114		146		124		158	
	Yearly Cost		135	29	123	4	146	19	134	20	158	21
	Total Yearly Cost		983	1,599	154	450	3,244	49	134	20	158	21

Notes:

1. *Typical repair and Maintenance costs do not include items such as changing of light fixtures and bulbs, signage, graffiti removal, snow removal, and flushing debris from structure.*
2. *All costs are rounded to the nearest 1,000, and include an assumed annual inflation rate of 2%.*
3. *All costs shown are in 2019 dollars and are exclusive of HST.*
4. *All costs include relevant Cost Amplification Factors for Cost Contingency, Engineering, PSPC In-House Costs, and Project Risk allowance.*
5. *Costs in 2019 for Counterweight Repairs are for Engineering.*
6. *Costs in 2022 for Major Rehabilitation are for Engineering.*
7. *Costs in 2022 for Seismic Retrofit are for Engineering.*
8. *Costs for Seismic Retrofit are a provisional allowance only and are based on the recommendatrions from the 2001 MRC report.*

Table 12: 10-Year Structure Management Plan – Mechanical

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	10-YEAR MANAGEMENT PLAN COSTS (x $1000)[1,2,3]									
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Costs and Studies												
1	Paint Underside of Span Drive Motors (*Motor Controls Contract Deficiency*)	M	0									
2	Remove Nest From South Second Link Pin	M	1									
3	Clean and Paint East Warning Gates	M	4									
4	Monitor Main Trunnion Bearing Contact	S-A	47									
5	Investigate/Replace Counterweight Trunnion Bearing Studs	S-A	673									
6	Install Plate Washer on Machinery Brake	A	1									
7	Clean and Paint B1 Bearing	A	2									
8	Clean and Paint Main Trunnion Bearing	A	4									
9	Clean and Paint Corroded Areas Around Span Locks (*Span Lock Contract Deficiency*)	A	0									
10	Clean and Paint Live Load Supports and Buffers	A	5									
11	Replace Main Trunnion Bearing Mounting Bolts	A	93									
12	Replace Counterweight Trunnion Bearing Lube Fittings	A	88									
13	Replace Second Link Lube Piping	A	22									
14	Install Barrier Gate at East Approach	A	219									
15	South Guide Assembly Repair	A	850									
16	Secure South Operating Strut Inboard Bearing	A	347									
17	Open Main Trunnion Bearing for Inspection	A	175									
18	Rehabilitate Full Open Operating Strut Support (only if bridge	A	438									
19	Adjust Buffer Strike Plates	A	22									
20	Perform In-Depth Inspection of South Guide Assembly (*only if repair not performed in 2019*)	B		411					454			
21	Monitor D and E Gearset	D	0									
22	Monitor Misaligned Span Drive Bearings	S-D	0									
	Total Yearly Cost		**2,991**	**411**	**0**	**0**	**0**	**0**	**454**	**0**	**0**	**0**

Notes:

1. *All costs are rounded to the nearest 1,000, and include an assumed annual inflation rate of 2%.*
2. *All costs shown are in 2019 dollars and are exclusive of HST.*
3. *All costs include relevant Cost Amplification Factors for Cost Contingency, Engineering, PSPC In-House Costs, and Project Risk allowance.*

Table 13: 10-Year Structure Management Plan – Electrical

ITEM NO.	ITEM DESCRIPTION	PRIORITY CODE	10-YEAR MANAGEMENT PLAN COSTS (x $1000)[1,2,3]									
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capital Costs and Studies												
1	Closely Monitor Feeder Cables for Span Lock Motor, Span Lock Motor Windings, Gate 1 and Gate 2 Feeders	M	1									
2	Perform Annual Ground Resistance Testing and Visual Inspection	M	2									
3	Investigate Cause of Water Infiltration in North Fully-seated Limit Switch and Repair as Necessary	S-A	4									
4	Determine Condition of Original Un-used Submarine Cable	S-A	2									
5	Carry out Protective Relaying Coordination and Arc Flash Studies for Electrical Distribution System	S-A	105									
6	Investigate Water Infiltration through Roof of Machinery Space and	S-A	4									
7	Provide Load Bank for Existing Standby Generator	A	22									
8	Remove the Drive Motor Temperature Monitors	A	1									
9	Carry out Low Resistance Ductor Testing every 5 Years	A	6					7				
10	Provide Hand-released Limit Switches on Existing Machinery Brakes and Incorporate into Control Logic	A	5									
11	Replace Wire Nuts with Permanent and CSA-approved Splices	A	9									
12	Properly Label all Wires inside Motor Brake Starter/Disconnect Switch Enclosure	A	5									
13	Provide a Hand Crank Limit Switch	A	11									
14	Clean, Remove Corrosion, Apply Protective Coating on Span Lock RCLS Covers	A	2									
15	Replace Traffic Gate Indicators on Main Control Desk	A	7									
16	Properly Train All Wires and Label Wires with Missing Tags inside Control Desk Wiring Cabinet	A	3									
17	Integrate Overspeed Trip Function to Control Circuit	A	5									
18	Provide Traffic Gate Enclosure Door Limit Switches and Integrate	A	9									
19	Provide Traffic Gate Hand Crank Limit Switches and Integrate into	A	7									
20	Clean all Traffic Gate Limit Switches and Provide Protective Covers	A	8									
21	Perform Housekeeping of Wiring in Traffic Gate Enclosures	A	7									
22	Provide Hand Crank Handle for Northwest Traffic Gate	A	1									
23	Add Additional Red/Green Pivoting Navigation Light at Toe End of	A	11									
24	Properly Terminate all Spare Wires, and Provide Labels for all Wires	A	5									
25	Procure and Install Purpose-made Covers for Thrustor Brakes in Machinery Space	B			11							
26	Replace Span Lock Operator and Control Switch	B			1							
27	Replace Operator's Control Desk	B			69							
28	Replace Existing Bridge Relay Control Logic	B			137							
29	Add Traffic Barriers to Bridge in ccordance with CHBDC Guidelines	B			456							
30	Prepare Formal Electrical O&M Manual	B			70							
	Total Yearly Cost		242	0	744	0	0	7	0	0	0	0

Notes:

1. *All costs are rounded to the nearest 1,000, and include an assumed annual inflation rate of 2%.*
2. *All costs shown are in 2019 dollars and are exclusive of HST.*
3. *All costs include relevant Cost Amplification Factors for Cost Contingency, Engineering, PSPC In-House Costs, and Project Risk allowance.*

14.0 Closure

We trust that this report contains sufficient information for your present purposes. If you have any questions regarding this report, please contact us.

Yours truly,

Parsons Inc.

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15.0 Bibliography

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Appendix A– Field Observation Record Forms (MCR/PCR Forms)

PWGSC BRIDGE INSPECTION MANUAL (BIM) FIELD OBSERVATION RECORD FORM

PROJECT TITLE & NUMBER: 2018 Comprehensive Detailed Condition Inspection Report - R.090045.001

STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
Primary Components – Through Truss						
Top Chord	0N-1N	4	5	4	5	Light pitting was noted on lower lattice. Light pitting (1mm) in bottom flange and pitting up to 4mm deep in web at top of member near 1N representing an overall 4% loss of cross-sectional area. Light corrosion and coating failure on south flange. Severe pitting 6 mm deep in south top flange 1.5 m above deck but there is a plate on the inside and hence capacity is not affected. Light to localized medium pitting in the vicinity of the node at 1N.
	1N-3N	6	6	6	6	Light pitting 1mm deep or less in south web was noted in the vicinity of the nodes. Some bent lattices.
	3N-5N	6	6	6	6	Light pitting was noted at the nodes. Rust jacking near 5N on the south side.
	5N-7N	5	6	5	6	Some bent top lattices. Light impact damage on lattice. Light corrosion between some lattices and bottom flange of member. Light pitting 1mm deep in south web at 5N.
	7N-9N	6	6	6	6	Localized minor pitting (less than 1mm) of bottom flange near 7N. Pitting 2mm deep at base of interior plate at 9N. Top batten plate bent at 9N.
	9N-11N	5	5	5	6	Localized pitting 1mm deep in southern top flange.
	11N-13N	4	4	4	5	Very severe pitting of diaphragm towards 13N and at base of interior splice. Some bent upper lattices.
	13N-16N	5	6	5	5	Member has been reinforced at intersection of 13N-16N and 14N-16N. Light pitting 1mm deep was noted in channels at interface between gusset plates at 16N. Impact damage to the south bottom flange with 3mm crack (which was later ground out). Localized severe pitting was noted in the diaphragm near 13N. Severe section loss in lattices above roadway. Pitting 4mm deep in south face of web at the bottom at 13N. Very severe pitting of the south bottom flange at the connection to the bracing lower gusset plate has resulted in 75% section los of the flange. Pitting 5mm deep in top of south flange 2m above deck representing an overall 6% loss of cross-sectional area. Pitting 3mm deep in top of north flange near 16N.
	0S-1S	5	5	5	5	Up to 50% localized section loss of lattice elements due to 4mm pitting near sidewalk over 3.5m in length. 5mm deep pitting and 40% section loss of rivet heads at bottom plate at 1S. Localized pitting 5mm deep in the bottom flange at 0S. Localized pitting 8 mm deep over 50% of height of north web at guiderail level. 50mm x 25mm pitting 4mm deep in north web below sidewalk representing an overall 3% loss of cross-sectional area of member.
	1S-3S	5	5	5	5	Very localized medium to severe pitting was observed in the interior of the inner bottom flange at the interface with the web at 1S (15mm x 300mm) representing an overall 5% loss of cross-sectional area. Minor pitting was noted on top angle.
	3S-5S	6	6	2	4	Localized pitting 1mm deep in north face of web. Light pitting at base of interior plates near 5S. 60mm lamination defect in south face of north channel with a possible crack parallel to main stress in web of primary tension member.
	5S-7S	6	6	6	6	Localized pitting 1mm deep in web.
	7S-9S	6	6	6	6	Localized pitting 1mm deep in web.
	9S-11S	6	6	6	6	Localized pitting 1mm deep in web.
	11S-13S	5	5	5	4	Pitting 7mm deep was noted on the bottom transverse plates on inside of channel at 13S along with a complete perforation of end stiffener/diaphragm at 13S. Note plate is 13mm thick.
	13S-16S	5	5	5	5	Several small perforations and severe section loss noted in bottom batten plate and lower flange of inner channel at 16S. Both webs of the members are severely corroded, perforated and have been reinforced at intersection of 13S-16S and 14S-15S.
Bottom Chord	0N-2N	5	6	5	6	Half of bottom chord replaced from 0N to mid-bay. Some light pitting 1mm deep noted in outer web at west end. Minor pitting noted in bottom lattice. An old weld was noted on the exterior channel at the west end. Some light corrosion. Small perforation near 2N.
	2N-4N	5	5	5	5	Moderate pitting and localized section loss in top flanges at east and west gusset plate. Light to moderate pitting on lower lattice and localized light pitting on webs and batten plates at 2N. Five lower lattices are deformed and three have severe section loss. Large number of rivets replaced with bolts. Some paint is chipped on the top flanges.
	4N-6N	5	5	5	5	Light pitting 1mm deep in horizontal surfaces including top and bottom flanges and bottom lattice and inner face of webs. Some lattices are deformed. Cracks were noted in the coating at the splice plates near 6N. Pitting was noted on interior face of inner and outer gusset plates at 4N and 6N.
	6N-8N	5	5	5	5	Pitting up to 4mm deep in half the width of the bottom flanges around lattice members is typical, representing an overall 5% loss of cross-sectional area. A few bottom lattice bars are bent and have light pitting 1mm deep.

PWGSC BRIDGE INSPECTION MANUAL (BIM) FIELD OBSERVATION RECORD FORM

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STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	8N-10N	5	5	5	5	Pitting on the top flanges at 8N and 10N and severe section loss in three lattices near 8N were noted. Pitting up to 4mm deep in half the width of the bottom flanges around lattice members representing 5% loss of cross-sectional area is typical. Coating is chipped at several locations. Moderate pitting of webs of bottom chord noted at gusset plates. Light pitting 1mm deep on bottom lattices.
	10N-12N	5	5	5	5	Light to moderate pitting in horizontal surfaces typical at nodes in channel web. Light accumulation of debris on horizontal surfaces at connections. Small areas of coating failure with rust staining on top flange. Light corrosion of bottom splice plate. Severe section loss and pitting in two lower lattices.
	12N-14N	5	5	5	5	Light to moderate pitting in horizontal surfaces and web of channels. Moderate to severe pitting of interior face of bottom chord at 12N. Moderate pitting and light corrosion noted on adjacent batten plates at 12N. Moderate pitting also noted in lattice at gusset plate. Light to moderate corrosion of lower fasteners near 12N.
	14N-15N	5	5	5	5	Light to moderate pitting in interior surfaces of web plates. Severe localized pitting in exterior of south web noted where 2 members (14N-16N and 14N-15N) intersect at 14N. Light corrosion was also noted in these areas and along interior web. Pack rust and active corrosion between web plate and channel web. Localized areas of peeling coating on south face.
	14N-16N	5	3	5	3	Light pitting 1mm deep noted in exterior face of outer web. Localized moderate to severe pitting and rust jacking noted on the inner face of the south channel web at the interface with 14N-15N. Perforation noted in inner web near 16N. The coating is missing over a large section of the outer face of the inner channel at 16N with light corrosion present.
	0S-2S	5	5	5	5	Half of bottom chord replaced from 0S to mid-bay. Light accumulation of debris on horizontal surfaces at connections. Severe localized section loss and a small perforation at base of exterior gusset plate and exterior web of channel at joint 2S at connection with sidewalk floor beam.
	2S-4S	5	5	5	5	Light pitting 1mm deep in horizontal surfaces, lower flanges at 4S and exterior face of outer web. Pitting up to 13mm high and 2mm deep in interior face of channel web along length of member.
	4S-6S	5	5	5	5	Severe localized section loss at base of exterior web at joints 4S and 6S at connection with sidewalk floor beam. Light pitting 1mm deep in horizontal surfaces and lower lattices. Two bent lower lattices.
	6S-8S	5	5	5	5	Light pitting 1mm deep in horizontal surfaces. A few bottom lattice elements have been bent. Some of the rivets were replaced with bolts in this member.
	8S-10S	5	5	5	5	Light to medium pitting was noted in horizontal surfaces, typically around upper lattice connections. Two lattices have severe section loss near 10S.
	10S-12S	5	5	5	5	Pitting noted in interior faces of batten plates and exterior surface of exterior channel at 10S. Light corrosion was noted at several spots on the top of the upper flanges. Rivets in splice have been replaced with bolts. Light corrosion was noted at the interior splice plate at 12S.
	12S-14S	5	4	5	5	Light pitting 1mm deep in horizontal surfaces. Severe pitting in underside of exterior flange at interface with lattice. Moderate pitting noted on inner and outer channel webs on the exterior sides at 12S. Rust jacking between web plate and channel at top of the interior face. Section loss in bottom flange of channel at lattice connections. Severe section loss in seven lower lattices.
	14S-15S	4	3	4	4	Large area of very severe pitting of exterior web and edge of bottom flange. Light to moderate pitting noted on most surfaces. Member has been reinforced and rivets have been replaced with bolts. Section loss of rivets noted at 14S. Severe localized section loss and knife-edge corrosion of both bottom flanges over 1m near node 14 where 2 members (14S-16S and 14S-15S) cross representing from 50 to 100% loss of flange thickness. Light to moderate active corrosion was also noted in these areas. Small perforation noted in north channel web and bottom of batten plate near 15S; multiple cracks were noted around the perforation in the bottom batten plate.
	14S-16S	5	3	2	3	All lattice have been replaced with cut-out plate and rivets have been replaced with bolts on the underside of the member. Rivets have been replaced with bolts on inboard gusset plate at 16S. 12mm long vertical crack in north channel web perpendicular to main stress. Severe localized pitting noted on inner webs where 14S-16S and 14S-15S intersect. 13 rivets in outboard channel connection to 16S have over 75% section loss of rivet heads. Member has deformed near 16S prior to cut-out plate replacement and appears to have further deformed following plate installation. Light pitting 1mm deep in horizontal surfaces. Light corrosion noted along the interior face of the north channel.

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STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
Diagonals	1N-4N	6	6	6	6	Light pitting 1mm deep in lattice and on web at 4N. Some bent lattices near deck level.
	4N-5N	5	6	5	6	Light to medium pitting was noted in the lattice along with deteriorated rivet heads. Scrapes in south channel. Pitting 1mm deep in top flange at lattice.
	5N-8N	5	5	5	5	Pitting 2mm deep in top flanges at interface with lattice towards 8N representing an overall 3% loss of cross-sectional area. Some light corrosion developing at the interface between the upper flanges and the lattice. Chips in top coat of south face of south channel.
	8N-9N	5	5	5	5	Pitting in lower lattice and rivet heads. Pitting has caused up to 30% localized cross-sectional loss in lower lattice and rivet heads.
	9N-12N	5	4	5	4	Very severe pitting and section loss was noted in the interior channel web at 12N. Several rivets have been replaced with high strength bolts. North and south channel have been strengthened. Pitting up to 3mm deep in top flange at lattice around railing level representing 4% cross-sectional loss.
	12N-13N	5	5	5	5	Medium pitting in top and bottom flanges at lattice and lattice itself at roadway level. Member strengthened. Light pitting also noted on inner face of webs. The upper 1.0m of the member and batten plate were noted to be deformed into an S-shape at node 13N. Pitting 3mm deep in underside of bottom lattice above railing level. Localized pitting 2mm deep in inside face of north channel just above repair representing an overall 4% loss of cross-sectional area.
	1S-4S	5	5	5	5	30% localized cross-sectional loss of top flange thickness at interface with bottom lattice. Minor pitting less than 1mm deep noted at connections. Up to 30% cross-sectional loss in lattice and scrapes in paint.
	4S-5S	5	5	5	5	Pitting 3mm deep in top flange at railing level and below. Pitting has caused up to 25% localized section loss of top flange at lattice. Localized coating failures.
	5S-8S	5	5	5	5	Pitting in lattice flange. Pitting has caused up to 50% localized section loss of lattice at the base of member. 6 bent lattices were observed.
	8S-9S	5	5	5	5	Pitting 3mm deep has caused up to 30% localized cross-sectional loss in lower lattice and rivet heads. The signboards have been welded to the flanges and gouged the diagonal. Localized light pitting 1mm deep on the inboard angle and bottom batten plate. Two angles installed to strengthen sign support. Some galvanized bolts were noted. Light corrosion and scrapes in member.
	9S-12S	4	4	5	5	Pitting has caused up to 70% localized section loss of bottom flange (6mm deep pitting) at base of member. The signboards have been welded to the flanges and gouged the diagonal. Member has been strengthened. Two new plates installed on outside faces of channels. Some galvanized bolts were noted.
	12S-13S	4	5	4	5	Pitting 6mm deep up to 50% localized section loss of bottom flange and web at connections to lattice in the lower section of member. Localized severe section loss of outer web noted below sidewalk level. Section loss noted in rivet heads on bottom flange. Buckling of the upper batten plate at node 13S was noted. 3 bent lattice and localized coating failures.
Verticals	1N-2N	5	6	2	5	Member has been extensively reinforced and numerous rivets have been replaced with high strength bolts. Impact damage observed to inner and outer flanges with some localized coating failure. Localized light corrosion jacking was noted between the flange of the exterior angle and plate. Southwest flange bent above bottom chord level. Several tack welds. 3mm crack at flame cut hole.
	3N-4N	5	5	5	5	Severe localized section loss due to pitting of gusset plates, lattice and flanges at 4N including perforations in inboard flanges at top of gusset plate. The most severe section loss was observed in lower lattice. Member has been reinforced with steel angles bolted to both inner and outer flanges. Light fixture has been welded to the interior flanges of the member. Scrapes at road level. Localized chips and light corrosion. Light pitting 1mm deep in lattice.
	5N-6N	5	5	5	5	Lattice has been replaced with cut-out steel plate and rivets have been replaced with bolts. Severe localized section loss noted in lower batten plate at the connection to the inner and outer webs. Two small perforations noted. Several tack welds.
	7N-8N	5	5	5	5	Small hole cut in inner angle at 8N. Localized pitting noted in lower batten plate and lattice below roadway. Some light 1mm deep localized pitting of lattice at connection to angles noted throughout member. A perforation was noted in the S/W flange at 8N. Southwest flange bent at deck level. Localized light corrosion.
	9N-10N	5	5	5	5	Lattice in member replaced with cut-out steel plate and many of the rivets have been replaced with bolts. Pitting and section loss were observed in the lower batten plate. Impact damage to the member has bent a portion of southeast flange above railing. Light corrosion on member. There is a flame-cut hole in the northwest flange, but no cracks were found. The flange is bent below the hole.

PROJECT TITLE & NUMBER: 2018 Comprehensive Detailed Condition Inspection Report - R.090045.001

STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	11N-12N	4	5	4	5	Severe localized section loss and perforations at 12N through entire length of original inner flanges. Inner and outer flanges heavily reinforced in lower half of member with additional angles, after it appears the member buckled. Welding of the roadway lighting has gouged the flange of one angle. Active corrosion of the original flanges at 12N. Pitting 4mm deep in lattices at railing level representing 15% loss of cross-sectional area. Light corrosion on member.
	13N-14N	4	6	4	6	Suspected fatigue cracks noted in both south side angles between the original batten plate and the new batten plate above 14N were repaired in the winter of 2017/2018 and strengthening of 14S and members at location of cracks was carried out. Lattice in member has been replaced with cut-out plate and ladder is provided for inspection of pin at 13N.
	1S-2S	5	6	5	6	Hole noted on outer flange of member. Impact damage to the member on the roadside was observed. The coating is damaged at the impact location and light corrosion is present. Lattice has been replaced with cut-out steel plate and some rivets have been replaced with bolts.
	3S-4S	4	4	4	4	Pitting up to 6mm deep of inside flange thickness at sidewalk level representing 70% localized loss of cross-sectional thickness. Section loss also noted in rivet heads. Up to 50% cross-sectional loss of lattice and the underside of the angles. Scrapes and light corrosion on inner angles.
	5S-6S	5	6	5	6	Member generally in good condition. Lattice has been replaced with cut-out plate and some rivets have been replaced with bolts. Northwest flange bent.
	7S-8S	5	6	5	6	Member generally in good condition. Light corrosion. Impact damage was noted on southwest angle. Navigation light has been welded to member.
	9S-10S	5	6	2	5	Lattice has been replaced with cut-out steel plate and some rivets have been replaced with bolts. Some localized corrosion noted at coating damage. Localized light pitting 1mm deep was observed on inboard surface of member. Sign previously welded to member has been reconnected with bolts. Light welded on south side. 3mm crack found at weld removal location.
	11S-12S	4	5	4	5	Pitting 6mm deep in flange representing up to 80% localized cross-sectional loss of flange thickness below sidewalk level. Member has been partially reinforced. Localized light corrosion.
	13S-14S	5	5	5	5	No crack was detected in the flame-cut hole in the northeast angle at the bolt approximately 2m above the roadway. Lattice has been replaced with cut-out steel plate and some rivets have been replaced with bolts.
Primary Components - Connections						
Main Trunnion Connections	15N/16N	5	5	3	4	Connection includes all gusset plates at 15N and 16N and member 15N-16N but does not include the trunnion collar plates at 15N or the vertical gusset plates connecting Tower Truss member 15N-17N. Crack-like initiation propagating from large perforation at base of inside vertical gusset plate between end of 14N-16N and FB16 at 16N parallel to shear stress affecting capacity. The remaining thickness of the 12.7mm plate above the perforation was determined by UT to be as low as 3mm. The south face of the interior vertical gusset plate has 3mm pitting at the interface with the top flange of 14N-16N. 6 rivet heads at the base of the interior face of the south vertical gusset plate between end of 14N-16N and FB16 at 16N have very severe section loss. The interior plate of the south triangular member behind FB16 has three perforations and 10 to 12mm section loss adjacent to the connecting clip angles. Severe pitting was also noted in the clip angles. There is a large perforation in the west transverse built-up plate (only visible when the bridge is in the open position) between the vertical gusset plates. Very severe section loss in the rivet heads and angle at the base of the exterior face of the south plate. The configuration of the connection traps water inside tower truss member 15N-18N and as a result the head end of the four bolts that secure the trunnion bearing housing to the structure has 100% section loss due to corrosion.
	15S/16S	5	5	3	4	Connection includes all gusset plates at 15S and 16S and member 15S-16S but does not include the trunnion collar plates at 15S or the vertical gusset plates connecting Tower Truss member 15S-17S. There are perforations at the base of the north and south vertical gusset plates between end of 14S-16S and FB16 at 16S. 13 rivet heads at the base of the interior face of the south vertical gusset plate at the end of 14S-16S at 16S have around 75% section loss, as does the base of the gusset plate. The exterior face of the south vertical gusset plate has 6mm pitting (50% section loss) at the interface with the top flange of 14S-16S. The exterior plate of the north triangular member behind FB16 has a large perforation at the base of the original plate. Additional perforations have been repaired by the addition of a welded plate. The upper section of the north (roadside) plate adjacent to the trunnion collar has widespread severe pitting. UT measurements indicate remaining thickness generally between 6.6mm and 9.6mm (original thickness was 12.7mm) with one location (at top of plate next to trunnion

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
						collar) of 3.3mm. The north vertical gusset plate has a perforation and a 3mm long crack in the east edge immediately above the north top flange of bottom chord 14S-16S. The north face of the plate has pitting at the interface with 14S-16S with a remaining thickness as low as 5.7mm. The rivets at the base of the north vertical gusset plate at the end of 14S-16S at 16S have been replace with bolts, and there is widespread 2mm pitting in the south face of the plate. The configuration of the connection traps water inside tower truss member 15S-18S and as a result the head end of the four bolts that secure the trunnion bearing housing to the structure has 100% section loss due to corrosion.
Through Truss Connections	0N	5	5	5	6	Some light corrosion and rust staining was noted at the vertical stiffener plate.
	1N	5	5	5	6	Light to medium pitting was noted on the interior surface of gusset plates.
	2N	5	5	2	2	The inboard gusset plate has delaminated into two segments above the bottom chord on the west and east sides over the full height of the plate. Full-width cracks were identified in both the east and west sides of the gusset plate. Vertical batten plate cut to accommodate cables. Light to moderate pitting of gusset plates. Large number of rivets replaced with bolts.
	3N	5	5	5	6	Gusset plates are in generally good condition. Light pitting 1mm deep was noted on upper surface of bottom gusset plate.
	4N	5	5	5	5	Pitting 6mm deep along the top flange of the bottom chord representing an overall 4% loss of cross-sectional area. Coating is peeling off on east side of 4N on the inboard gusset.
	5N	6	6	6	6	Gusset plates are in generally good condition. Light pitting 1mm deep near south side.
	6N	5	5	5	5	Pitting 3mm deep along the top flange of the bottom chord representing an overall 3% loss of cross-sectional area and light rust jacking was noted.
	7N	6	6	6	6	Minor pitting 1mm deep in gusset plates.
	8N	5	5	5	5	Pitting 2mm deep in inboard gusset plate representing an overall 2% loss of cross-sectional area noted along the top flange of the bottom chord.
	9N	5	5	5	5	Localized light pitting 1mm deep along top edge of gusset plates at top plate. Top of horizontal gusset plate bent at 9N.
	10N	5	5	5	5	Localized light pitting 1mm deep was noted along the top flange of the bottom chord. Severe pitting 3mm deep at base of exterior gusset plate representing an overall 3% loss in cross-sectional area and pitting 4mm deep in angle at connection with sidewalk floor beam representing an overall 30% loss in cross-sectional area.
	11N	6	6	6	6	Gusset plates are in generally good condition.
	12N	5	5	5	5	Additional plates have been welded to the west side of the inboard and outboard gusset plates. 60% very severe section loss of the inboard gusset was noted at the top flange of the BC. The remnants of a previously welded horizontal plate were observed on the inboard side of the inboard gusset on the east side of 12N. Very severe 50% section loss was observed on the east side of the inboard gusset plate along the floor beam connection.
	13N	6	5	6	5	Inboard gusset plate is slightly bent due to corrosion jacking south side of top gusset plate.
	14N	5	5	5	5	Light to moderate pitting 2mm deep in inboard gusset plate along the top flange of the bottom chord. The coating is peeling on the underside gusset plate and there is light corrosion.
	0S	5	5	5	5	Minor rust staining at bolt threads and cracks in coating.
	1S	6	6	6	6	Gusset plates are in generally good condition.
	2S	5	5	5	5	Severe localized section loss at base of exterior gusset plate and angle at connection with sidewalk floor beam.
	3S	5	5	5	5	Light pitting 1mm deep was noted on bottom gusset plate of bracing.
	4S	5	5	5	5	Pitting 4mm deep at base of exterior gusset plate representing an overall 9% loss of cross-sectional area. Severe localized section loss in angle at connection with sidewalk floor beam. Pitting 3mm deep was observed in gusset plates along the top flanges of the BC members.
	5S	5	5	5	5	Light pitting 1mm deep was noted on top of upper gusset plate close to rivet line. Top horizontal plate bent.
	6S	5	5	5	5	Severe localized section loss due to 4mm deep pitting at base of exterior gusset plate and angle at connection with sidewalk floor beam.
	7S	5	5	5	5	Light pitting 1mm deep was noted on the top surface of bottom gusset plate brace connection.
	8S	5	5	5	5	Severe localized pitting 4mm deep at base of exterior gusset plate representing an overall 3% loss of cross-sectional area. Severe localized pitting 3mm deep in angle at connection with sidewalk floor beam representing an overall 25% loss of cross-sectional area.

PWGSC BRIDGE INSPECTION MANUAL (BIM) FIELD OBSERVATION RECORD FORM

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STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	9S	6	6	6	6	Gusset plates are in generally good condition.
	10S	5	4	5	4	Severe pitting 3mm deep at base of exterior gusset plate representing an overall 3% loss in cross-sectional area and pitting 4mm deep in angle at connection with sidewalk floor beam representing an overall 30% loss in cross-sectional area. Cracks in coating at connection to floor beam.
	11S	5	5	5	5	Light pitting 1mm deep on top surface of bottom gusset plate brace connection.
	12S	5	4	5	4	Severe localized pitting 3mm deep representing an overall 7% loss of cross-sectional area at base of exterior gusset plate at connection along base with sidewalk floor beam. Lower gusset plate is collecting debris. 30% section loss of gusset plate at top flange of channels.
	13S	5	4	5	4	The outboard gusset plate connection to 12S-13S is bent. Coating failure on gusset plate connecting member 13S-13N. Buckling of the upper batten plate at node 13S was noted. Perforation of end stiffener/diaphragm at 13S.
	14S	3	2	3	2	Severe localized section loss at base of angle and localized moderate pitting in exterior gusset plate at connection with sidewalk floor beam. 50% cross-sectional loss was observed along the top flanges of the BC members. Coating failure in exterior gusset plate at recent repair locations.
Tower Truss Connections	15N	4	2	4	2	Localized pitting 2-7mm deep representing up to 70% loss of cross-section of plate, four perforations, and 80% loss of rivet head noted in the inboard gusset plate at roadway level. Water is trapped inside the connection. The short column below 15N (only visible when the bridge is the open position) is in generally good condition.
	17N	6	6	6	6	Gusset plates are in generally good condition.
	18N	4	2	4	3	Up to 30% localized section loss of the gusset plate thickness and active corrosion along the top flange of members 15N-18N and 18N-19N with a perforation noted on the inboard gusset plate.
	19N	5	3	5	3	Moderate to localized severe pitting representing 30-70% section loss of the plates noted along the vertical flange of the 19N-20N and along the underside of the bottom flange of 18N-19N. Three perforations in the upper and lower gusset plates. 50-95% section loss of rivet heads typical in bottom plate and at base of gusset plates. Active corrosion at the base of the interior face of the inboard gusset plate. Southwest triangular gusset plate is deformed.
	20N	6	6	6	6	Gusset plates are in generally good condition.
	15S	5	3	5	3	Severe pitting of the inboard gusset plate with a perforation below 15S-18S.
	17S	6	6	6	6	Gusset plates are in generally good condition.
	18S	4	2	4	2	40% severe section loss in the interior of the gusset plates along the top flange of members 15S-18S and 18S-19S plus a small perforation.
	19S	5	5	5	6	Some light pitting 1mm deep was observed in the gusset plates. Localized coating failures with active light corrosion.
	20S	6	6	6	6	Gusset plates are in generally good condition.
Counterweight Truss Connections	21N	6	6	6	6	Gusset plates are in generally good condition.
	22N	6	6	6	6	Gusset plates are in generally good condition.
	23N	6	6	6	6	Gusset plates are in generally good condition.
	24N	6	6	6	6	Gusset plates are in generally good condition.
	25N	6	6	6	6	Gusset plates are in generally good condition.
	26N	6	6	6	6	Gusset plates are in generally good condition.
	27N	6	6	6	6	Gusset plates are in generally good condition.
	21S	6	6	6	6	Gusset plates are in generally good condition.
	22S	6	6	6	6	Gusset plates are in generally good condition.
	23S	6	6	6	6	Gusset plates are in generally good condition.
	24S	6	6	6	6	Gusset plates are in generally good condition. Light pitting 1mm deep along bottom edge of north exterior gusset plate.
	25S	6	6	6	6	Light rust staining and jacking on top plate at west side.
	26S	6	6	6	6	No significant defects noted.
	27S	6	6	6	6	Gusset plates are in generally good condition.
Operating Struts	13N-17N	6	6	5	6	Operating strut has been heavily reinforced and lattice has been replaced with cut-out steel plates. Coating on the top flange and

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
						on the web has been damaged extensively by the operation of the bridge. Running and sagging in coating. Pitting up to 2mm deep in inboard web representing less than 1% loss of cross-sectional area.
	13S-17S	5	5	5	6	Operating strut has been heavily reinforced and lattice has been replaced with cut-out steel plates. Pitting up to 5mm deep representing less than 1% loss of cross-sectional area was noted in inner plate of member at edges but plate was added to outside face to strengthen member. Coating on the upper flange and on the web have been damaged extensively by the operation of the bridge. Coating along the bottom flange has also been damaged. Runs and sags observed in coating.
Primary Components – Tower Truss						
Tower Truss	15N-17N	5	3	4	3	A few lower lattice elements at base of member are bent. Localized severe pitting in flanges of channels at connection to lattice. Water is trapped inside 15N-17N at 15N and as a result there is severe pitting in the interior of the member at the connection and 5 rivet heads inboard and 2 rivet heads outboard exhibit severe to complete section loss. The standing water has also led to 100% section loss of the stiffening angles at node 15N and the bolt heads from the trunnion. Active corrosion between web plate and northwest angle at base of member. Rust jacking between web plates and light corrosion at several locations.
	15N-18N	3	4	3	4	Moderate to very severe pitting of channel flanges, generally at connection to lattice and at the base of web. Dirt and debris noted on member. Several areas of localized 10% section loss of bottom flanges. Perforation at mid-span on the inner channel. Light and localized moderate pitting is visible on members near 15N.
	17N-18N	4	5	4	5	Localized 3mm pitting in south angles at 17N gusset with rust jacking. Localized pitting 4mm deep representing an overall 15% loss of cross-sectional area in west interior angle near base of member.
	17N-19N	4	5	4	5	Pitting noted at lower connection. Up to 50% localized section loss of inner vertical components at gusset and some sagging of paint. Active corrosion of top flanges at 19N gusset plates.
	17N-21N	5	6	5	6	Bottom outside flange bent near node 17N.
	18N-19N	3	4	3	4	Localized moderate to severe pitting of channels and rivet heads at 19N. Pitting generally occurs at connection to lattice and at the base of web. Dirt and debris noted on member. Several areas of localized 10% section loss of bottom flanges. Perforations in upper and lower batten plates at node 19N and in the inner channel at mid-span.
	19N-20N	5	5	5	5	Up to 95% section loss of some rivet heads at the base of the member at 19N. Severe localized section loss of web plate at base. Impact damage to roadside east and west flanges. Active corrosion between web and southwest angle. Deformations in northeast and northwest flanges at machinery room level.
	20N-21N	5	6	5	6	Outer east and west flanges are bent.
	15S-17S	5	3	4	3	The lower connection at 15S traps water inside 15S-17S causing severe pitting in the interior of the members and many of the rivet heads exhibit severe section loss. Up to 20% localized section loss of the underside of the bottom flange at lattices near base of member. Corrosion jacking noted on inner and outer web plates near base of member. Pitting in interior of south web plate above gusset plate at 15S. Runs and sagging noted in coating. Several bent lattices.
	15S-18S	4	4	2	4	10-30% section loss of top flange of the channels at lattice. Areas of up to 80% localized section loss of bottom flange thickness and up to 70% section loss of rivet heads. Localized active corrosion and pitting of top batten plate at east end. Medium corrosion noted on flanges around bolts in channels at east end. Active rust jacking on reinforcement plate. There is a 3mm long crack emanating from a perforation in the south channel.
	17S-18S	5	4	4	5	Localized light pitting 1mm deep noted in bottom batten plate. 30% section loss of bottom gusset plates with active rust jacking causing deformation of gusset. Localized light corrosion was also noted. Street light welded on to north face of member.
	17S-19S	5	5	5	5	Localized light pitting 1mm deep noted in bottom batten plates at the level of the roadway. Minor pitting also noted in angles. Runs and sagging noted in coating. Some corrosion also noted on inner plate also at joints.
	17S-21S	5	6	5	6	Minor rust jacking of web plate.
	18S-19S	4	4	2	4	Pitting 5mm deep in bottom flange and rivet heads at joint 18S representing an overall 9% loss of cross-sectional area. 10-20% section loss around rivet heads throughout member. Section loss and perforations noted in bottom batten plates. There is a 60mm long crack emanating from a perforation in the south channel.

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	19S-20S	5	5	5	5	70% localized section loss of 6 rivet heads at base of member. Impact damage to the west flange was noted approximately 2 meters above road level. Localized light pitting 1mm deep of a vertical batten plate. Some corrosion also noted on inner plate at joints.
	20S-21S	6	6	6	6	Runs noted in coating.
Operating Pinion Struts	17N	5	6	5	5	Moderate to severe corrosion noted on the exposed sections of the strut inside the mechanical housing. Severe pitting and section loss are present outside the housing but here the truss has been cleaned and coated and exhibits no ongoing corrosion. Upper stiffeners are bent.
	17S	5	6	5	5	Moderate to severe corrosion noted on the exposed sections of the strut inside the mechanical housing. Severe pitting and section loss are present outside the housing but here the truss has been cleaned and coated and exhibits no ongoing corrosion. Upper stiffeners are bent.
Primary Components – Counterweight Truss & Link						
Counterweight Truss Members	21N-22N	5	5	5	5	Localized severe pitting 2mm deep in north and south bottom angles at first stiffener representing 15% loss of cross-sectional area of angles. Localized severe pitting 3mm deep in batten plate at this location representing 3% loss of cross-sectional area with severe section loss of four rivet heads. Some light pitting 1mm deep noted on batten plates. Some minor running and sagging in coating. Outstanding leg of lower angle in interior stiffener plate has corroded away.
	22N-23N	5	5	5	5	3 top lacings slightly bent. Light pitting 1mm deep in plates. East bottom batten plate has severe pitting along its edges, a perforation and appears to be holding water. Light corrosion at areas of coating loss from abrasion at northern upper angles.
	23N-24N	5	5	5	6	Light 2mm pitting in angles and plates at connections. Cracks in coating of lower east batten plate.
	24N-25N	5	5	5	5	5% section loss in angles and plates at connections. The lower south angle has been poorly trimmed 8mm to fit through the connection. Trim has left jagged cut. Cracks in coating at lattice to flange connections (active corrosion).
	25N-26N	5	5	5	5	5% section loss in angles and plates at connections. Cracking in coating at lattice and batten plate connection with active corrosion and rust staining.
	26N-27N	5	4	5	4	100% section loss of southern bottom flange at bracing connection (Comment from 2017 CDI report and not seen during current inspection.)
	21N-27N	5	5	2	4	Very localized area of pitting at west end at base of interior web and bottom flange representing 20% section loss of angle thickness with severe section loss of a rivet head at this location. Crack confirmed over full width of outstanding leg of lower interior angle at 27N.
	21N-23N	5	6	5	6	Light localized pitting 1mm deep of batten plate at catwalk. Bent lacing on bottom west side.
	21N-24N	5	5	5	6	Light pitting noted at 21N. Minor runs and sags in paint.
	21N-25N	6	5	6	6	Some minor pitting of batten plate noted at 21N. Minor runs and sags in paint.
	25N-27N	5	5	5	6	Localized pitting (5%) at base of member at gusset plate and batten plates. Bent angle at gusset.
	21S-22S	5	5	5	5	Pitting 2mm deep representing 15% loss of cross-sectional area in bottom angles at first stiffener. Some light pitting 1mm deep noted on batten plates. Some minor running and sagging in coating. Active rust jacking at first stiffener at top angle.
	22S-23S	5	5	5	6	Light to moderate pitting in lower east batten plate.
	23S-24S	5	5	5	5	5-10% section loss in bottom angles at gusset plates and web at inside stiffeners. Light pitting 1mm deep in batten plates.
	24S-25S	5	5	5	5	5-10% section loss in bottom angles at gusset plates and web at inside stiffeners. Light pitting 1mm deep in batten plates.
	25S-26S	6	6	5	6	Light pitting 1mm deep on batten plates. Bent gusset at 25S sway brace gusset plate.
	26S-27S	5	5	5	6	Light pitting 1mm deep on batten plates.
	21S-27S	5	5	5	5	Localized severe pitting up to 12mm deep representing an overall 50% loss of cross-sectional area at very end of vertical and horizontal flanges of bottom interior angle at west end; 40% section loss of last rivet head. Light pitting 1mm deep noted in batten plates. Rust jacking of west top batten plate.
	21S-23S	6	6	6	6	Member generally in good condition.
	21S-24S	6	5	6	6	Minor pitting in upper east plate. Sagging noted in paint.
	21S-25S	6	6	6	6	Minor pitting along south angle.
	25S-27S	5	5	5	6	Light pitting 1mm deep in end of south-west flange thickness at base of member.

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Counterweight Links	13N-22N	5	5	5	6	Pitting and section loss at connections at intersection with lattice angles. Up to 15% section loss in lower angles, rust jacking on bottom gusset plates and debris on gusset plates.
	13S-22S	5	5	5	6	Localized 15% section loss at vertical lattice near the top of the member. Deformation in gusset plate from sway braces was observed.
Primary Components – Floor System						
Roadway Floor Beams	FB0	6	6	6	5	Coating has been touched up in a few locations. Floor beam is generally in good condition. Localized light corrosion was noted at the center of the floor beam. 18 holes without bolts drilled in member at midspan.
	FB2	6	5	6	6	Minor runs and sags on web. Light pitting 1mm deep was noted on east face of the web at 2N.
	FB4	6	6	6	6	Accumulation of debris on bottom flanges. Floor beam generally in good condition.
	FB6	6	6	6	6	Accumulation of debris on bottom flanges. Floor beam generally in good condition.
	FB8	6	5	6	5	Extensive running and sagging of coating noted on underside of girder. Local deformations in floor beam web up to 16mm were observed at each stringer connection to floor beam.
	FB10	6	5	6	5	Local deformations in floor beam web up to 16mm were observed.
	FB12	6	5	6	5	Localized areas of coating failure on west side of web. Local deformations in floor beam web up to 16mm were observed.
	FB14	6	5	6	5	Local deformations in floor beam web up to 16mm were observed.
	FB16	6	6	6	6	Accumulation of debris on bottom flanges. Floor beam generally in good condition.
Sidewalk Floor Beams	0	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss.
	2	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well. Coating loss of bottom flange.
	4	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
	6	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
	8	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
	10	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well. Exterior stringer has two loose bolts in sidewalk connection.
	12	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
	14	5	5	5	5	Localized moderate pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
	16	5	5	5	5	Localized severe pitting and section loss of bottom flange and web at connection to south truss. Severe section loss of rivet heads in this area as well.
Stringers FB0-FB2	A (South)	6	6	2	5	1mm crack was noted at the eastern end top cope.
	B	5	6	2	4	A 10mm crack was noted at the eastern end bottom cope. Flaking coating on north side.
	C	5	6	5	6	A crack was noted in the coating at the top and bottom cope but does not extend into the steel. Flaking coating on north side.
	D	5	6	5	6	A crack was noted in the coating at the bottom cope but does not extend into the steel.
	E	1	4	1	4	A 15mm notch/crack in the steel was noted at the eastern end bottom cope. The crack has progressed since the 2015 inspection. Flaking coating on both sides and on cantilever stringers on east side of FB0.
	F	2	5	2	5	A 3mm notch/crack in the coating and steel was noted at the eastern end bottom cope.
	G	2	5	6	6	Member generally in good condition.
	H	6	6	6	6	Member generally in good condition.
	I (North)	6	6	6	6	Member generally in good condition.
Stringers FB2-FB4	A (South)	6	6	6	6	Member generally in good condition.
	B	6	6	6	6	Member generally in good condition.

PWGSC BRIDGE INSPECTION MANUAL (BIM) FIELD OBSERVATION RECORD FORM

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Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	C	6	6	6	6	Member generally in good condition.
	D	2	5	6	6	Member generally in good condition.
	E	6	6	2	5	A 3mm notch/crack was noted at the bottom cope at both FB2 and FB4.
	F	6	6	2	4	10mm notch/crack at bottom cope was noted at FB2.
	G	2	5	2	4	5mm notch/crack at bottom cope was noted at FB2 and 20mm notch/crack at bottom cope at FB4.
	H	6	6	6	6	Member generally in good condition.
	I (North)	6	6	2	5	3mm notch/crack at bottom cope was noted at FB4.
Stringers FB4-FB6	A (South)	6	6	5	6	Deformation of top flange near 4S.
	B	6	6	6	6	Member generally in good condition.
	C	6	6	6	6	Member generally in good condition.
	D	6	6	6	6	Member generally in good condition.
	E	6	6	6	6	Member generally in good condition.
	F	6	6	6	6	Member generally in good condition.
	G	6	6	6	6	Member generally in good condition.
	H	6	6	6	6	Member generally in good condition.
	I (North)	6	6	6	6	Member generally in good condition.
Stringers FB6-FB8	A (South)	5	6	6	6	Member generally in good condition.
	B	5	6	6	6	Member generally in good condition.
	C	5	6	6	6	Member generally in good condition.
	D	5	6	6	6	Member generally in good condition.
	E	5	6	6	6	Member generally in good condition.
	F	5	6	2	4	15mm notch/crack at bottom cope was noted at FB6.
	G	2	5	2	4	15mm notch/crack at bottom cope was noted at FB6 and 5mm notch/crack at bottom cope at FB8.
	H	2	5	2	4	15mm notch/crack at bottom cope was noted at FB6 and 7mm notch/crack at bottom cope at FB8.
	I (North)	6	6	6	6	Member generally in good condition.
Stringers FB8-B10	A (South)	6	6	6	6	Member generally in good condition.
	B	6	6	6	6	Member generally in good condition. Light corrosion on sill bolts.
	C	6	6	6	6	Member generally in good condition. Two loose sill bolts.
	D	6	6	6	6	Localized coating failure at loose sill bolts.
	E	6	6	2	5	Localized coating failure at loose sill bolts. 5mm notch/crack at bottom cope was noted at FB8 and 3mm notch/crack at top cope at FB10.
	F	6	6	6	6	Member generally in good condition.
	G	6	6	6	6	Member generally in good condition. Two missing sill bolts.
	H	6	6	6	6	Member generally in good condition.
	I (North)	6	5	6	6	Member generally in good condition. Bottom flange at west end is bent.
Stringers FB10-FB12	A (South)	5	6	5	6	Light corrosion at west connection.
	B	5	6	6	6	Member generally in good condition. One loose sill bolt and one missing.
	C	5	6	6	6	Member generally in good condition.
	D	5	6	6	6	Paint has peeled on bottom flange. One loose sill bolt and one missing.
	E	5	6	2	4	15mm notch/crack at bottom cope was noted at FB10.
	F	2	5	2	4	10mm notch/crack at top cope was noted at FB12.
	G	2	5	6	6	Member generally in good condition.
	H	5	6	2	5	A 3mm notch/crack was noted in the top cope at FB12.
	I (North)	2	5	2	5	5mm notch/crack at bottom cope was noted at FB10.

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Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
Stringers FB12- FB14	A (South)	5	6	6	6	Member generally in good condition.
	B	5	6	6	6	Peeling paint on bottom flange.
	C	5	6	6	6	Paint has peeled on bottom flange.
	D	5	6	6	6	Paint has peeled on bottom flange.
	E	5	6	2	5	Peeling paint on member. 3mm crack at top cope was noted at FB12.
	F	2	5	2	4	10mm notch/crack at bottom cope was noted at FB12.
	G	5	6	2	5	3mm notch/crack at bottom cope was noted at FB12.
	H	5	6	5	6	Member generally in good condition. Peeling paint on member.
	I (North)	5	6	6	6	Member generally in good condition.
Stringers FB14- FB16	A (South)	6	6	6	6	Member generally in good condition.
	B	6	6	6	6	Member generally in good condition.
	C	6	6	6	6	Member generally in good condition. Sill bolts are loose. There is a gap between sill and stringer.
	D	6	6	2	4	15mm notch/crack at bottom cope was noted at FB14.
	E	6	6	2	4	Majority of sill bolts are loose on south side. 20mm notch/crack at bottom cope and 25mm notch/crack at top cope was noted at FB14.
	F	5	6	2	4	The bolts connecting the sills are loose, and the sills are not in contact with stringer. The top flange at this location appears to have been worn down by approximately 1mm. 10mm notch/crack at bottom cope and 10mm notch/crack at top cope was noted at FB14.
	G	2	5	2	4	20mm notch/crack at bottom cope and 10mm notch/crack at top cope was noted at FB14. 15mm notch/crack at bottom cope and 3mm notch/crack at top cope was noted at FB16.
	H	2	5	2	4	7mm notch/crack at bottom cope. 15mm notch/crack at bottom cope and 15mm notch/crack at top cope was noted at FB16.
	I (North)	2	5	2	4	5mm notch/crack at bottom cope at FB14. 7mm notch/crack at bottom cope and 12mm notch/crack at top cope was noted at FB16.
Sills	All	5	4	5	4	The sidewalk ends of some members were noted as being deformed. Several anchor bolts to stringers were noted as missing, loose, or severely corroded and corrosion is typical where the grating has been filled with concrete. There is widespread light corrosion on the top flange where the coating has failed. The sills above stringer F between FB14-FB16 have a 6mm gap between the sills and the stringer. The majority of the sills have permanent dead-load deflection.
Primary Components - Other						
Concrete Counterweight and Housing	-	3	4	3	4	All except the north and south faces of the counterweight are covered with what appear to be corrugated metal roofing panels. Damp staining, large areas of light corrosion, stalactites, and impact damage were noted on the panels on the underside of the counterweight. The doors to the two lower chambers on the east side of the counterweight are in poor condition and are difficult to open and close. The concrete in the two lower chambers exhibits spalls, disintegration, map cracking, efflorescence deposits and wet stains. Two new small perforations were noted adjacent to the repaired sections of the panels below the chamber doors. The sections of the bottom face of the counterweight visible though gaps in the panels exhibits efflorescence deposits and wet staining. The two upper chambers in the top face of the counterweight contain concrete blocks and catch basin lids used as ballast. The concrete in the upper chambers exhibits spalls, disintegration, and wet areas. The steel plates covering the north and south faces are in good condition overall although some localized areas of deep pitting were noted, particularly in the north plate near node 26N. Some nuts on the ends of the tie rods are loose or are missing. Approximately 450mm of disintegrated concrete has collected between the concrete and the panels in the northeast corner.
Structural Steel Coating on Primary Components	-	5	6	5	5	The entire truss is coated in light green paint. A few areas have been touched up since the structure was re-coated. The coating has experienced some isolated minor damage and in hard to reach and below deck areas some deterioration was observed. See individual member for details.
Deck Grating	-	5	5	4	3	Steel grating exhibits light to medium corrosion on vertical surfaces of the bearing and cross bars. Concrete noted in some voids at east end of the deck. Bent bearing and cross bars were observed throughout the grating. Broken bars were observed at the west and east ends. Cracked bar-to-bar and bar-to-sill welds were noted at several locations. Grating panels C and D in bay 10-12 were

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
						replaced with new galvanized panels but not all bars were welded to the sills. A new armouring angle was recently installed on the east end of the deck grating which eliminated the elevation difference between the deck and the east approach armouring. The serrations have been worn away in the wheel tracks, significantly reducing traction.
Main Trunnions	15S & 15N	3	4	3	4	There is contact between the moving structure and the fixed structure in the vicinity of the main trunnion bearings during operation of the bridge. The contact is at the outboard side at both bearings and may be a result of contraction of the bridge due to temperature. Four mounting bolts at each main trunnion bearing have failed due to corrosion and should be replaced. See Mechanical section of report for full details. See Brouco report in 2018 Fatigue Inspection and Evaluation report for thickness measurements.
Counterweight Trunnions	21S & 21N	3	4	3	4	The sleeve studs used to secure the bearing sleeves to the structure are not tight at some locations. There is strong evidence that there are at least two broken studs: the west-most nut on the inboard side of the south trunnion bearing, and the top east stud at the outboard side of the north trunnion. Based on paint removal, it appears that there has been an attempt to tighten them, but that this was unsuccessful. Maintenance personnel have previously indicated that they used a hammer to drive one of the north counterweight bearing studs in while operating the bridge. This is an indication that the stud has sheared. The results of the phased array testing indicate corrosion is present on the upper surface of both the north and south shafts. See Mechanical section of report for full details. See Brouco report in 2018 Fatigue Inspection and Evaluation report for thickness measurements.
Abutments	East	4	6	5	6	The majority of the abutment wall is not visible. The bearing seat is in good condition. Minor accumulation of dirt and debris noted on bearing seat.
	West	4	6	5	6	The majority of the abutment wall is not visible. Minor accumulation of dirt and debris noted on bearing seat. Area of severe scaling on the bearing seat north of the truss and a shallow area of disintegration at the south end.
Foundations	-	6	6	6	6	Foundations below ground. No visible evidence of instability.
Waterway	-	6	4	5	5	No visible flow obstruction or obstructions which would impede navigation were noted during our inspection. The seated limit switches on the east abutment were found to have water inside which may be a result of high tide and/or storm conditions.
Secondary Components – Through Truss						
Upper Cross Bracing	1S-3N	6	5	6	5	Light to localized moderate pitting 2mm deep was noted on the lower vertical angle above gusset at the south end of the member at the connection. Light section loss of rivet head. Light pitting 1mm deep at 3N.
	1N-3S	6	5	6	5	Light pitting 1mm deep observed on bottom flange of angle near connection and on upper surface of batten plate connecting members.
	3S-5N	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep in both flanges at 5N. Light pitting 2mm deep in lower batten plate.
	3N-5S	6	6	6	6	Upper lateral bracing generally in good condition. Pitting 4mm deep in center of cross brace and light pitting 1mm deep on upper surface of lower batten plate and angle.
	5S-7N	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate and angle.
	5N-7S	6	5	6	5	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate and top surface of bottom horizontal flange near 7S and 5N.
	7S-9N	5	5	5	5	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate. Localized light pitting on bottom flanges of angle near cross connection.
	7N-9S	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate and angle.
	9S-11N	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate and bottom flange.
	9N-11S	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate and bottom flange of member.
	11S-13N	6	6	6	6	Upper lateral bracing generally in good condition. Light pitting 1mm deep on upper surface of lower batten plate. Light corrosion jacking between upper batten plate and member. Light section loss of rivet head near 11S. Pitting 2mm deep at center connection of bottom flange and web plate.
	11N-13S	6	5	6	5	Upper lateral bracing generally in good condition. Light pitting on upper surface of lower batten plate. Light corrosion jacking

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
						between upper batten plate and member. Pitting 2mm deep at center connection of bottom flange and web plate.
Lateral Struts	1S-1N	6	5	5	5	Generally, in good condition. Strut located directly adjacent to east portal truss has rust jacking throughout top plate and flange. Light pitting was noted throughout vertical flange. Pitting 2mm deep in lower gusset at east end. Disused welded sign support on the east side.
	3S-3N	6	5	5	6	Generally, in good condition. Light 1mm pitting was noted on lattice and on the top surface of bottom angle.
	7S-7N	6	5	5	6	Light 1mm pitting was noted on the bottom flange in north section. Loss of 15% of 2 rivet head was observed at connection 7S.
	11S-11N	6	5	5	6	Generally, in good condition. Light pitting 1mm deep was noted on top surface of bottom horizontal flanges. Light section loss of rivet head near 11S.
Portals	1S-1N	5	5	5	5	Portal truss consists of a single built-up member composed of lattice on 4 sides with steel angles forming the corners. Impact damage was present on lower west angle. Six lattice on the bottom and west side of the truss are bent. Small perforation in western angle at 1S. Localized coating loss and light corrosion. Light pitting 1mm deep on top surface of several lattice at west and east connection. Water ponding in lower angle. Very severe section loss of south batten plate. There is a crack in the weld connecting the vertical clearance sign to the member. Localized light corrosion.
	13S-13N	5	5	5	5	Portal truss consists of a bottom and top chord and 3 cross braces. Portal truss is generally in good condition with bottom chord and cross bracing exhibiting medium pitting 2mm deep representing an overall 15% loss of cross-sectional area. Small perforations observed near 13S. Light pitting 1mm deep is also typical on top surface of bottom angle. Severe section loss was noted in the bottom gusset plate and south top chord. Localized coating loss and light corrosion. Bent lattice in bottom chord. Lattice severely bent along the top member above south lane. Light rust jacking at connections.
Sway Bracing	5S-5N	4	5	4	5	Two moderate impact damage observed in bottom chord of sway bracing above westbound lane. East angle has been significantly deformed (38mm vertically). Deformed top flange of chord at north and south connection. Localized light corrosion and coating failure at impact locations. Light pitting 1mm deep was noted on top surface of horizontal flanges.
	9S-9N	5	5	5	5	Minor impact damages observed in bottom flange of sway bracing above the westbound lane. The east angle forming the bottom chord has been deformed (at 2 locations, approximately 20mm). Deformed top chord at north and south ends (10mm). Light corrosion and local loss of coating at impact locations. Light pitting 1mm deep on top surface of bottom flange and in vertical connection plates.
	13N-13S	5	5	5	5	Sway bracing consists of built-up truss spanning between the top chord members 13S-11S and 13N-11N. Local area of perforation ($100mm^2$) was observed at 13S. Light pitting 1mm deep throughout top surface of bottom angle was noted.
Secondary Components – Tower Truss						
Tower Truss Sway Bracing	17N-20N	5	5	5	5	Sway bracing consists of a truss spanning between member 17N-21N and 20N-21N. Bent lattice in lower south section of truss near Joint 17N. Localized corrosion jacking between clip and angle and gusset plate at lower east gusset plate. Localized light pitting 1mm deep on batten plates and angles.
	17S-20S	5	5	5	5	Sway bracing consists of a truss spanning between member 17S-21S and 20S-21S. Truss is generally in good condition.
	20N-20S	4	4	4	4	Sway bracing consists of a truss spanning between member 20N-21N and 20S-21S. Deep pitting 4mm deep and large perforations were noted in the lower north and south batten plate and angles representing 40 to 100% loss of cross-sectional area in batten plates and 40% in angles. Several severely deteriorated rivet heads were observed at connections. Pitting up to 3mm deep representing an overall 15% local loss of cross-sectional area was noted in most angles that make up the bracing truss. Pitting 5mm deep representing an overall 20% loss of cross-sectional area was noted in the bottom east angle at 20N and seven rivet heads have almost 100% section loss on both east and west sides. Very severe section loss of four rivet heads on the east side of bottom angle near 20S.
	21N-21S	4	4	4	4	Sway bracing consists of a truss span between member 21N-17N and 21S-17S. Lower batten plate at north end on lower chord exhibits severe pitting and perforations. Numerous rivet heads showing greater than 50% section loss were noted. Moderate pitting noted on upper batten of top chords at both ends of chord. The east flange of the northern connection to member 17N-21N has been trimmed to accommodate the mechanical house. Active corrosion of east flange at south bottom connection. Impact damage of top flange of western brace at south end.
Secondary Components – Counter Weight Truss & Link						

PWGSC BRIDGE INSPECTION MANUAL (BIM) FIELD OBSERVATION RECORD FORM

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STRUCTURE: LaSalle Causeway - Bascule Bridge

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
Counterweight Truss Lateral Struts	West 21N-21S (21-27 Plane)	5	5	5	5	The west lateral member spans between 21N-21S just west of joints 21N/S. Lower west and east angles: 20% localized section loss of horizontal and vertical legs thickness over 1000mm at north and south ends; 30% section loss in 5 rivet heads at north end and 5 rivet heads at south end; up to 20% localized section loss of gusset plate thickness typical.
	East 21N-21S (21-22 Plane)	5	5	5	5	The east lateral member spans between 21N-22N and 21S-22S just east of joint 21S/N. Moderate pitting 2mm deep was noted on the horizontal flanges of the lower angles representing an overall 10% loss of cross-sectional area.
	Center 21N-21S (21–24 Plane)	5	5	5	5	The center lateral strut spans between the bases of 21N-24N and 21S-24S. Plates have been installed on the lower west angles at the ends of the member to reinstate the cross-sectional area lost through the severe pitting and perforations in the angles and rivets at these locations. Localized areas of coating are beginning to fail on the bolts at the north end. The west lower angle has 2mm deep pitting along the length of the member.
	Upper 22N-22S	5	5	5	5	The upper strut is located just west of the joints 22N/S along members 22N-23N and 22S-23S. Light localized pitting 1mm deep representing 10% section loss of east lower flange thickness at ends of upper bracing member. 1 bent lattice member was observed. Repairs have been previously carried out at the lower south gusset plate connection.
	Lower 22N-22S	4	4	4	4	The lower strut is located just west of joints 22N/S along members 22N-21N and 22S-21S. Light pitting 1mm deep representing 10% localized section loss of lower flange thickness along length of lower bracing member with typical pitting of the angle horizontal flanges. 30% section loss of lower east angle along its entire length with perforations and section loss at the south gusset plate connection.
	23N-23S	4	5	4	5	Pitting up to 2mm deep representing 20% localized section loss of bottom flange thickness of west angle at north end of gusset plate connection with active corrosion. Light pitting 1mm deep in bottom and vertical flanges of east lower angle. Localized corrosion staining and severe pitting in lower gusset plates.
	24N-24S	5	5	5	5	8 small holes located in flanges. Member strengthened with plate and bolts at connections. The coating is in good condition. Severe pitting and section loss in bottom angles at 24S and 24N and perforation of east angle.
	25N-25S	5	5	5	5	Flanges at north end are bent. Pitting and 15% section loss were noted in the angle. Coating in good condition.
Counter Weight Truss Cross Bracing	21S-22N	6	5	5	6	Light localized pitting 1mm deep at connections.
	21N-22S	6	5	5	6	Light localized pitting 1mm deep at lower connection.
	22S-23N	5	5	5	5	Light pitting 1mm deep in bottom flange typical. Top flange slightly bent at mid-span of north-west section. Localized area of 10% section loss of south-east bottom flange around rivets. 15% localized section loss of south-east gusset plate thickness, but plate has been previously repaired.
	22N-23S	5	5	5	5	Light pitting 1mm deep of the bottom angles is typical. Pitting in bottom gusset plate at 22N along 22N-23N resulting in 10% section loss.
	23S-24N	5	5	5	5	A bent lattice and section loss in the gusset at 23S were noted.
	23N-24S	6	6	5	6	Rust jacking on south end. Light corrosion at chips in paint. Light pitting less than 1mm deep in center of gusset plate.
	24S-25N	5	5	5	5	Pitting on middle plate connecting bracing and gusset plate at 24S.
	24N-25S	5	5	5	5	20% localized section loss of bottom flange thickness at north-east end at gusset plate.
	25S-26N	5	6	5	6	Minor rust jacking at south end gusset plate has bent the gusset plate.
	25N-26S	5	6	5	6	Minor rust jacking at end and center gusset plates. Light corrosion on rivets.
	21S-27N	5	2	5	2	North-west end: 100% section loss of full width of horizontal lower leg plus many small perforations. Member has been previously strengthened, however, the strengthening has not addressed the connection of the lower angle to the gusset plate. South-east end: 10% localized section loss of lower horizontal leg thickness at lattice.
	21N-27S	5	4	5	4	North-east end: 50% section loss of horizontal upper leg thickness over 750mm length; some pitting in horizontal lower leg. South-west end: 50% localized section loss of lower vertical leg thickness, 100mm x 100mm.
	21S-24N	6	5	6	6	Minor pitting at connections to plates. Minor runs and sags in coating.
	21N-24S	6	5	6	6	Minor runs and sags in coating. Minor pitting on connection plates.

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Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
Counterweight Link Lateral Bracing	13N-13S	5	5	5	6	Localized pitting 1mm deep was noted at connections.
	13.5N-13.5S	5	5	5	5	Localized light pitting noted. 5% section loss of bottom flange thickness along length of member. Debris on north and south lower gusset plates. Top north and south gusset plates are slightly bent.
	22N-22S	5	5	5	5	Localized light pitting noted. 5% section loss of bottom flange thickness along length of member.
	13S-13.5N	5	5	5	6	Localized pitting 1mm deep was noted at connections.
	13N-13.5S	5	5	5	6	Localized pitting 1mm deep was noted at connections.
	13.5S-22N	5	5	5	6	Localized pitting 1mm deep was noted at connections.
	13.5N-22S	5	5	5	6	Localized pitting 1mm deep was noted at connections.
Secondary Components - Deck						
Lower Cross (Bottom Chord) Bracing	0S-2N	6	6	6	6	Member is slightly deformed.
	0N-2S	6	6	6	6	Member is slightly deformed.
	2S-4N	5	6	5	6	Minor pitting 1mm deep noted on underside of bracing at north end.
	2N-4S	5	6	5	6	Minor pitting 1mm deep noted on underside of bracing at north end. Paint coating has failed at centre of span.
	4S-6N	5	6	5	6	Minor pitting 1mm deep noted at connections.
	4N-6S	5	6	5	6	Minor pitting 1mm deep noted at connections. Pitting 2mm deep on east and north side in gusset plate representing an overall 2% loss of cross-sectional area.
	6S-8N	6	6	5	6	Accumulation of debris on bottom flanges. Coating failure with rust staining and corrosion on member and gusset plate at 8N.
	6N-8S	6	6	5	6	Accumulation of debris on bottom flanges. Pitting 2mm deep on east and north side in gusset plate representing an overall 2% loss of cross-sectional area.
	8S-10N	6	6	5	6	Pitting 2mm deep in gusset plate.
	8N-10S	6	6	6	6	No significant defects noted.
	10S-12N	5	5	5	5	Moderate pitting at connections. Rust staining and cracked paint at centre of span.
	10N-12S	5	5	4	4	Moderate pitting at connections. Rust staining and cracked paint at centre of span and at end connections. Deformation of gusset plate at 10N with light corrosion at connection. Severe deformation of member. Lug angle at 12S is deformed from previous rust jacking. Delamination of coating.
	12S-14N	5	5	5	5	Moderate pitting at connections. Rust staining and cracked paint at centre of span.
	12N-14S	5	5	5	5	Moderate pitting 2mm deep at connections. Rust staining and cracked paint at centre of span and at 14S.
	14S-16N	5	6	5	6	Moderate pitting at connections. Coating peeling at underside of connection plate.
	14N-16S	5	6	5	6	Moderate pitting at connections.
Sidewalk Floor Beam Bracing	0S-2S	5	6	5	6	Member is sagging but is in good material condition.
	2S-4S	5	6	5	6	Member is sagging but is in good material condition.
	4S-6S	5	6	5	6	Member is sagging but is in good material condition.
	6S-8S	5	6	5	6	Member is sagging but is in good material condition.
	8S-10S	5	6	5	6	Member is sagging but is in good material condition.
	10S-12S	5	6	5	6	Member is sagging but is in good material condition.
	12S-14S	5	6	5	6	Member is sagging but is in good material condition.
	14S-16S	5	6	5	6	Member is sagging but is in good material condition.
Secondary Components - Other						
Mechanical Platform and Housing	-	5	5	4	5	The mechanical platform supports the drive motors and machinery and consists of structural steel members embedded in a reinforced concrete slab; the housing walls consist of corrugated steel panels; the housing roof consists of steel members overlain by a membrane style flat roof with three access hatches. The underside of the concrete slab exhibits light to moderate scaling, light honeycombing, several light to medium spalls with exposed rebar and delaminated areas. These delaminated areas are over the traffic lanes and pose a risk to vehicles passing underneath. The top surface of the slab is in good condition with no obvious defects noted.

Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
						The structural steel members have been coated inside with black paint and are generally in good condition overall. There is a hole in the web of the center beam. Severe corrosion on bottom flanges of northeast and southeast angled braces. 5mm section loss in top flange of north motor support beam at west end caused by water leaking into housing. Pitting 7mm deep in bottom flange of east girder at second from south catwalk cantilever support. Very severe rust jacking at west end of bottom flange of second from south and north lower beams. Corrugated steel cladding has been coated and is generally in good condition with old perforations noted around steel framing. Flat roof is sheathed with asphaltic membrane. Indication of leakage was noted on the north wall, at the centre, and in the northwest corner of the mechanical housing.
Structural Steel Coating on Secondary Components	-	6	6	5	5	The entire truss is coated in light green paint. A few areas have been touched up since the structure was re-coated in 2010. The coating has experienced some isolated minor damage and in hard-to-reach or below-deck areas some localized deterioration was observed. Generally, though the coating is in like new condition. See individual members for details.
Joints	-	6	4	5	4	The joints at the ends of the deck are open. On the approaches the top of the ballast wall is exposed and an armoring angle is provided which protects the leading edge of the ballast wall. A new armoring angle was recently installed on the east end of the deck grating to eliminate the elevation difference between the deck and the east approach armouring. The top of the ballast walls exhibits moderate scaling and wear at the armoring angle and several transverse wide joints. 50% of west joint armoring sounds hollow when sounded.
Railings	Pedestrian	6	6	6	6	Pedestrian railing on the south side of the sidewalk and on southeast and southwest approach sidewalks is a galvanized steel railing consisting of steel HSS section rails and posts and steel mesh. The railings are in good condition with no significant defects noted.
	Operator's House	Not Rated	Not Rated	4	4	The cast iron railings between the Operator's House and the north trunnion were in poor condition at the time of the inspection, as two posts nearest to the trunnion had perforations at the base over at least 60% of the width of the post (Photo S105). These posts were repaired in October 2018.
	North Roadway	6	4	5	4	North railing consists of thrie beam guide rail with a lattice railing. Guide rail is generally in good condition. Several bolts were observed to be missing from splices in the guide rails. Light corrosion on west end of guide rail and handrail splice at 9-11. The existing barriers do not meet current CHBDC crash-tested requirements (in terms of geometry and direct attachment to the truss) and could subject primary members of the main truss to damage or failure during vehicle collision along the barrier. The top rail is 1.40m above the deck grating and therefore the railings meet the CHBDC minimum height requirements of 1.37m for combination traffic/bicycle barriers.
	South Roadway	6	4	5	4	South railing consists of thrie beam guide rail with a lattice railing. Guide rail is generally in good condition. The railing currently leaves a large gap at the trunnion which could allow a pedestrian to fall into the roadway. Several bolts were observed to be missing from splices in the guide rails. Post at east end has been anchored with lag bolts into sidewalk planks. Light corrosion at west end of thrie-beam and throughout east end of diagonal. Coating flaking on handrail. The existing barriers do not meet current CHBDC crash-tested requirements (in terms of geometry and direct attachment to the truss) and could subject primary members of the main truss to damage or failure during vehicle collision along the barrier. The top rail is 1.40m above the deck grating and therefore the railings meet the CHBDC minimum height requirements of 1.37m for combination traffic/bicycle barriers.
Curb	North	5	5	5	5	Impact damage to east end of timber curb. A few narrow and medium splits and checks were noted. Several bolts used to anchor the curbs were noted to be missing nuts. Curb is not anchored at the east end.
Sidewalk	South	6	5	5	5	Some light to medium splitting and checks in sidewalk timber decking. Sidewalk is only 1.2m wide at truss panel points. Several bolts holding down sidewalk planks on roadway are missing nuts. Curb section at west end not anchored correctly. There are some protruding screws at the west end.
Ballast Walls	East	5	6	5	6	Map cracking with damp staining and some efflorescence deposits noted at south end of east ballast wall. Several hairline and narrow vertical cracks also observed.
	West	5	6	5	6	Several hairline and narrow stained cracks noted on ballast wall.
Wingwalls	SE	5	6	5	6	Extensive concrete repairs were previously carried out with a new section of wall cast. Extensive light honeycombing was noted and a 10mm wide vertical crack extending into the sidewalk was present at the east end in the original concrete.

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Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	SW	5	6	5	6	Extensive concrete repairs were previously carried out with a new section of wall cast. Very severe spall (2m x 2m) at base of wall was observed beyond repaired section at east end at the interface with the abutment. Medium horizontal crack at east end.
Abutment Bearings / Live Load Supports	East Abutment	4	6	4	5	At the east abutment 2 large pedestal bearings (live load supports) are provided. The northwest anchor bolt of the south bearing is bent and has medium to severe corrosion on the lower section. Light corrosion was noted on the anchor bolts and on some steel plates of the north and south bearings. The bottom of the north bearing is covered in dirt and debris. The north side of the leaf span is not fully seated on the north bearing with a gap of approximately 2mm noted. Under live load the span becomes fully seated. Light corrosion was noted on the bearing plates of the buffer supports.
Approach Slabs	East	4	3	4	3	The east end of the approach slab is lower than the west end, suggesting differential settlement has occurred. In addition, two wide transverse cracks near the centre of the slab are at the same location as wide cracks in the curb, sidewalk and southeast wingwall. Settlement was also noted in the adjacent sidewalk and curbs. The interface between the slab and the adjacent asphalt wearing surface has opened up especially on the north side - spalling was noted at the east end of the slab on the north side and the adjacent asphalt is cracked and forming potholes. There is a wide transverse crack at the west end of the slab at the interface with the top of the ballast wall. The slab has widespread abrasion/wear from vehicles.
	West	4	4	4	4	Longitudinal wide transverse cracks noted. The slab has widespread abrasion/wear from vehicles. The wide gap (up to 35mm) at the interface with the ballast wall is only partially sealed.
Guide Rails	NE	5	4	5	1	Guide rail is not (and cannot be) connected to the structure. Minor impact damage to east end treatment. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards.
	NW	5	5	6	1	No significant material defects noted. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards.
	SW	5	4	4	1	Posts are breakaway type which may allow the railing to move onto the sidewalk in the event of a vehicle impact. The 7th and 8th posts from the west end have been damaged by vehicular impact and require replacement. Minor damage to steel channel. The spacing of the guide rail posts adjacent to the connection to the structure does not meet current MTO standards.
Embankments not Supporting Foundations	SW	6	6	6	6	Embankment generally in good condition with no significant scour or erosion noted.
	SE	6	6	6	6	Embankment generally in good condition with no significant scour or erosion noted.
Auxiliary Components						
Slope Protection	SW	6	6	6	6	Armor stone is in good condition and performing well.
	SE	6	6	6	6	Armor stone is in good condition and performing well.
Marine Structures	SW	6	6	5	6	Multiple piles have splits and rot. The fourth and fifth safety line posts from the north end are loose. Cables around the southern dolphin are corroded and loose. The second safety line post from the north end is wooden rather than steel.
	SE	5	6	5	6	Several fenders have splits including a severe split in the top east fender at the north end. Some nuts are missing or are loose in bottom fenders. Some vegetation growth on top of walers.
Signs	-	Not Rated	Not Rated	Not Rated	Not Rated	Object Marker signs are provided at all four corners and are in generally good condition.
Utilities	-	Not Rated	Not Rated	Not Rated	Not Rated	The submarine cables were replaced in 2012 and were noted to be in good condition during the 2015 underwater inspection. A number of the original cables are still in place, but it is unclear if they are still in service.
Catwalks	17N-17S	5	5	5	5	Catwalk at mechanical room generally in good condition. Some light corrosion on grating. The east c-channel supporting the catwalk outside the mechanical room is supported by the tapered cantilevered members below but only 25mm of the bottom flange is actually supported. Opening next to mechanical house at the south end is a fall hazard. Third post from north end is cracked.
	21N-21S	5	2	5	2	East support for cantilevered platform on north side has a severe perforation, reducing bolt edge distance to almost zero. Rust jacking on top flange of channel is typical. East and west supports for cantilevered platform on south side have a severe perforation and severed rivet. The west railing has two open sections (leading to ladders) which are a potential falling hazard. The safety cages at the ladders at the ends of the catwalk are too short which is a potential falling hazard. Light corrosion on floor grating.
	22N-22S	5	6	5	6	East handrail is bent at north end. 2 cracked welds in railing at northeast corner.

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STRUCTURE: LaSalle Causeway - Bascule Bridge

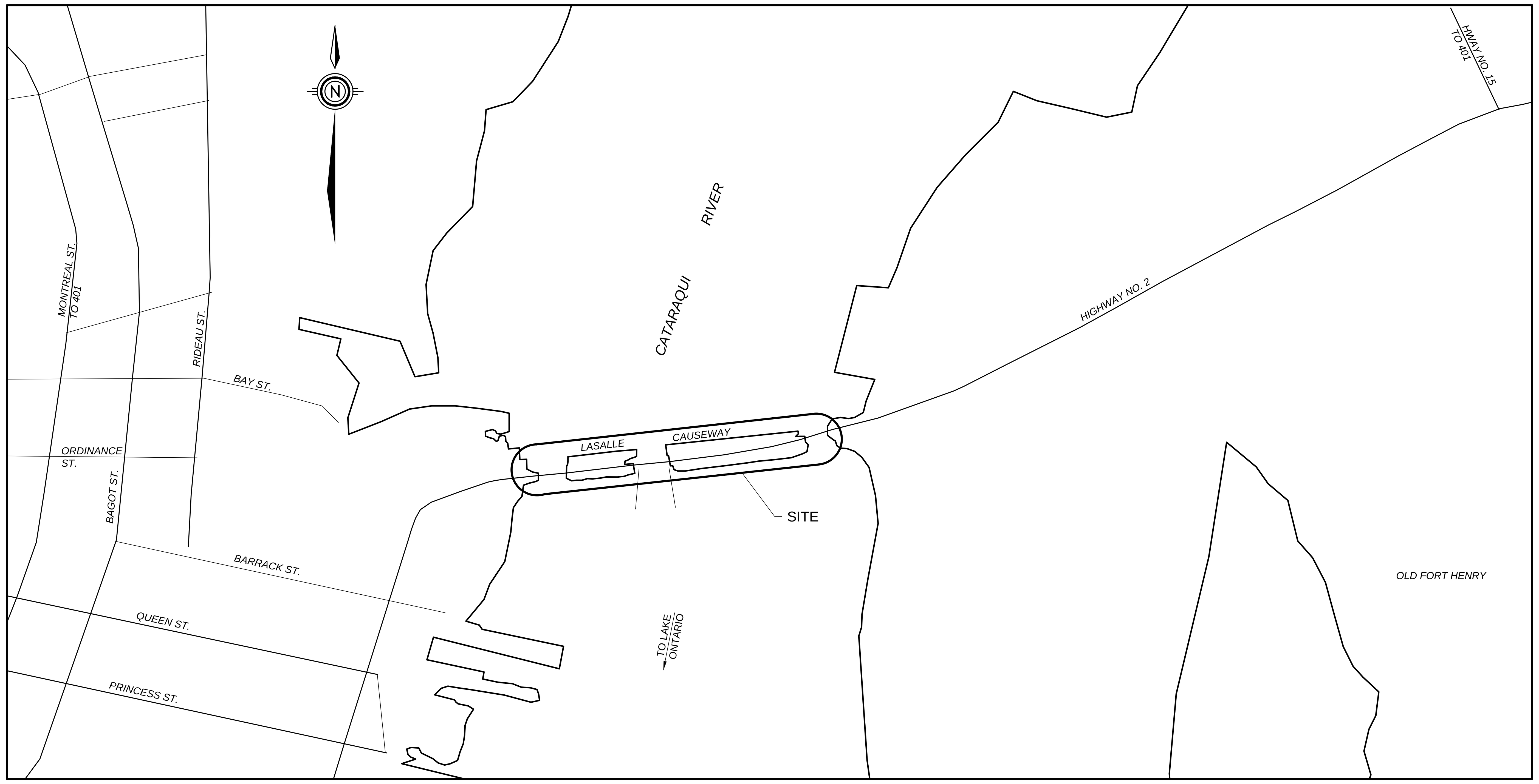
Element	Member	Previous MCR	Previous PCR	New MCR	New PCR	Comments
	Counter Weight (21-27)	5	4	5	4	3 posts on the north side of the catwalk have split vertically over half their height. There is no safety chain or gate at the west end of the catwalk preventing access onto the counterweight roof.
Stairs	15N-17N	5	6	5	6	Access staircase generally in good condition with local light corrosion on south handrail post at bottom.
	15S-17S	5	6	5	6	Access staircase generally in good condition.
	17N-21N	4	5	4	5	Top handrail on north side of north truss is bent. Severe pitting 3mm deep in channels representing an overall 30% loss of cross-sectional area and pitting 3mm deep in supporting angles at steps typical representing an overall 20% loss of cross-sectional area. Cracked weld at top of north rail inclined section. Perforation in north support at 17N. Southwest post on platform below 21N is split.
	17S-21S	5	6	5	5	Light corrosion and split post on north side. Handrail bent at several locations. Severe pitting 3mm deep in channels representing an overall 30% loss of cross-sectional area and pitting 3mm deep in supporting angles at steps typical representing an overall 20% loss of cross-sectional area. Light corrosion on washers on steps typical.
	21-22	3	3	3	4	Large perforation (225mm^2) in north top flange at 3rd step from the top, and in south web at 11th step from bottom and top step; several small perforations in north and south beam at bottom step. Severe pitting 3mm deep and 4mm^2 perforation in south channel web at the top step representing an overall 40% loss of cross-sectional area. Pitting 2mm deep in webs at some steps representing an overall 20% loss of cross-sectional area.
Chain Link Fence	Southwest	6	6	6	6	No significant defects noted. Vegetation is covering fence.
	Southeast	6	6	6	6	No significant defects noted.
	East	6	6	6	6	No significant defects noted.
Lighting	North, South	Not Rated	Not Rated	Not Rated	Not Rated	Navigation lights are welded to vertical member 7S-8S and 7N-8N and appear to be in general good material condition. Roadway lights are welded to through truss verticals 3N-4N and 11N-12N and appear to be in general good material condition.

Note: 2018 observations / comments in blue text.

Appendix B– General Arrangement and Deterioration Drawings

Public Services and
Procurement Canada

Services publics et
Approvisionnement Canada



KEY PLAN

LIST OF DRAWINGS:

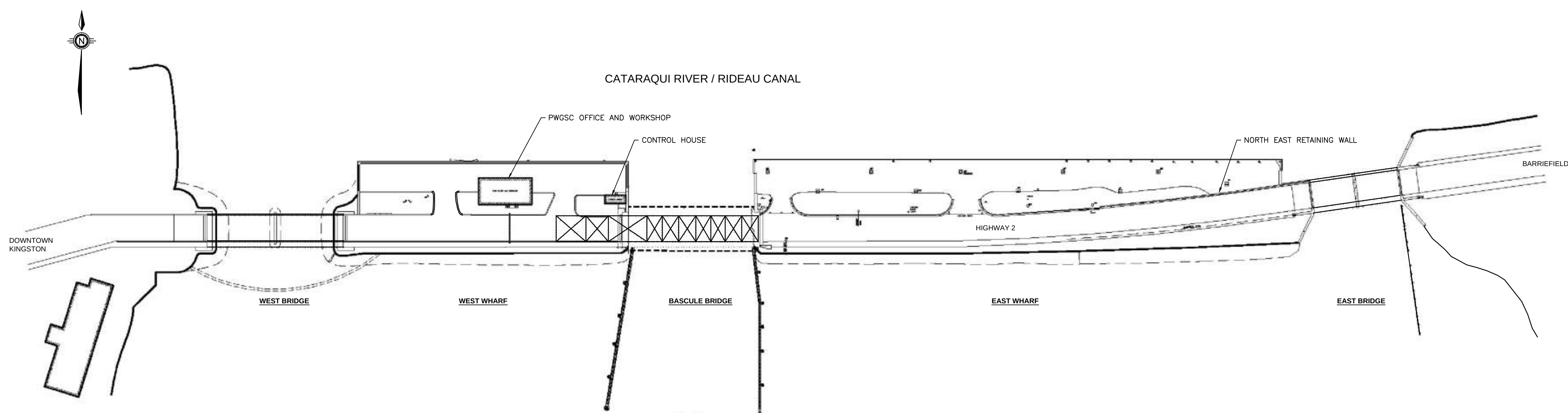
- B01 SITE PLAN
- B02 GENERAL ARRANGEMENT
- B03 FLOOR SYSTEM - STRINGER DETERIORATION
- B04 FENDER WALL DETERIORATION

LASALLE CAUSEWAY BASCULE BRIDGE
2018 COMPREHENSIVE DETAILED INSPECTION
(CDI)

PROJECT R.090045.001

04 11

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 millimetres



PLAN
1:750

Public Services and Procurement Canada
Services publics et Approvisionnement Canada

PARSONS

revision	description	date

Do not scale drawings.
Verify all dimensions and conditions on site and immediately notify the engineer of all discrepancies.

A Detail No. No. du détail
B drawing no. – where detail required dessin no. – où détail exigé
C drawing no. – where detailed dessin no. – où détaillé

project title
titre du projet

LaSALLE CAUSEWAY
BASCULE BRIDGE
2018 COMPREHENSIVE DETAILED INSPECTION

KINGSTON ONTARIO

drawing title
titre du dessin

SITE PLAN

drawn by
dessine par
R. DYNKA

designed by
conc par
E. BOULAY

approved by
approuve par
P. HARVEY

tender
soumission
PARVIZ AFROOZ
P. Eng, P.E.
project manager
administrateur de projets

project date
date du projet
DECEMBER 2018

project no.
no. du projet
R.090045.001

drawing no.
dessine no.
B01

GSC-B1 DATE PLOTTED: YYYY/MM/DD PLOT SCALE: PLOT_SCALE CAD FILE: S:\PRS\CAD\GROUP\CITY\ADDRESS\PROJECT NO\FILE.DWG

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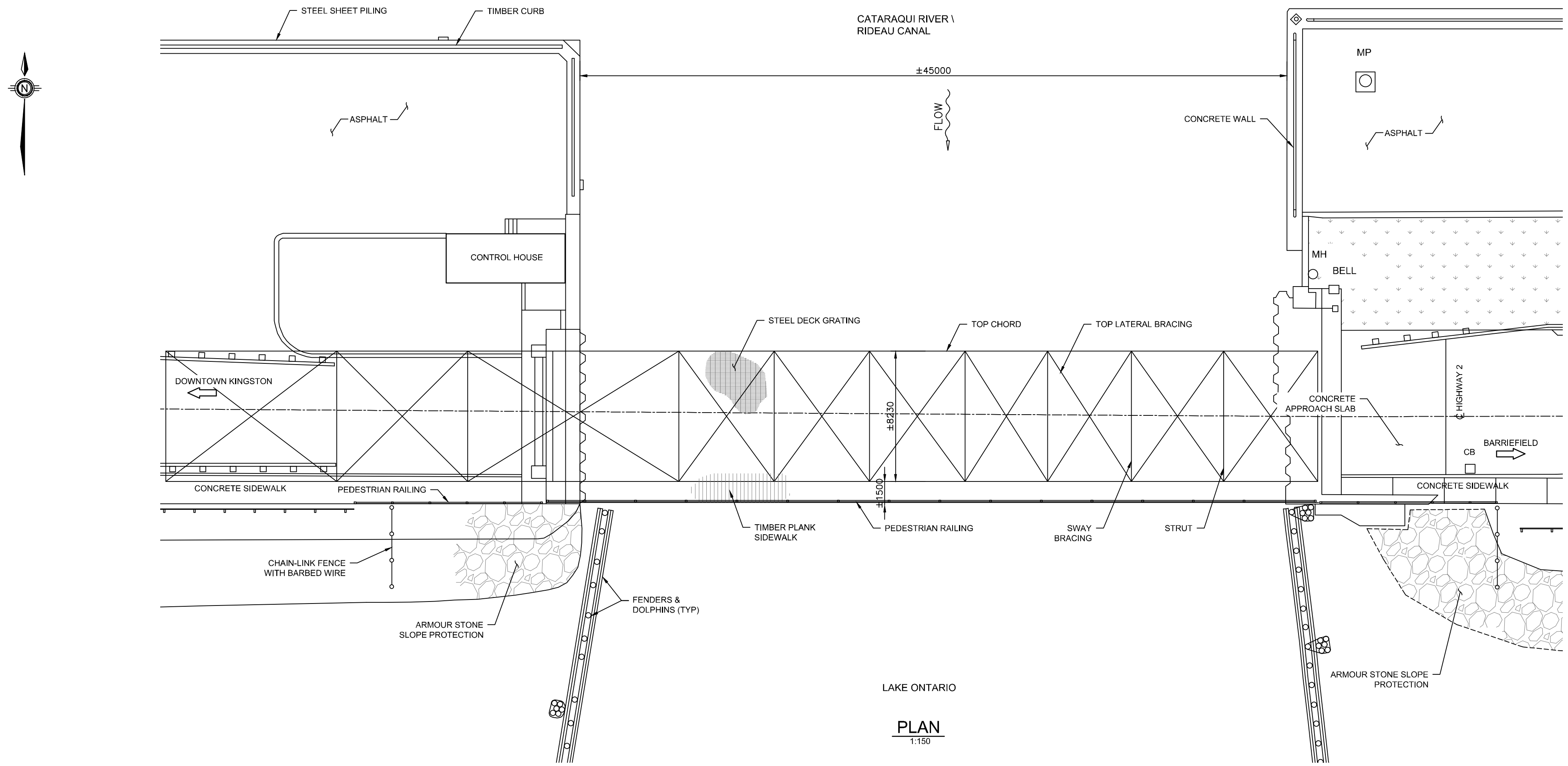
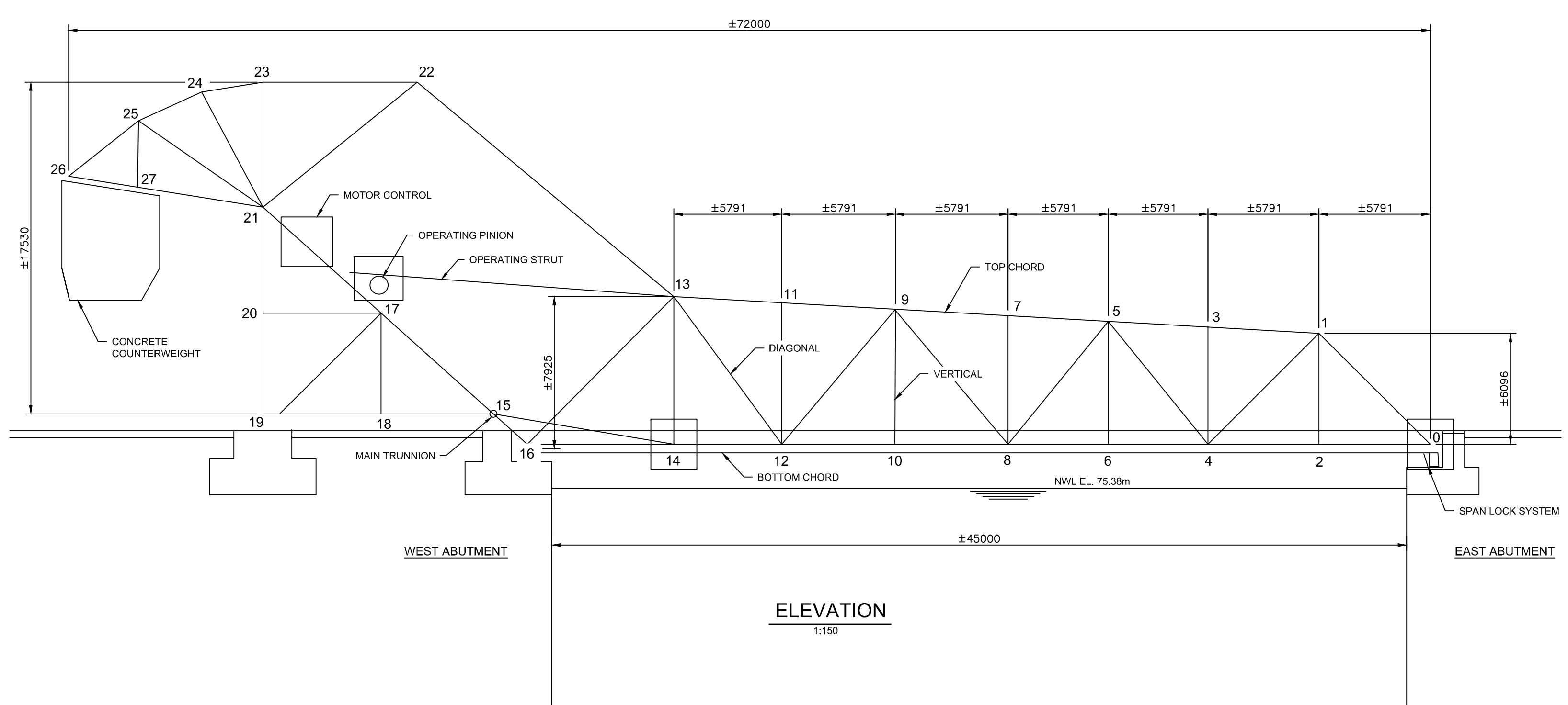
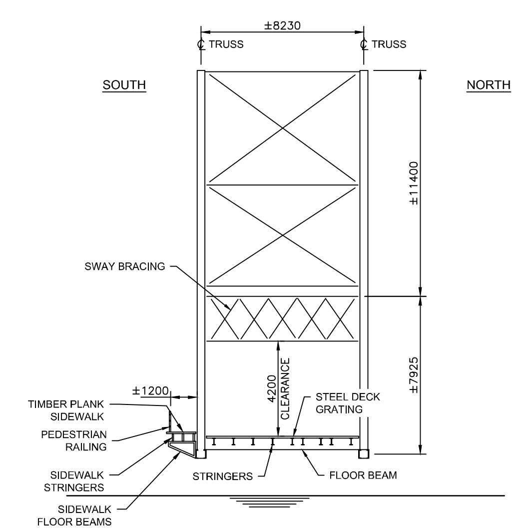


PLAN
1:150



ELEVATION
1:150



SECTION
1:150

Public Services and Procurement Canada
Services publics et Approvisionnement Canada

PARSONS

revision	description	date

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A Detail No. / No. du détail
B drawing no. – where detail required / dessin no. – où détail exigé
C drawing no. – where detailed / dessin no. – où détaillé

project title / titre du projet
LaSALLE CAUSEWAY BASCULE BRIDGE
2018 COMPREHENSIVE DETAILED INSPECTION
KINGSTON ONTARIO

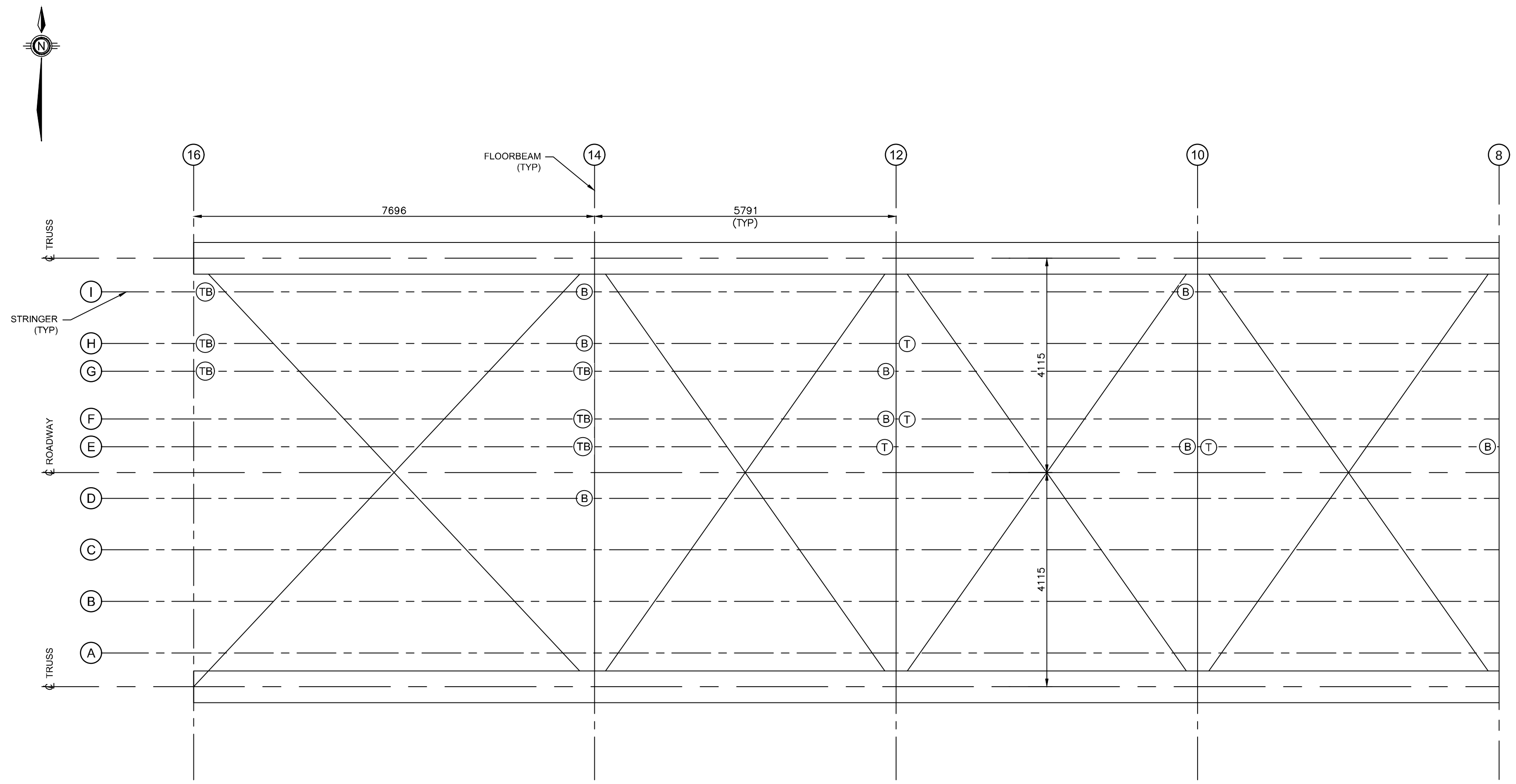
drawing title / titre du dessin
GENERAL ARRANGEMENT

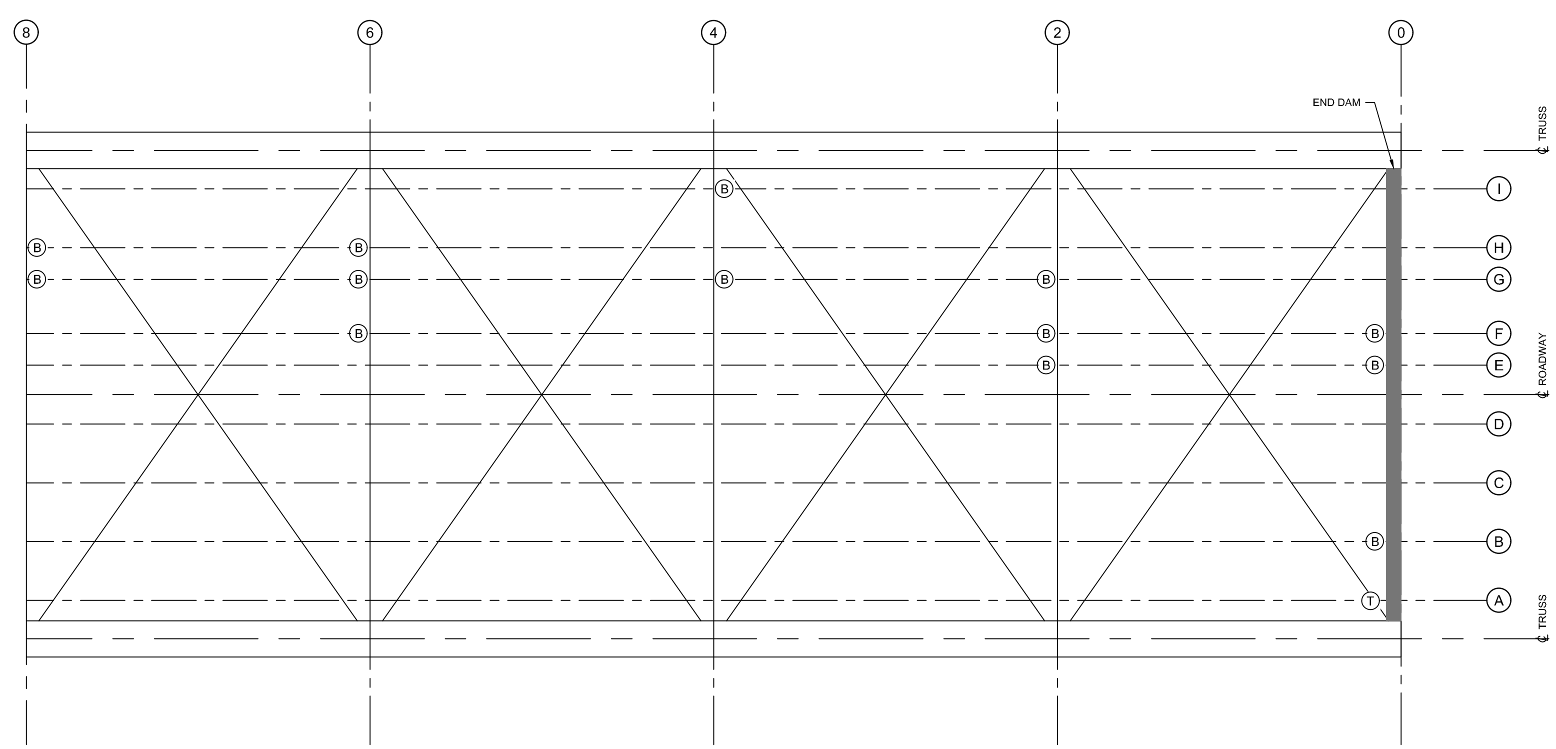
drawn by / dessiné par: R. DYNKA
designed by / conç par: E. BOULAY
approved by / approuvé par: P. HARVEY
tender / soumission: PARVIZ AFROOZ P. Eng, P.E. — project manager / administrateur de projets
project date / date du projet: DECEMBER 2018
project no. / no. du projet: R.090045.001
drawing no. / dessin no.: B02

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 millimetres

LEGEND / LÉGENDE

- (T) CRACK/NOTCH FOUND AT TOP COPE
- (B) CRACK/NOTCH FOUND AT BOTTOM COPE
- (TB) CRACK/NOTCH FOUND AT TOP & BOTTOM COPE





Public Services and Procurement Canada
Services publics et Approvisionnement Canada

PARSONS

revision	description	date

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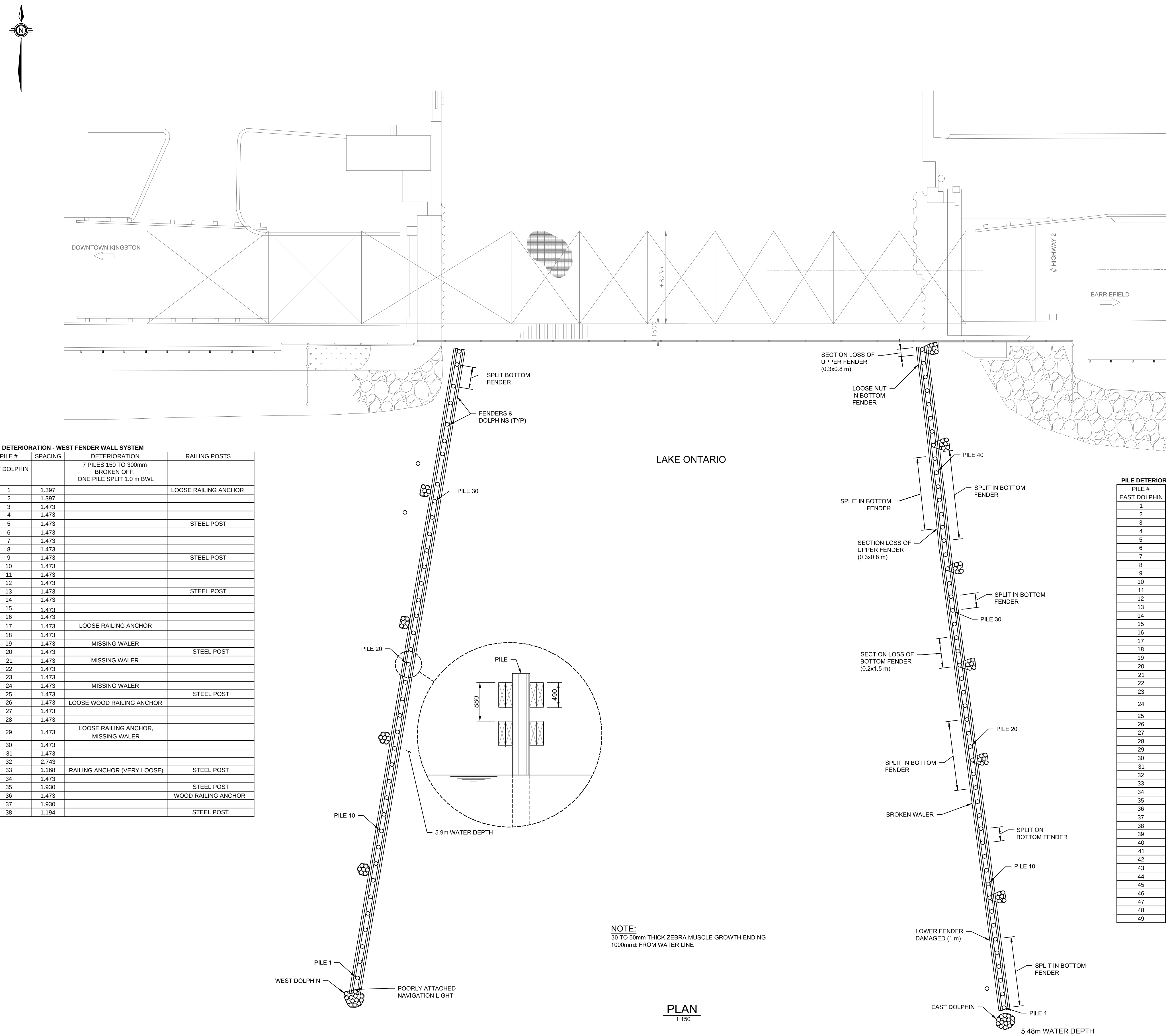
A Detail No. / No. du détail
B drawing no. – where detail required / dessin no. – où détail exigé
C drawing no. – where detailed / dessin no. – où détaillé

project title / titre du projet
LaSALLE CAUSEWAY BASCULE BRIDGE
2018 COMPREHENSIVE DETAILED INSPECTION
KINGSTON ONTARIO

drawing title / titre du dessin
FLOOR SYSTEM STRINGER DETERIORATION

drawn by / dessiné par	R. DYNKA
designed by / conç par	E. BOULAY
approved by / approuvé par	P. HARVEY
tender / soumission	PARVIZ AFROOZ P. Eng, P.E. — project manager / administrateur de projets
project date / date du projet	DECEMBER 2018
project no. / no. du projet	R.090045.001
drawing no. / dessin no.	B03

04 11



PILE DETERIORATION - WEST FENDER WALL SYSTEM

PILE #	SPACING	DETERIORATION	RAILING POSTS
WEST DOLPHIN		7 PILES 150 TO 300mm BROKEN OFF, ONE PILE SPLIT 1.0 m BWL	
1	1.397		LOOSE RAILING ANCHOR
2	1.397		
3	1.473		
4	1.473		
5	1.473		STEEL POST
6	1.473		
7	1.473		
8	1.473		
9	1.473		STEEL POST
10	1.473		
11	1.473		
12	1.473		
13	1.473		STEEL POST
14	1.473		
15	1.473		
16	1.473		
17	1.473	LOOSE RAILING ANCHOR	
18	1.473		
19	1.473	MISSING WALER	
20	1.473		STEEL POST
21	1.473	MISSING WALER	
22	1.473		
23	1.473		
24	1.473	MISSING WALER	
25	1.473		STEEL POST
26	1.473	LOOSE WOOD RAILING ANCHOR	
27	1.473		
28	1.473		
29	1.473	LOOSE RAILING ANCHOR, MISSING WALER	
30	1.473		
31	1.473		
32	2.743		
33	1.168	RAILING ANCHOR (VERY LOOSE)	STEEL POST
34	1.473		
35	1.930		STEEL POST
36	1.473		WOOD RAILING ANCHOR
37	1.930		
38	1.194		STEEL POST

PILE DETERIORATION - EAST FENDER WALL SYSTEM

PILE #	SPACING	DETERIORATION	RAILING POSTS
EAST DOLPHIN			
1	1.1938		
2	1.2192		STEEL POST
3	1.2192		
4	1.1430		
5	1.1430		
6	1.2954		
7	1.1938	SOME ROT ON TOP	
8	1.2192		STEEL POST
9	1.2446		
10	1.1684		
11	1.1938		
12	1.2192		
13	1.2192	SOME ROT ON TOP	
14	1.2192		
15	1.2192		
16	1.2192		STEEL POST
17	1.2192	SPLIT FROM TOP 500mm	
18	1.2192		
19	1.2192		
20	1.2192		
21	1.2192	SPLIT 300mm	
22	1.2192		
23	1.2192	SPLIT 300mm	STEEL POST
24	1.2192	500mm GAUGE LONG WIDE, 20mm DEEP, 400mm BELOW WL EAST SIDE	
25	1.2192		
26	1.2192		
27	1.2192		STEEL POST
28	1.2192		
29	1.2192	WANE 200mm, SOME ROT ON TOP	
30	1.2192		
31	1.2192	SPLIT 1.8m	
32	1.2300		
33	1.2192		
34	1.2192		
35	1.2192	SPLIT 900mm	STEEL POST
36	1.2192	600mm BROKEN OFF	
37	1.2192	3 SPLITS 300mm	
38	1.2192	SPLIT 600mm	
39	1.2192	SPLIT 600mm	STEEL POST
40	1.2192		
41	1.2192	SPLIT 2.2m CHIP 210mm 10% LOSS	
42	1.2192	SPLIT 300mm	
43	1.2192	150mm ROT 300mm SPLIT	STEEL POST
44	1.2192		
45	1.2192	SPLIT 900mm 6 PIECES - NO CHANGE BWL	
46	1.2192	SPLIT 300mm - 2 OLD PILES 1m BWL	
47	1.2192		STEEL POST
48	1.2192		
49	1.2192	SPLIT 800mm BELOW WATER LEVEL	STEEL POST

NOTE:
30 TO 50mm THICK ZEBRA MUSCLE GROWTH ENDING 1000mm± FROM WATER LINE

PLAN
1:150

Public Services and Procurement Canada
Services publics et Approvisionnement Canada

PARSONS

revision	description	date

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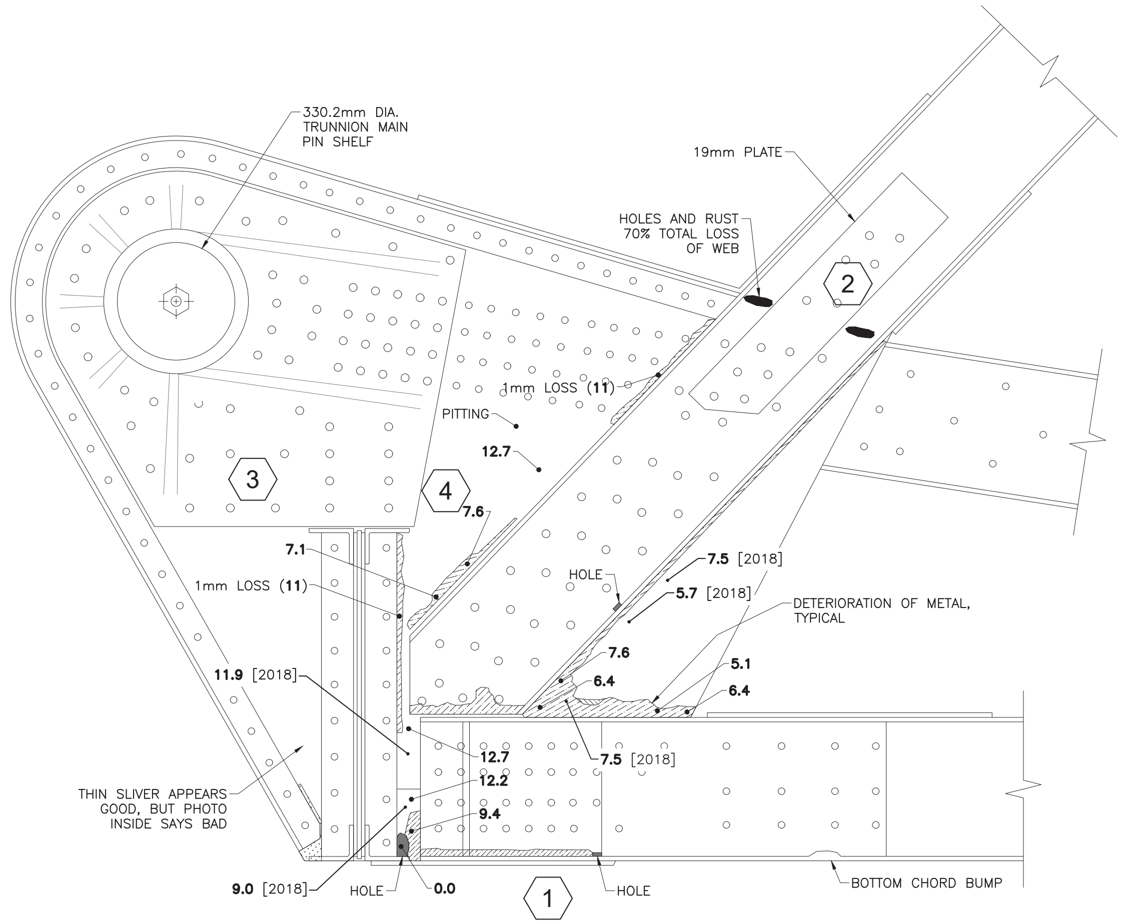
A Detail No. No. du détail
B drawing no. – where detail required dessin no. – où détail exigé
C drawing no. – where detailed dessin no. – où détaillé

project title / titre du projet
LaSALLE CAUSEWAY BASCULE BRIDGE
2018 COMPREHENSIVE DETAILED INSPECTION
KINGSTON ONTARIO

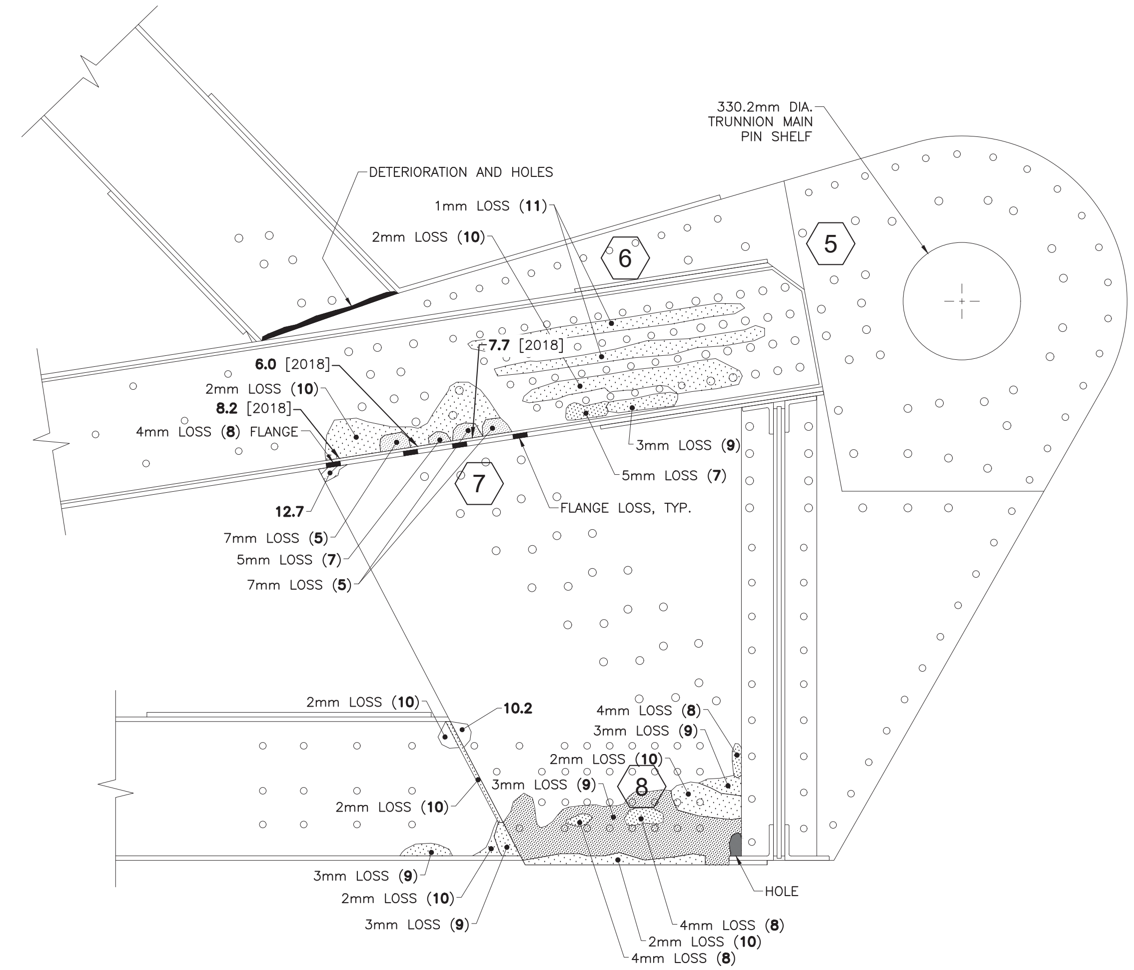
drawing title / titre du dessin
FENDER WALL DETERIORATION

drawn by / dessiné par: R. DYNKA
designed by / conç par: E. BOULAY
approved by / approuvé par: P. HARVEY
tender / soumission: PARVIZ AFROOZ P. Eng, P.E. — project manager / administrateur de projets
project date / date du projet: DECEMBER 2018
project no. / no. du projet: R.090045.001
drawing no. / dessin no.: B04

GSC-B1 DATE PLOTTED: YYYY/MM/DD PLOT SCALE: PLOT_SCALE CAD FILE: S:\PRS\CAD\GROUP\CITY\ADDRESS\PROJECT NO\FILE.DWG



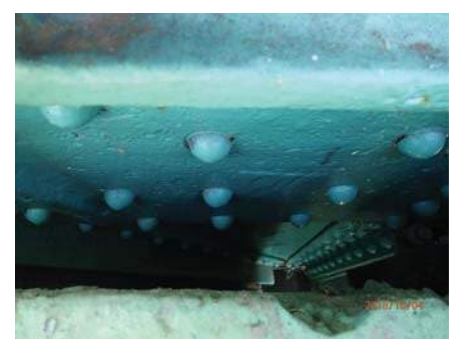
A ELEVATION: SOUTH TRUNNION EXTERIOR PLATE EXTERIOR DETERIORATION
1:10



B ELEVATION: SOUTH TRUNNION EXTERIOR PLATE INTERIOR DETERIORATION
1:10

1

2



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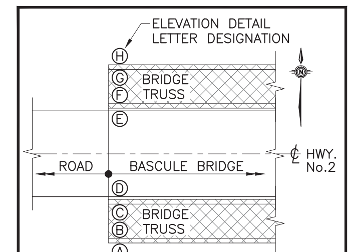
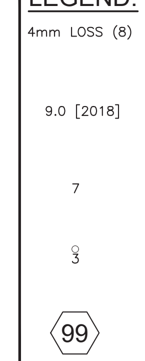


KEY PLAN
N.T.S.

LEGEND:



4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
99	PHOTOGRAPH KEY
•	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

Public Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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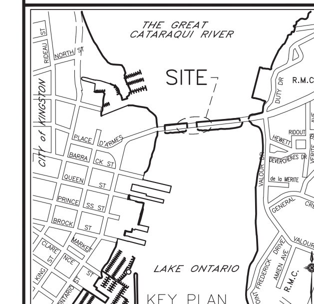
PARSONS



Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

L'entrepreneur doit vérifier les dimensions et conditions sur le site et en aviser l'ingénieur immédiatement de toute divergence.

DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet

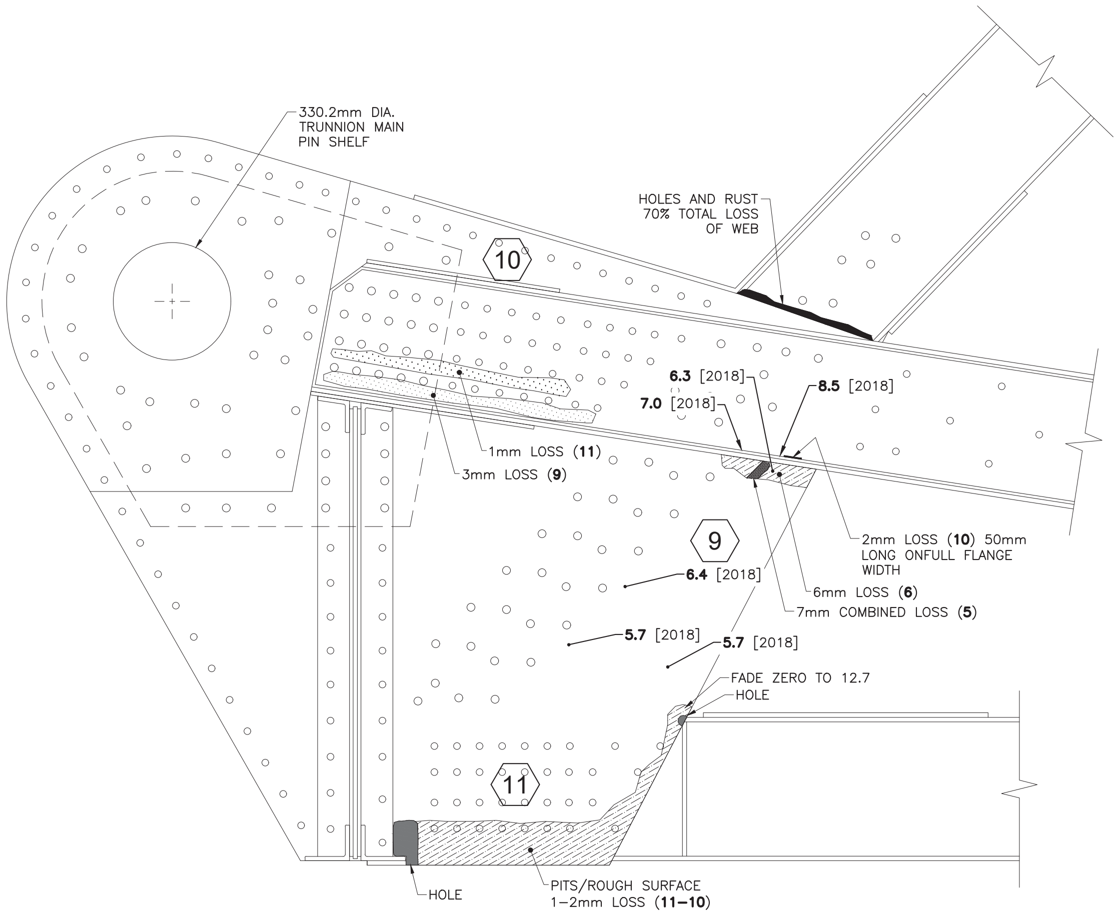
LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin

SOUTH TRUNNION
EXTERIOR PLATE
DETERIORATION

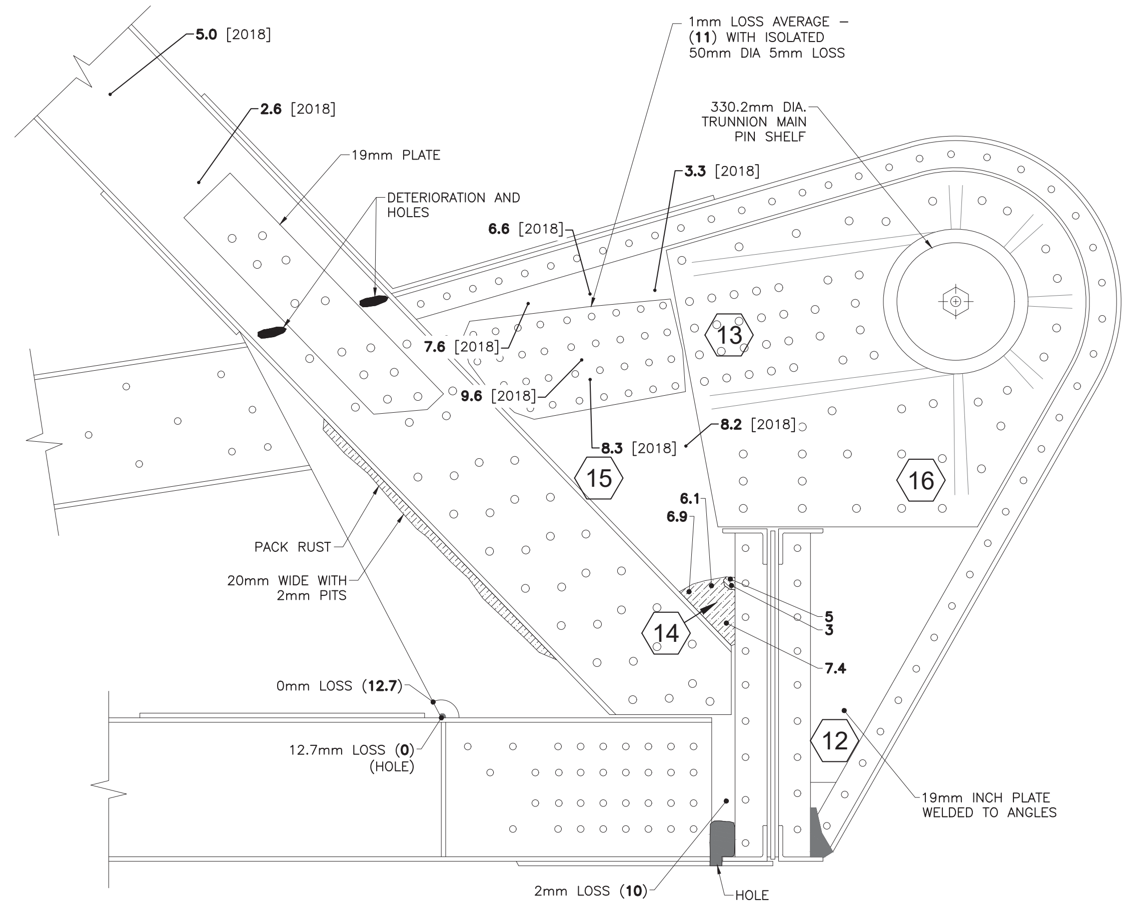
Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-01	No. du dessin

PWGSC A1 (841x594)



C ELEVATION: SOUTH TRUNNION INTERIOR PLATE INTERIOR DETERIORATION

1:10



D ELEVATION: SOUTH TRUNNION INTERIOR PLATE EXTERIOR DETERIORATION

1:10

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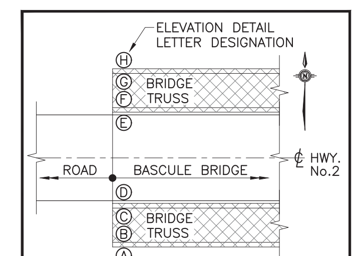

KEY PLAN

N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
99	PHOTOGRAPH KEY
•	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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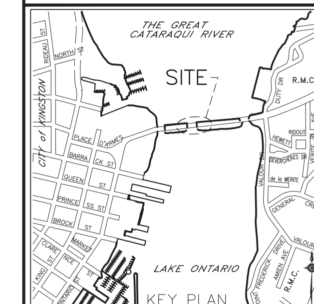
PARSONS



Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

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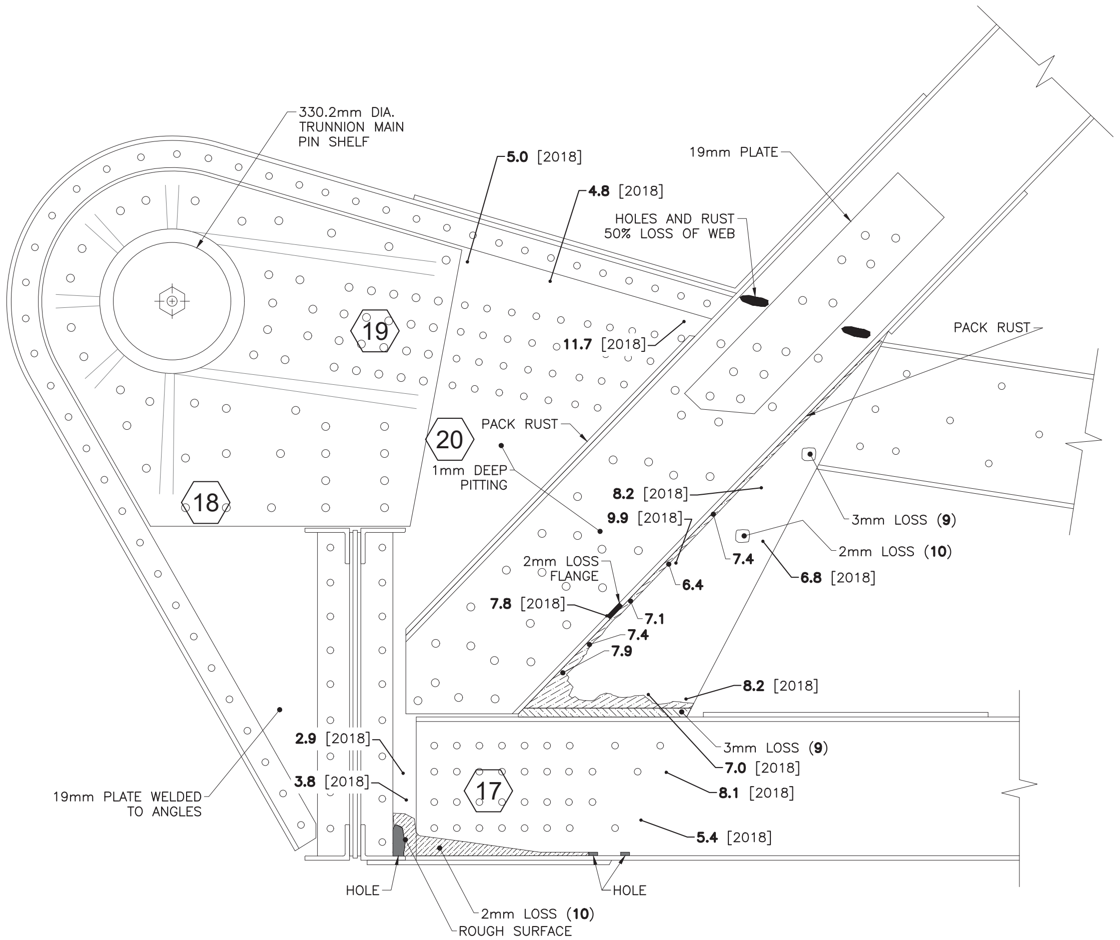
DRAFT

revisions	description	date

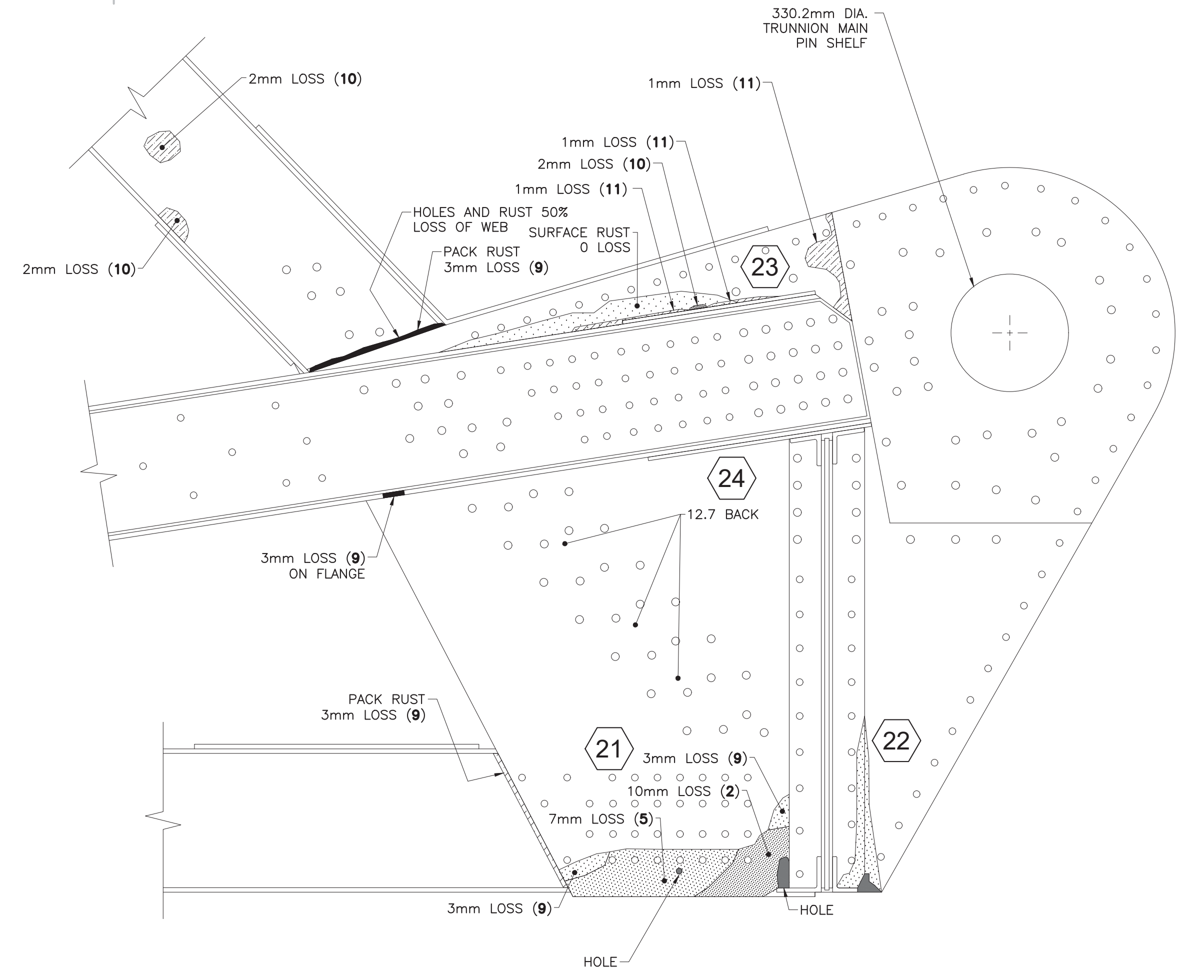
A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project	projet
LASALLE CAUSEWAY TRUNNION EVALUATION	
drawing	dessin
SOUTH TRUNNION INTERIOR PLATE DETERIORATION	
Designed By J.B.C.	Conçu par
Date 30 NOV 2018	(yyyy/mm/dd)
Drawn By R.D.	Dessiné par
Date 30 NOV 2018	(yyyy/mm/dd)
Reviewed By P.H.	Examiné par
Date 30 NOV 2018	(yyyy/mm/dd)
Approved By	Approuvé par
Date	(yyyy/mm/dd)
Tender	Soumission
Project Manager	Administrateur de projets
Project no. R.090045.001	No. du projet
Drawing no. 0000-02	No. du dessin

PWGSC A1 (841x594)

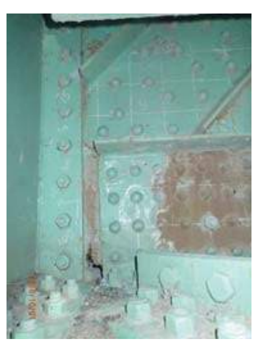


E ELEVATION: NORTH WEST CORNER INTERIOR PLATE EXTERIOR DETERIORATION
1:10



2018 NDT RESULTS FOR THIS PLATE ARE SHOWN ON FIGURE E

F ELEVATION: NORTH WEST CORNER INTERIOR INTERIOR DETERIORATION
1:10



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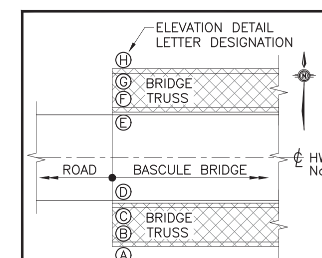

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
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•	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

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Canada

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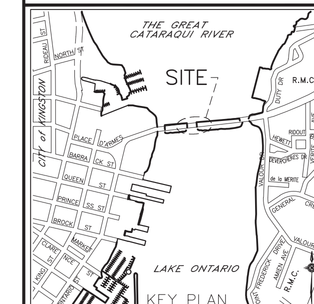
PARSONS



Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

L'entrepreneur doit vérifier les dimensions et conditions sur le site et en aviser l'ingénieur immédiatement de toute divergence.

DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

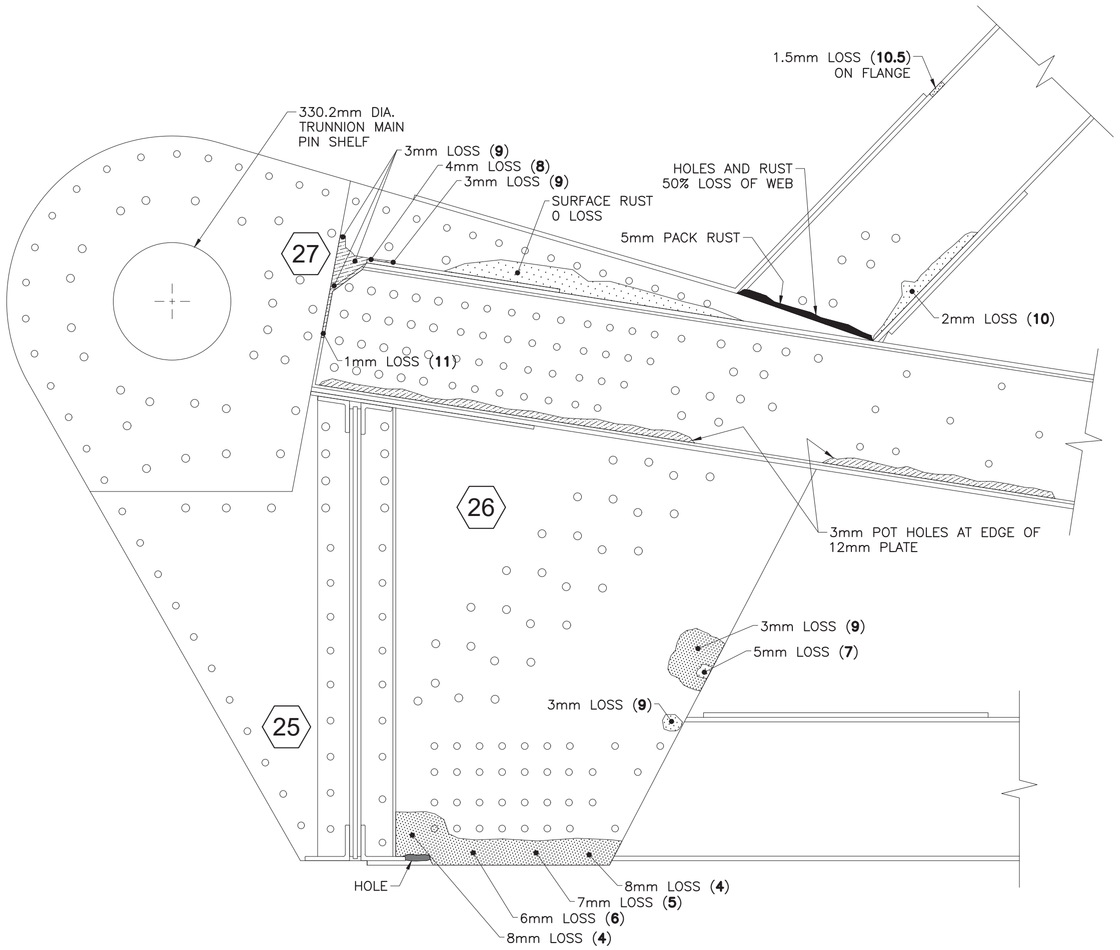
project / projet: LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin: NORTH TRUNNION INTERIOR PLATE DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-03	No. du dessin

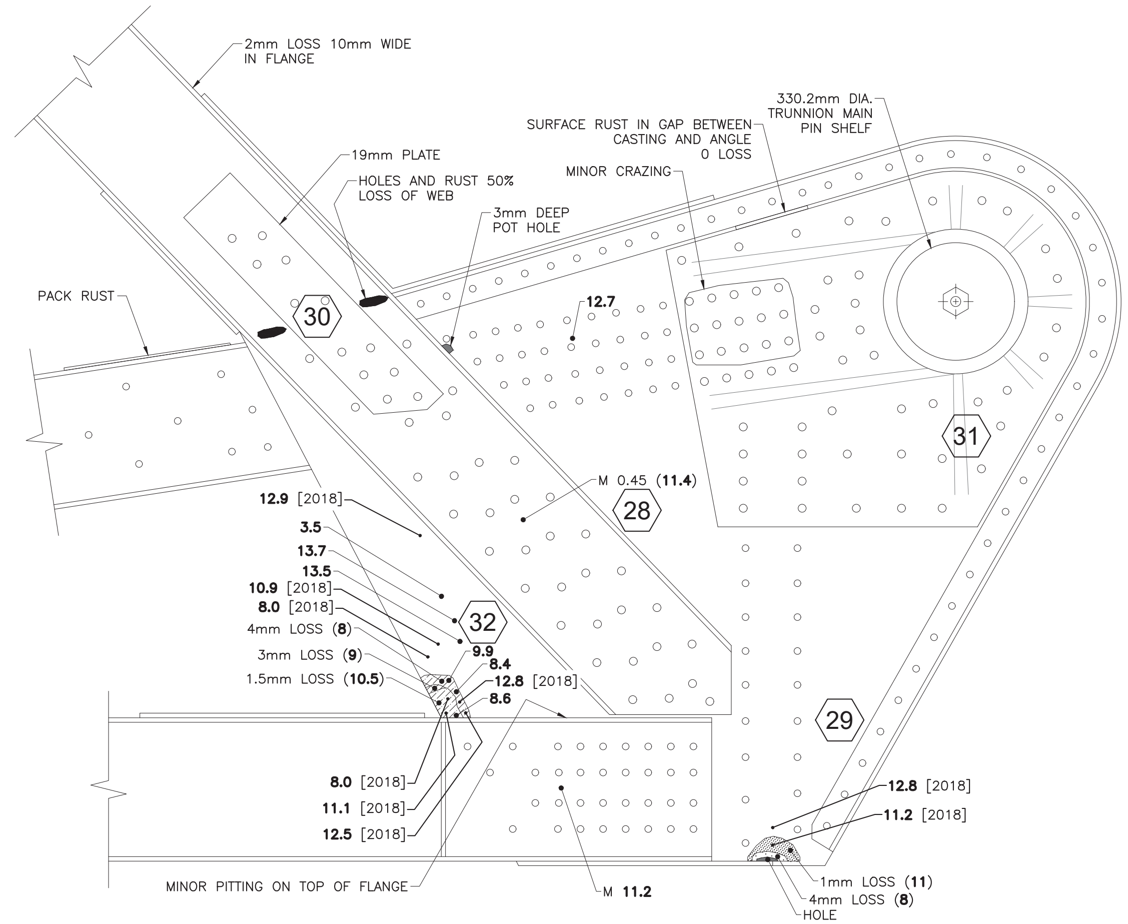
PWGSC A1 (841x594)

0 10 20mm 40 60 80 100 120 140 160 180 200mm



G ELEVATION: NORTH WEST CORNER INTERIOR DETERIORATION
1:10

2018 NDT RESULTS FOR THIS PLATE ARE SHOWN ON FIGURE (H)



H ELEVATION: NORTH WEST CORNER EXTERIOR DETERIORATION
1:10

25

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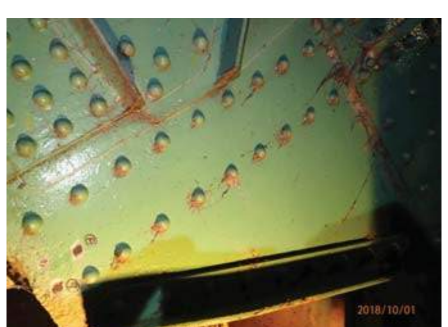

29

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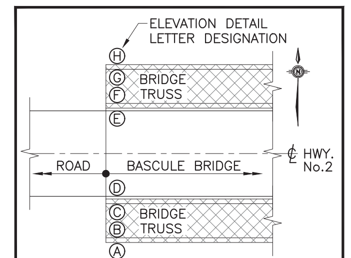

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
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Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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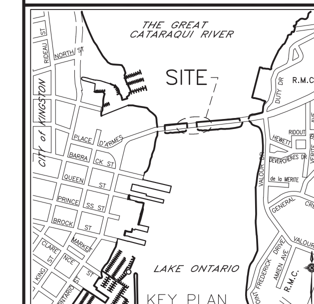
PARSONS



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DRAFT

revisions | description | date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet
LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin
NORTH TRUNNION EXTERIOR PLATE DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-04	No. du dessin

PWGSC A1 (841x594)

0 10 20mm 40 60 80 100 120 140 160 180 200mm

Publics Works and Government Services Canada
Travaux publics et services gouvernementaux Canada

Canada

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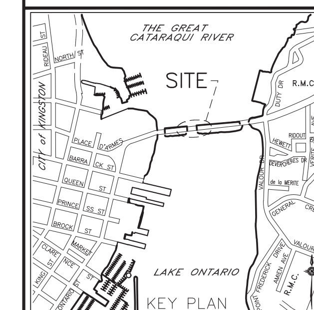
PARSONS



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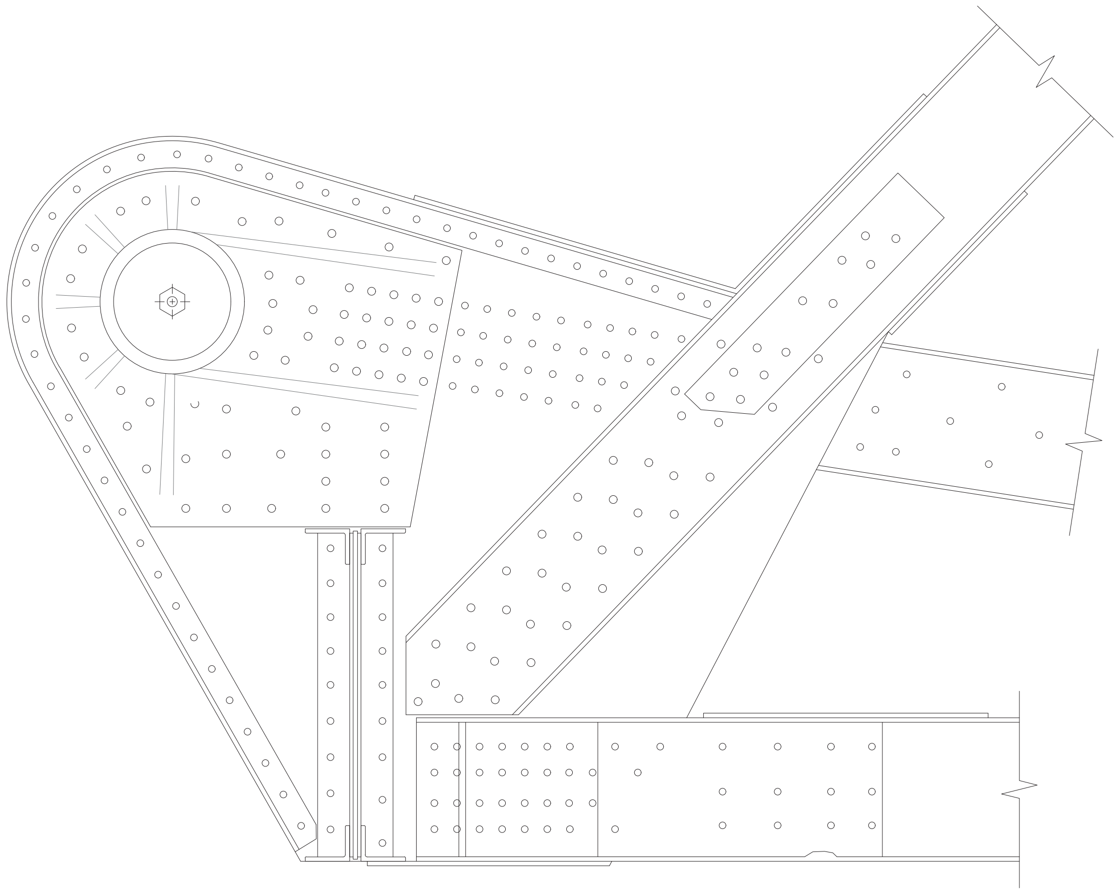
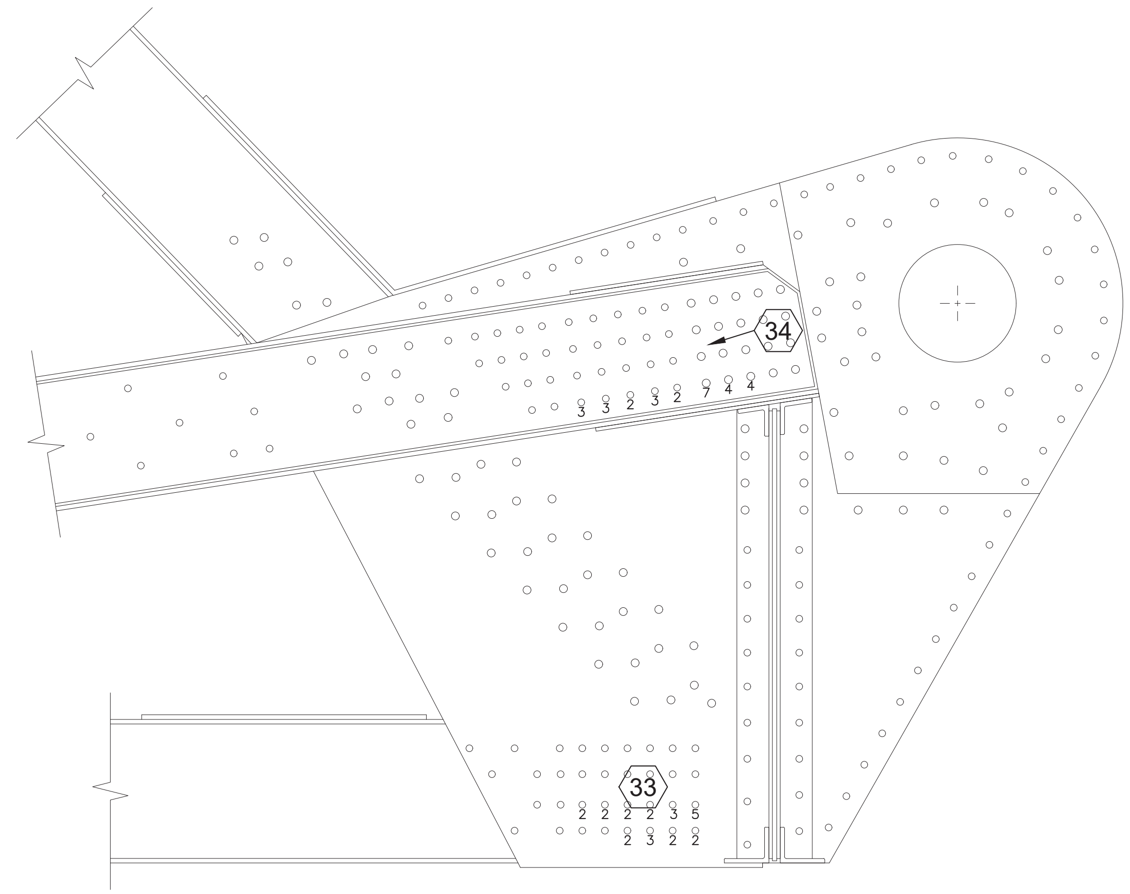
DRAFT

revisions	description	date



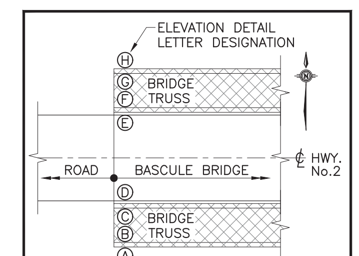
(A) ELEVATION: SOUTH TRUNNION EXTERIOR PLATE EXTERIOR DETERIORATION
1:10



(B) ELEVATION: SOUTH TRUNNION EXTERIOR PLATE INTERIOR DETERIORATION
1:10

33

34*



KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
99	PHOTOGRAPH KEY
*	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet

LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin

SOUTH TRUNNION
EXTERIOR PLATE
RIVET DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-05	No. du dessin

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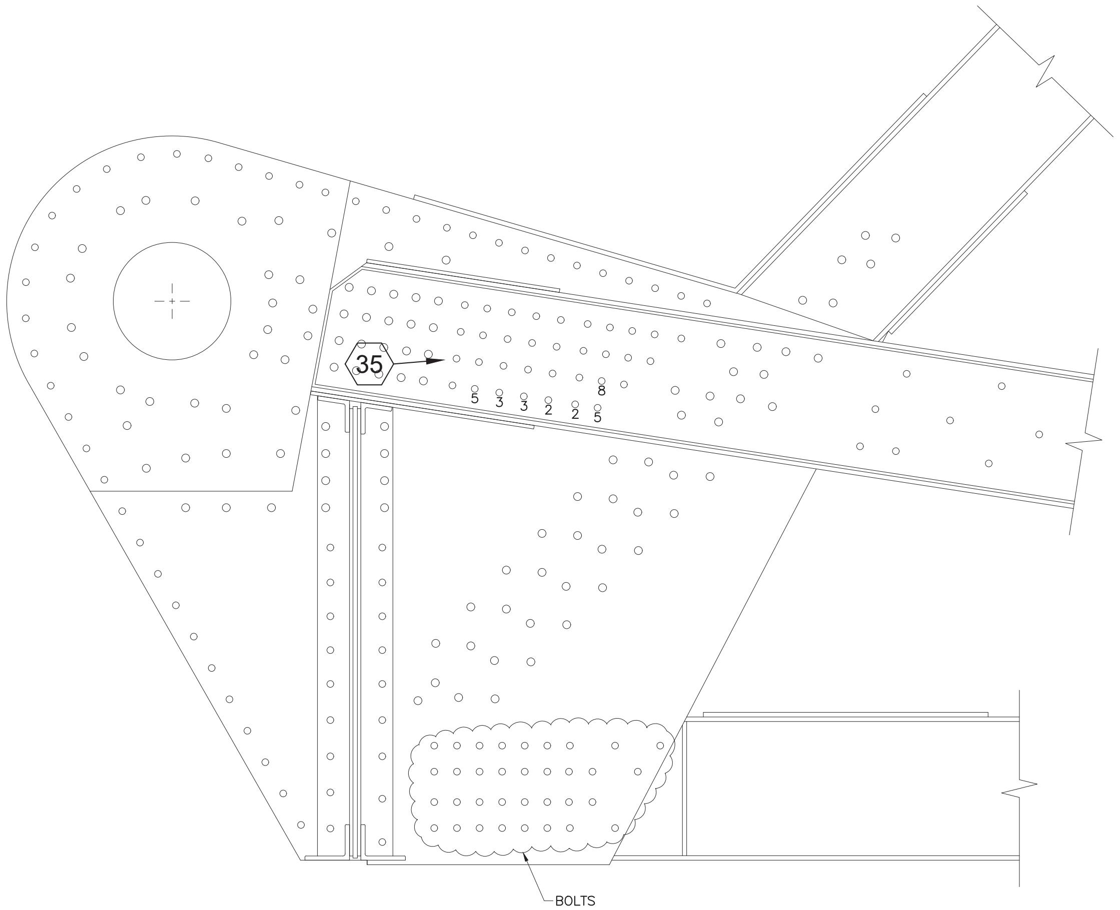
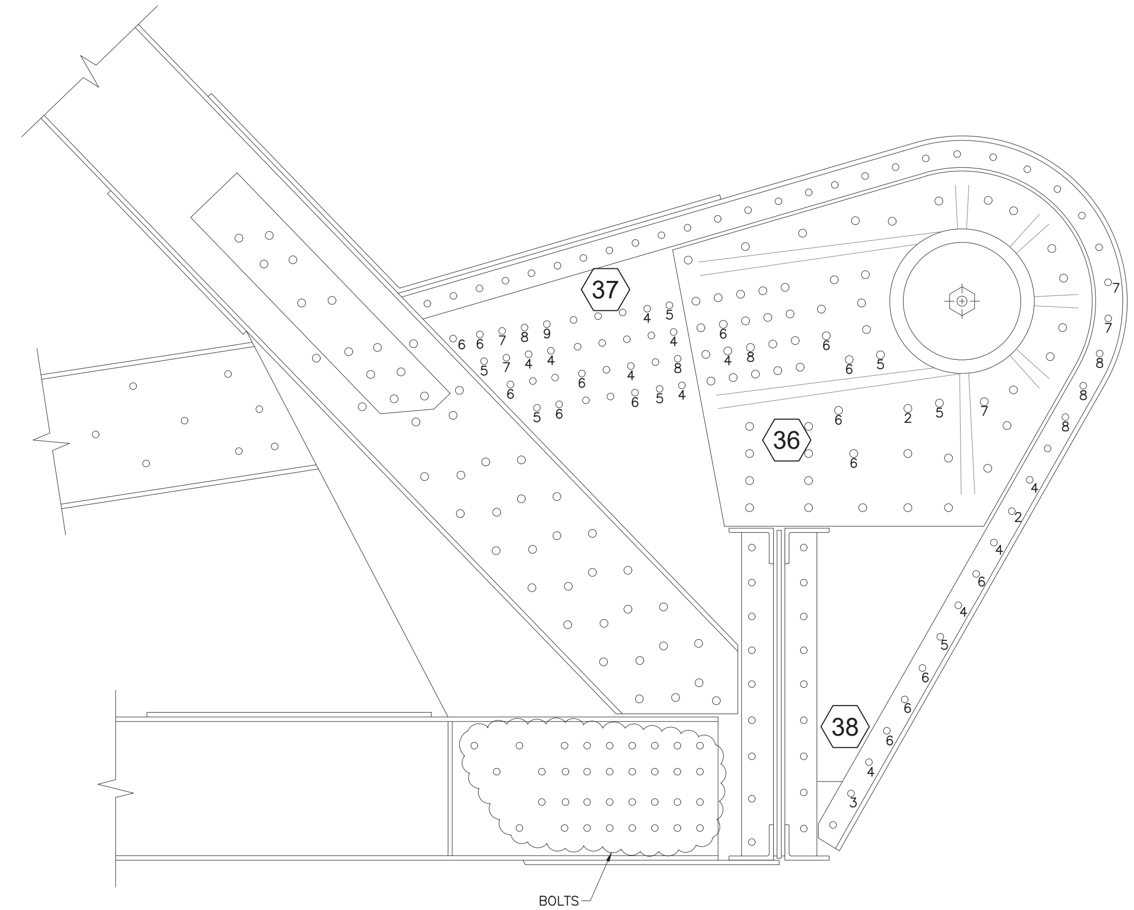


C ELEVATION: SOUTH TRUNNION INTERIOR PLATE INTERIOR DETERIORATION

1:10



D ELEVATION: SOUTH TRUNNION INTERIOR PLATE EXTERIOR DETERIORATION

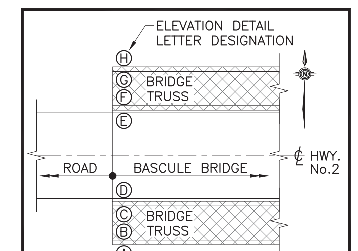
1:10

35*

36

37

38



KEY PLAN

N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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*	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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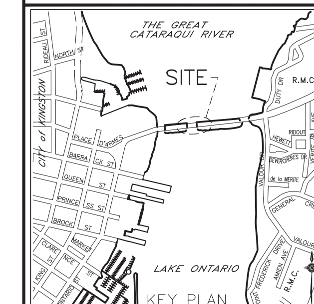
PARSONS



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DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet: LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin: SOUTH TRUNNION INTERIOR PLATE RIVET DETERIORATION

Designed By / Conçu par	J.B.C.	
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By / Dessiné par	R.D.	
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By / Examiné par	P.H.	
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By / Approuvé par		
Date		(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		
Project no. / No. du projet	R.090045.001	
Drawing no. / No. du dessin	0000-06	

PWGSC A1 (841x594)

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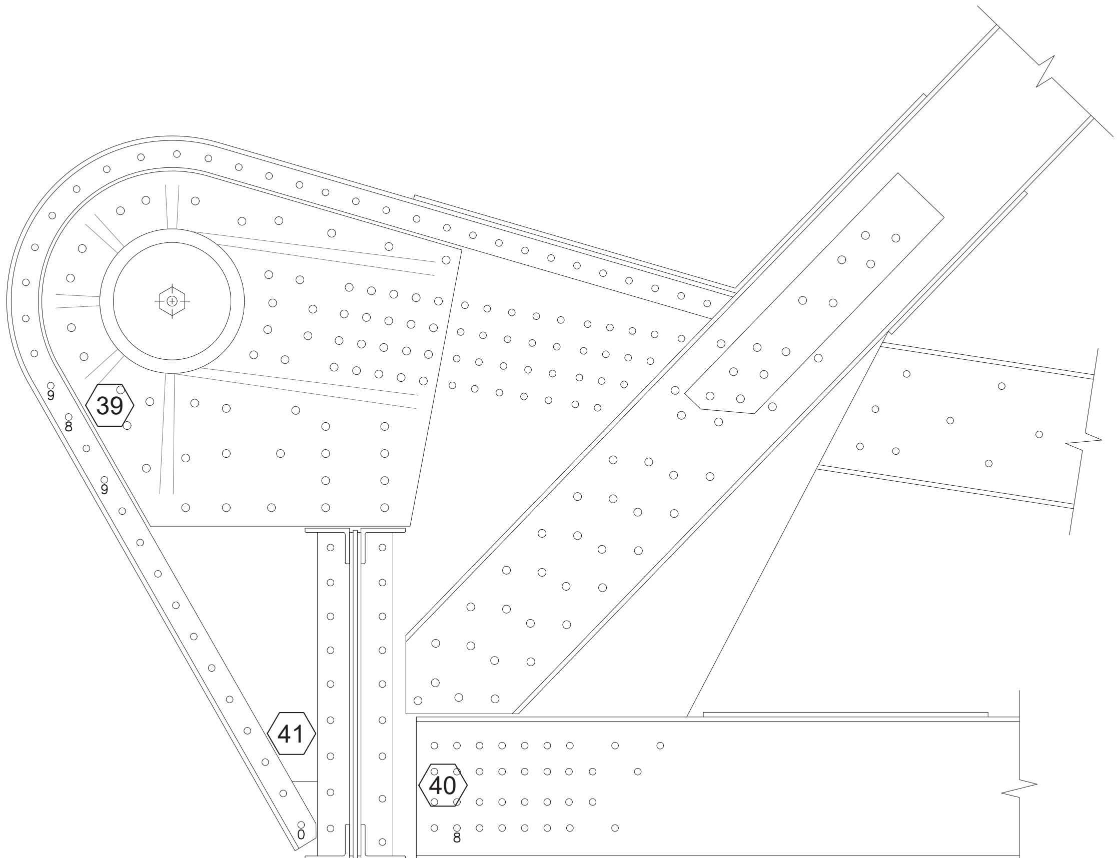
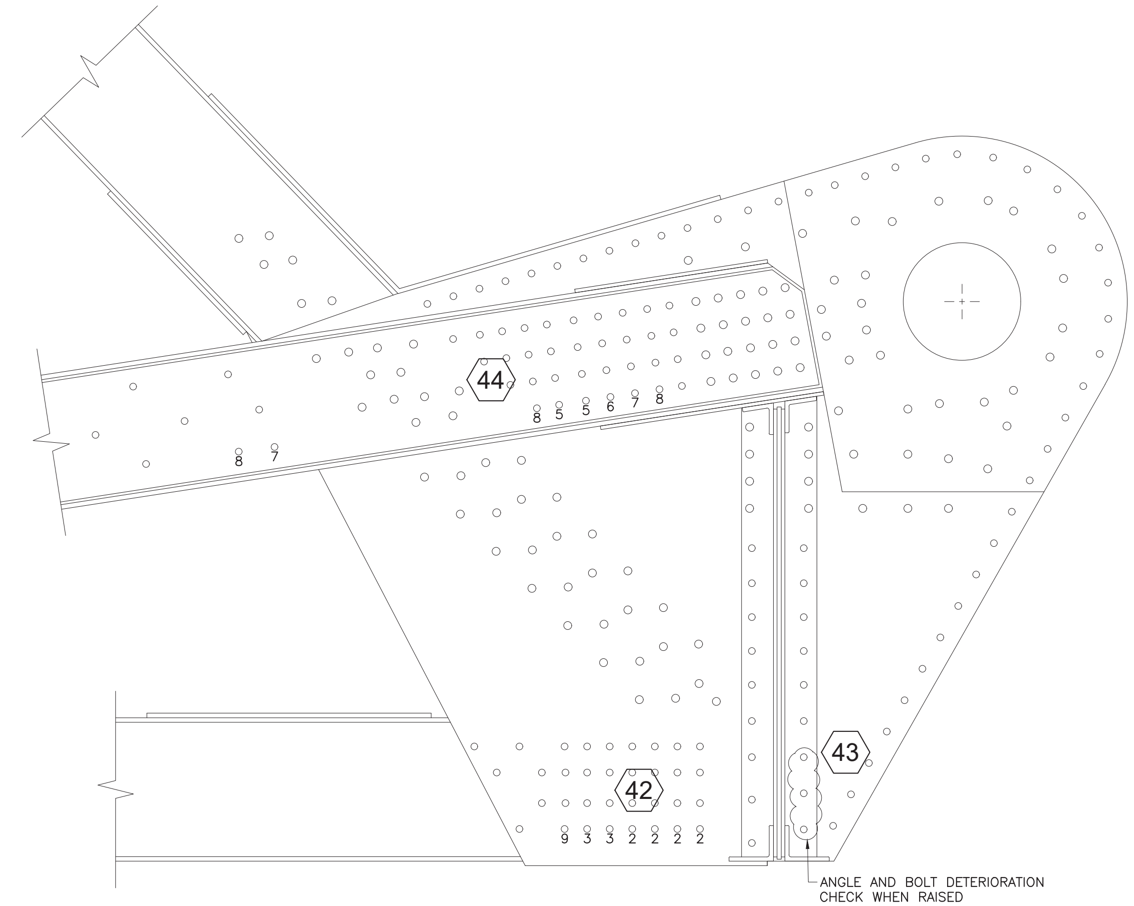
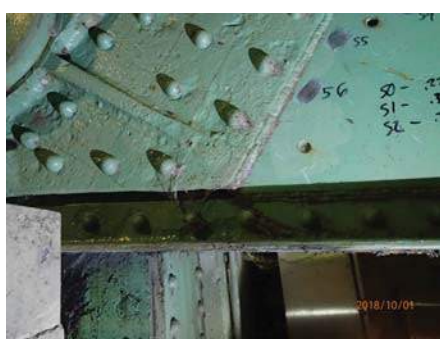


E ELEVATION: NORTH WEST CORNER INTERIOR PLATE EXTERIOR DETERIORATION
1:10



F ELEVATION: NORTH WEST CORNER INTERIOR INTERIOR DETERIORATION
1:10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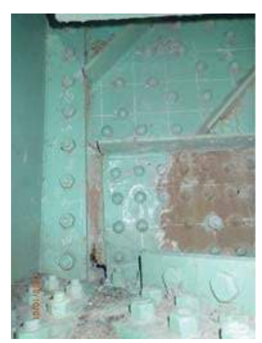
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42


43


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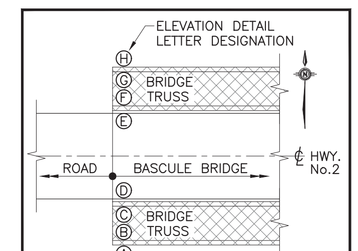

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
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*	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

Public Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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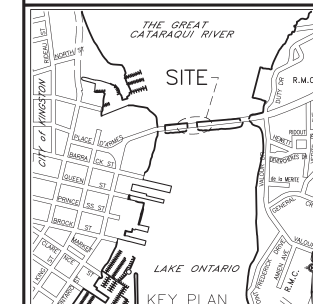
PARSONS



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DRAFT

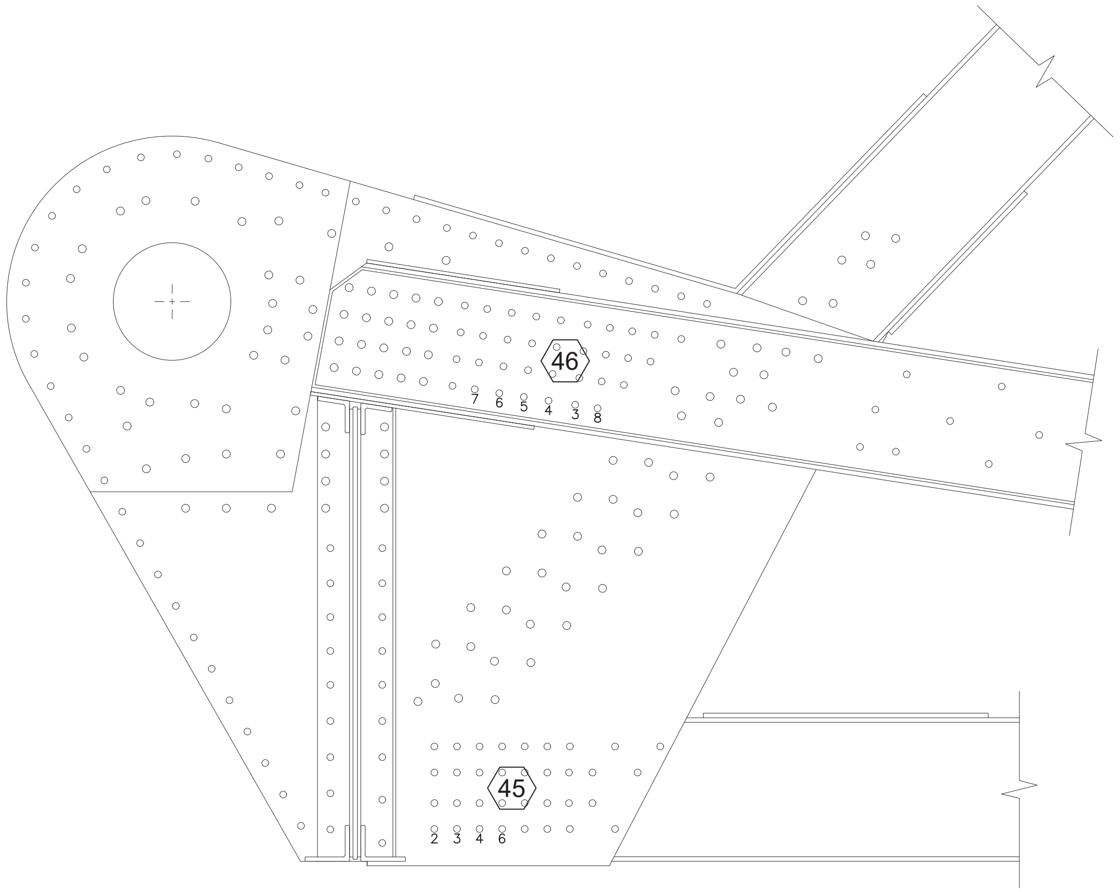
revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

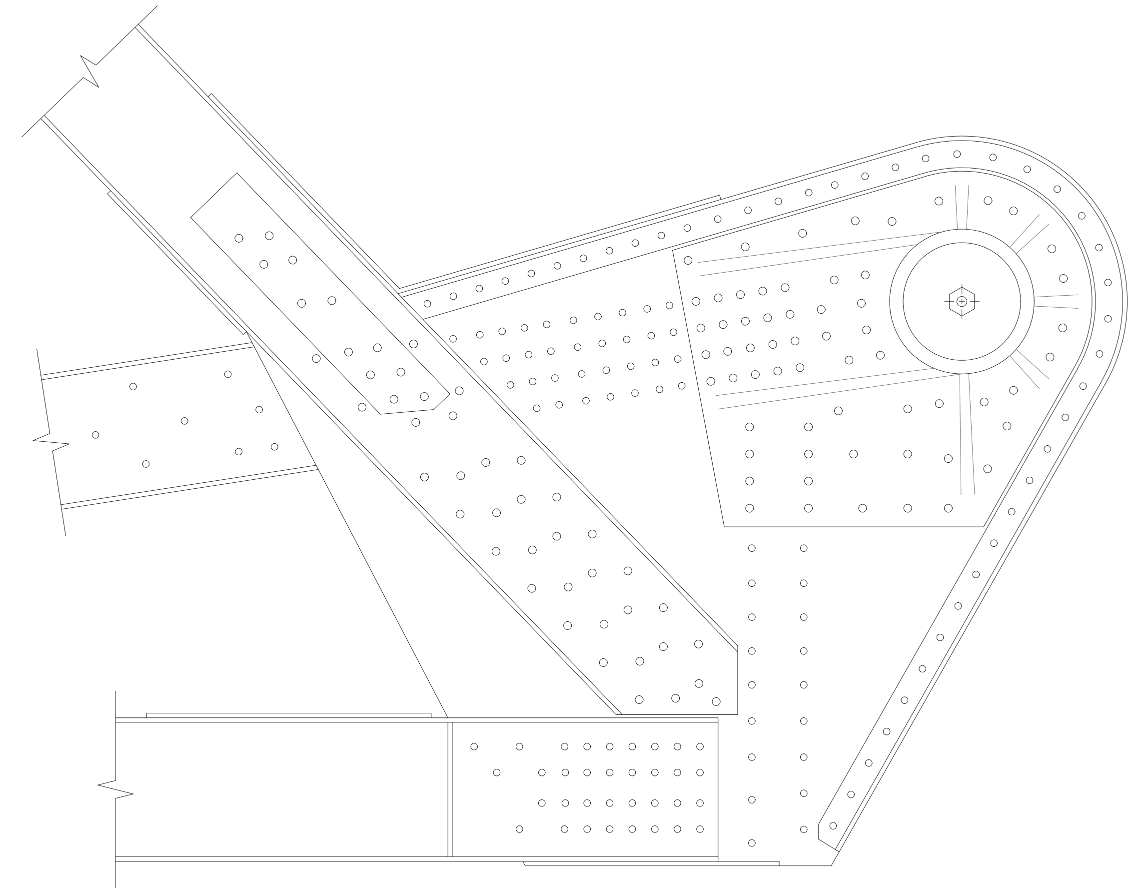
project / projet: LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin: NORTH TRUNNION INTERIOR PLATE RIVET DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 APR 2014	(yyyy/mm/dd)
Reviewed By	D.A.H.	Examiné par
Date	30 APR 2014	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-07	No. du dessin



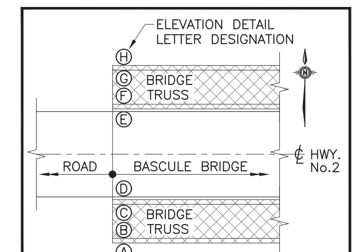
G ELEVATION: NORTH WEST CORNER INTERIOR DETERIORATION
1:10



H ELEVATION: NORTH WEST CORNER EXTERIOR DETERIORATION
1:10

45*

46



KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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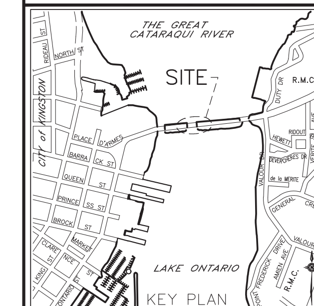
PARSONS



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DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet: LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin: NORTH TRUNNION EXTERIOR PLATE RIVET DETERIORATION

Designed By / Conçu par	J.B.C	
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By / Dessiné par	R.D.	
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By / Examiné par	P.H.	
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By / Approuvé par		
Date		(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		
Project no. / No. du projet	R.090045.001	
Drawing no. / No. du dessin	0000-08	

PWGSC A1 (841x594)

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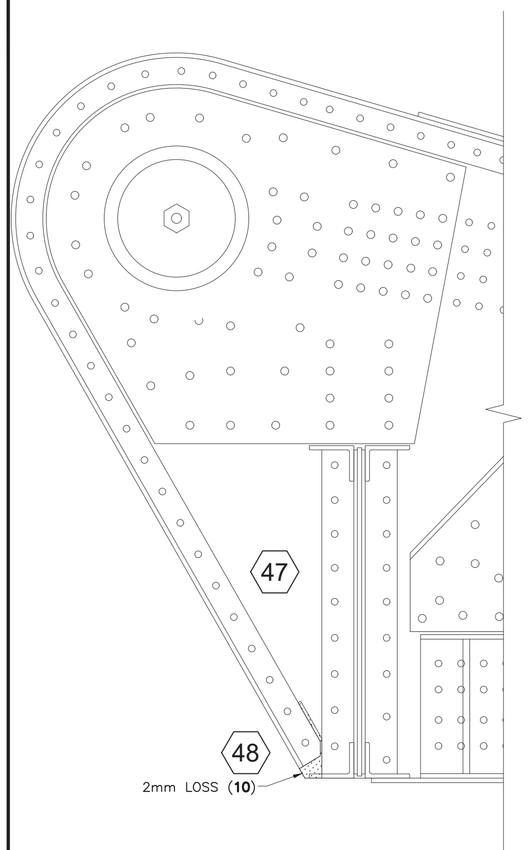
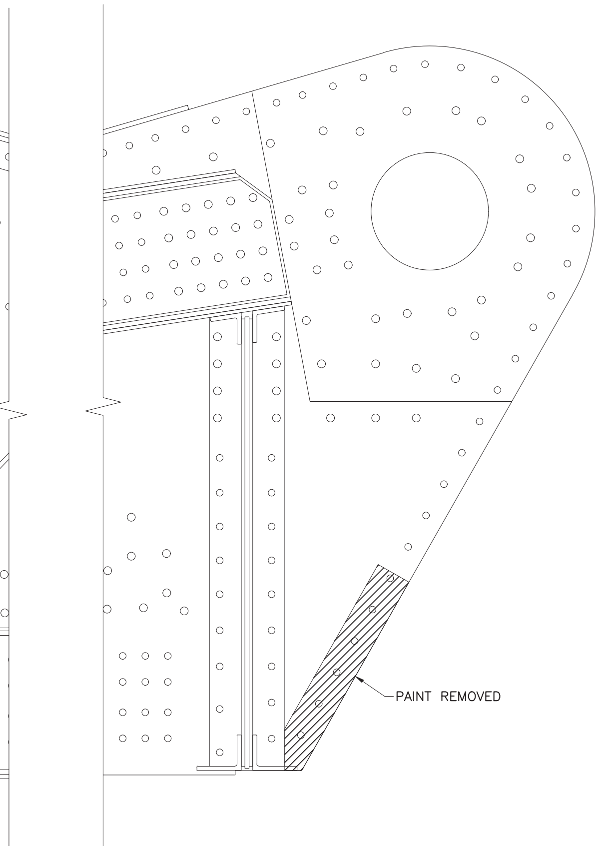
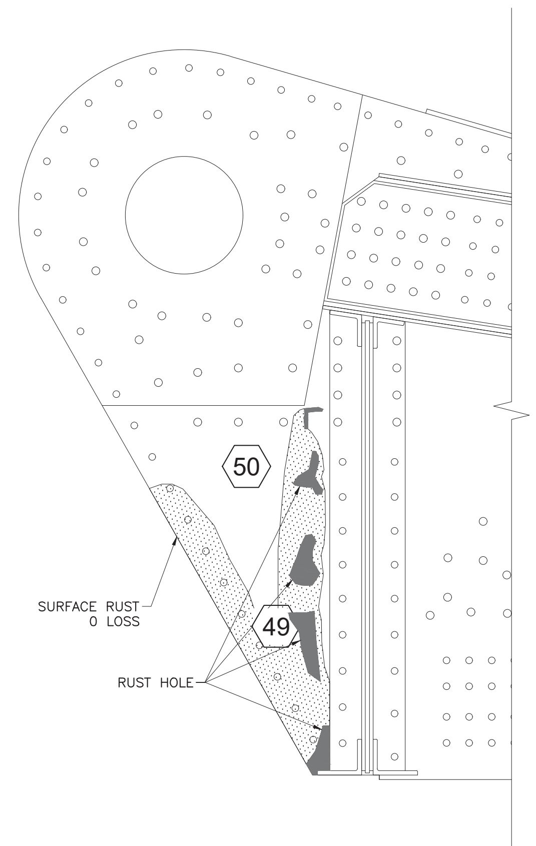


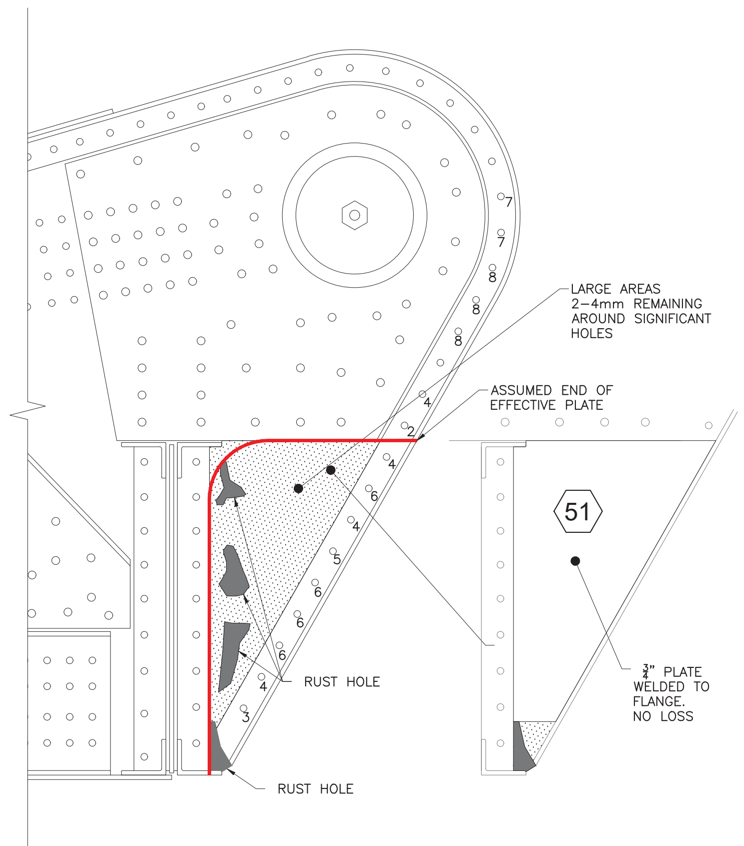
A ELEVATION: SOUTH TRUNNION EXT. PL. EXTERIOR TRIANGLE DETERIORIATION
1:10



B ELEVATION: SOUTH TRUNNION EXT. PL. INTERIOR TRIANGLE DETERIORIATION
1:10



C ELEVATION: SOUTH TRUNNION INT. PL. INTERIOR TRIANGLE DETERIORIATION
1:10



D ELEVATION: SOUTH TRUNNION INT. PL. EXTERIOR TRIANGLE DETERIORIATION
1:10

47

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50

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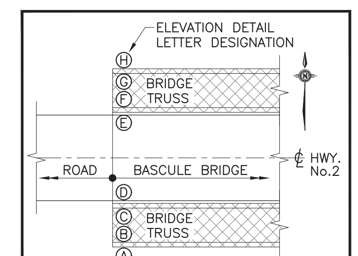

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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99	PHOTOGRAPH KEY
*	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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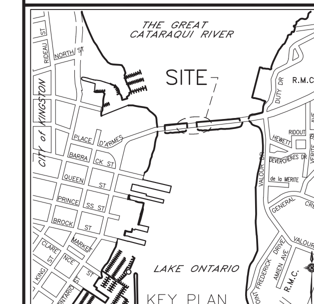
PARSONS



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DRAFT

revisions	description	date

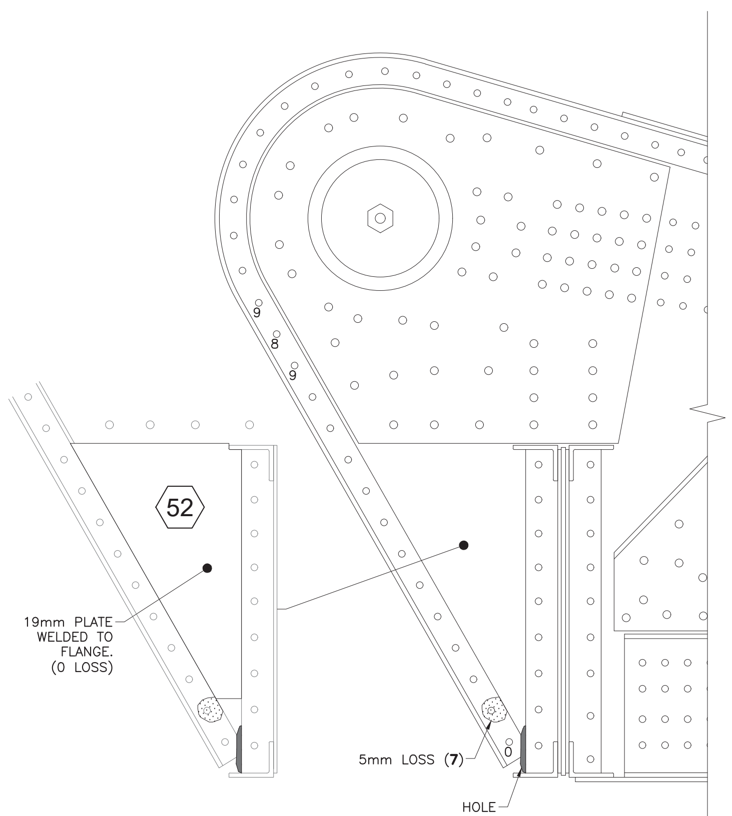
A detail no. / no. du detail; B location drawing no. / sur dessin no.; C drawing no. / dessin no.

project / projet: LASALLE CAUSEWAY TRUNNION EVALUATION

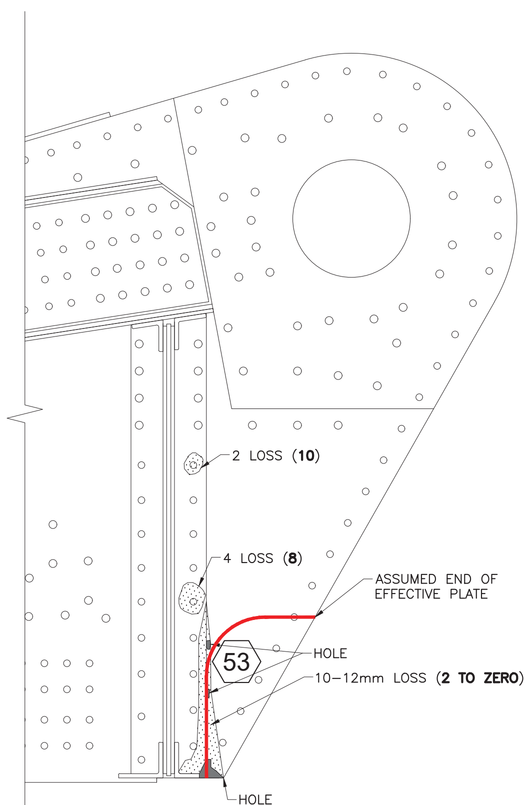
drawing / dessin: SOUTH TRUNNION TRIANGLE DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-09	No. du dessin

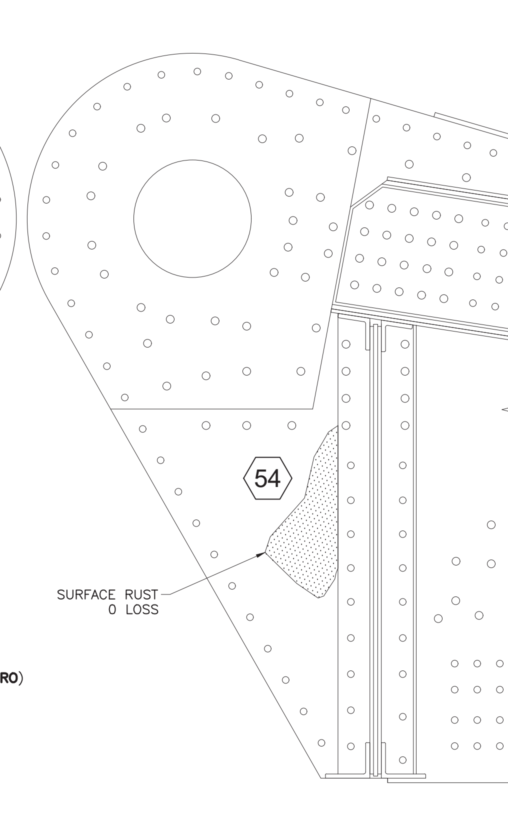
PWGSC A1 (841x594)



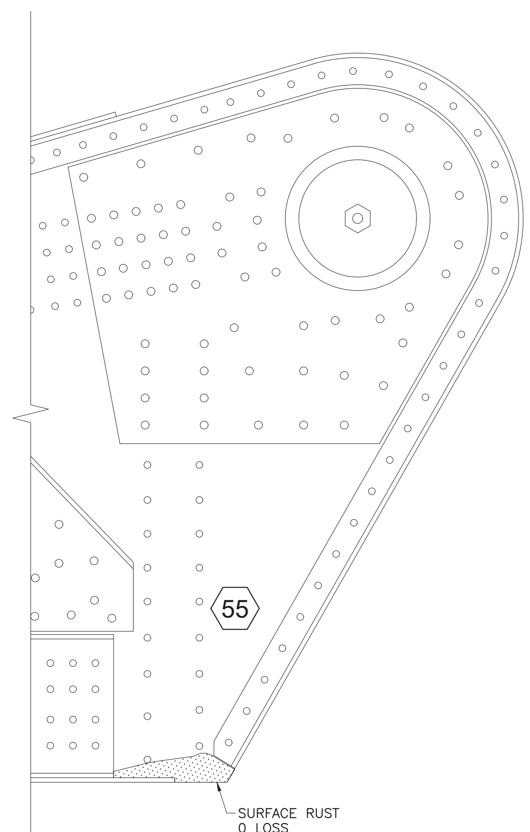
E ELEVATION: NORTH TRUNNION INT. PL. EXTERIOR TRIANGLE DETERIORIATION
1:10



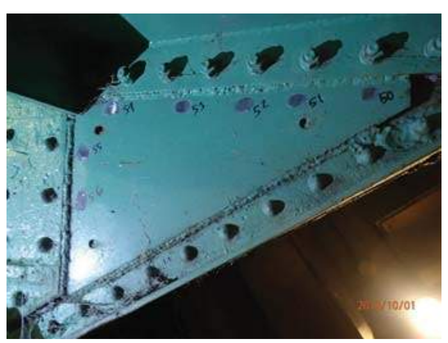
F ELEVATION: NORTH TRUNNION INT. PL. INTERIOR TRIANGLE DETERIORIATION
1:10



G ELEVATION: NORTH TRUNNION EXT. PL. INTERIOR TRIANGLE DETERIORIATION
1:10



H ELEVATION: NORTH TRUNNION EXT. PL. EXTERIOR TRIANGLE DETERIORIATION
1:10



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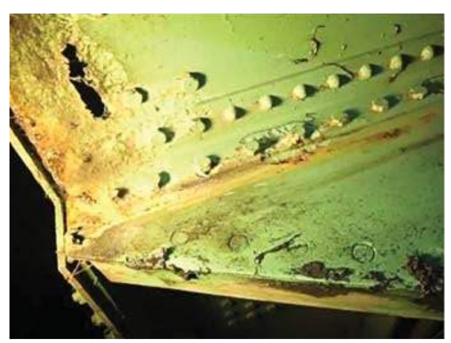

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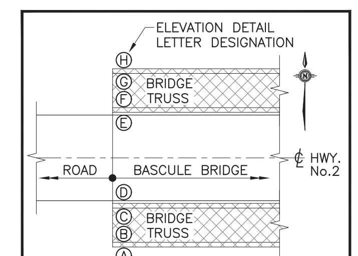

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

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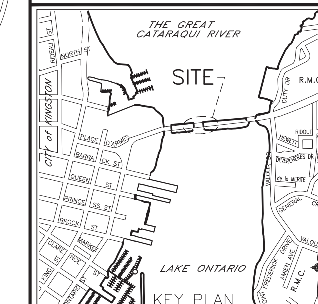
PARSONS



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DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet
LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin
NORTH TRUNNION
TRIANGLE DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-10	No. du dessin

PWGSC A1 (841x594)

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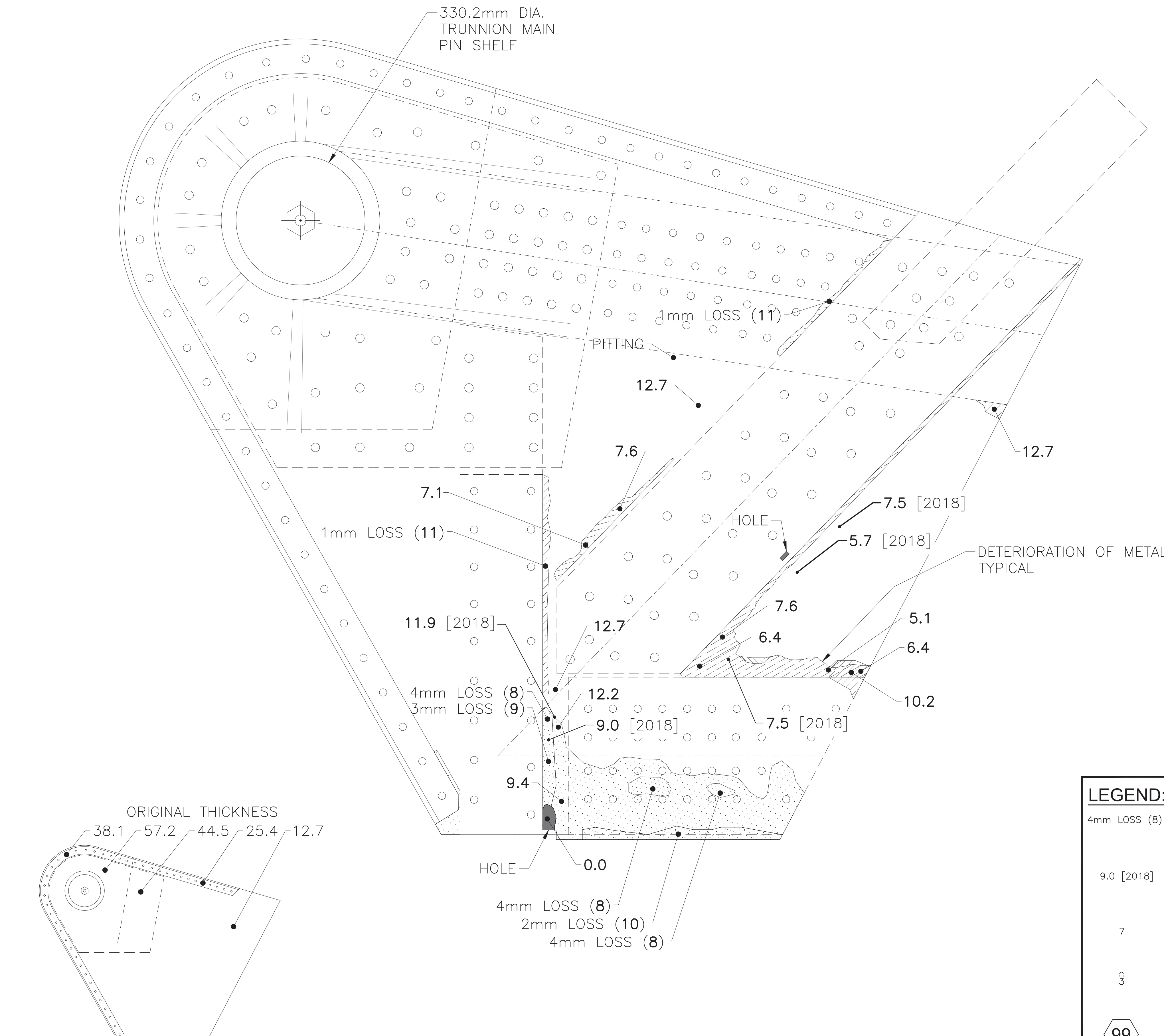

MAIN CASTING – CAST STEEL – 11/4" 31.75mm
INTERIOR PLATE – PLATE STEEL – 1/2" 12.7mm
GUSSET – PLATE STEEL – 1/2" 12.7mm

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
7	REMAINING THICKNESS IN MILLIMETRES. BASED ON ULTRASONIC MEASUREMENTS
3	DETERIORATED RIVETS PERCENT SECTION REMAINING DIVIDED BY 10 (i.e. 1=10%, 2=20%, 3=30%, ETC.)
99	PHOTOGRAPH KEY
*	PHOTO FROM 2015 MMM GROUP LIMITED REPORT

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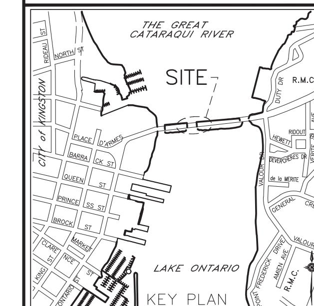

Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

L'entrepreneur doit vérifier les dimensions et conditions sur le site et en aviser l'ingénieur immédiatement de toute divergence.

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revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

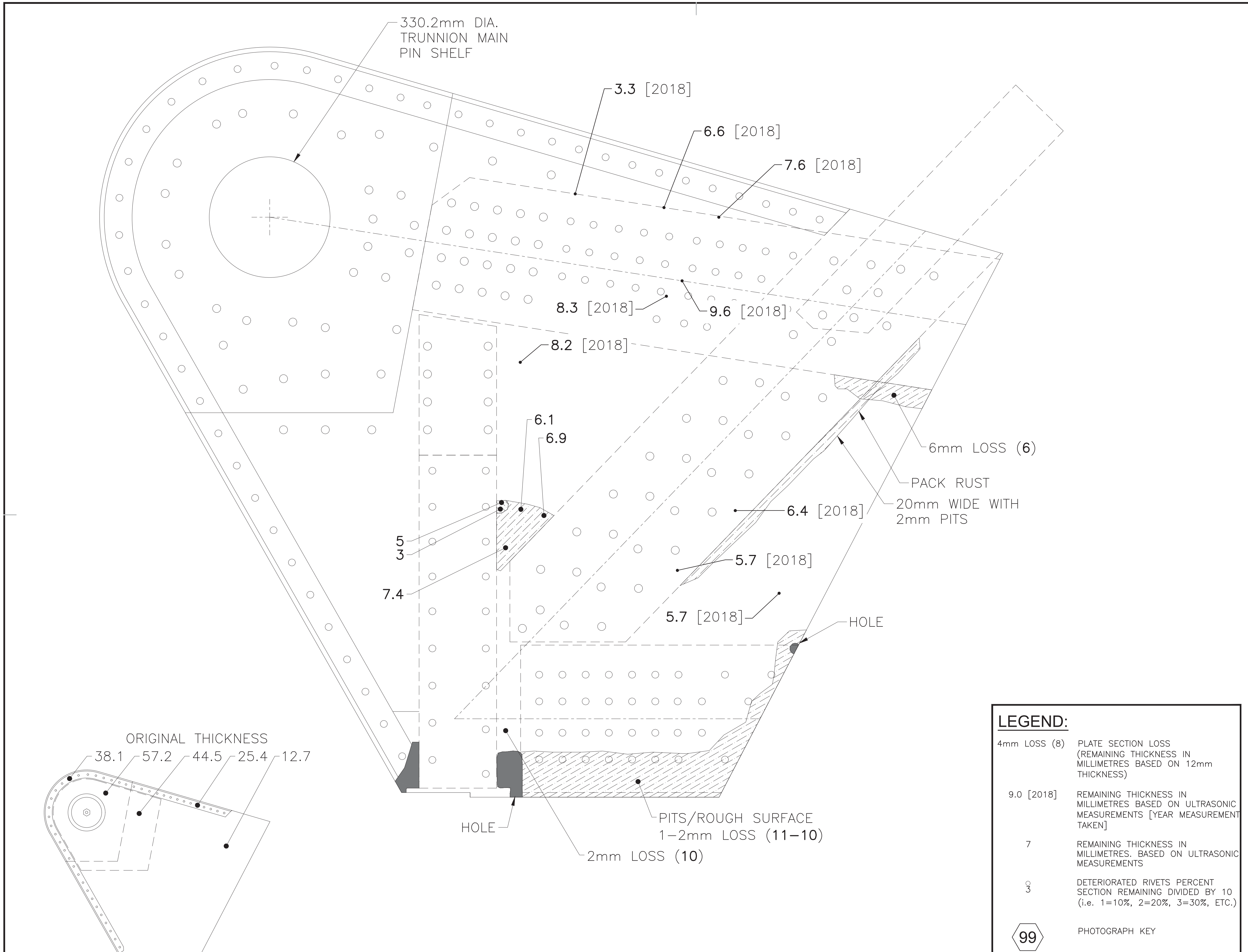
project / projet
LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin
SOUTH TRUNNION
FULL EXTERIOR PLATE
DETERIORATION
A B

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets

Project no. / No. du projet
R.090045.001

Drawing no. / No. du dessin
0000-11



MAIN CASTING – CAST STEEL – 11/4" 31.75mm
INTERIOR PLATE – PLATE STEEL – 1/2" 12.7mm
GUSSET – PLATE STEEL – 1/2" 12.7mm

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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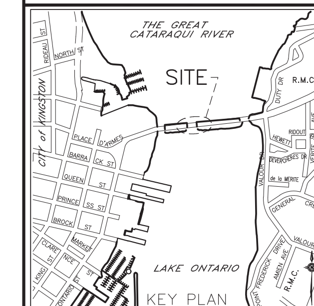

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revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
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project / projet

LASALLE CAUSEWAY
TRUNNION EVALUATION

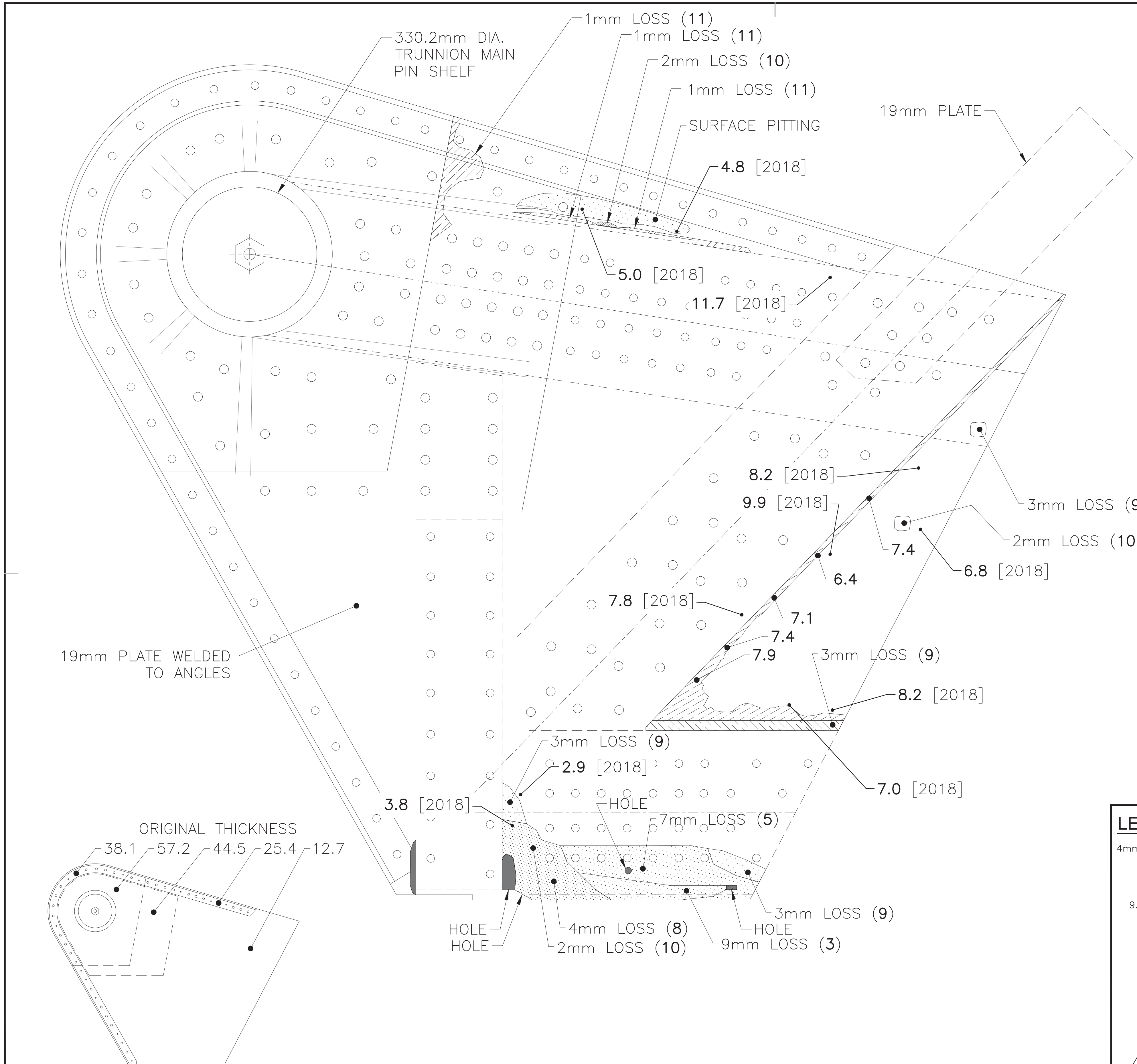
drawing / dessin

SOUTH TRUNNION
FULL INTERIOR PLATE
DETERIORATION
C D

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets

Project no. / No. du projet
R.090045.001

Drawing no. / No. du dessin
0000-12



MAIN CASTING – CAST STEEL – 11/4" 31.75mm
INTERIOR PLATE – PLATE STEEL – 1/2" 12.7mm
GUSSET – PLATE STEEL – 1/2" 12.7mm

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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PARSONS

THE GREAT CATARAQUI RIVER
SITE
LAKE ONTARIO
KEY PLAN

Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

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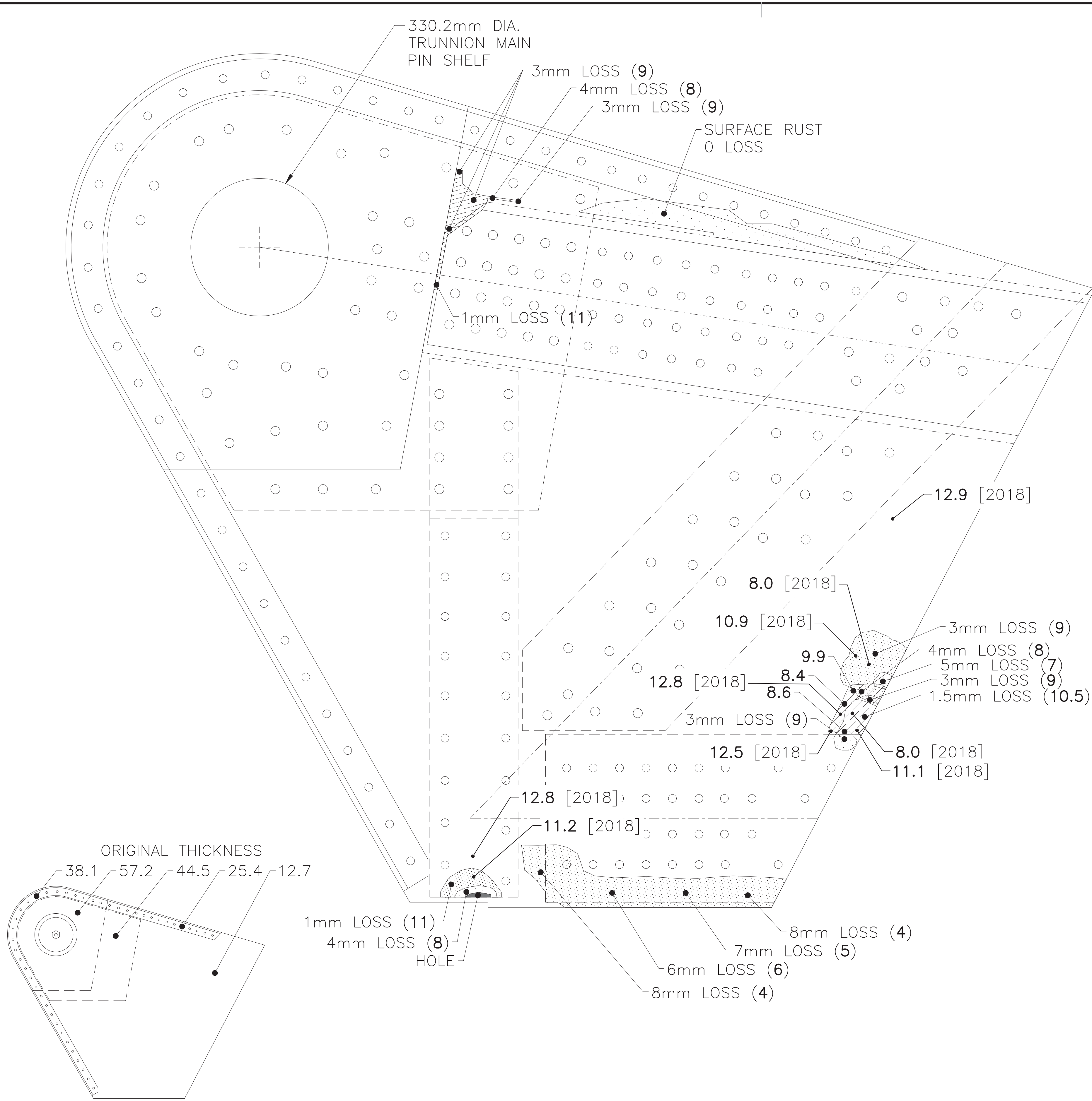
revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet
LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin
NORTH TRUNNION
FULL INTERIOR PLATE
DETERIORATION
E F

Designed By / Conçu par	J.B.C.	
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By / Dessiné par	R.D.	
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By / Examiné par	P.H.	
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By / Approuvé par		
Date		(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		
Project no. / No. du projet	R.090045.001	
Drawing no. / No. du dessin	0000-13	



MAIN CASTING – CAST STEEL – 11/4" 31.75mm
INTERIOR PLATE – PLATE STEEL – 1/2" 12.7mm
GUSSET – PLATE STEEL – 1/2" 12.7mm

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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0 10 20mm 40 60 80 100 120 140 160 180 200mm

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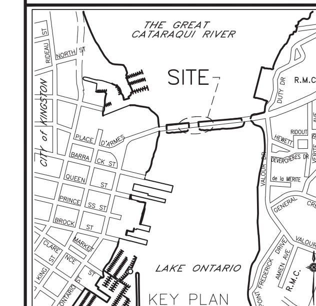

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project / projet
LASALLE CAUSEWAY
TRUNNION EVALUATION

drawing / dessin
NORTH TRUNNION
FULL EXTERIOR PLATE
DETERIORATION
G H

Designed By	J.B.C.	Conçu par
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Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
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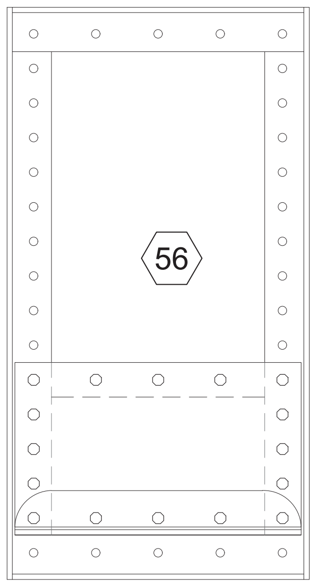
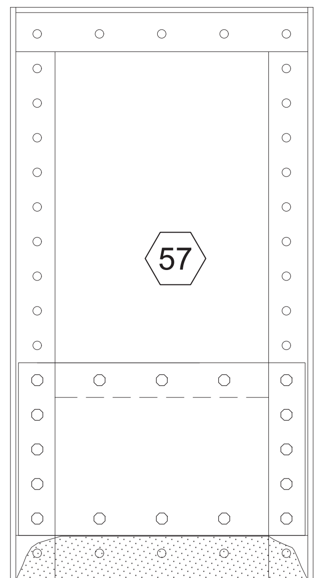
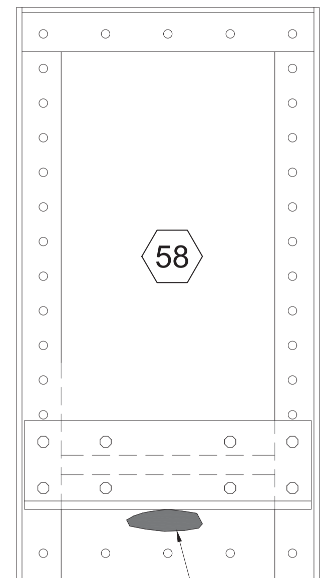
Project Manager		Administrateur de projets
Project no.	R.090045.001	No. du projet
Drawing no.	0000-14	No. du dessin



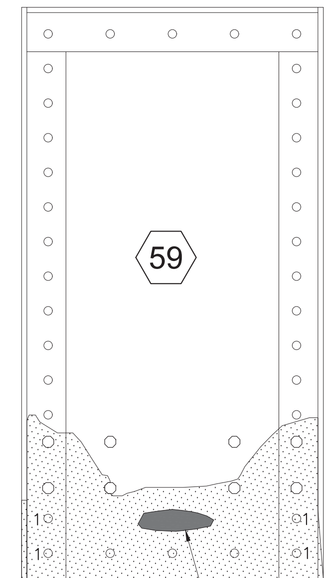
(B-C) PLATE BETWEEN B-D WEST ELEVATION
1:8



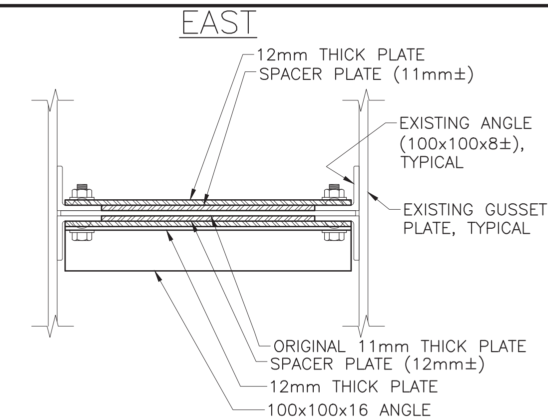
(B-C) PLATE BETWEEN B-D EAST ELEVATION
1:8



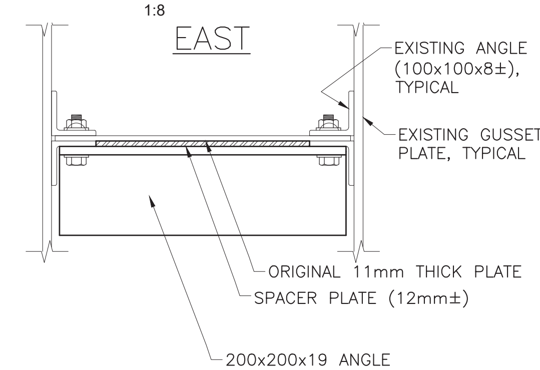
(F-G) PLATE BETWEEN F-G WEST ELEVATION
1:8



(F-G) PLATE BETWEEN F-G EAST ELEVATION
1:8

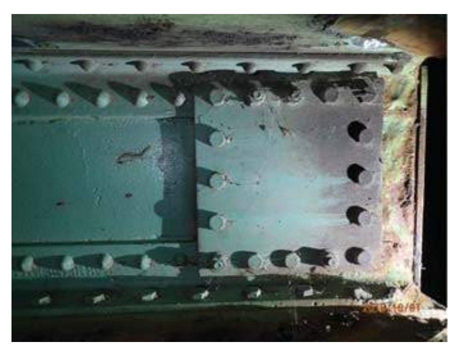


(B-C) SPACER PLATE REPAIR DETAIL
1:8



(F-G) SPACER PLATE REPAIR DETAIL
1:8

56



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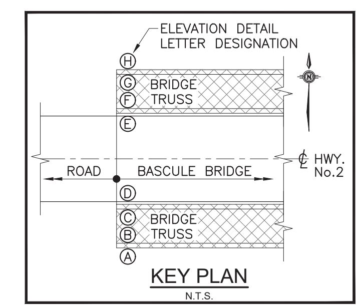

KEY PLAN
N.T.S.

LEGEND:

4mm LOSS (8)	PLATE SECTION LOSS (REMAINING THICKNESS IN MILLIMETRES BASED ON 12mm THICKNESS)
9.0 [2018]	REMAINING THICKNESS IN MILLIMETRES BASED ON ULTRASONIC MEASUREMENTS [YEAR MEASUREMENT TAKEN]
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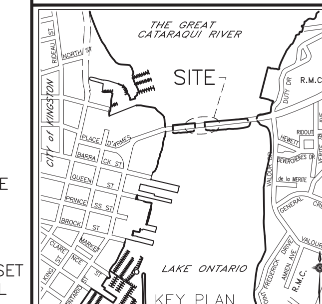

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DRAFT

revisions	description	date

A detail no. / no. du detail
B location drawing no. / sur dessin no.
C drawing no. / dessin no.

project / projet
LASALLE CAUSEWAY TRUNNION EVALUATION

drawing / dessin
NORTH & SOUTH TRUNNIONS PLATE DETERIORATION

Designed By	J.B.C.	Conçu par
Date	30 NOV 2018	(yyyy/mm/dd)
Drawn By	R.D.	Dessiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Reviewed By	P.H.	Examiné par
Date	30 NOV 2018	(yyyy/mm/dd)
Approved By		Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets

Project no. / No. du projet
R.090045.001

Drawing no. / No. du dessin
0000-15

Appendix C– Structural Inspection Photographs

Bascule Bridge, LaSalle Causeway

Photo S1: South elevation.

Photo S2: North elevation (photo from 2017 inspection).

Photo S3: Top of truss, looking east.

Photo S4: Looking east.


Photo S5: Bridge in open position.

Photo S6: North side of the counterweight truss.

Photo S7: West approach, looking east.

Photo S8: East approach, looking west.

Photo S9: West abutment. Note the map cracking in the ballast wall.

Photo S10: East abutment, looking south.


Photo S11: Localized severe pitting in north web of top chord member 0S-1S.

Photo S12: Leaf truss top chord member 3S-5S has a 60mm long lamination defect with a possible crack (photo by Brouco NDT).

Photo S13: Perforation and severe pitting of diaphragm inside top chord member 11S-13S near node 13S.

Photo S14: Perforation in the web of bottom chord member 14N–16N near node 16N and generalized light corrosion.

Photo S15: Severe pitting and rust jacking between member 14N-15N and 14N-16N.

Photo S16: Severe localized section loss and perforation in web of south channel of leaf truss bottom chord member 0S-2S at node 2S adjacent to the sidewalk floor beam connection.

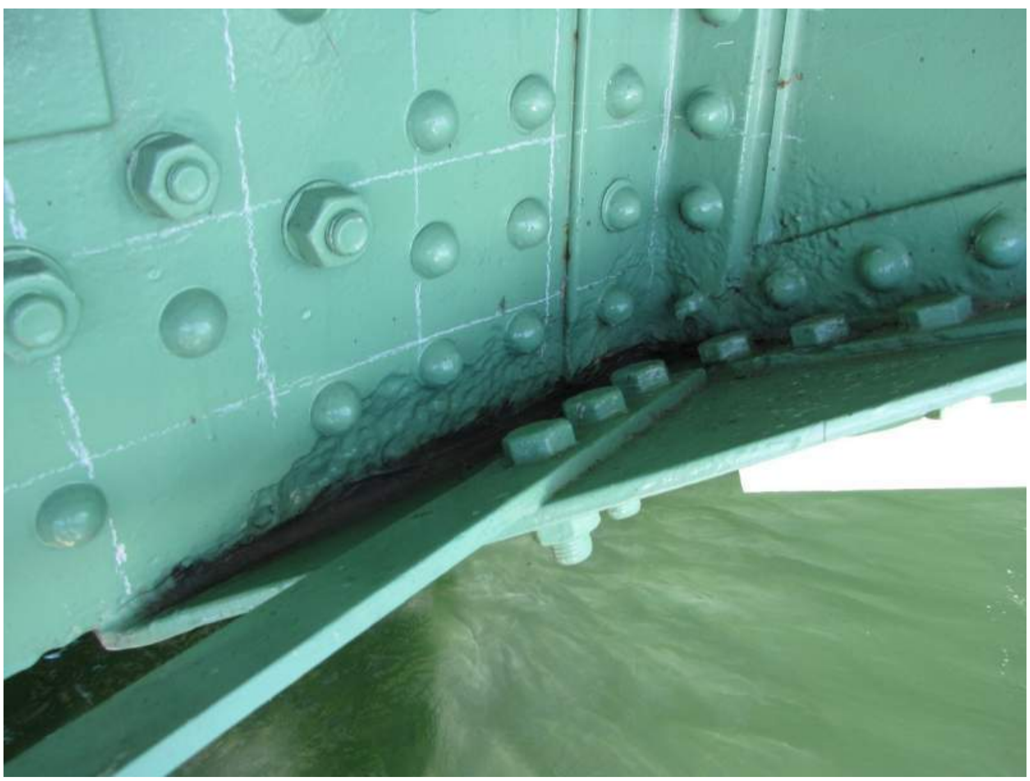

Photo S17: Severe localized section loss of south web of bottom chord member 4S-6S at FB4.

Photo S18: The top and bottom flanges of leaf truss bottom chord member 14S-16S have deformed near 16S.

Photo S19: Perforation and 12mm long crack in interior channel of bottom chord member 14S–16S (photo by Brouco NDT).

Photo S20: Severe localized pitting and section loss of flanges where 14S-16S and 14S-15S intersect. Several rivet heads have over 75% section loss.

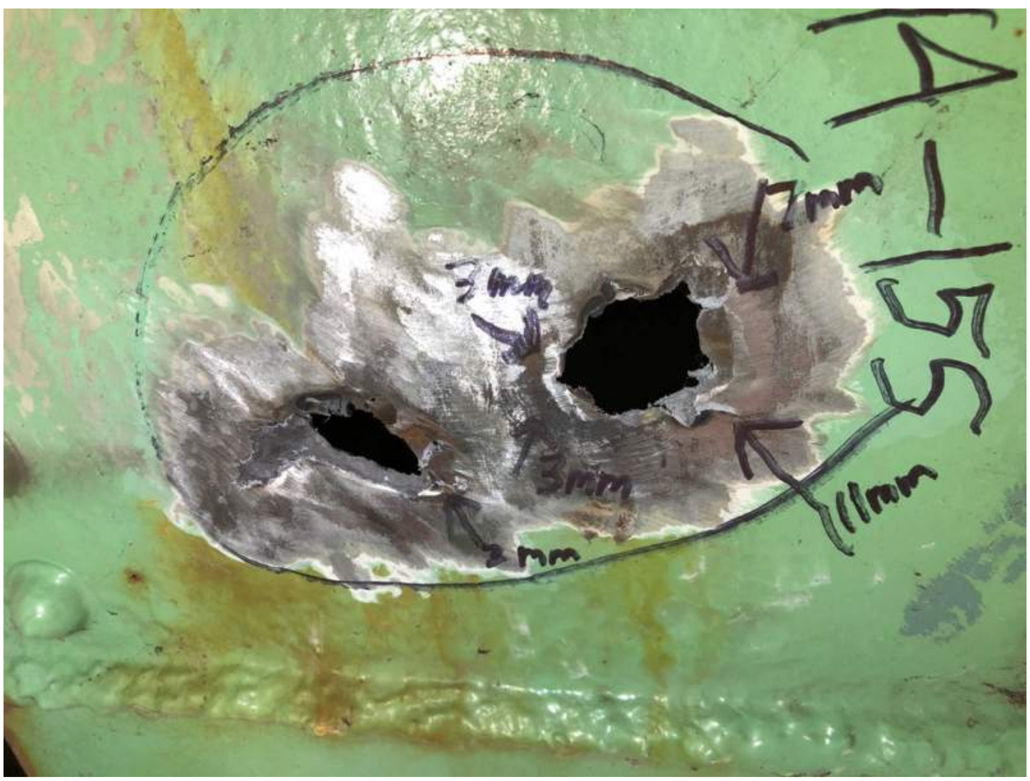

Photo S21: Perforations and cracks in bottom batten plate of bottom chord member 14S–15S near node 15S. The cracks range in length from 3mm to 11mm (photo by Brouco NDT).

Photo S22: The upper batten plate of diagonal member 12S-13S near node 13S is deformed.

Photo S23: Suspected crack at flame-cut hole in southeast angle of vertical member 1N–2N (photo by Brouco NDT).

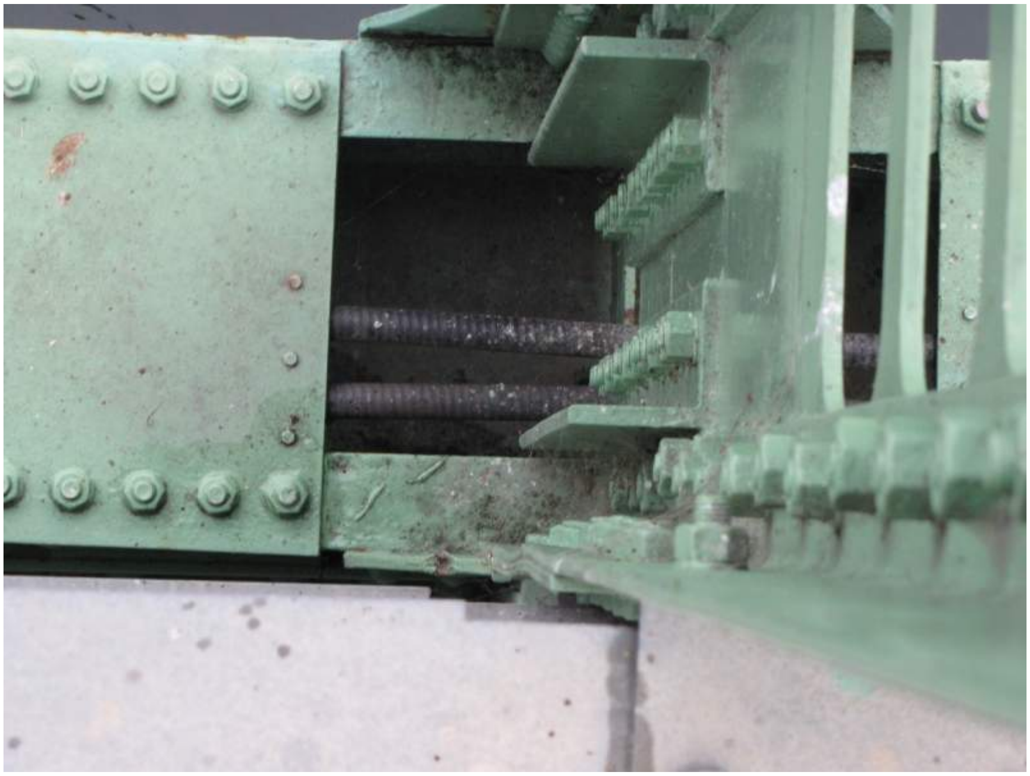

Photo S24: The outstanding leg of the southwest angle of 1N-2N is bent above the bottom chord.

Photo S25: Deformation of the northwest leg of vertical member 9N–10N was noted below the flame-cut hole (photo by Brouco NDT).

Photo S26: Very severe pitting with a small perforation in the south angles of vertical member 9N-10N above node 10.


Photo S27: Impact damage to vertical member 9N-10N has bent a portion of the southeast flange.

Photo S28: Perforation in the south angles of vertical member 11N-12N above node 12.


Photo S29: Both south flanges of vertical member 11N-12N near 12N are perforated but the member has been strengthened.

Photo S30: 3mm long crack in top of southeast leg of vertical member 9S–10S at weld location (photo by Brouco NDT).

Photo S31: Severe corrosion and section loss of rivet heads at the base of 15N-17N and section loss of the gusset plate at the main trunnion (photo from 2017 inspection).

Photo S32: View of the west side of the north trunnion. Note the loss of the bottom flange of the north channel of tower truss member 15N-18N (photo from 2017 inspection).

Photo S33: Truss tower horizontal member 18N-19N has severe section loss of interior angles and rivet heads plus a perforated lower batten plate (photo from 2017 inspection).

Photo S34: Perforations in upper and lower batten plates of bottom chord 18N-19N at node 19N.

Photo S35: Tower truss vertical member 19N-20N has severe section loss in the rivet heads and web plate at roadway level and deformation (likely due to impact damage) in the southeast and southwest flanges.

Photo S36: Perforation and 3mm long crack in south channel of tower truss bottom chord member 15S-18S (photo by Brouco NDT).

Photo S37: Perforation and 60mm long crack in south channel of tower truss bottom chord member 18S-19S (photo by Brouco NDT).

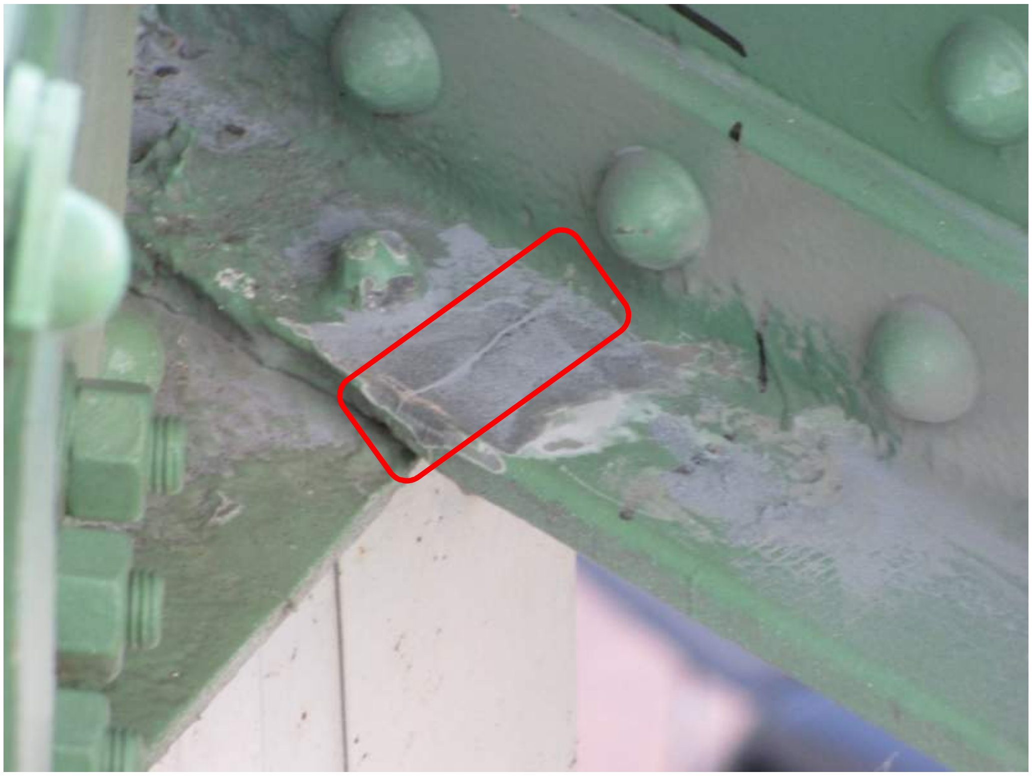

Photo S38: Crack across full width of bottom leg of interior angle of 21N-27N counter weight truss member at node 27N.

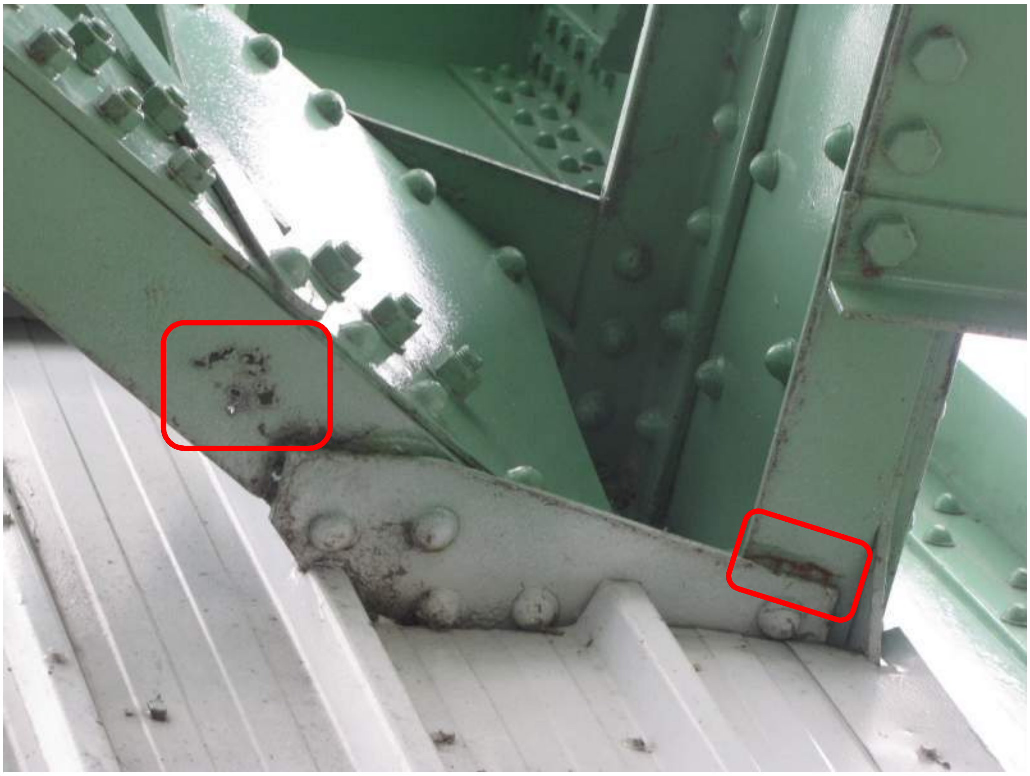

Photo S39: The northwest end of counterweight truss cross bracing 21S-27N has several perforations in the lower flange (left). Note the crack in the south lower flange of member 21N-27N (right).

Photo S40: Debris and water are collecting on member 26N-26S.

Photo S41: Severe corrosion on the bottom flange of the northeast transverse strut in the mechanical room.

Photo S42: The interior vertical gusset plate at node 16N exhibits severe section loss and a perforation with a crack.

Photo S43: The interior faces of the plates and rivet heads at the base of the north trunnion have localized severe section loss.

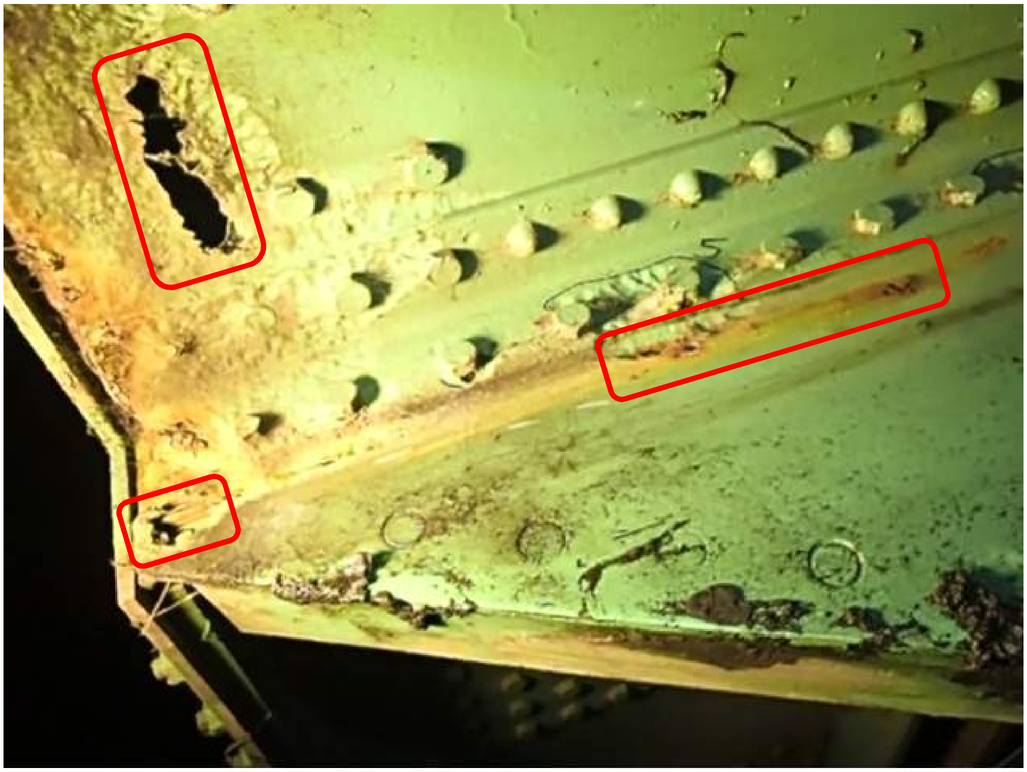

Photo S44: Perforations in the interior face of the south plate and front plate of the north trunnion at 16N.

Photo S45: Very severe section loss in the rivet heads and angle at the base of the exterior face of the south plate of the north trunnion.

Photo S46: View of the interior of the north plate of the south trunnion below deck level. A crack was found at the perforation circled.

Photo S47: Severe pitting at the base of the interior face and rivet heads of the south plate of the south trunnion.

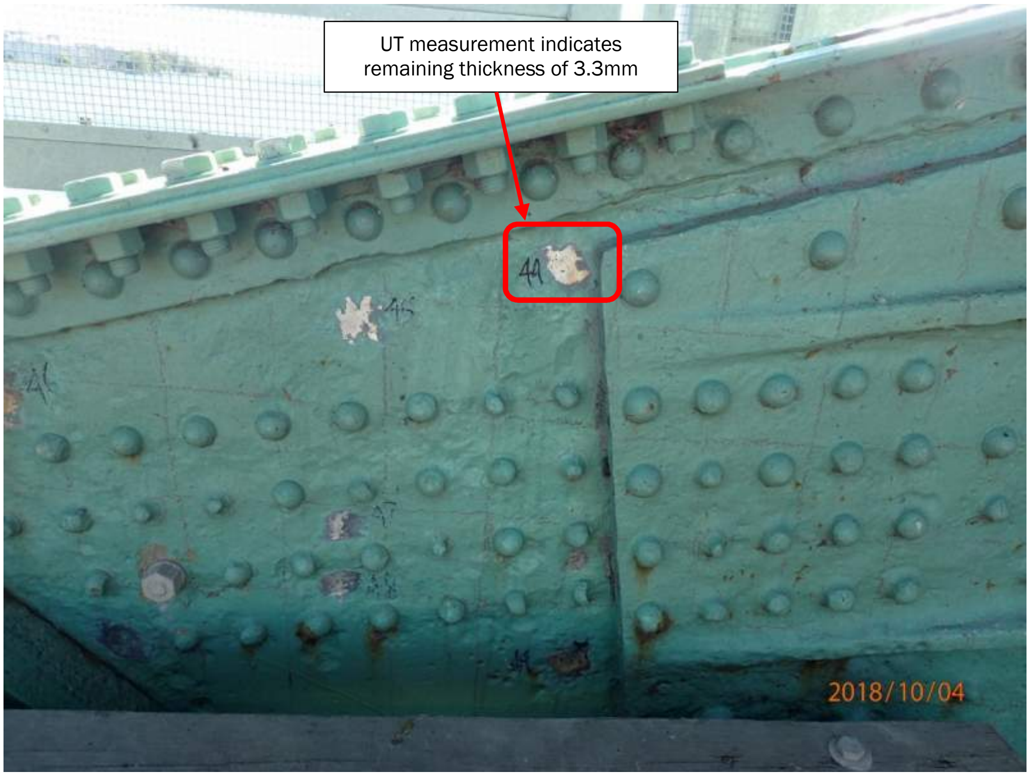

Photo S48: The north (roadway) side of the south trunnion has widespread pitting in the collar plate (right side), connection plate (left side) and some rivet heads.

Photo S49: The north (roadway) side of the south trunnion has widespread pitting in the collar plate (not shown), connecting plate, and some rivet heads.

Photo S50: Crack in southwest vertical gusset plate at 2N (photo by Brouco NDT).

Photo S51: The vertical gusset plate at node 15N at roadway level exhibits very severe section loss and perforations.

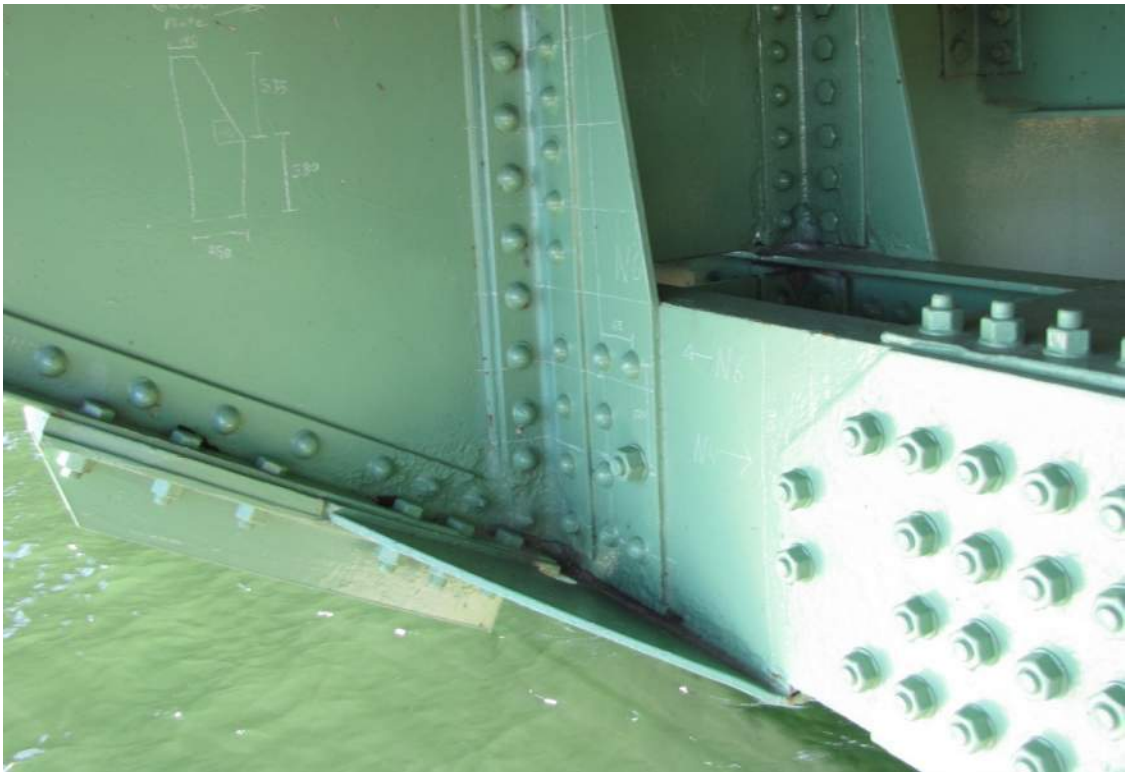

Photo S52: Severe localized section loss at the base of the gusset plate and sidewalk floor beam clip angle at 6S.

Photo S53: 15mm notch/crack in the bottom cope of Stringer E (FB0-FB2) at FB0.

Photo S54: 15mm notch/crack in the bottom cope of Stringer E (FB10-FB12) at FB10 (photo by Brouco NDT).

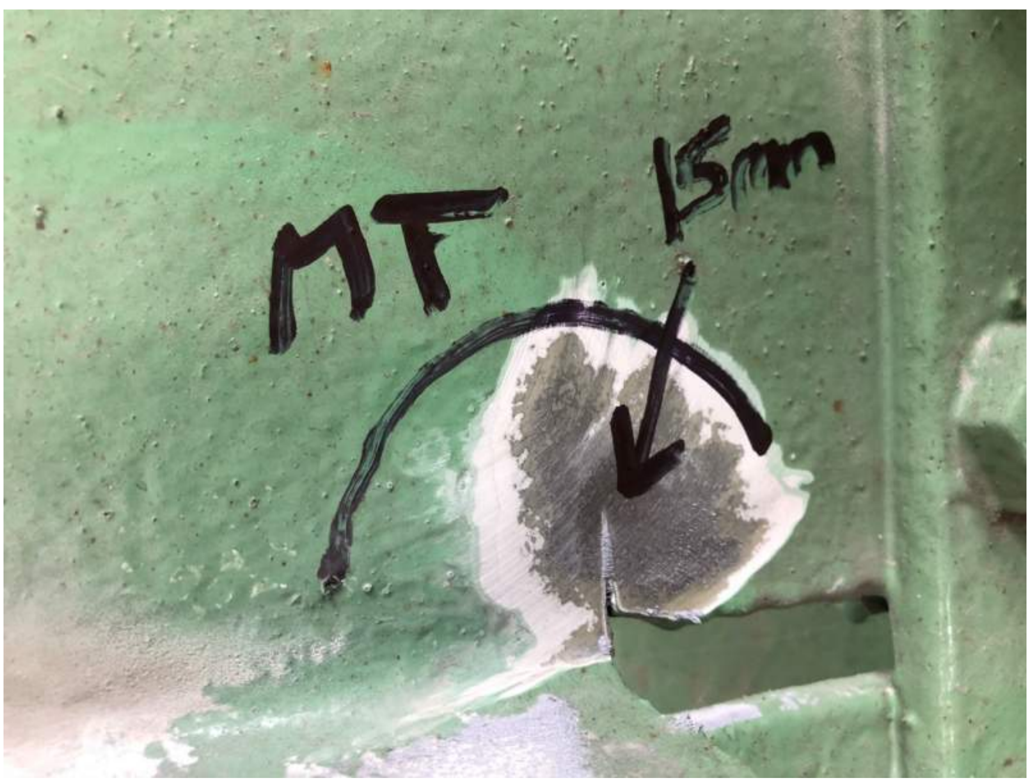

Photo S55: 15mm notch/crack in the bottom cope of Stringer D (FB14-FB16) at FB14 (photo by Brouco NDT).

Photo S56: 20mm notch/crack in the bottom cope of Stringer E (FB14-FB16) at FB14 (photo by Brouco NDT).

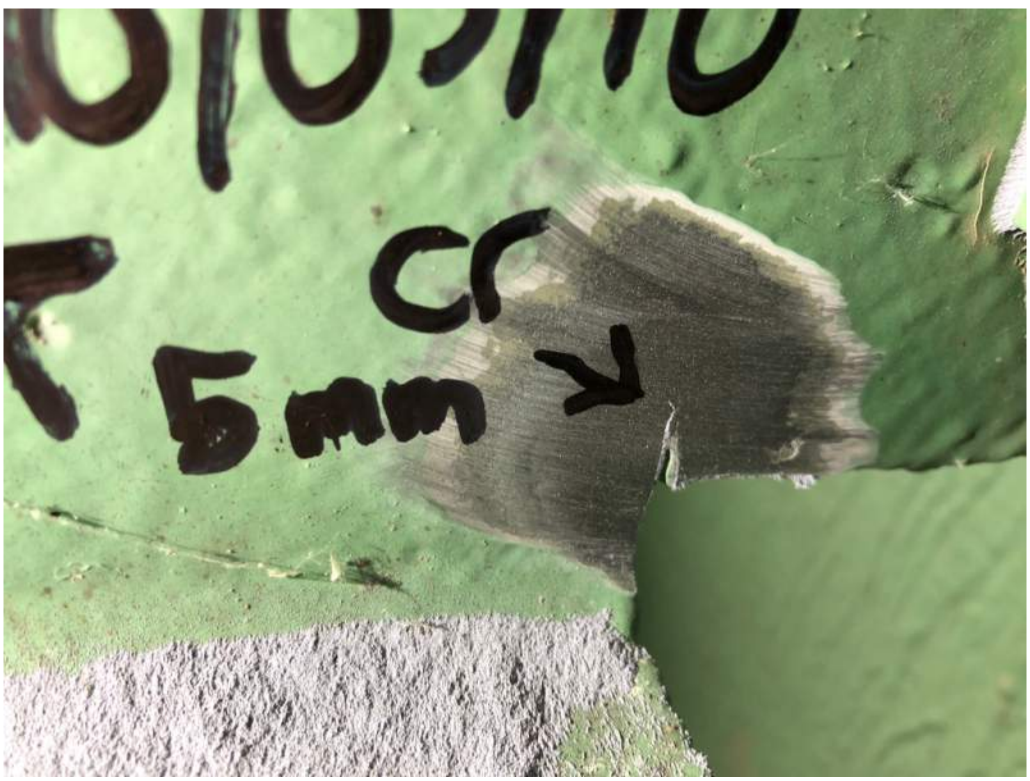

Photo S57: 5mm notch/crack in the bottom cope of Stringer I (FB14-FB16) at FB14 (photo by Brouco NDT).

Photo S58: The sills supporting the deck grating are typically permanently deflected.

Photo S59: Multiple sills in bay 14-16 are not bearing on the stringers below.

Photo S60: Several of the bolts connecting the north timber curb to the sills at the east end are loose.

Photo S61: The underside of the east edge of the counterweight panelling is leaking and exhibits corrosion and efflorescence deposits.

Photo S62: The panels on the underside of the counterweight have widespread corrosion and wet areas/stains.

Photo S63: Gaps in the counterweight panels are permitting smaller pieces of aggregate from the disintegrated counterweight concrete to fall onto the roadway below.

Photo S64: Spalls, disintegration, map cracking, efflorescence deposits, and wet stains were typically noted in the counterweight concrete inside the two voids in the east face (photo from 2017 inspection).

Photo S65: There is a small perforation beneath the north door in the east face of the counterweight panels adjacent to the previous repair.

Photo S66: Efflorescence deposits and staining on the underside of the counterweight concrete.

Photo S67: The concrete in the two upper chambers in the top face of the counterweight exhibits spalls, disintegration, and wet areas (2016 photo).

Photo S68: The concrete in the two upper chambers in the top face of the counterweight exhibits spalls, disintegration, and wet areas (2016 photo).

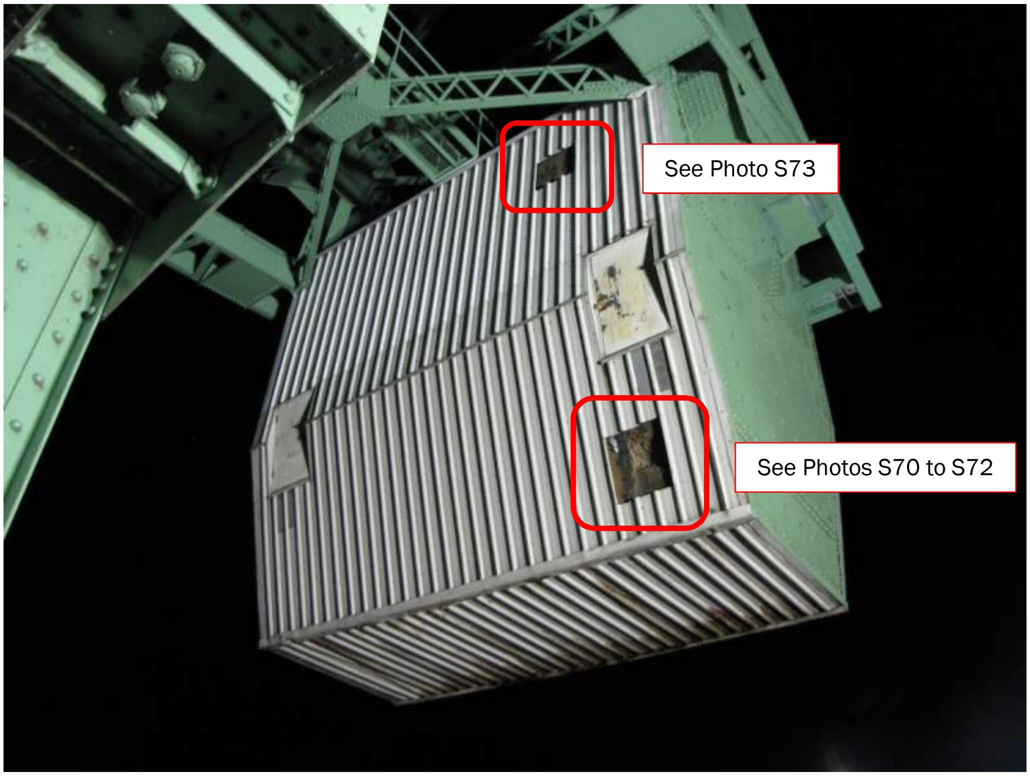

Photo S69: Locations of cladding removal in the northeast corner of the counterweight.

Photo S70: The counterweight concrete in the lower northeast corner exhibits a very severe spall/disintegration, delaminated areas, and exposed and corroded reinforcing bars and wire mesh.

Photo S71: Very severe spall/disintegration of the counterweight concrete in the lower northeast corner (looking north).

Photo S72: The counterweight concrete in the lower northeast corner has a severe spall/disintegration and a wide diagonal crack that extends at least 2 metres.

Photo S73: The counterweight concrete in the upper northeast corner has a wide crack but is otherwise in generally good condition (photo by Gemtec).

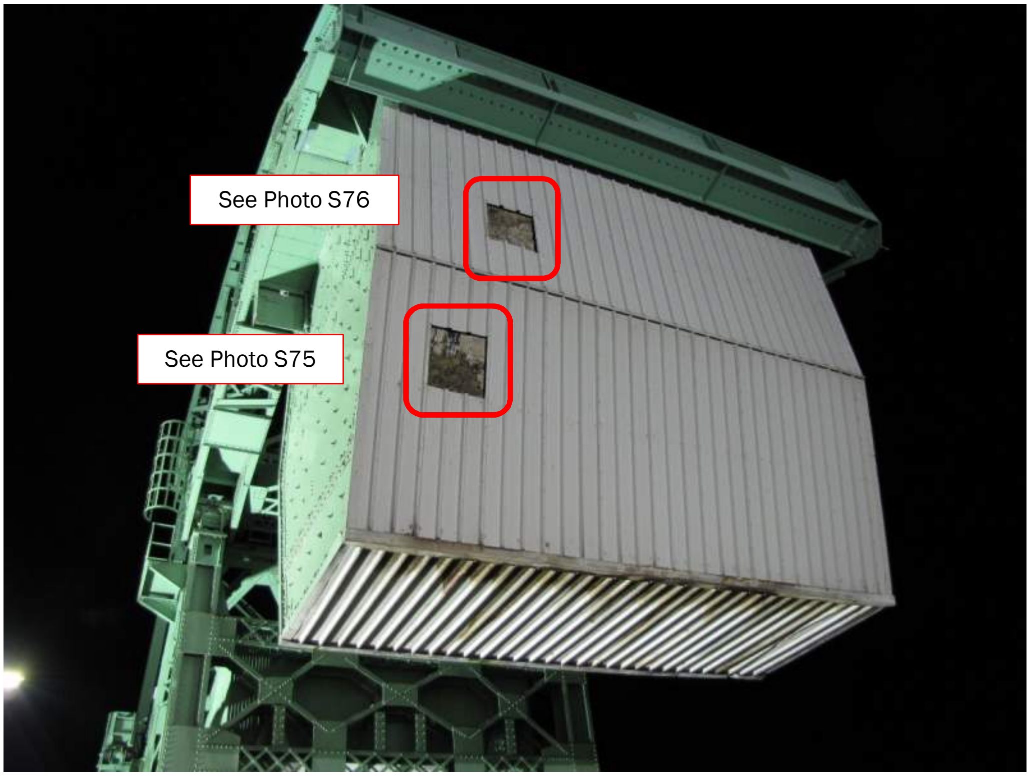

Photo S74: Locations of panel removal in the northwest corner of the counterweight.

Photo S75: The counterweight concrete in the lower northwest corner exhibits widespread wide map cracking and a wet area.

Photo S76: The counterweight concrete in the upper northwest corner exhibits a large area of disintegration, delaminated areas, and exposed and corroded wire mesh.

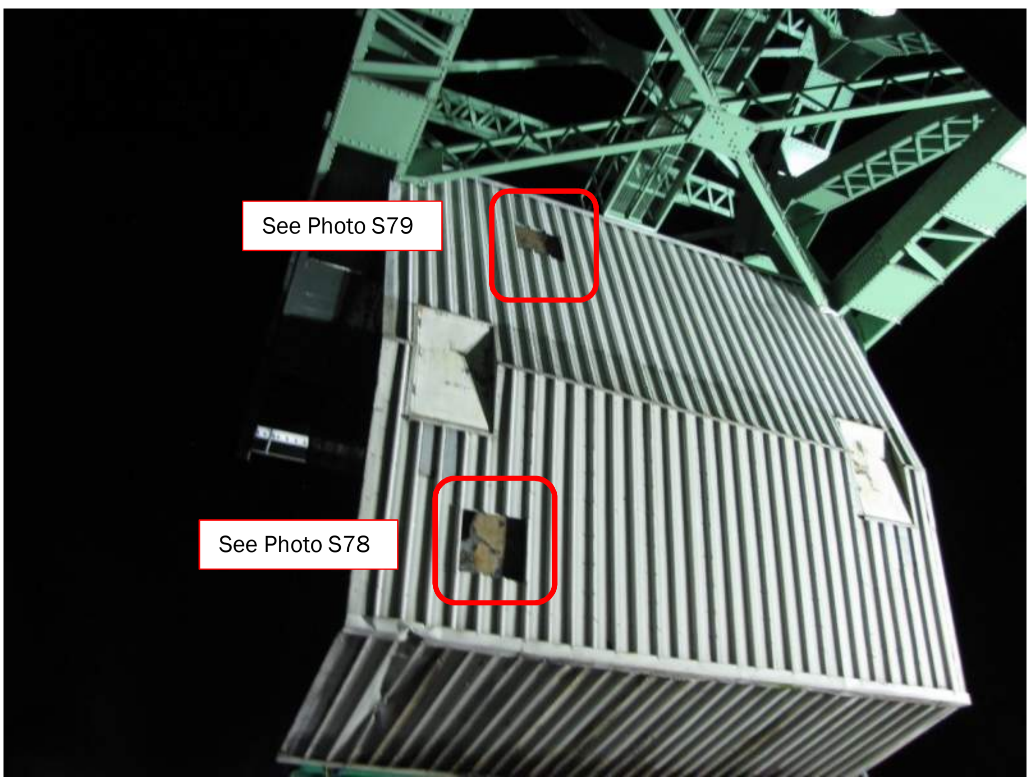

Photo S77: Locations of panel removal in the southeast corner of the counterweight.

Photo S78: The counterweight concrete in the lower northwest corner exhibits a severe spall and wide cracks.

Photo S79: The counterweight concrete in the upper northwest corner exhibits wide cracks.

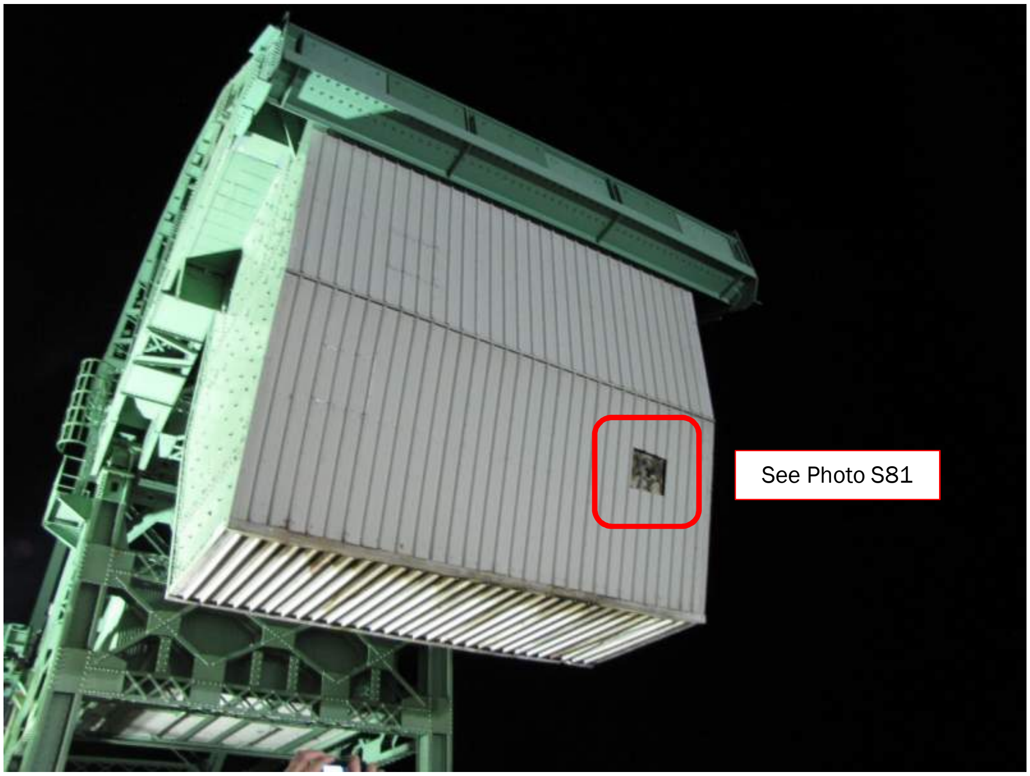

Photo S80: Location of panel removal in the southwest corner of the counterweight.

Photo S81: The counterweight concrete in the lower southwest corner exhibits an area of disintegration, and map cracking with wet stains.

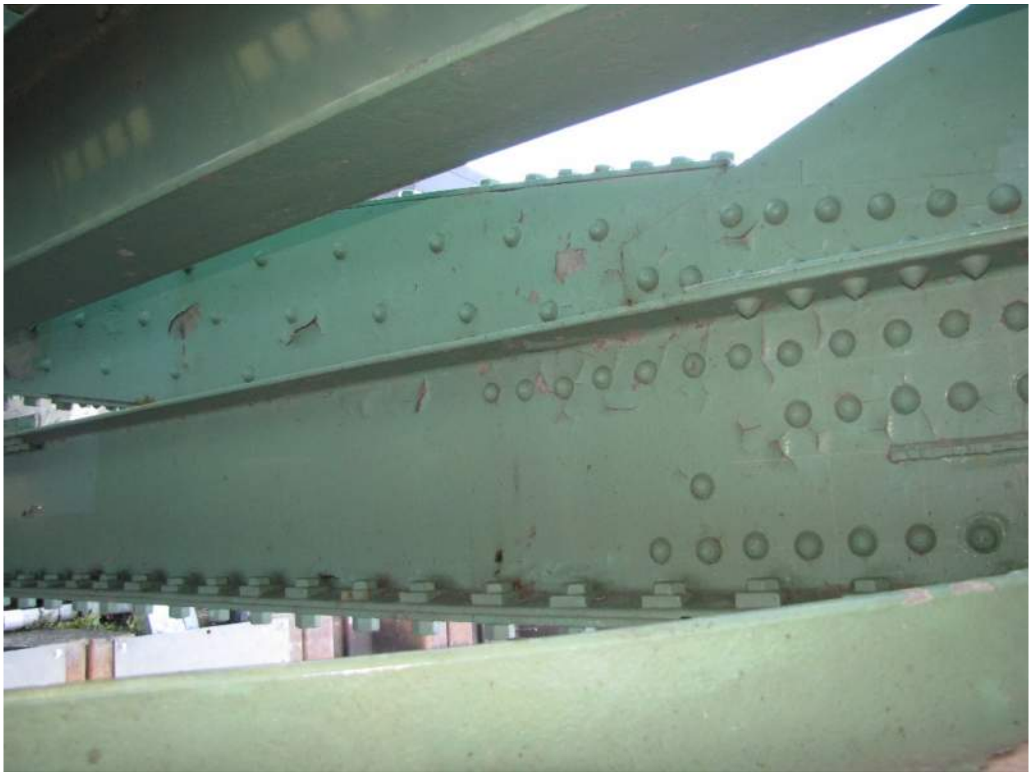

Photo S82: The painted coating is cracking and peeling off at several locations on the structure (members 14N-15N and 14N-16N shown).

Photo S83: The roadway grating has widespread light to medium corrosion along the north and south edges (north side shown).

Photo S84: Repairs have recently been carried out to areas of the steel deck grating with broken and bent bars (east end shown).

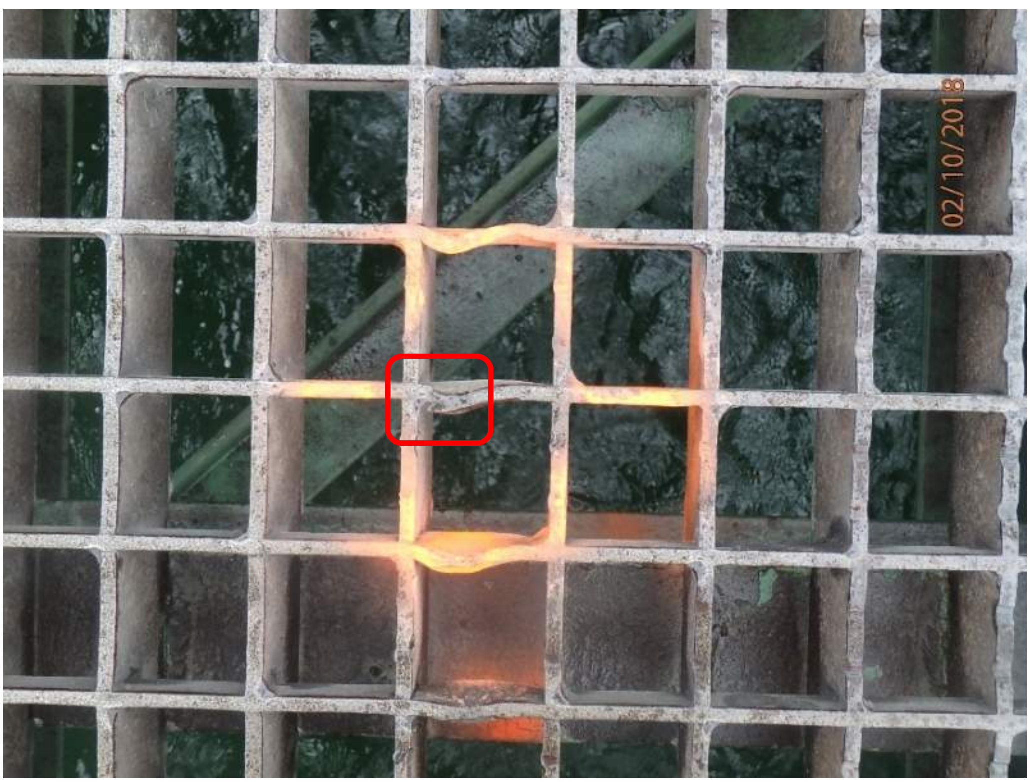

Photo S85: Cracked bar in deck grating panel 14-15 B. The serrated edges have been completely worn away within the wheel tracks.

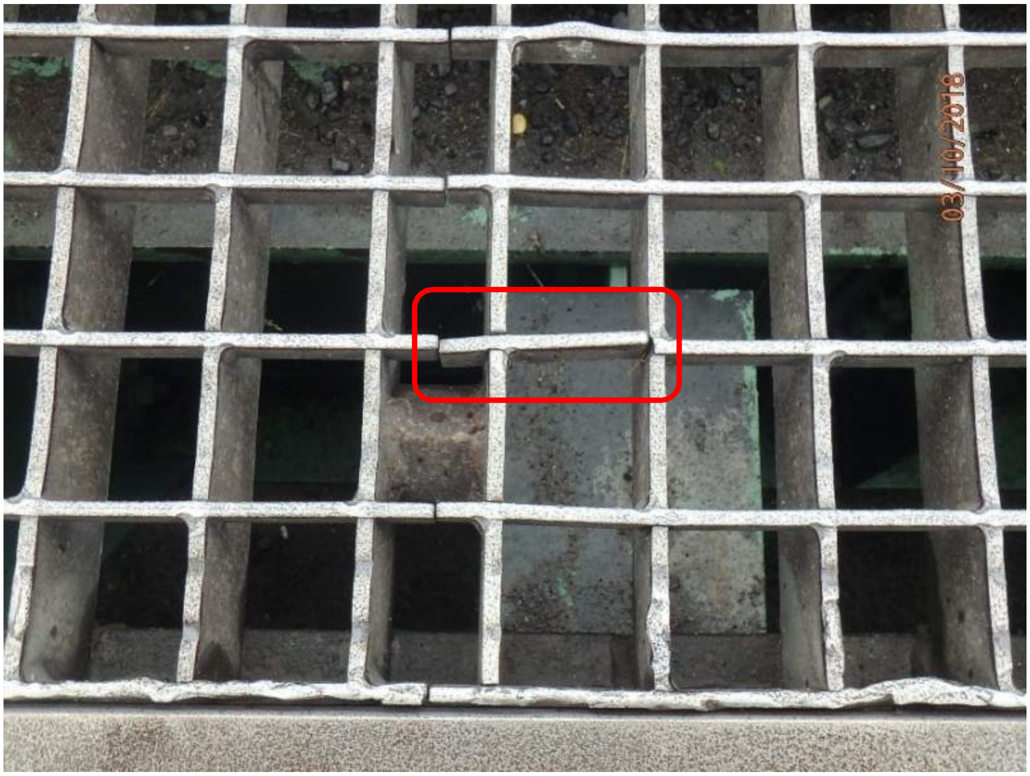

Photo S86: Broken bar in deck grating panel 0-2 G. The serrated edges have been completely worn away within the wheel tracks.

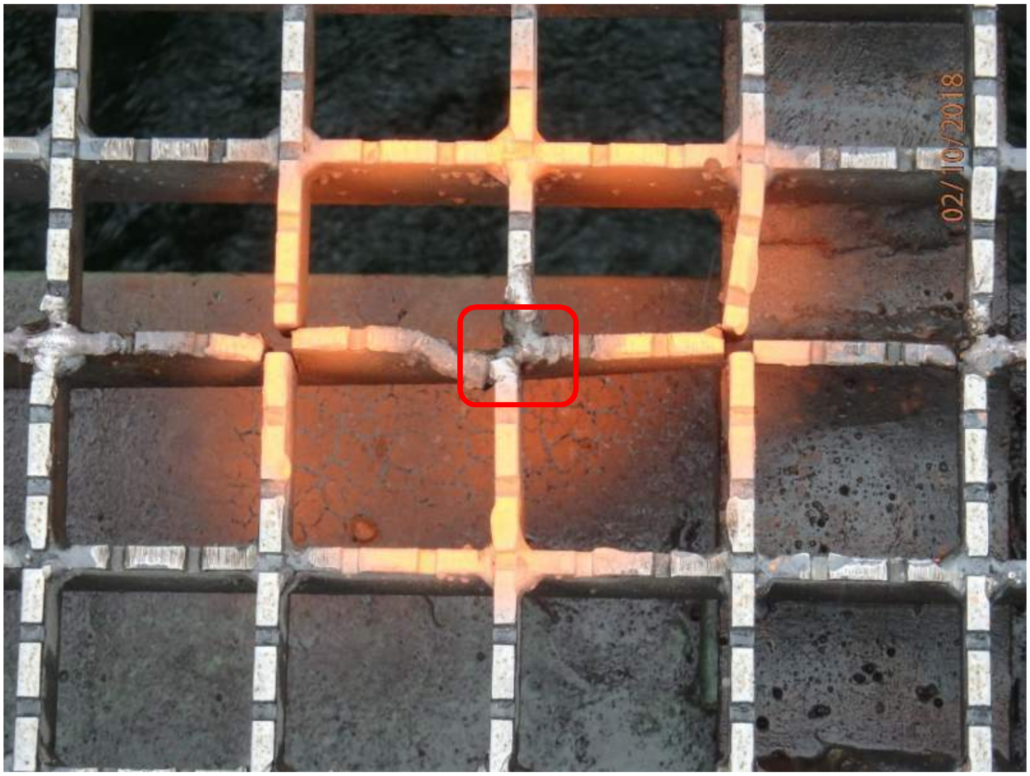

Photo S87: Cracked weld in deck grating panel 10-12 C.

Photo S88: View of the top of the south trunnion.

Photo S89: View of the top of the north trunnion.

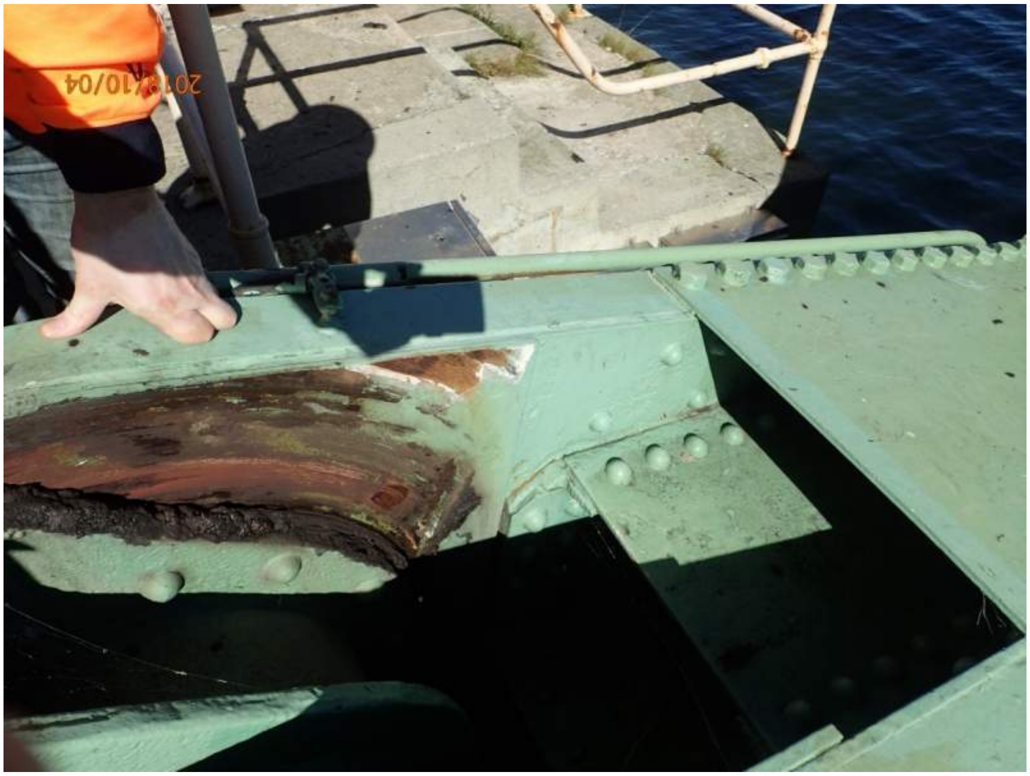

Photo S90: Areas of coating on the interior of the north plate of the north trunnion have been worn away.

Photo S91: View of the west side of the south trunnion. Note the severe corrosion of member 15S-18S (photo from 2017 inspection).

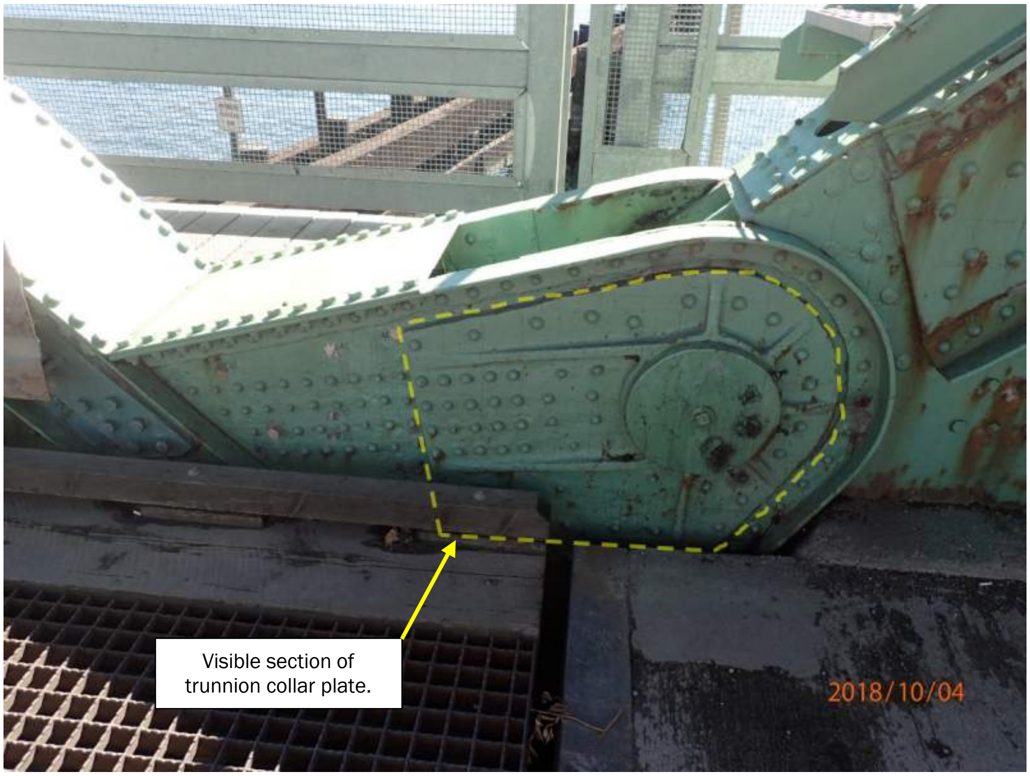

Photo S92: The north (roadway) side of the south trunnion.

Photo S93: Six lattices in portal truss member 1S-1N are bent, likely due to vehicular impact of the bottom angle.

Photo S94: The lower angle of portal truss member 1S-1N is holding water.

Photo S95: Severe impact damage to the bottom east angle of sway brace member 5S-5N.

Photo S96: Tower truss sway bracing member 20N-20S has several perforations and deep pitting in the bottom gusset plate and severe section loss of the rivet heads at node 20N.

Photo S97: Tower truss sway bracing member 20N-20S has deep pitting in the bottom gusset plate and severe section loss of the rivet heads at node 20S.

Photo S98: Counterweight truss member 21S-27N has severe localized section loss of the lower south angle at the west end at node 27N.

Photo S99: Lower cross bracing member 10N-12S is deformed.

Photo S100: The bracing members that connect the cantilever sidewalk floor beams are typically sagging.

Photo S101: The mechanical room soffit exhibits several spalls and delaminated areas. Scaling of the delaminated areas is recommended as they are located over the roadway.

Photo S102: Water was leaking into the northwest corner of the mechanical room during the inspection. Over time this has caused corrosion of the top flange of one of the steel beams supporting the motors.

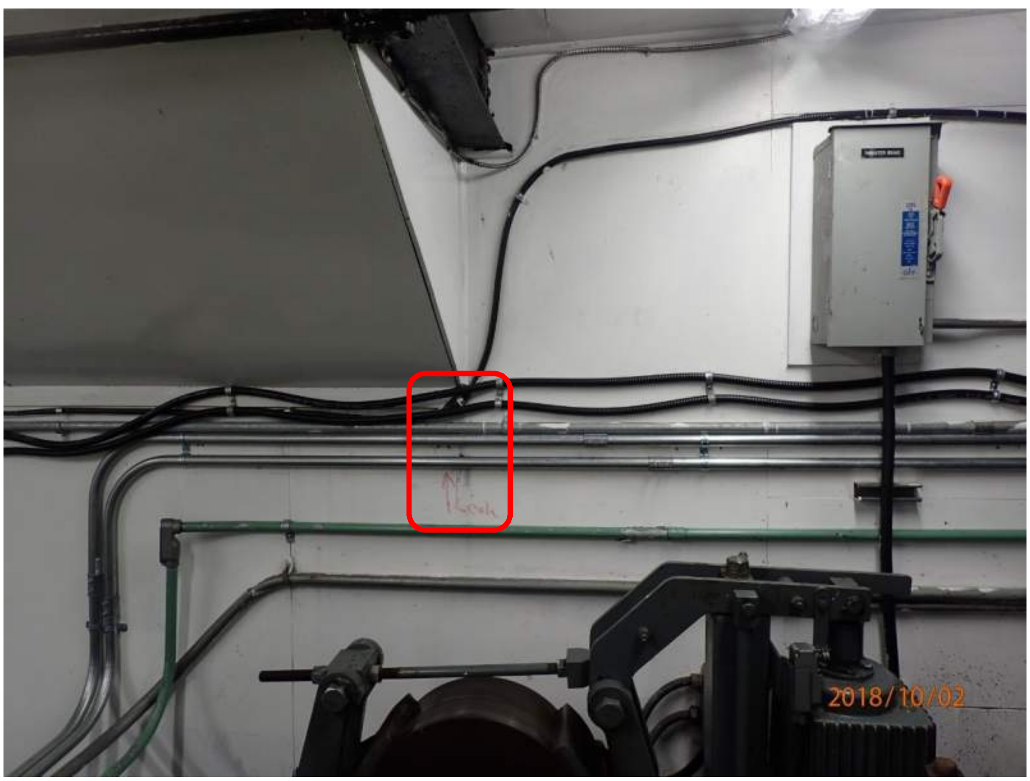

Photo S103: Water was leaking into the north side of the mechanical room during the inspection.

Photo S104: Areas of the west joint armoring sound hollow when tapped, indicating a void between the angle and underlying concrete.

Photo S105: Two of the railing posts between the north trunnion and the control room are perforated at the base (north post shown, south post similar). These posts were subsequently repaired in October 2018.

Photo S106: The east end of the north timber curb has some impact damage and is not anchored to the deck.

Photo S107: A wide crack in the southeast wingwall extends across the sidewalk.

Photo S108: Very severe spall at the base of the southwest wingwall at the interface with the abutment.

Photo S109: The northwest anchor bolt of the southeast live load support is bent and exhibits medium to severe corrosion.

Photo S110: The leaf span is not fully seated on the northeast live load support (right) and only seats fully when vehicles are on the east end of the deck (left).

Photo S111: The east end of the east approach slab appears to have settled over time creating an uneven ride for vehicles.

Photo S112: There are two wide cracks that extend across the full width of the east approach slab.

Photo S113: There is a wide crack and patched potholes at the interface between the east approach slab and adjacent roadway wearing surface.

Photo S114: A timber post in the southwest guiderail has been split by vehicular impact.

Photo S115: There is severe split in the top east fender at the north end of the east training wall.

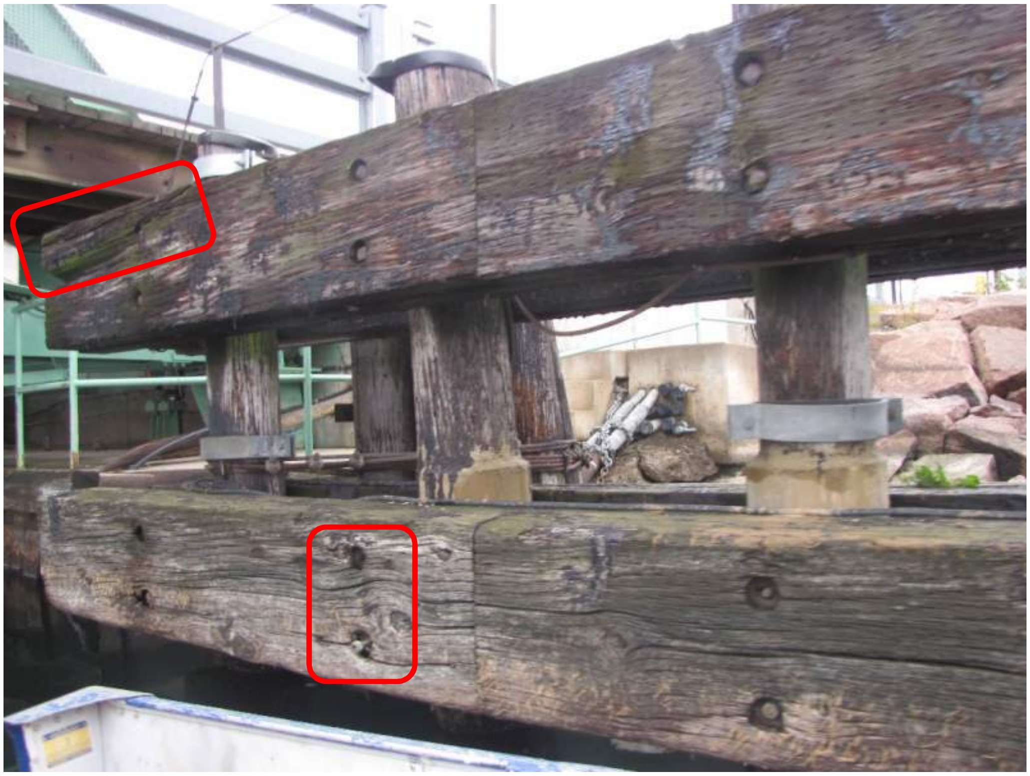

Photo S116: Severe rot in the upper fender at the north end of the east training wall. Note the loose (lower) and missing (upper) bolted connections in the lower fender.

Photo S117: The lower cables securing the dolphin to the south end of the west training wall are loose and corroded. One pile has broken off.

Photo S118: The east C-channel supporting the catwalk outside the mechanical room is supported by the tapered cantilevered members below but only 25mm of the bottom flange is actually supported.

Photo S119: There are no safety chains across the two open sections of the west railing on catwalk 21N-21S which is a potential failing hazard (south side shown).

Photo S120: Bent catwalk safety railing above node 22N.

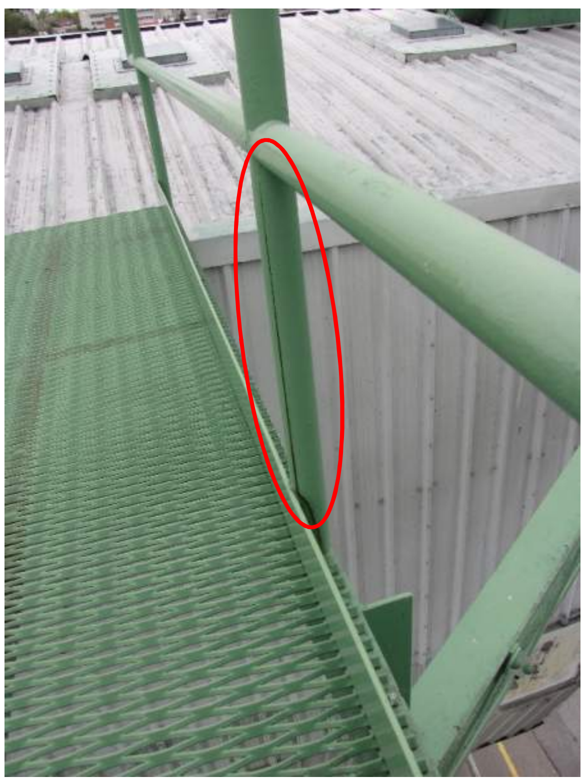

Photo S121: Several catwalk railing posts have split (second post from west of counterweight catwalk 21-27 north railing shown).

Photo S122: Severe pitting and perforation in south channel at bottom step of catwalk stairs from 21-22.

Photo S123: The top of 12N-13N near 13N is deformed.

Appendix D– Mechanical Inspection Photographs

Photo M1: Span Drive Machinery B1-N Bearing. There is light paint deterioration and corrosion between the bearing cap and base at the upper split line. B1-S Bearing is similar.

Photo M2: Span Drive Machinery Brake. The north east mounting bolt nut has poor bearing. The mounting bolt and surrounding areas are lightly corroded.

Photo M3: Span Drive Machinery South Motor. The underside of the motor mounting support is unpainted. The span drive north motor is similar. View Photo M4 for a detailed view under the mounting plate.

Photo M4: Span Drive Machinery South Motor. The underside of the motor mounting support is unpainted. The span drive north motor is similar.

Photo M5: Span Drive Machinery Gear D. Note the light damage on the south side of the closing face of this gear.

Photo M6: Span Drive Machinery North Pinon G. The contact wear pattern at the north G pinion indicates light cross bearing with heavier contact on the north side of the opening face and heavier contact on the south side of the closing face.

Photo M7: North Operating Strut Guide Assembly. There is no access to inspect many of the machinery interfaces internal to the guide assembly.

Photo M8: South Operating Strut, Inboard Bearing. The cracked paint and fretting corrosion at the rivets indicate that the connection is loose.

Photo M9: South Operating Strut, Outboard Bearing. The bearing housing stiffener is rubbing on the structure.

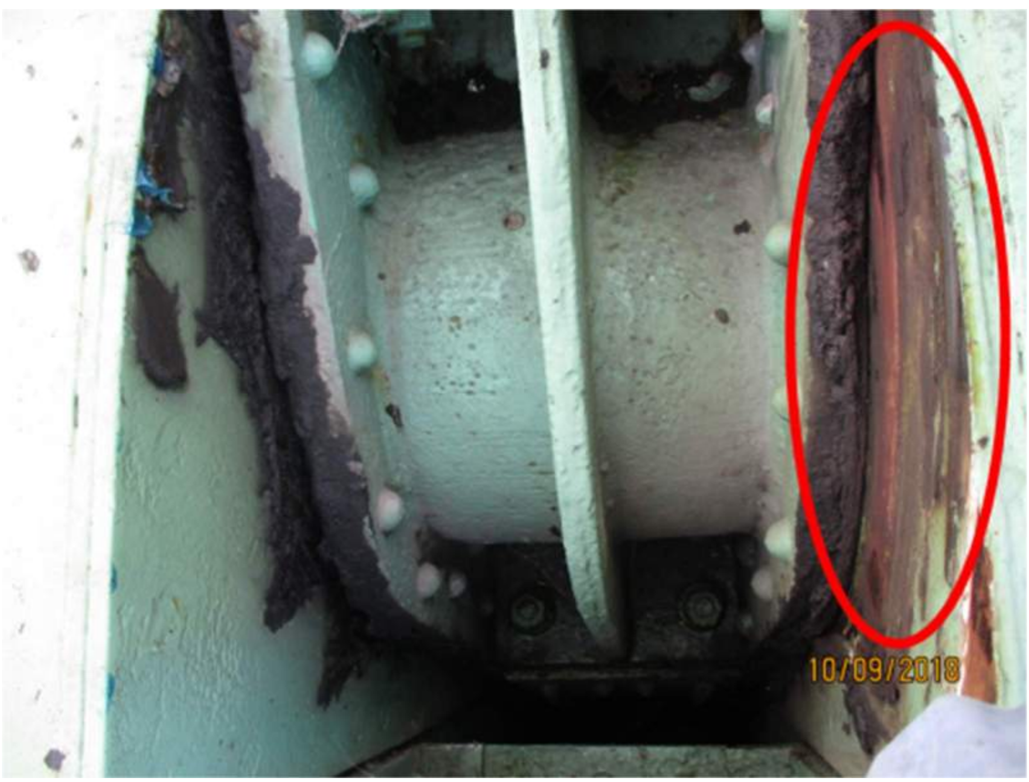

Photo M10: North Main Trunnion Bearing. There is contact between the moving structure and the fixed structure.

Photo M11: Truss Near South Main Trunnion Bearing. Note the evidence of contact between the span structure and the bearing support.

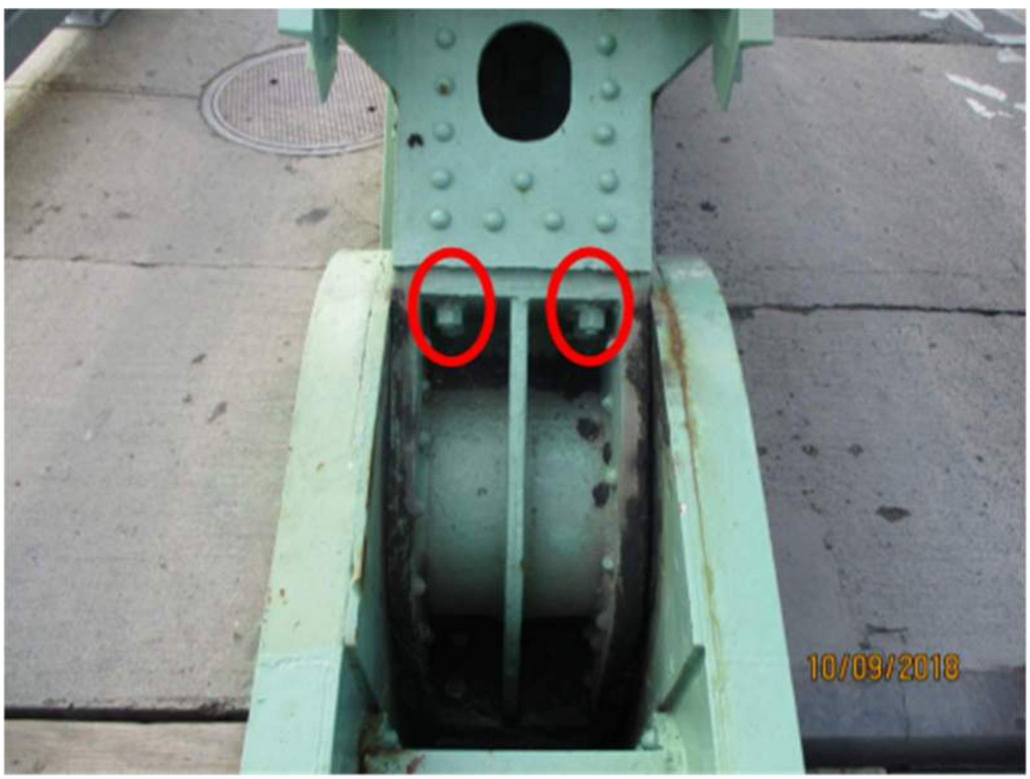

Photo M12: South Main Trunnion Bearing. The head end of the four bolts that secure the bearing housing to the structure has 100% section loss due to corrosion. The nut end of these bolts (circled) are pictured in this photo.

Photo M13: North Counterweight Trunnion Bearing, Inboard Side. All of the sleeve stud nuts are either not tight or show signs of movement. Paint removal from some of the nuts shows that an attempt at tightening these bolts has been made.

Photo M14: South Counterweight Trunnion Bearing, Inboard Side. All of the sleeve stud nuts are either not tight or show signs of movement. The east lubrication line has evidence of leakage, the center lubrication port has shear off, and the west lubrication port is plugged.

Photo M15: South First Link Pin. There is cracked paint and fretting between the nut and the structure indicating slight movement.

Photo M16: South Second Link Pin, Inboard Side. The lube ports at the inboard side of the second link pins are piped together to a common fitting. This is not good practice. Additionally, note the bird nest near the second link pin.

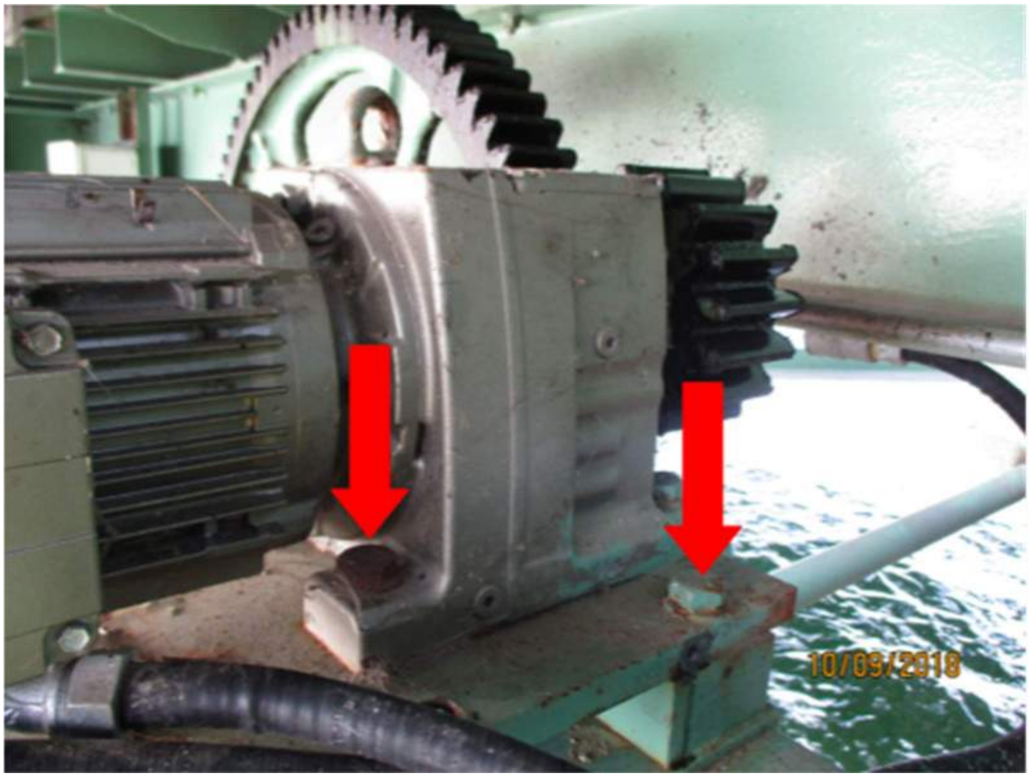

Photo M17: Span Lock Motor and Enclosed Speed Reducer. The mounting bolts and support for the motor and speed reducer are not fully painted and corroded.

Photo M18: Span Lock Bearing B3. The span lock mounting bolt underside is not fully painted and corroded. The underside of bearing B4 mounting bolts are similar.

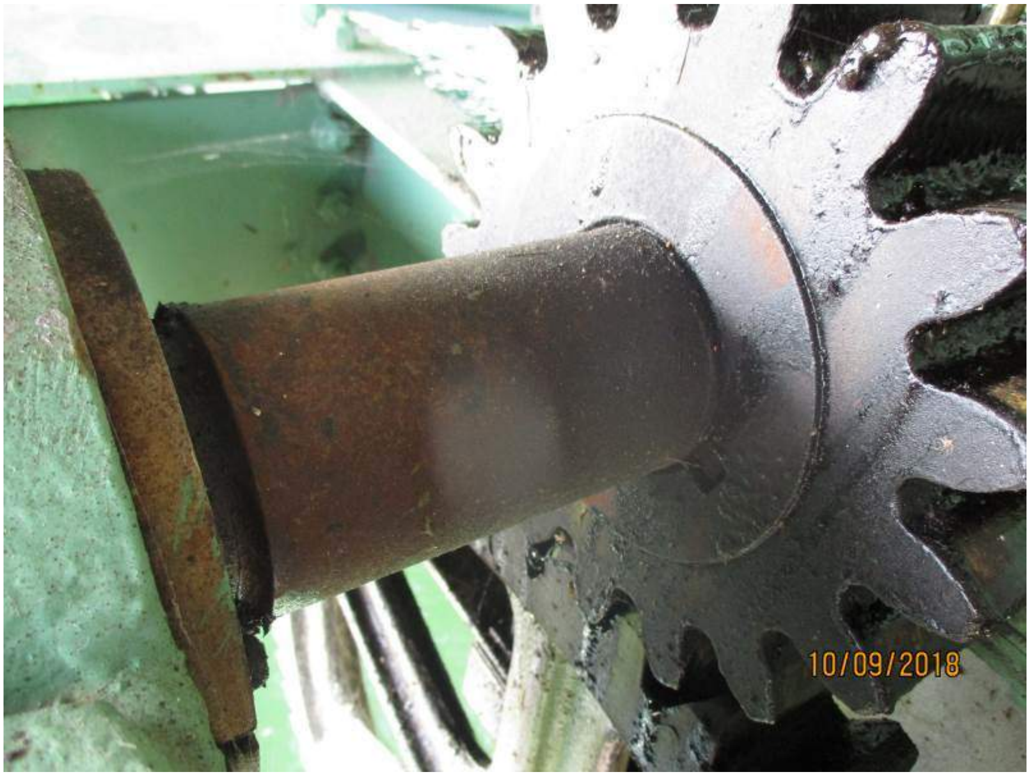

Photo M19: Span Lock Shaft. The span lock drive shaft between bearings B3 and B4 is not painted and corroded.

Photo M20: Span Lock Cross Shaft Bearing B1-S. The housing for the bearing exhibits paint deterioration and light corrosion. All of the span lock cross shaft bearings are similar.

Photo M21: South Span Lock Crank Shaft CR1. The position indication shaft threads are not painted and corroded. The north location is similar.

Photo M22: South Span Lock Crank Shaft CR2. The mounting bolts for the rotary cam positon crank CR2 located on the lock bar are not fully painted and exhibit light corrosion. North Span Lock Crank Shaft CR2 is similar.

Photo M23: North Span Lock Rotary Cam. The rotary cam limit switch cover exhibits paint deterioration and light corrosion.

Photo M24: South Live Load Strike Plate. General view of strike plate and span lock receiver.

Photo M25: North Live Load Strike Plate. The underside of the strike plate support and mounting bolts are corroded. The south live load strike plate assembly is similar.

Photo M26: South Buffer. General View of the buffer, strike plate and seated limit switch. Note, the cylinder body has light to moderate spotty corrosion. The north buffer is similar.

Photo M27: South Buffer. There is light corrosion between the top plate and the cylinder body. The mounting bolts exhibit moderate corrosion. The north buffer is similar.

Photo M28: Northeast Warning Gate. The warning gate arms are not fully painted, and corrosion is still evident under the paint. The southeast warning gate is similar.

Appendix E– Electrical Inspection Photographs

Photo E1: Utility Meter. The bridge electric service is provided with a utility meter that is located inside the operator's control house and is mounted on the side of the MCC. Note both the meter and metering pan are in good condition.

Photo E2: Standby Generator. The standby generator was installed in 2015 to provide a backup source of power for the bridge facilities in the event of utility power failure. Note that the generator, since the original drives and motors were replaced, is now capable of handling of span operation with one operating drive motor. Also note the generator and generator housing is in excellent physical condition.

Photo E3: Standby Generator Breakers. The standby generator is provided with a 60A main disconnect breaker and a 60A load test breaker. Note the generator is not provided with a load bank and the load test breaker is not connected.

Photo E4: Manual Transfer Switch (MTS). A manual transfer switch has been mounted on the side of MCC in the operators control house to allow the transfer of power between utility power and the generator power. This MTS is in excellent physical and operational condition.

Photo E5: Motor Control Centre (MCC). The bridge is provided with a motor control center (MCC) for bridge power distribution. The MCC is located inside the operator's control house. The MCC was installed in 1994 and is in good serviceable condition.

Photo E6: Ground Fault Indicators. A ground fault indicator light is provided for each phase of the 3-phase power. These indicator lights are provided on the MCC main breaker cubicle and were in an operational condition at the time of the inspection.

Photo E7: Span VFD Drive Cabinet. The span variable frequency drives are newly installed and replace the original drive motor controllers for the span drive. The new VFD drives are located in their respective drive enclosures and provide excellent and variable speed and torque control for the operating bridge.

Photo E8: Typical Span Drive Motor. The bridge is provided with two span drive motors, the two motors can be configured to operate the span simultaneously or they can be configured to operate the span individually. These span drive motors are squirrel-cage induction type and replaced the original wound rotor motors when the new VFD drives were installed.

Photo E9: Typical Dynamic Braking Resistors. Dynamic braking resistors have been installed in conjunction with the VFD drives to provide speed and torque braking control for the span drive motors. These resistors were installed when the VFD drives were installed and are in freestanding enclosures located behind the MCC.

Photo E10: Span Drive Motor Disconnects. The span drive motors are provided with local disconnect switches as per Canadian Electrical Code. These disconnect switches were installed as the same time as the new drive motors and are in as new condition.

Photo E11: Typical Motor Brake. The motor brakes are in as-new physical and operational condition and are provided with set, released, and hand released limit switches as per code.

Photo E12: A black plastic bag is covering the junction box near motor brake #2. No water was observed at the time of the inspection, but traces of water stains indicate leaking of the roof is occurring.

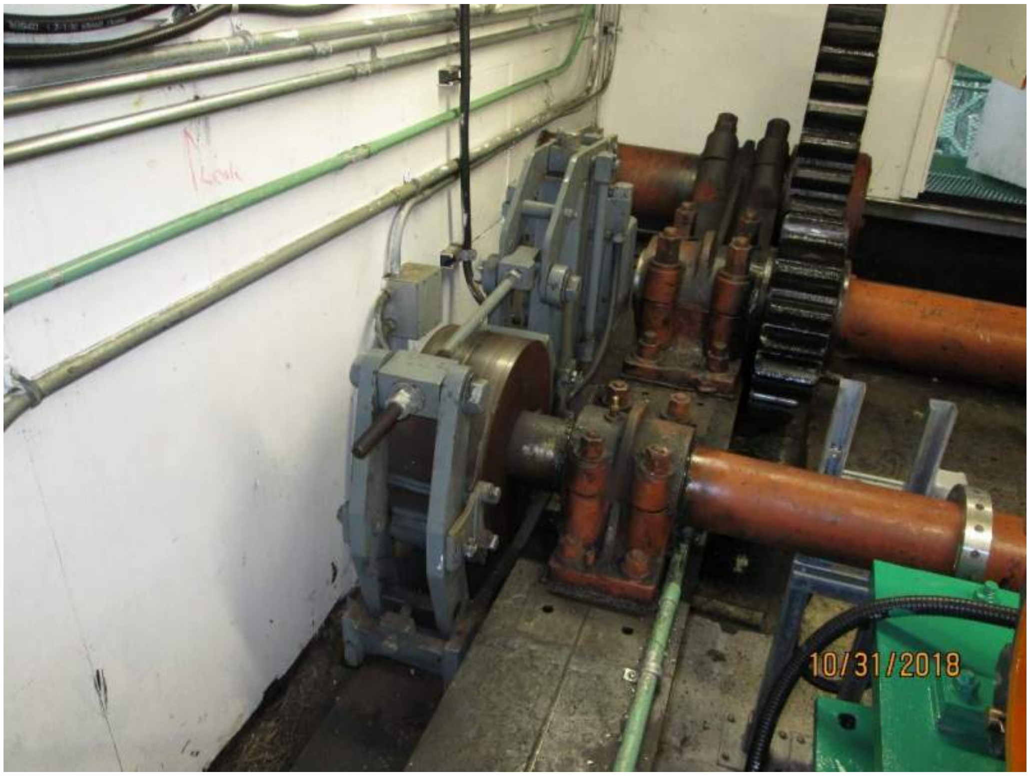

Photo E13: Manual (Machinery) Brake & Disconnect. A manual brake with a local disconnect switch is provided in the bridge machinery space. Only set and released limit switches have been provided for this brake; the code-required brake hand released limit switch has not been provided.

Photo E14: Motor Brake Disconnect and Starter enclosures. New motor brake starters were recently installed in the bridge machinery space and are in excellent condition. The MCP of the motor brake starter also serves as the local disconnect switch. The wires in the enclosure have not been labelled to aid troubleshooting.

Photo E15: Span Lock Starter Compartment. Note the span lock was originally designed with 6-speed operating steps. However, at the time of the inspection the span lock was operating at single speed only and the speed stepping contactor and resistor circuit had been disabled.

Photo E16: Span Lock Motor, Rotary Cam Limit Switch (RCLS) and Disconnect Switch. The span lock motor is housed in a stainless-steel enclosure and is provided with a local disconnect switch. The span lock is also provided with a two-cam limit switch for control, interlock and indication during bridge operation. Note the minor corrosion on the RCLS enclosure.

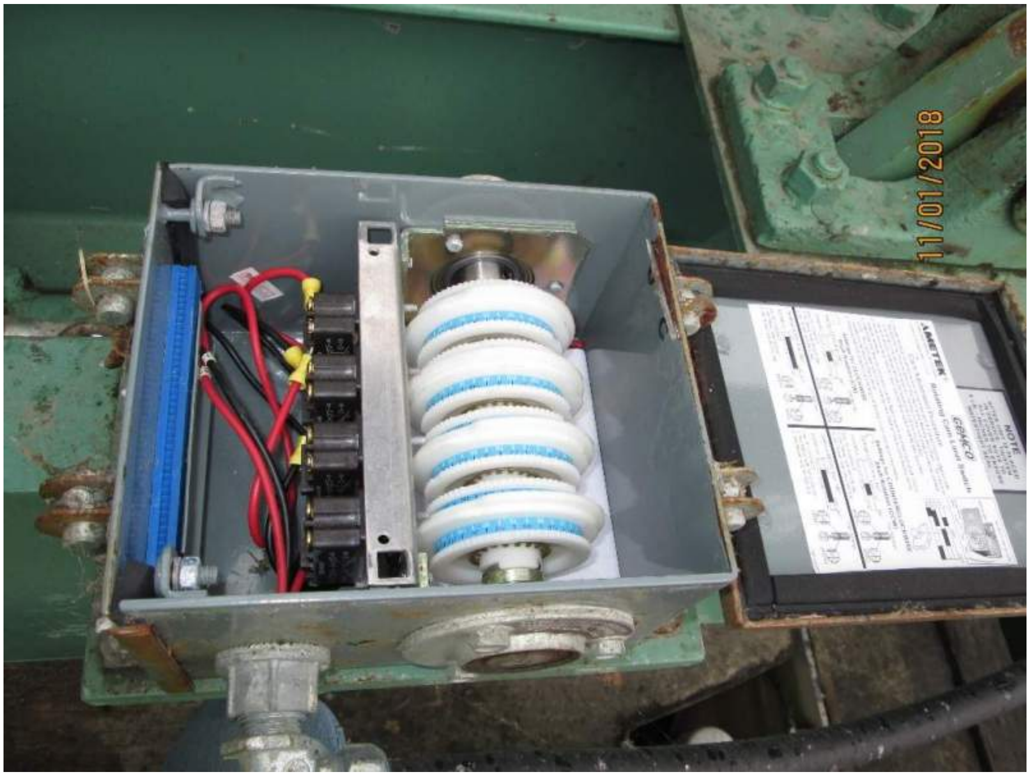

Photo E17: North Side Span Lock Rotary Cam Switch. The span lock is provided with a second RCLS to monitor the position of the north lock bar. The cam switches inside the enclosure are in very good physical and operational condition.

Photo E18: Control Desk. The location of the control desk provides the operator with a complete view of the channel and vehicular and pedestrian roadway traffic. The control desk is in acceptable condition. Note the foot switch next to the control desk on the floor is in good operational condition.

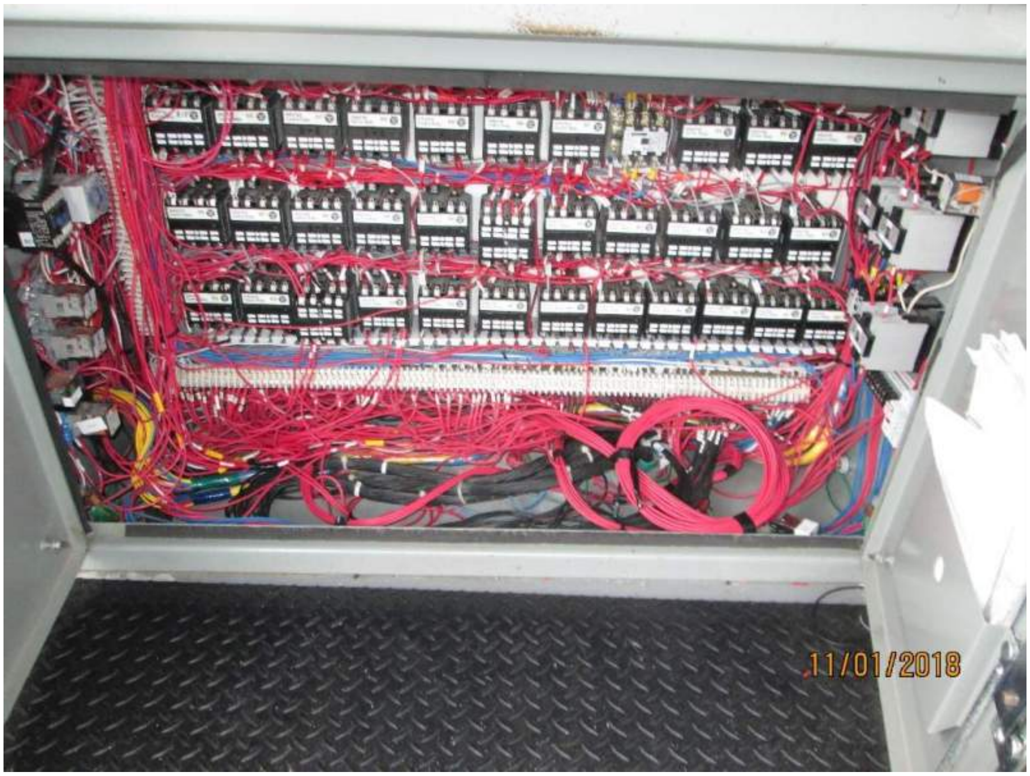

Photo E19: Relay Control Inside the Control Desk. This relay cabinet was modified during the drive/motor replacement project to accommodate the new control required for the new drive system.

Photo E20: Machinery Space Local E-Stop. This E-Stop switch is located near the machinery space entrance. It allows maintenance personnel to prevent or stop bridge operation when work is being performed in the machinery space.

Photo E21: Span Fully Seated Limit Switch. Two span seated limit switches are provided at the toe end of the span, one at each corner. North seated limit switch exhibits standing water inside the enclosure.

Photo E22: Speed Switch Sensor. A Hall Effect speed switch was installed as part of a 2012 rehabilitation project to provide span position and motor speed indication on the operator's control desk. The speed switch sensor is in excellent condition.

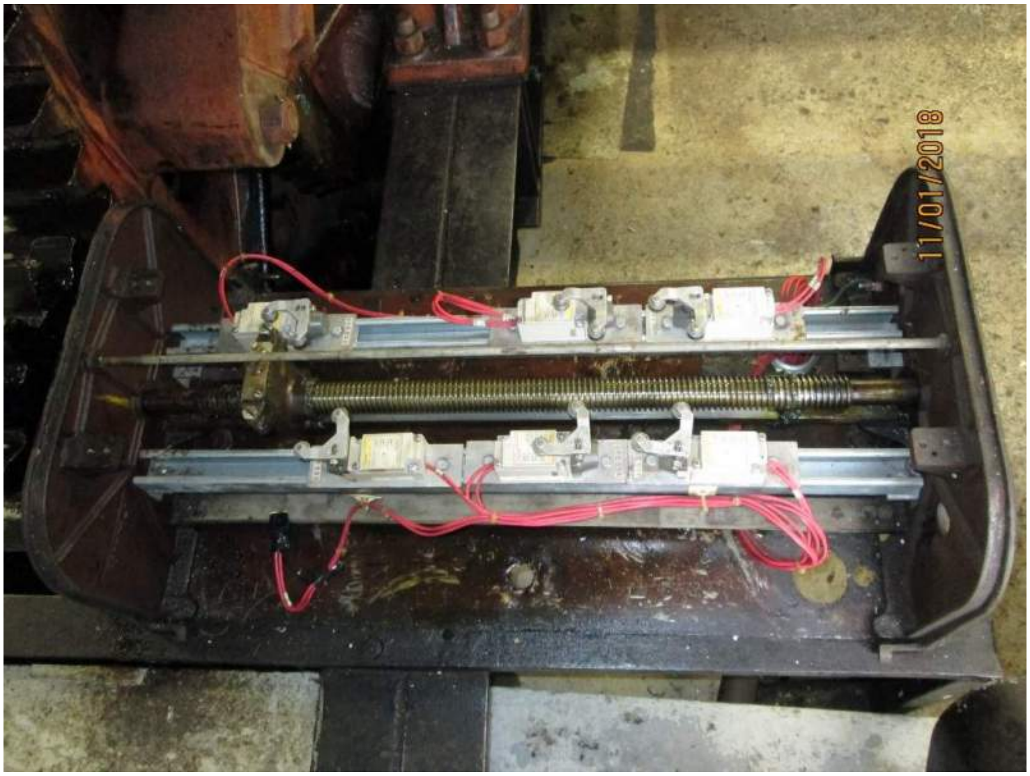

Photo E23: Span Position Limit Switches. The targets on the auxiliary threaded shaft are used to toggle the lever type limit switches and provide discrete signals of the bridge position. The limit switch housing exhibits signs of corrosion, but the limit switches inside are in good operational condition.

Photo E24: Span Over-Travel Limit Switch. The span control is provided with an over-travel limit switch to stop bridge operation in the event of span over travel.

Photo E25: Typical Traffic Signal (West Shown). Each bridge approach is provided with two sets of traffic signal fixtures mounted on cantilevered arms and suspended over the roadway. Additionally, a warning gong and a pedestrian signal light have been provided at each of the south traffic signal poles. The traffic signal equipment was installed as part of a recent rehabilitation project and is in excellent condition.

Photo E26: Typical Traffic Gate (Fully Raised). The bridge is provided with four (4) traffic gates, one at each approach to the span. All gates and gate arm lights were in good operational condition at the time of the inspection.

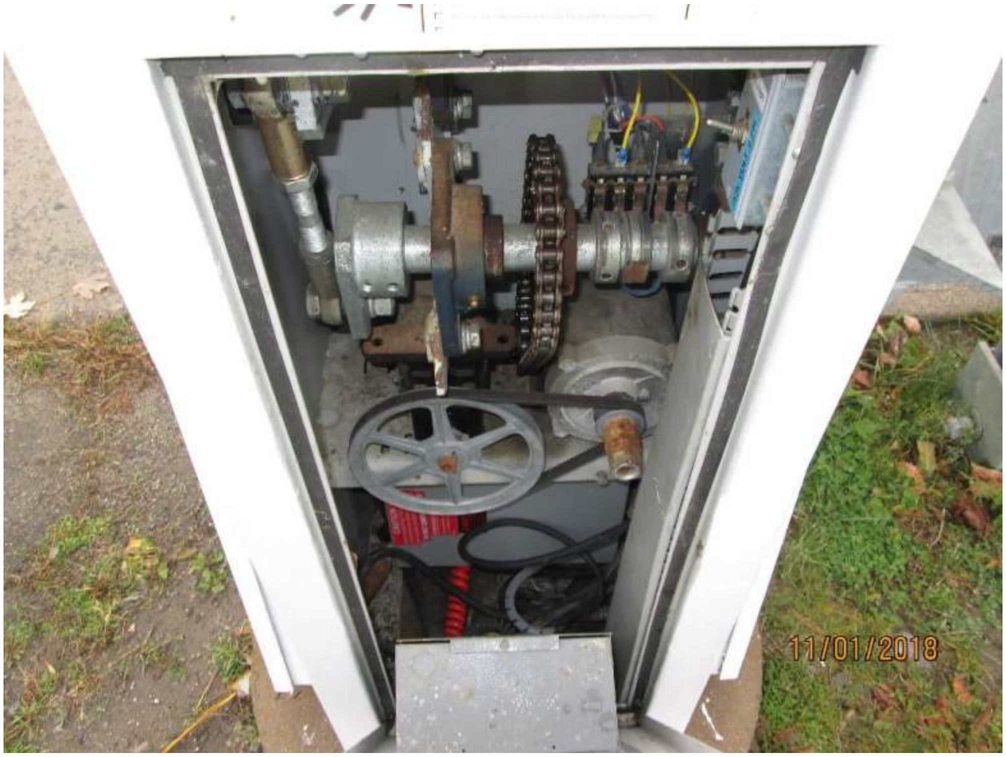

Photo E27: Typical Traffic Gate Housing. The motor starter is located inside the gate housing. Note that no door limit switches have been provided to prevent gate operation when the gate door(s) are open for maintenance or troubleshooting but a sign has been installed to indicate that the gate is powered and should be disconnected at the MCC prior to maintenance being performed. Also note no hand crank limit switch has been provided in accordance with code.

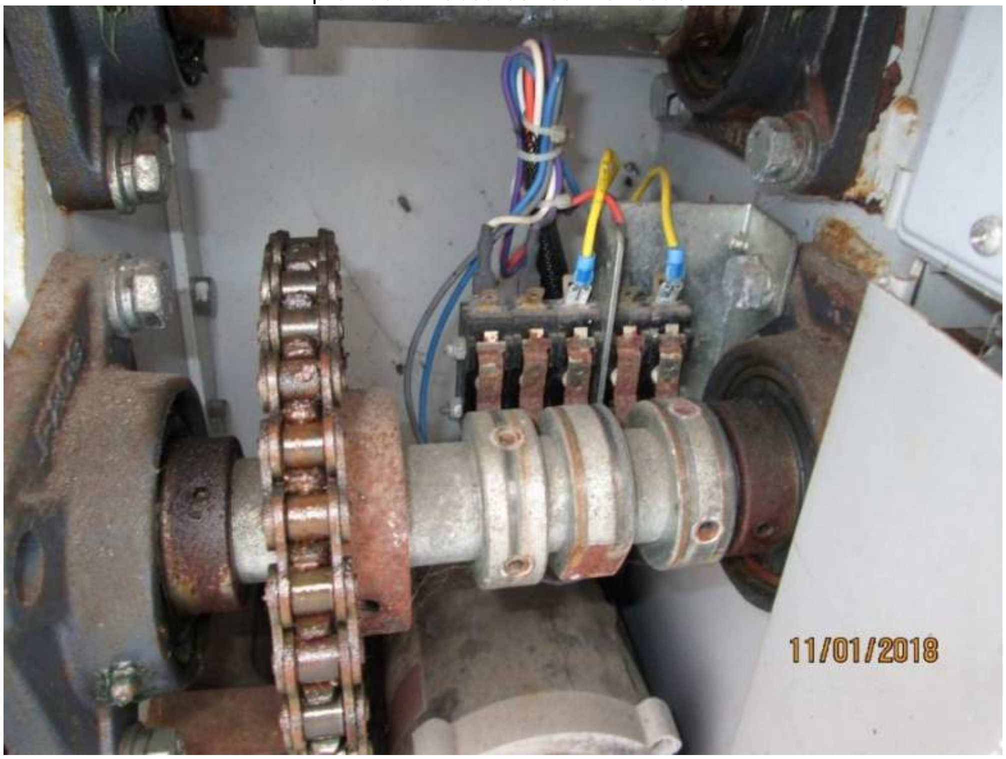

Photo E28: Typical Traffic Gate Limit Switches. The traffic gates are provided with a cam type limit switch. Although these limit switches were in operational condition at the time of the inspection, they are missing protective covers, switch contacts exhibit excessive corrosions due to the exposure which might cause premature failure.

Photo E29: Typical Span Navigation Light. Note that roadway type lights are being used. The location of the navigation lights does not provide marine traffic with a clear visual indication as to when the span has been raised and it is safe to proceed.

Photo E30: Typical Fender Light. The bridge is provided with 4 fender light fixtures, one at each corner of the fender. The north fender lights are flash red and the south fender lights are flash green. The fender lights are of LED type and are in good operational condition.

Photo E31: Typical Outdoor Junction Box. Many of the outdoor junction/pull boxes are NEMA 4X boxes. Note the junction/pull boxes are in good physical condition, but some of the boxes do exhibit signs of corrosion inside the boxes.

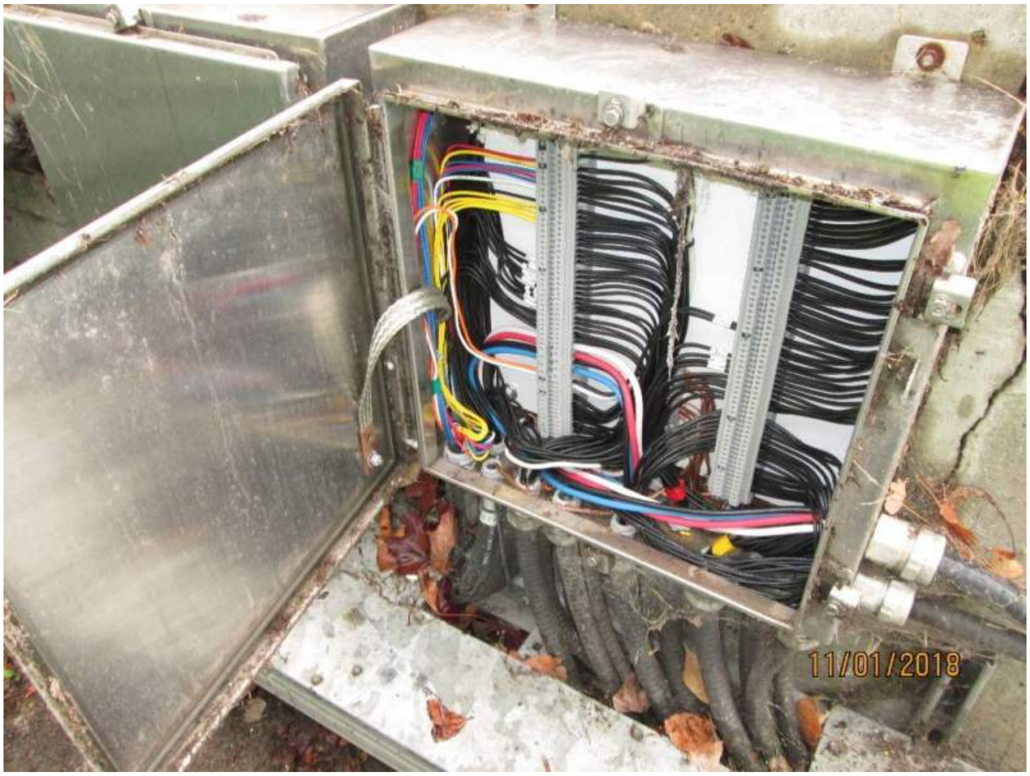

Photo E32: Typical Submarine Cable Junction Box. The submarine cable junction box is in good condition with proper grounding and bonding but covered with debris both internally and externally. Note the wires inside the submarine cable junction boxes are not properly labelled.

Photo E33: Typical Submarine Power Cables. The submarine cable is used to carry control and power across the channel. Both recently installed and originally installed submarine cables were found at the bridge. It was unclear if the old submarine cable was abandoned or still in service. Note the new submarine cable is of the Teck cable type and is protected with wireways above water level on the pier.

Photo E34: Bridge Grounding & Bonding System. The bridge steel structures are provided with proper grounding and bonding system in accordance with code.

Photo E35: Fire Alarm System. The bridge is equipped with a fire alarm system. Fire detection devices are provided in the bridge maintenance building, the bridge control house and machinery space. The main fire alarm control panel is located in the bridge maintenance facility with a remote annunciator located in the bridge operators control house. All fire alarm equipment was in good serviceable condition at the time of the inspection.

Photo E36: General and Emergency Lighting. The lighting in the operator's control house provides sufficient illumination level for both operation and maintenance and is in good working condition. The emergency lights were tested at the time of inspection and are operational.

Photo E37: Machinery Space Lighting. The machinery space is provided with T5 light fixtures. These fixtures are in excellent operational condition and provide adequate lighting levels for maintenance and troubleshooting.

Photo E38: CCTV System and Roadway Lighting. A CCTV system was installed at the bridge for monitoring of the bridge roadway, waterway and machinery space from the maintenance facility and the operators control house. The CCTV installation is in excellent condition. LED type roadway lighting is provided on the bridge and is photocell controlled.

Photo E39: General Indoor Electrical Installation (Machinery Space Shown). Indoor electrical raceway installation in the machinery space and operators control house generally consists of rigid steel conduits. These conduits are in good condition. The bridge cable installation consists of wire in conduit and with Teck cables that were recently installed to feed the new drive motors.

Photo E40: General Outdoor Installation. The bridge outdoor installation generally consists of Teck cable, painted RGS conduits, and stainless-steel junction boxes. The installation is generally in good serviceable condition but with some of the cable/conduit support brackets exhibiting moderate signs of corrosion.

Appendix F–Counterweight Materials Testing Report (Gemtec)

GEMTEC Consulting Engineers and Scientists Limited
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Ottawa, ON, Canada
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www.gemtec.ca

November 29, 2019

File: 63333.34 – R01

Parsons
1223 Michael Street, Suite 100
Ottawa, ON
K1J 7T2

Attention: Peter Harvey, P.Eng. – Structural Engineer

Re: Concrete Core Logging and Test Results
Bascule Bridge at LaSalle Causeway, Kingston, Ontario

As outlined in Houle Chevrier Engineering Ltd. (now GEMTEC Consulting Engineers and Scientists Limited) Proposal 63333.34 dated August 25, 2017, GEMTEC was retained by Parsons Corporation (Parsons) to carry out the logging and materials testing of extracted concrete cores at the above noted site.

SCOPE OF SERVICES

Please find attached the following results of our scope of services:

- Digital photos of extracted core specimens (in PDF attached and JPEG format separately) in accordance with Part 1, Section 5 of the MTO Structure Rehabilitation Manual;
- Compressive Strength test results from one (1) prepared core specimen (detailed GEMTEC format);
- Chloride content test results from two (2) prepared core specimens (Certificate of Analysis from RPC Science and Engineering format);
- Air void analysis test results from one (1) prepared core specimen (detailed GEMTEC format);
- MTO Core Logs for Exposed Concrete for six (6) extracted core specimens in accordance with Part 1, Section 5 of the MTO Structure Rehabilitation Manual; and

A Summary of Findings of the above services in now provided.

SUMMARY OF FINDINGS

General

A total of 6 cores were extracted, with the general locations noted in Table 1. In general, the bascule bridge counterweight primarily comprised of Portland Cement Concrete (PCC).

Table 1: Summary of Coring Effort and Test Results

Location	Core No.	Compressive Strength, MPa (approx. Depth)	Air Void Analysis (Air Content, %;)	Chloride Content, Corrected Percent (approx. Depth)
West Face, North End, Bottom	1	n/a	n/a	n/a
West Face, North End, Top	2	11.9 (50mm – 255 mm)	n/a	n/a
East Face, North End, Bottom	3	n/a	n/a	n/a
East Face, South End, Top	4	n/a	2.25	0.000 @ 0-30mm 0.004 @ 260-320 mm
East Face, South End, Bottom	5	n/a	n/a	n/a
West Face, South End, Bottom	6	n/a	n/a	n/a

Compressive Strength Results

Compressive strength results are also summarized in Table 1. Due to the poor quality of the core specimens, one compressive strength specimen was selected.

The compressive strength test result was 11.9 MPa for the compressive strength specimen in core number 2 (50 – 255 mm).

Chloride Content Results

At the direction of Parsons, chloride content testing was completed on Core 4. The results are also summarized in Table 1.

As per Section 5.4.3 of the MTO Structural Rehabilitation Manual (SRM), the background chloride content was selected as the lowest value from the component of the core tested. The lowest chloride value from Core 4 (0.016 percent) has been used as the background value for Core 4.

Corrected chloride content results were 0.004 (260 – 320 mm) and 0.000 (0 – 30 mm) for Core 4.

Using the chloride content provided in the MTO SRM of 0.025 percent as a conservative lower bound for corrosion potential; significant corrosion of reinforcing steel is unlikely.

Air Content Results

Air content results are also summarized in Table 1. The air content is 2.25 percent in core 4 (130 – 230 mm).

Brett Webster, BASc

Stephen Goodman, Ph.D., P.Eng.

Manager, Pavements and Materials

Enclosures
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ATTACHMENTS

Report ID: 293651-IAS
Report Date: 08-Nov-18
Date Received: 22-Oct-18

CERTIFICATE OF ANALYSIS

for
Gemtec Limited
191 Doak Road
Fredericton, NB E3C 2E6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Warren Mawhinney
Project #: 63333.34
Location: Lasalle Causeway Bridge

Analysis of Samples

Analytes:		Chloride
Units:		mg/kg
RL:		10
RPC Sample ID	**Client Sample ID**	
293651-1	Core C1; 0 - 30 mm	160
293651-1 Dup	Lab Duplicate	170
293651-2	Core C3; 260 - 320 mm	200

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Ross Kean

Ross Kean
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst
Analytical Chemist
Inorganic Analytical Chemistry

CERTIFICATE OF ANALYSIS

for
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Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

General Report Comments

Chloride was determined colourimetrically.

GEMTEC Consulting Engineers and Scientists			Air Void Analysis
	Client	Parsons Corporation	
	Project:	Concrete Sampling and Testing, LaSalle Causeway, King	
	Project #:	6333334	

Description: Core #4	Sample ID: C-2
Date/Time Sampled: 18/10/25 11:39:00 AM	Date/Time Tested: 18/10/25 11:39:46 AM

Total number of stops:	1779
Number of stops on voids:	40
Number of stops on paste:	475
Number of stops on minerals:	1264
Number of voids passed:	196
Total length traversed, mm:	2777
Air content, %:	2.25%
Average number of voids/mm:	0.071
Average chord length of voids, mm:	0.32
Specific surface, 1/mm:	12.5582
Paste content, %:	26.7004%
Paste/Air ratio:	11.875
Spacing factor, mm:	0.5450

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON
K2K 2A9
Tel.: 613-836-1422
Fax.:613-836-9731

COMPRESSIVE STRENGTH of CONCRETE CORE

CLIENT: Parsons **PROJECT No.:** 63333.34

Project: LaSalle Causeway Bridge **REPORT NO:**

Date Received: **Date Tested:** 17-Oct-18

Lab no.	C4					
Core ID	Concrete Core 2					
Depth (m)	0.050-0.255					
Cut length (mm)	164.60					
Ground length (mm)	164.60					
Diameter (mm)	95.70					
Ground Mass (g)	2820.00					
Length:Diameter ratio	1.72					
Correction factor	0.98					
Failure load (kN)	86.80					
Uncorrected Strength (MPa)	12.10					
Corrected Strength (MPa)	**11.90**					

Remarks

Checked by: Krystle Smith, Laboratory Manager

Reviewed by: Steve Goodman, Ph.D., P.Eng.

CORE LOG FOR EXPOSED CONCRETE

Page 1 **of** 2 **SITE NO.** 63333.34

Component Type and Location Lasalle Causeway Bridge

Core No.		1		2		3	
Location		West Face, North End, Bottom		West Face, North End, Top		East Face, North End, Bottom	
Diameter, mm		95		95		95	
Length, mm		274		242		611	
Full Depth (Yes/No)		No		No		No	
Defects in Concrete (1)		C, D, R, Sc, S		C, R		C, D, R, Sc, S	
Condition of Rebar (2)		SR		n/a		n/a	
Corrosion Potential (At Closest Grid Point)							
Compressive Strength, MPa		n/a		11.9		n/a	
Chloride Content **% Chloride by Weight of Concrete**		Total	Corrected	Total	Corrected	Total	Corrected
	0-10mm						
	20-30mm						
	40-50mm						
	60-70mm						
	80-90mm						
Air Voids	**Air Content, %**						
	Spec. Surf., mm^2/mm^3						
	Spacing Factor, mm						
Test Laboratory		GEMTEC		GEMTEC		GEMTEC	
Remarks		Significant deterioration of Portland Cement Concrete evident		Cracking occurs at about 110 mm and 230 mm		Significant deterioration of Portland Cement Concrete evident	

1. **Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling**
2. **Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A - No rebar exposed**

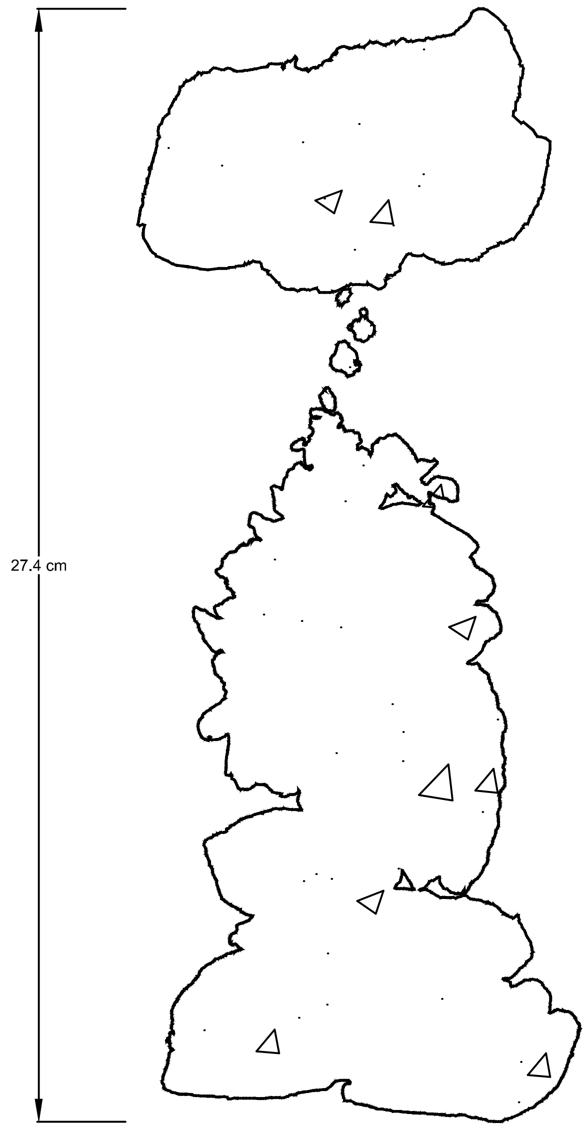
CORE LOG FOR EXPOSED CONCRETE

Page 2 **of** ______ **SITE NO.** _________

Component Type and Location ______________________________

			4		5		6	
Core No.			4		5		6	
Location			East Face, South End, Top		East Face, South End, Bottom		West Face, South End, Bottom	
Diameter, mm			95		95		95	
Length, mm			345		126		319	
Full Depth (Yes/No)			No		No		No	
Defects in Concrete (1)			C, D, R, Sc, S		C, R		C, D, R, Sc, S	
Condition of Rebar (2)			SR		n/a		LR	
Corrosion Potential (At Closest Grid Point)								
Compressive Strength, MPa			n/a		n/a		n/a	
Chloride Content **% Chloride by Weight of Concrete**			Total	Corrected	Total	Corrected	Total	Corrected
	0 - 30 mm		0.016	0.000				
	260 - 320 mm		0.020	0.004				
Air Voids	**Air Content, %**		2.25					
	Spec. Surf., mm^2/mm^3		12.56					
	Spacing Factor, mm		0.545					
Test Laboratory			GEMTEC		GEMTEC		GEMTEC	
Remarks			Corrosion unable to be tested at set intervals due to poor condition of concrete core. Significant deterioration of Portland Cement Concrete evident		Vertical crack through length of core return		Significant deterioration of Portland Cement Concrete evident	

1. **Defects - C = Cracked, D = Delamination, R = Rough, Sc = Scaling, S = Spalling**
2. **Condition Rebar - LR = Light Rust, SR = Severe Rust, N/A - No rebar exposed**



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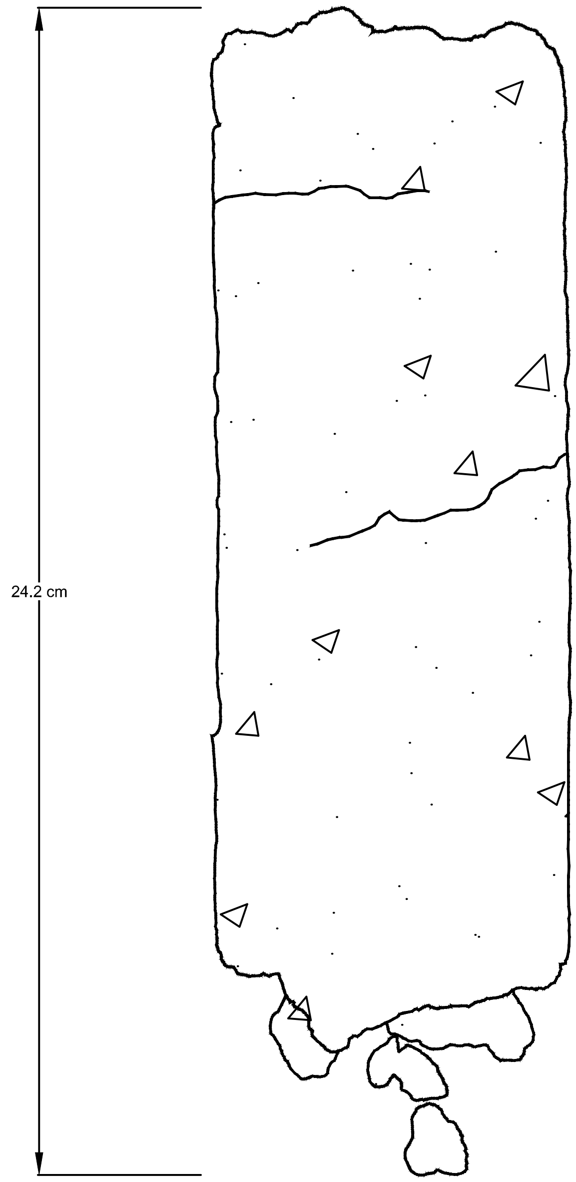
CORE 1 - WEST FACE, NORTH END

Project		Project No.	
	BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	63333.34	**FIGURE C1**



CORE 2 - WEST FACE, NORTH END

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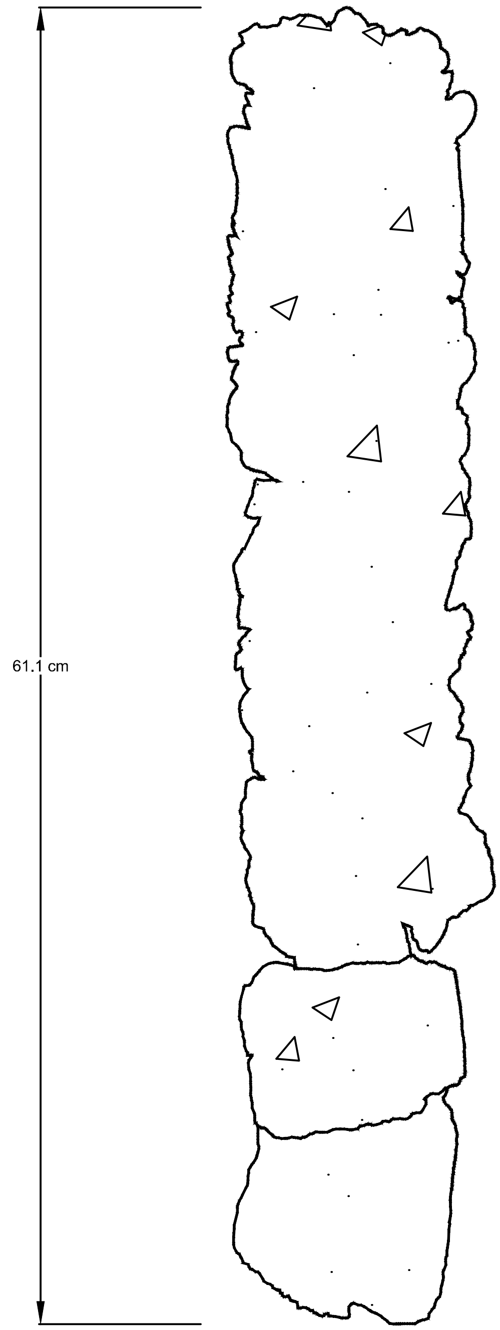
Project	BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	Project No. 63333.34	**FIGURE C2**



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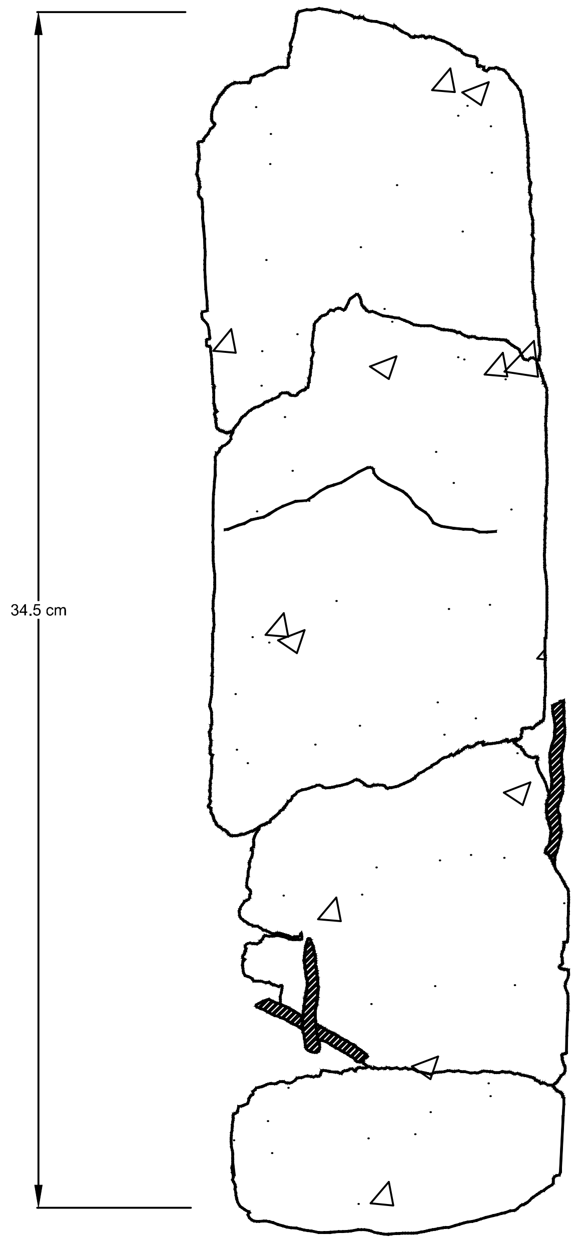
CORE 3 - EAST FACE, NORTH END

Project	Project No.	
BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	63333.34	**FIGURE C3**



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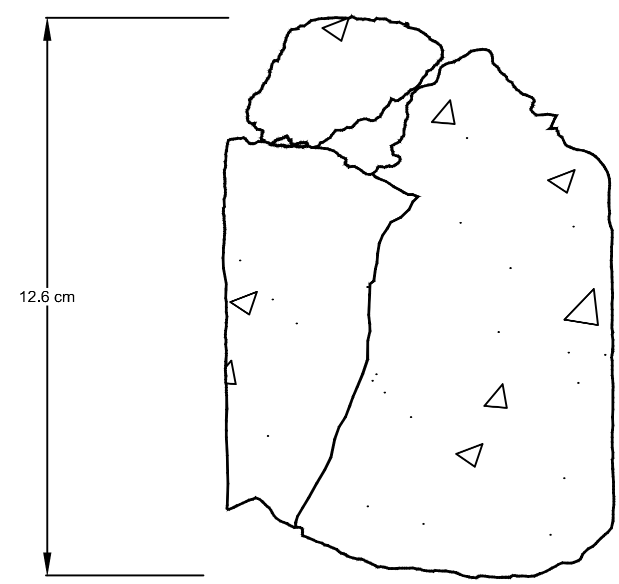
CORE 4 - EAST FACE, SOUTH END

Project		Project No.	
	BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	63333.34	**FIGURE C4**



CORE 5 - EAST FACE, SOUTH END

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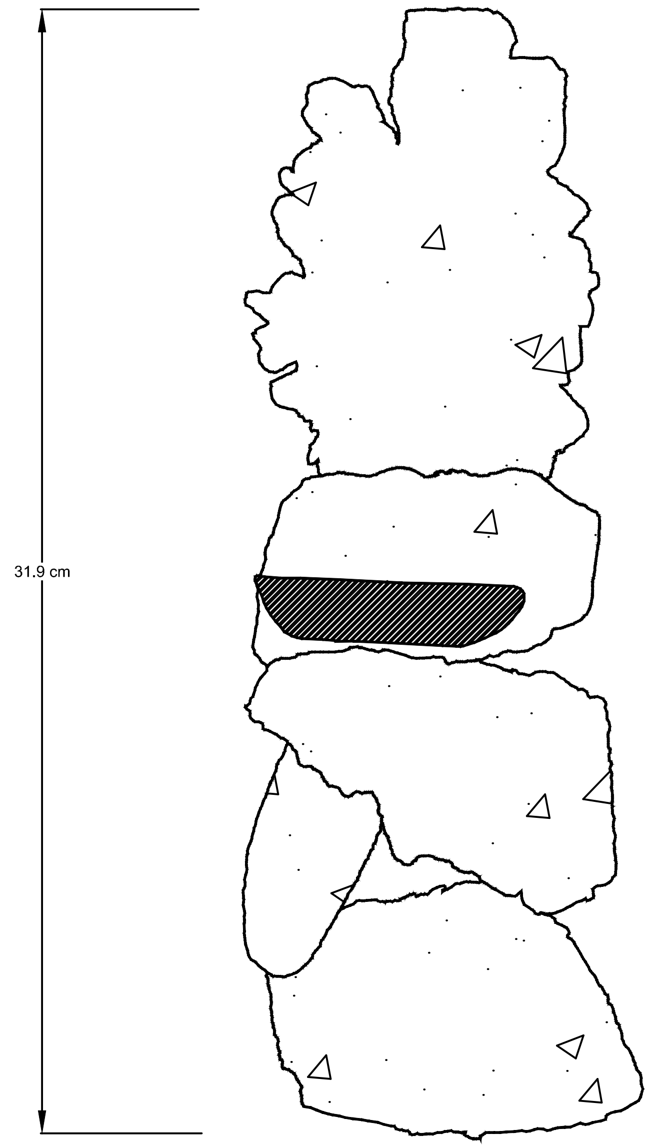
Project	Project No.	
BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	63333.34	**FIGURE C5**



CORE 6 - WEST FACE, SOUTH END

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Project		Project No.	
	BASCULE BRIDGE AT LASALLE CAUSEWAY KINGSTON, ON	63333.34	**FIGURE C6**

PARSONS

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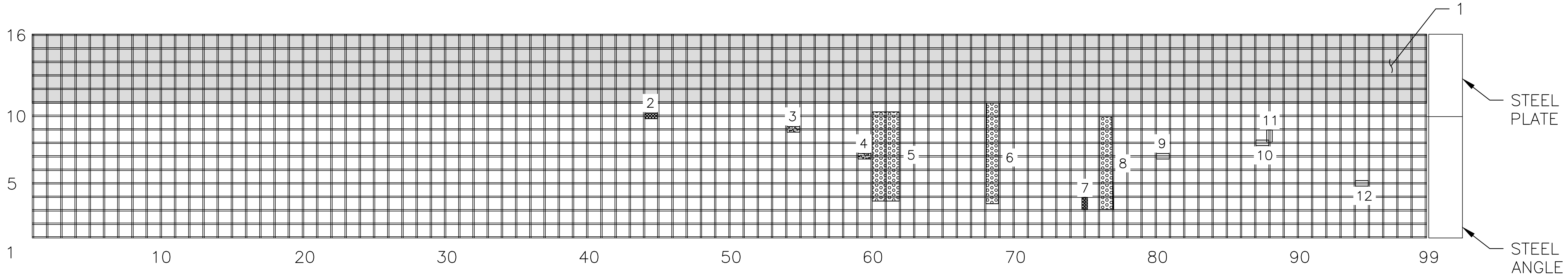
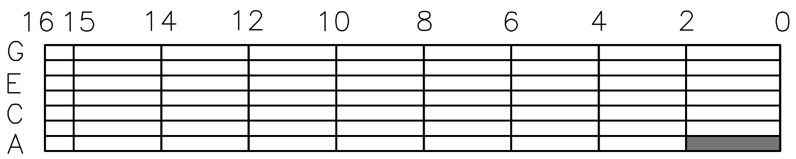
Appendix G– Deck Grating Inspection Drawings



0–2 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR
3	BROKEN LONGITUDINAL BAR
4	BROKEN LONGITUDINAL BAR
5	DEBRIS
6	DEBRIS
7	BENT TRANSVERSE BAR
8	DEBRIS
9	STEEL BAR REPAIR
10	STEEL BAR REPAIR
11	STEEL BAR REPAIR
12	STEEL BAR REPAIR



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ONTARIO

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CW designed by / conc par
PH approved by / approuve par
tender soumission / project manager administrateur de projets

18–11–05 project date / date du projet
R.090045.001 project no. / no. du projet
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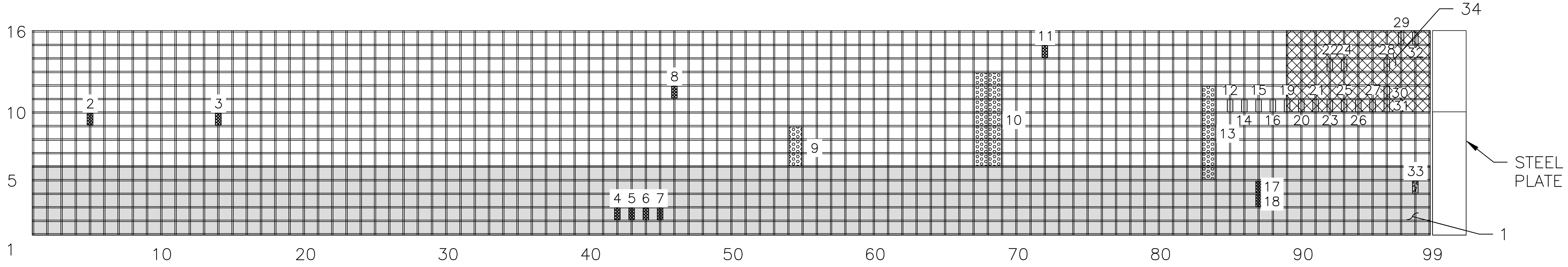
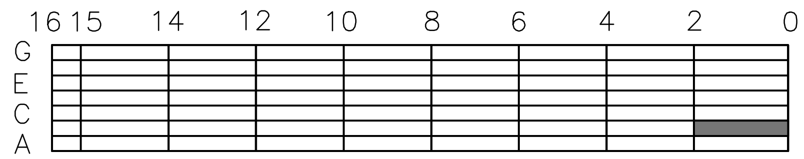


0-2 - B

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	18	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR	19	STEEL BAR REPAIR
3	BENT TRANSVERSE BAR	20	STEEL BAR REPAIR
4	BENT TRANSVERSE BAR	21	STEEL BAR REPAIR
5	BENT TRANSVERSE BAR	22	STEEL BAR REPAIR
6	BENT TRANSVERSE BAR	23	STEEL BAR REPAIR
7	BENT TRANSVERSE BAR	24	STEEL BAR REPAIR
8	BENT TRANSVERSE BAR	25	STEEL BAR REPAIR
9	DEBRIS	26	STEEL BAR REPAIR
10	DEBRIS	27	STEEL BAR REPAIR
11	BENT TRANSVERSE BAR	28	STEEL BAR REPAIR
12	STEEL BAR REPAIR	29	STEEL BAR REPAIR
13	DEBRIS	30	STEEL BAR REPAIR
14	STEEL BAR REPAIR	31	STEEL BAR REPAIR
15	STEEL BAR REPAIR	32	STEEL BAR REPAIR
16	STEEL BAR REPAIR	33	BROKEN TRANSVERSE BAR
17	BENT TRANSVERSE BAR	34	SEVERELY BENT AND BROKEN TRANSVERSE BARS



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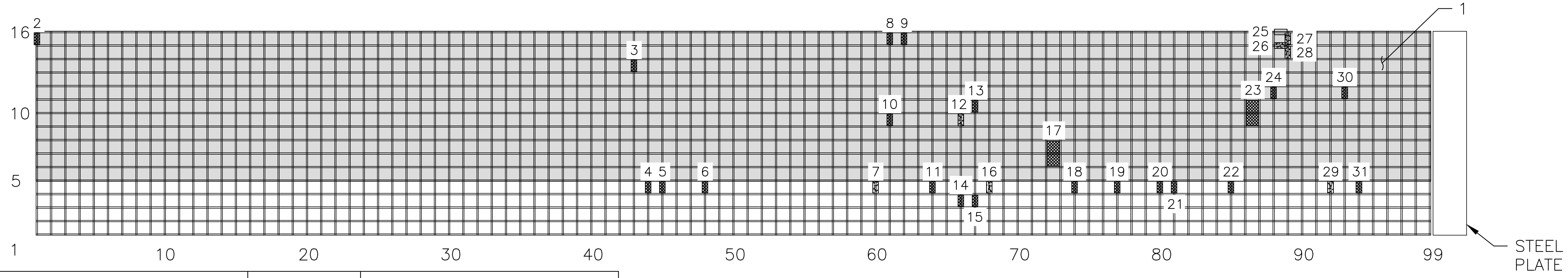
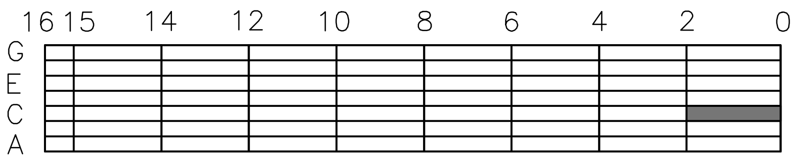


0-2 - C

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	17	BROKEN AND BENT BARS
2	BENT TRANSVERSE BAR	18	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR	19	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR	20	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR	21	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR	22	BENT TRANSVERSE BAR
7	BROKEN TRANSVERSE BAR	23	BENT AND BROKEN BARS
8	BENT TRANSVERSE BAR	24	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR	25	STEEL BAR REPAIR
10	BENT TRANSVERSE BAR	26	BROKEN LONGITUDINAL BAR
11	BENT TRANSVERSE BAR	27	BROKEN TRANSVERSE BAR
12	BROKEN TRANSVERSE BAR	28	BROKEN TRANSVERSE BAR
13	BENT TRANSVERSE BAR	29	BROKEN TRANSVERSE BAR
14	BENT TRANSVERSE BAR	30	BENT TRANSVERSE BAR
15	BENT TRANSVERSE BAR	31	BENT TRANSVERSE BAR
16	BROKEN TRANSVERSE BAR		



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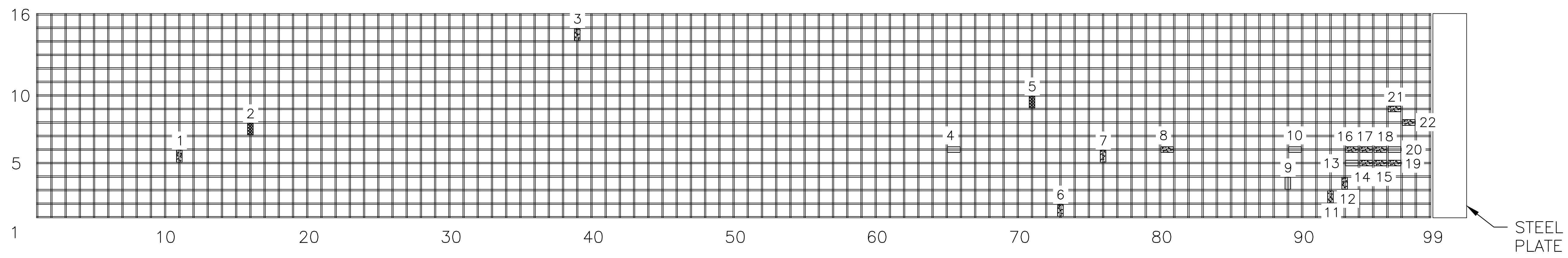
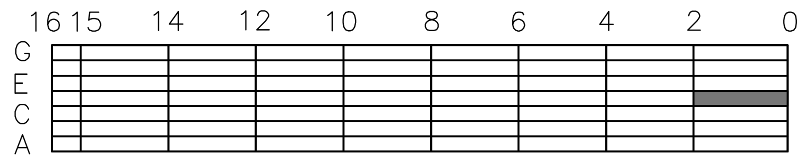


0−2 − D

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	BROKEN TRANSVERSE BAR	12	BROKEN TRANSVERSE BAR
2	BENT TRANSVERSE BAR	13	FIXED STEEL BAR
3	BROKEN TRANSVERSE BAR	14	BROKEN LONGITUDINAL BAR
4	FIXED STEEL BAR	15	BROKEN LONGITUDINAL BAR
5	BENT TRANSVERSE BAR	16	BROKEN LONGITUDINAL BAR
6	BROKEN TRANSVERSE BAR	17	BROKEN LONGITUDINAL BAR
7	BROKEN TRANSVERSE BAR	18	BROKEN LONGITUDINAL BAR
8	BROKEN LONGITUDINAL BAR	19	BROKEN LONGITUDINAL BAR
9	FIXED STEEL BAR	20	FIXED STEEL BAR
10	FIXED STEEL BAR	21	BROKEN LONGITUDINAL BAR
11	BROKEN TRANSVERSE BAR	22	BROKEN LONGITUDINAL BAR



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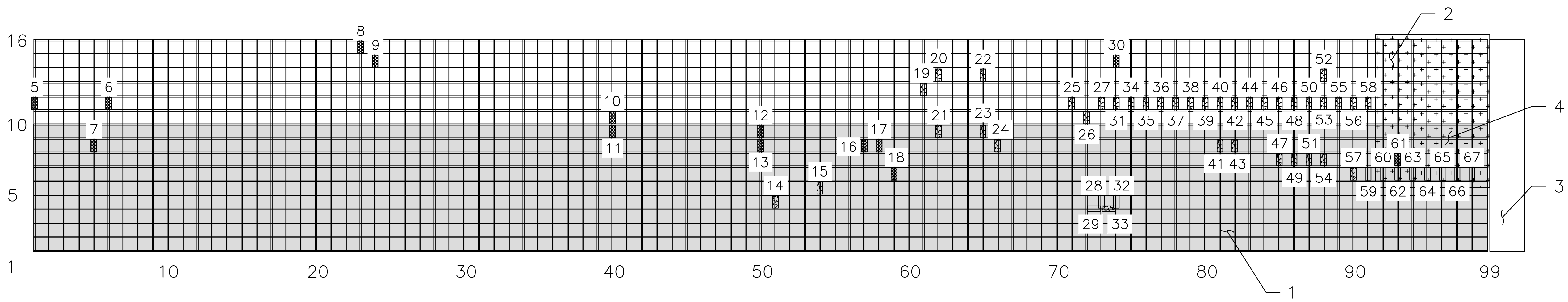
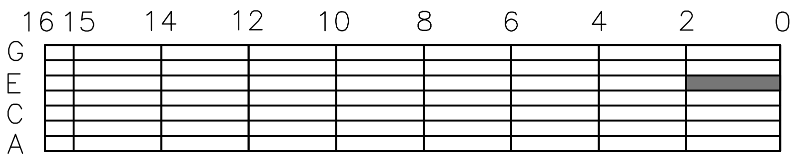


O-2 – E

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	20	BROKEN TRANSVERSE BAR	39	BROKEN TRANSVERSE BAR	58	BROKEN TRANSVERSE BAR
2	TEMPORARY STEEL PLATE	21	BROKEN TRANSVERSE BAR	40	BROKEN TRANSVERSE BAR	59	STEEL BAR REPAIR
3	MISSING STEEL PLATE	22	BROKEN TRANSVERSE BAR	41	BROKEN TRANSVERSE BAR	60	STEEL BAR REPAIR
4	LONGITUDINAL AND TRANSVERSE BARS MISSING	23	BROKEN TRANSVERSE BAR	42	BROKEN TRANSVERSE BAR	61	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR	24	BROKEN TRANSVERSE BAR	43	BROKEN TRANSVERSE BAR	62	STEEL BAR REPAIR
6	BENT TRANSVERSE BAR	25	BROKEN TRANSVERSE BAR	44	BROKEN TRANSVERSE BAR	63	STEEL BAR REPAIR
7	BENT TRANSVERSE BAR	26	BROKEN TRANSVERSE BAR	45	BROKEN TRANSVERSE BAR	64	STEEL BAR REPAIR
8	BENT TRANSVERSE BAR	27	BROKEN TRANSVERSE BAR	46	BROKEN TRANSVERSE BAR	65	STEEL BAR REPAIR
9	BENT TRANSVERSE BAR	28	STEEL BAR REPAIR	47	BROKEN TRANSVERSE BAR	66	STEEL BAR REPAIR
10	BENT TRANSVERSE BAR	29	STEEL BAR REPAIR	48	BROKEN TRANSVERSE BAR	67	STEEL BAR REPAIR
11	BENT TRANSVERSE BAR	30	BENT TRANSVERSE BAR	49	BROKEN TRANSVERSE BAR		
12	BENT TRANSVERSE BAR	31	BROKEN TRANSVERSE BAR	50	BROKEN TRANSVERSE BAR		
13	BENT TRANSVERSE BAR	32	STEEL BAR REPAIR	51	BROKEN TRANSVERSE BAR		
14	BROKEN TRANSVERSE BAR	33	BROKEN LONGITUDINAL BAR	52	BROKEN TRANSVERSE BAR		
15	BROKEN TRANSVERSE BAR	34	BROKEN TRANSVERSE BAR	53	BROKEN TRANSVERSE BAR		
16	BENT TRANSVERSE BAR	35	BROKEN TRANSVERSE BAR	54	BROKEN TRANSVERSE BAR		
17	BENT TRANSVERSE BAR	36	BROKEN TRANSVERSE BAR	55	BROKEN TRANSVERSE BAR		
18	BENT TRANSVERSE BAR	37	BROKEN TRANSVERSE BAR	56	BROKEN TRANSVERSE BAR		
19	BROKEN TRANSVERSE BAR	38	BROKEN TRANSVERSE BAR	57	BROKEN TRANSVERSE BAR		



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LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

JS drawn by / dessine par
CW designed by / conc par
PH approved by / approuve par
tender soumission / project manager administrateur de projets

18-11-05 project date / date du projet
R.090045.001 project no. / no. du projet
05 OF 63 drawing no. / dessine no.

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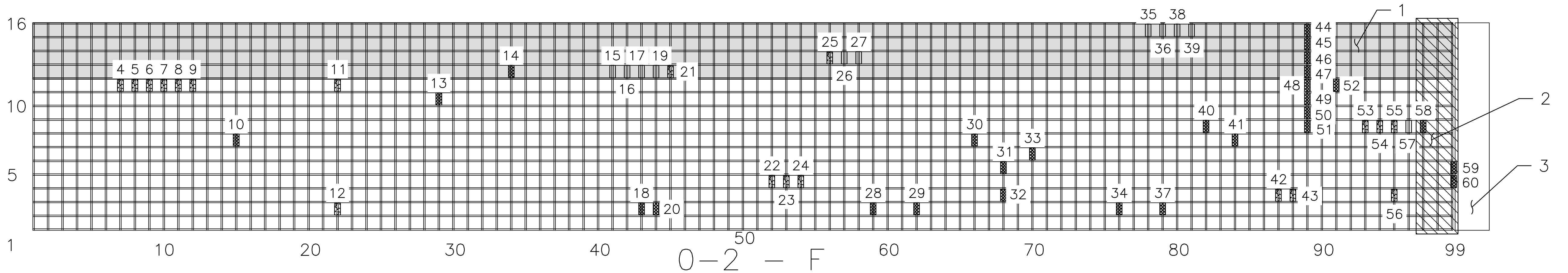
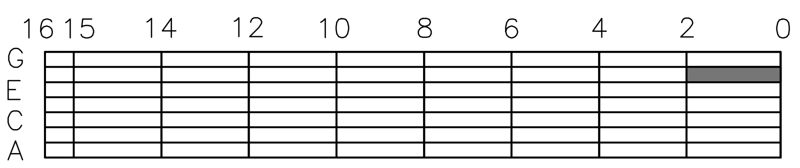


O-2 – F

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	22	BROKEN TRANSVERSE BAR	43	BROKEN TRANSVERSE BAR
2	AREA OF BROKEN TRANSVERSE BARS	23	BROKEN TRANSVERSE BAR	44	BENT TRANSVERSE BAR
3	MISSING STEEL PLATE	24	BROKEN TRANSVERSE BAR	45	BENT TRANSVERSE BAR
4	BROKEN TRANSVERSE BAR	25	BROKEN TRANSVERSE BAR	46	BENT TRANSVERSE BAR
5	BROKEN TRANSVERSE BAR	26	STEEL BAR REPAIR	47	BENT TRANSVERSE BAR
6	BROKEN TRANSVERSE BAR	27	STEEL BAR REPAIR	48	BENT TRANSVERSE BAR
7	BROKEN TRANSVERSE BAR	28	BENT TRANSVERSE BAR	49	BENT TRANSVERSE BAR
8	BROKEN TRANSVERSE BAR	29	BENT TRANSVERSE BAR	50	BENT TRANSVERSE BAR
9	BROKEN TRANSVERSE BAR	30	BENT TRANSVERSE BAR	51	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR	31	BENT TRANSVERSE BAR	52	BENT TRANSVERSE BAR
11	BROKEN TRANSVERSE BAR	32	BENT TRANSVERSE BAR	53	BROKEN TRANSVERSE BAR
12	BROKEN TRANSVERSE BAR	33	BENT TRANSVERSE BAR	54	BROKEN TRANSVERSE BAR
13	BENT TRANSVERSE BAR	34	BENT TRANSVERSE BAR	55	BROKEN TRANSVERSE BAR
14	BENT TRANSVERSE BAR	35	STEEL BAR REPAIR	56	BROKEN TRANSVERSE BAR
15	STEEL BAR REPAIR	36	STEEL BAR REPAIR	57	STEEL BAR REPAIR
16	STEEL BAR REPAIR	37	BENT TRANSVERSE BAR	58	BENT TRANSVERSE BAR
17	STEEL BAR REPAIR	38	STEEL BAR REPAIR	59	BENT TRANSVERSE BAR
18	BENT TRANSVERSE BAR	39	STEEL BAR REPAIR	60	BENT TRANSVERSE BAR
19	STEEL BAR REPAIR	40	BENT TRANSVERSE BAR		
20	BENT TRANSVERSE BAR	41	BENT TRANSVERSE BAR		
21	BROKEN TRANSVERSE BAR	42	BROKEN TRANSVERSE BAR		



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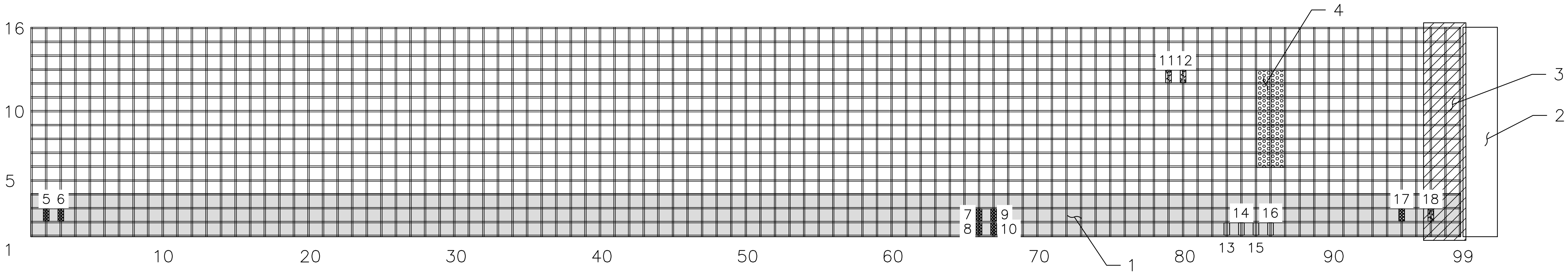
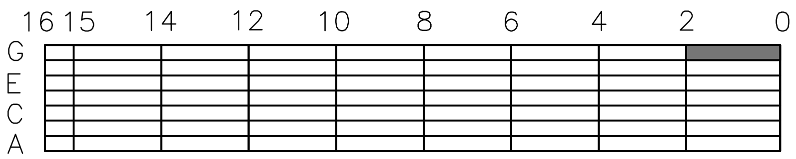


0-2 - G

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	13	STEEL BAR REPAIR
2	MISSING STEEL PLATE	14	STEEL BAR REPAIR
3	AREA OF BENT TRANSVERSE BARS	15	STEEL BAR REPAIR
4	DEBRIS	16	STEEL BAR REPAIR
5	BENT TRANSVERSE BAR	17	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR	18	BROKEN TRANSVERSE BAR
7	BENT TRANSVERSE BAR		
8	BENT TRANSVERSE BAR		
9	BENT TRANSVERSE BAR		
10	BENT TRANSVERSE BAR		
11	BROKEN TRANSVERSE BAR		
12	BROKEN TRANSVERSE BAR		



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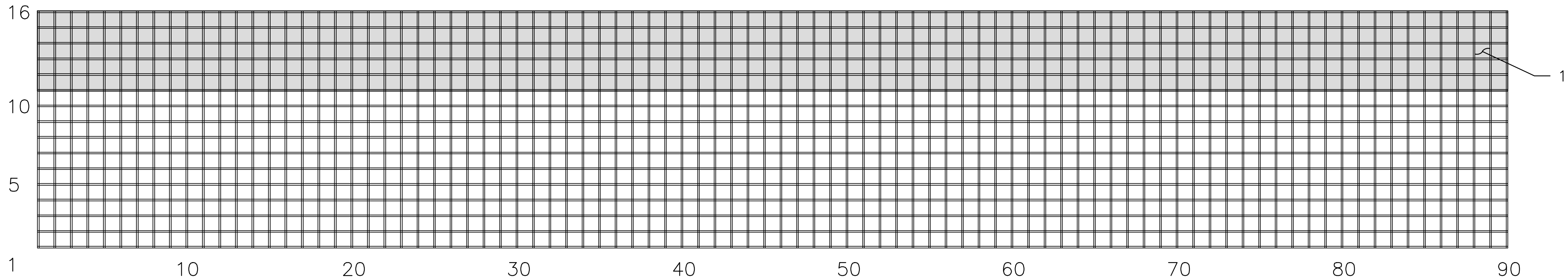
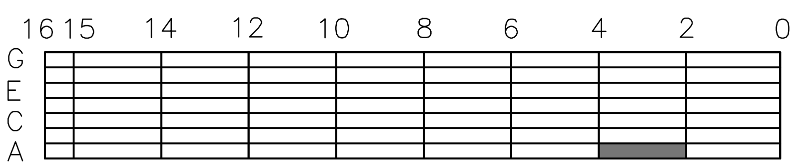


2-4 - A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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R.090045.001
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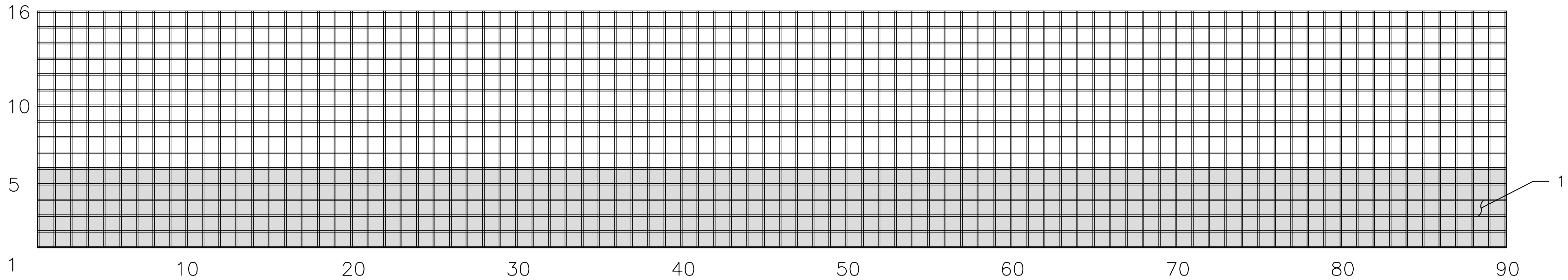
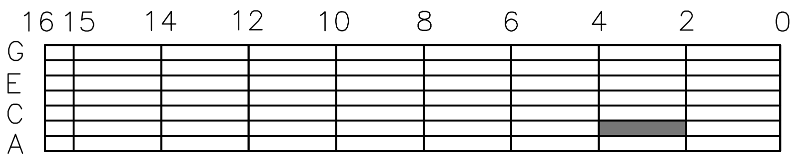


2-4 – B

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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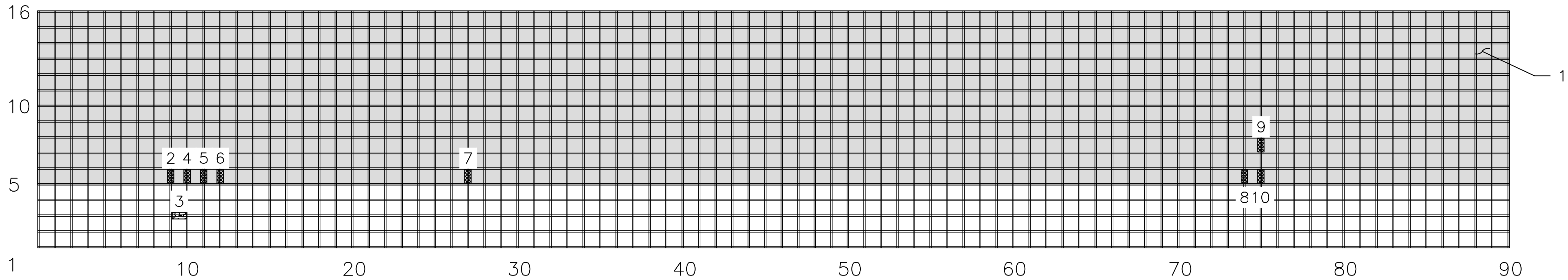
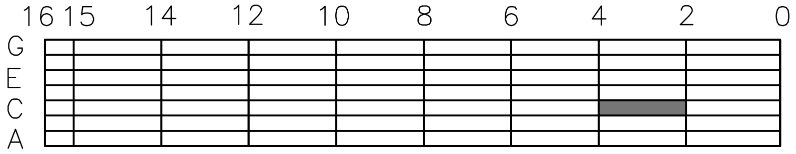


2–4 – C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	CRACKED WELD
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR



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PH — approved by / approuve par	10 OF 63 — drawing no. / dessine no.
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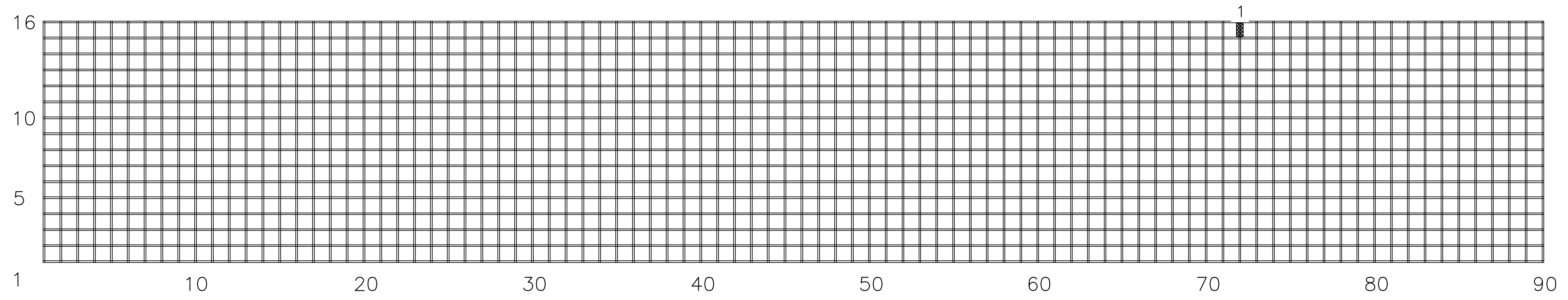
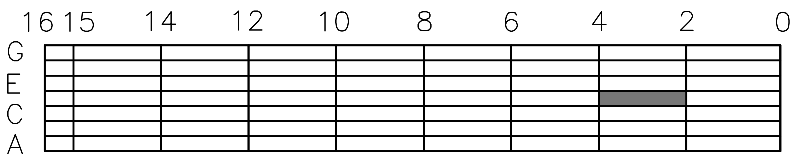


2–4 – D

1:20

DEFECT No.	DESCRIPTION
1	BENT TRANSVERSE BAR



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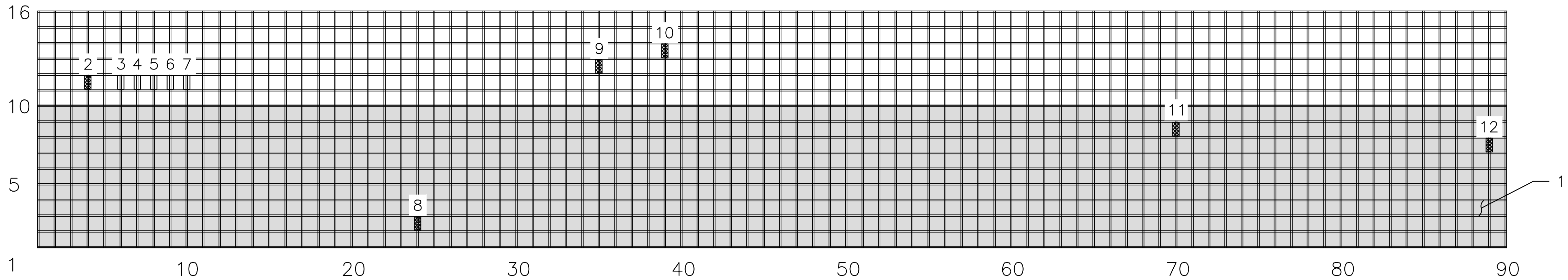
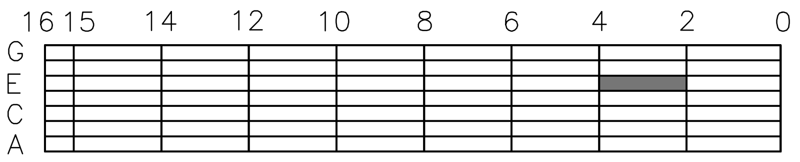


2-4 - E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	STEEL BAR REPAIR
4	STEEL BAR REPAIR
5	STEEL BAR REPAIR
6	STEEL BAR REPAIR
7	STEEL BAR REPAIR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR



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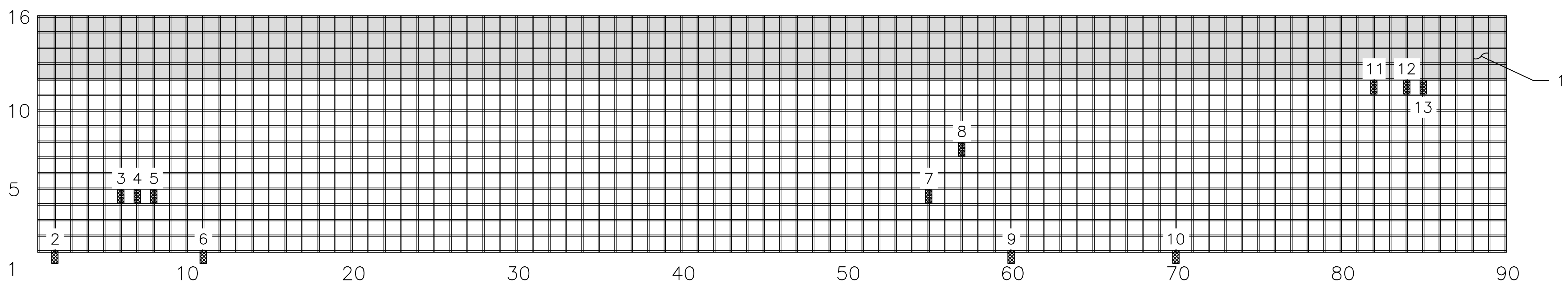
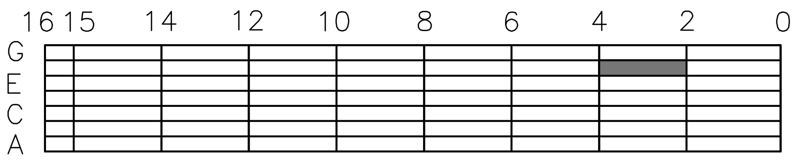


2-4 - F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR
13	BENT TRANSVERSE BAR



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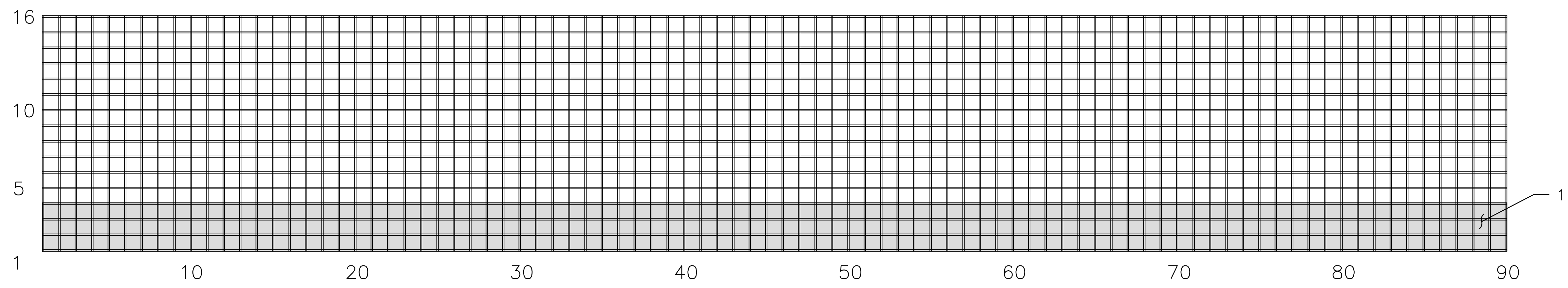
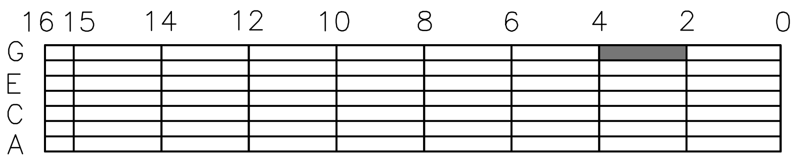


2-4 - G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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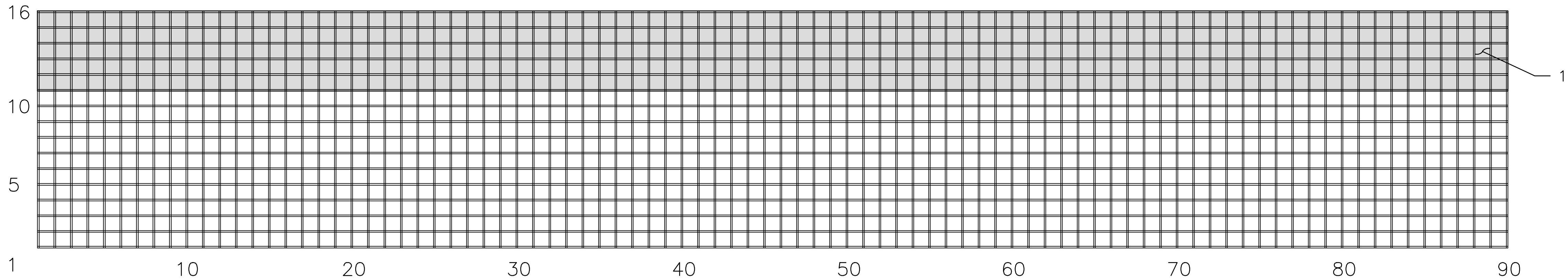
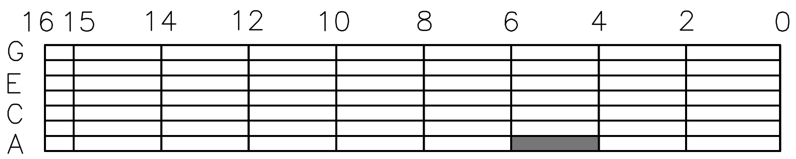


4–6 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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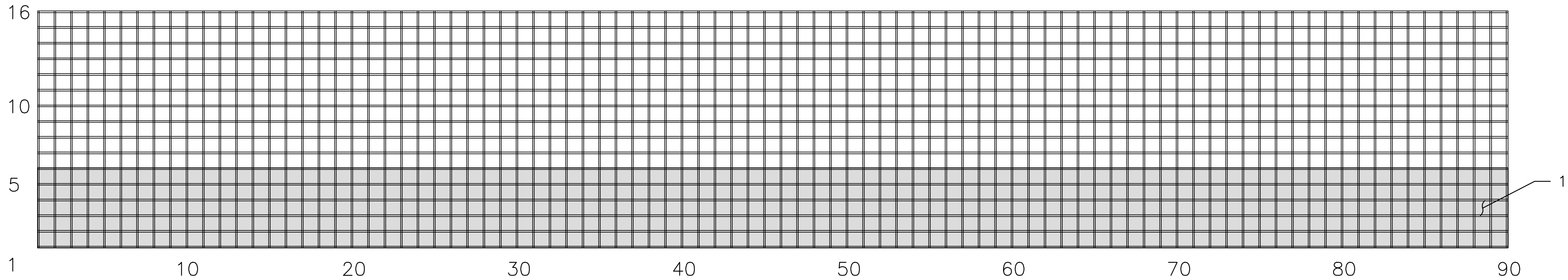
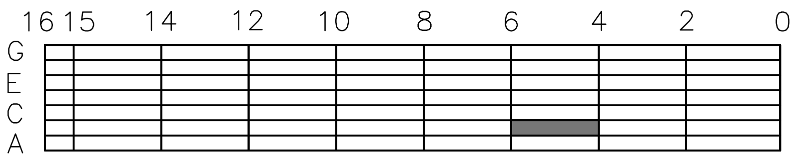


4–6 – B

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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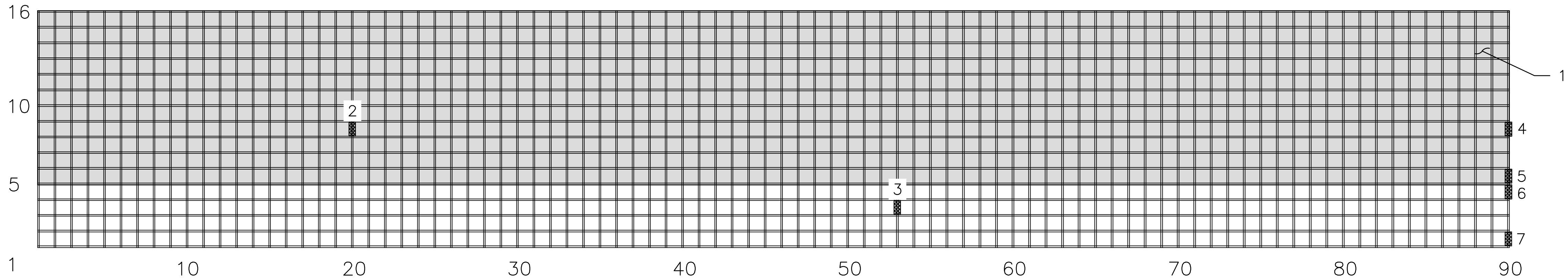
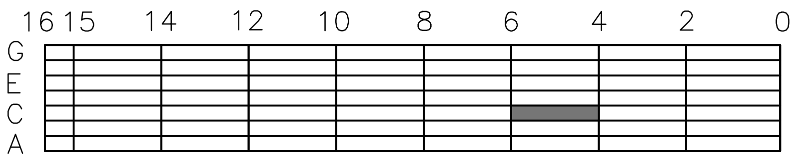


4-6 - C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR



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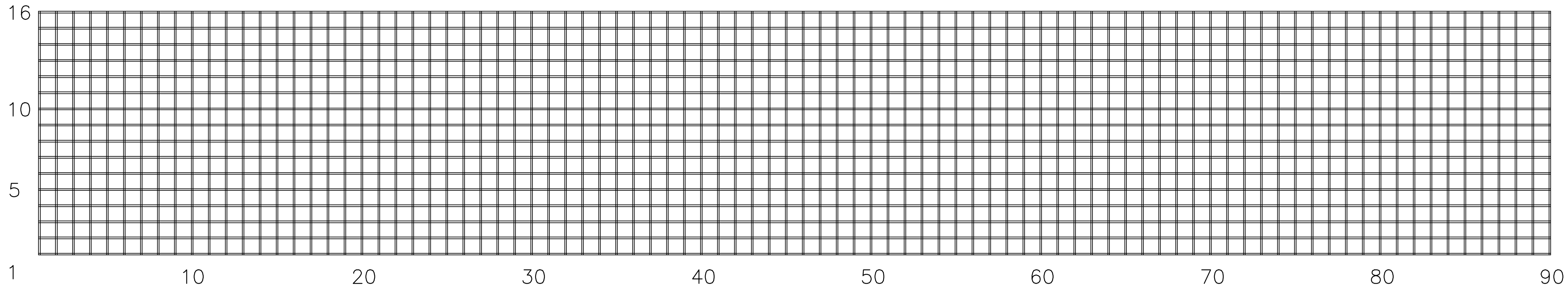
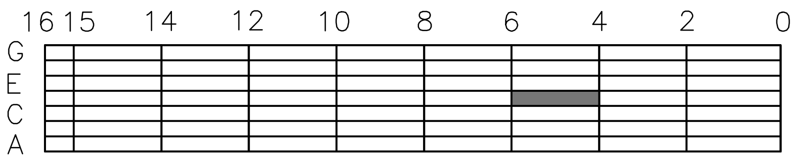


4–6 – D

1:20



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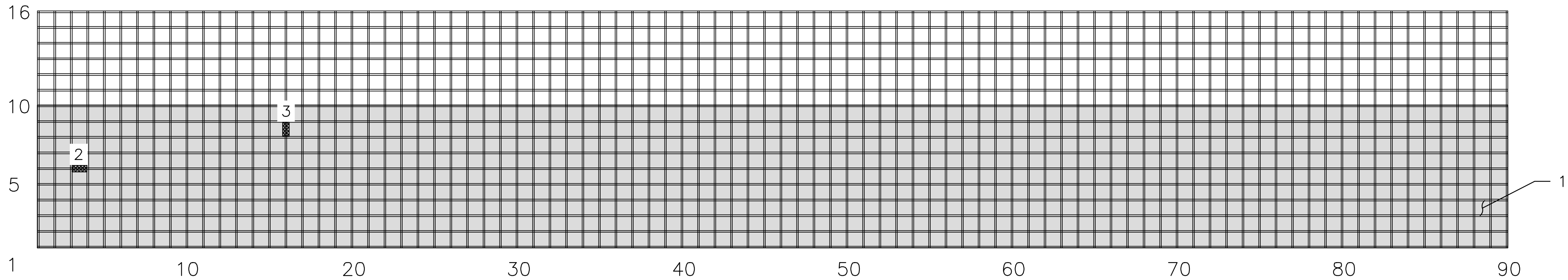
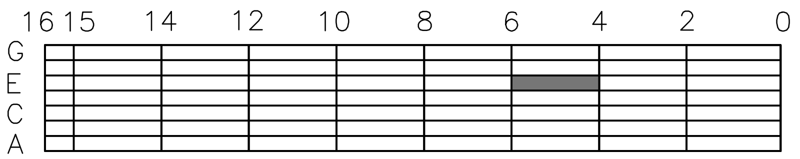


4-6 — E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR
3	BENT TRANSVERSE BAR



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LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

JS	drawn by / dessine par
CW	designed by / conc par
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19 OF 63
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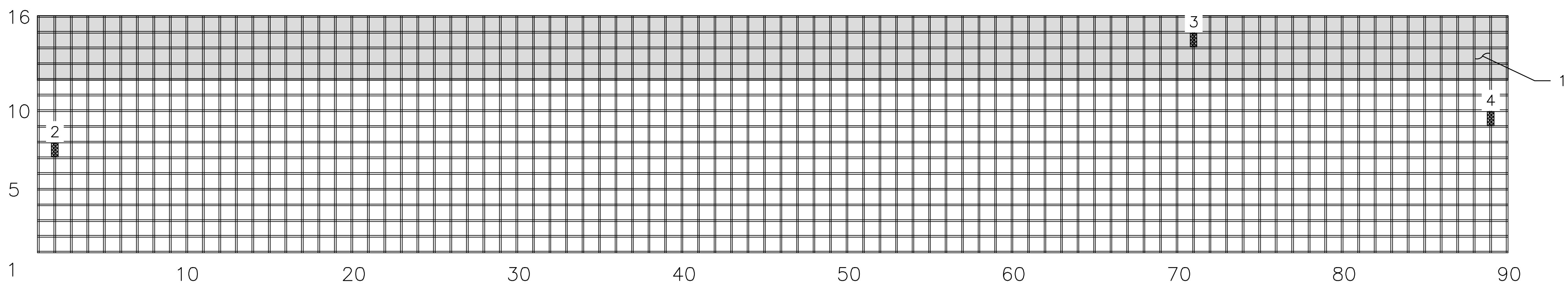
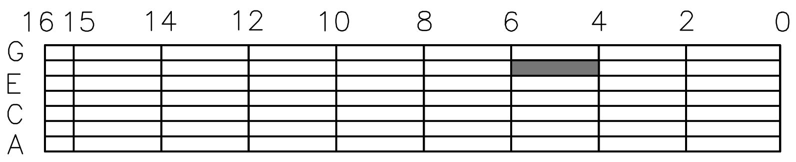


4-6 - F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR



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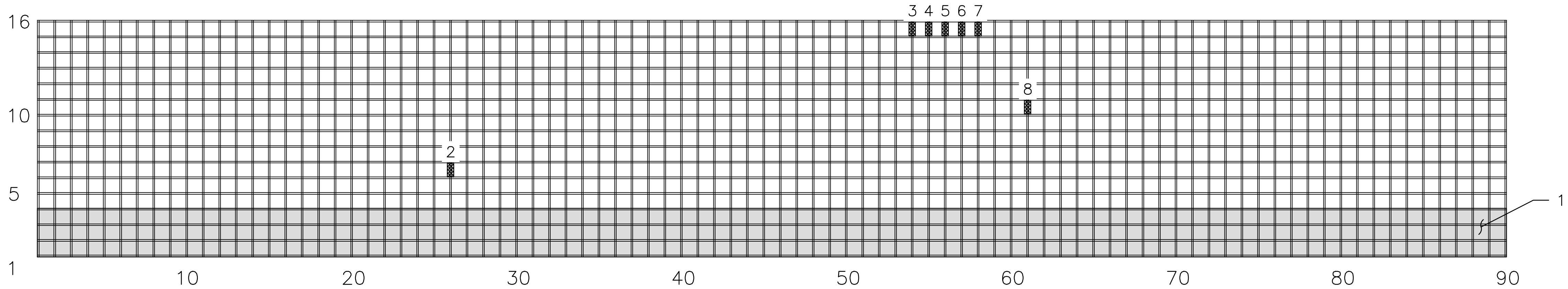
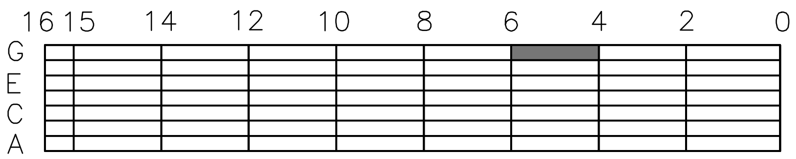


4-6 - G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR



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BRIDGE GRATING DETERIORATIONS

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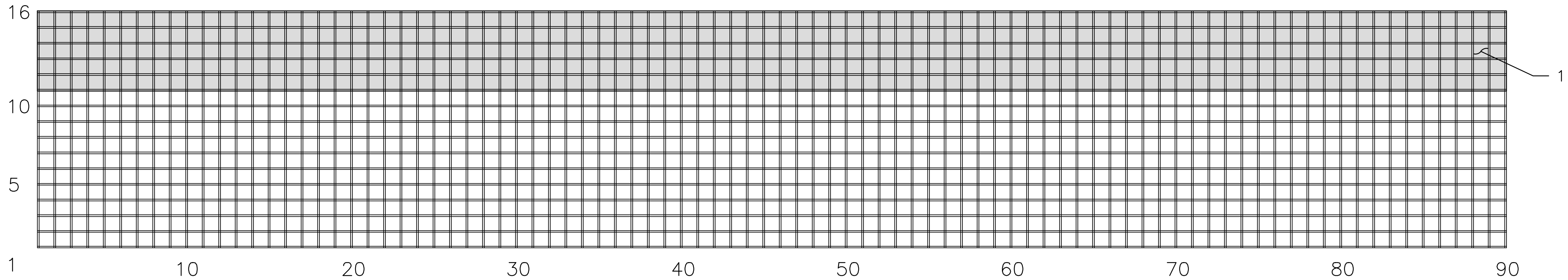
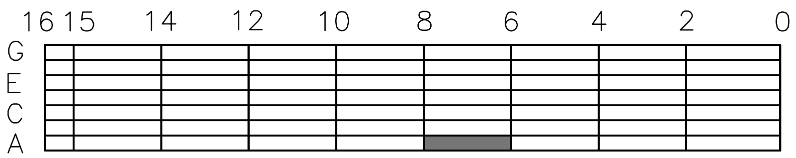


6–8 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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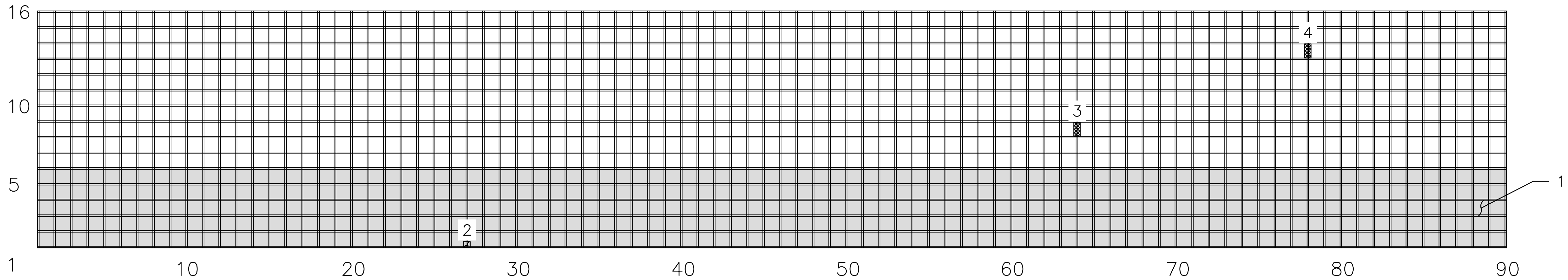
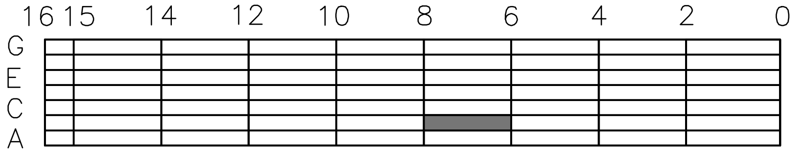


6-8 - B

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BROKEN WELD
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR



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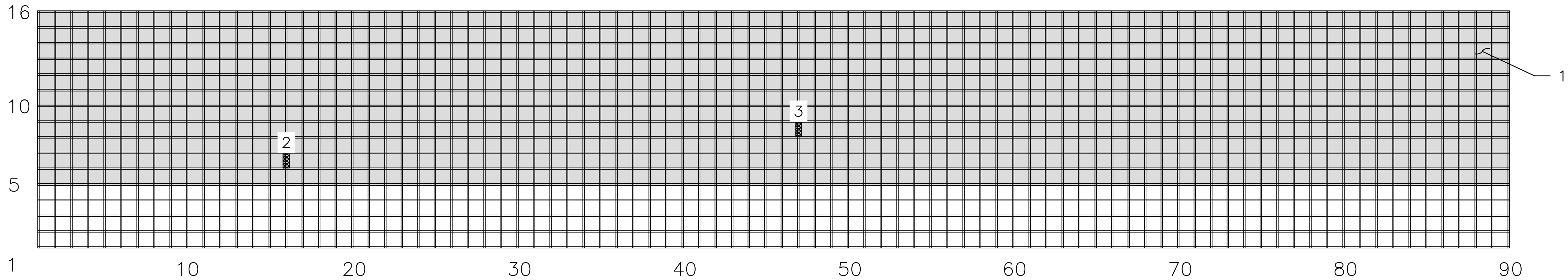
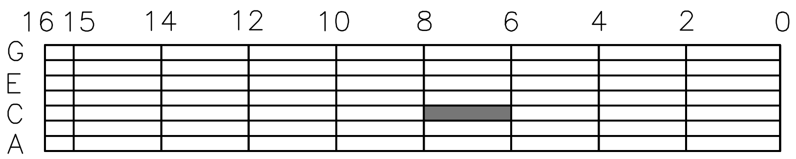


6-8 - C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR WITH BROKEN WELD



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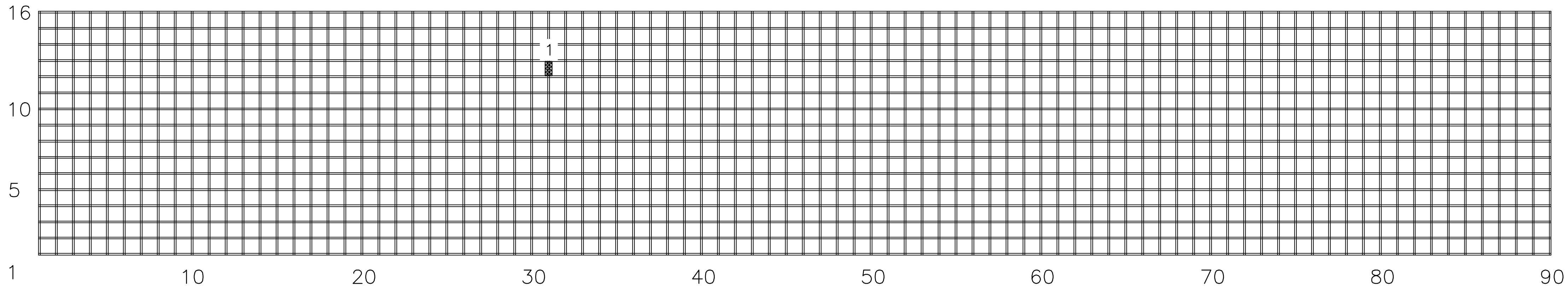
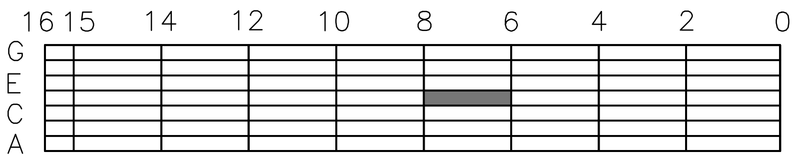


DEFECT No.	DESCRIPTION
1	BENT TRANSVERSE BAR

6-8 - D

1:20



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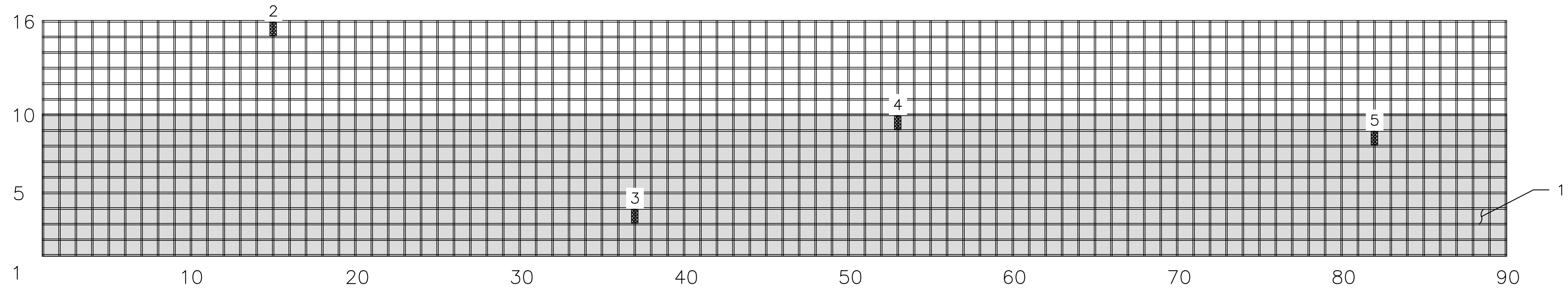
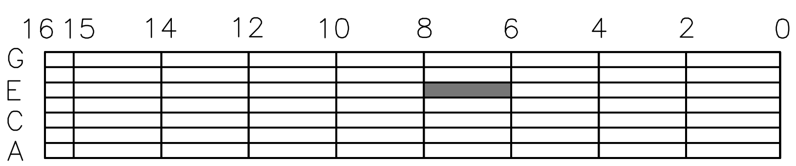


6-8 - E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR



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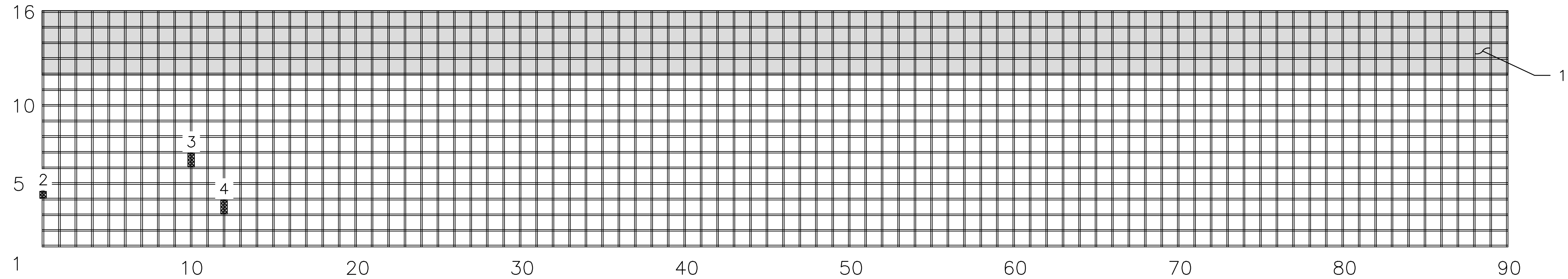
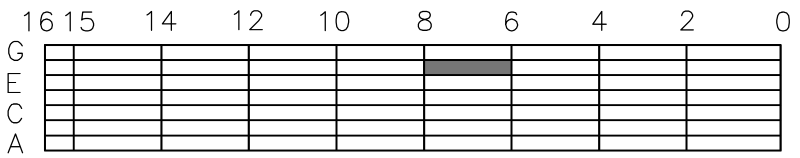


6–8 – F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	CRACKED WELD
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR



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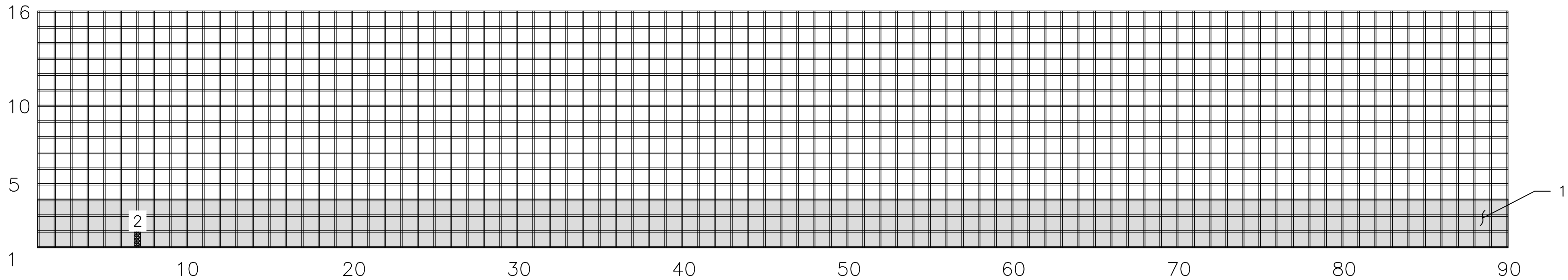
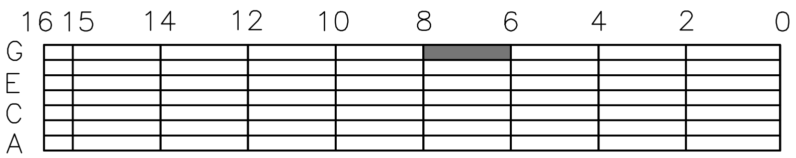


6–8 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR



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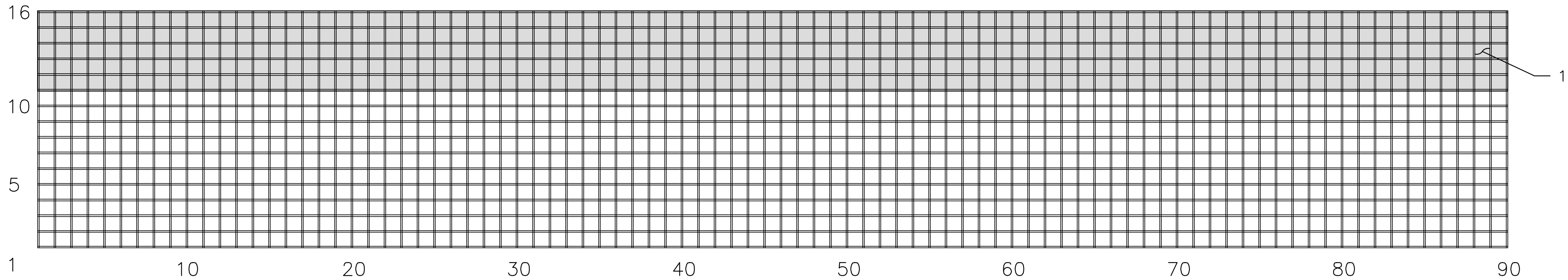
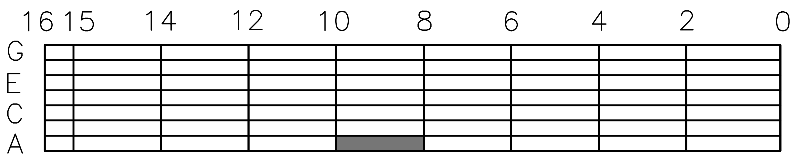


8–10 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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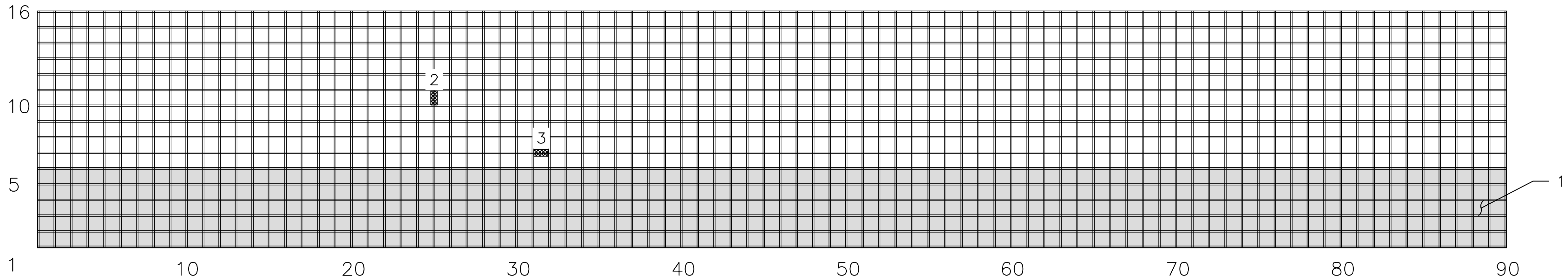
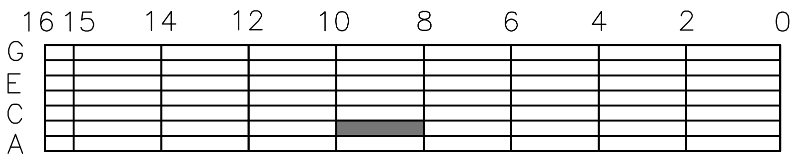


8–10 – B

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT LONGITUDINAL BAR



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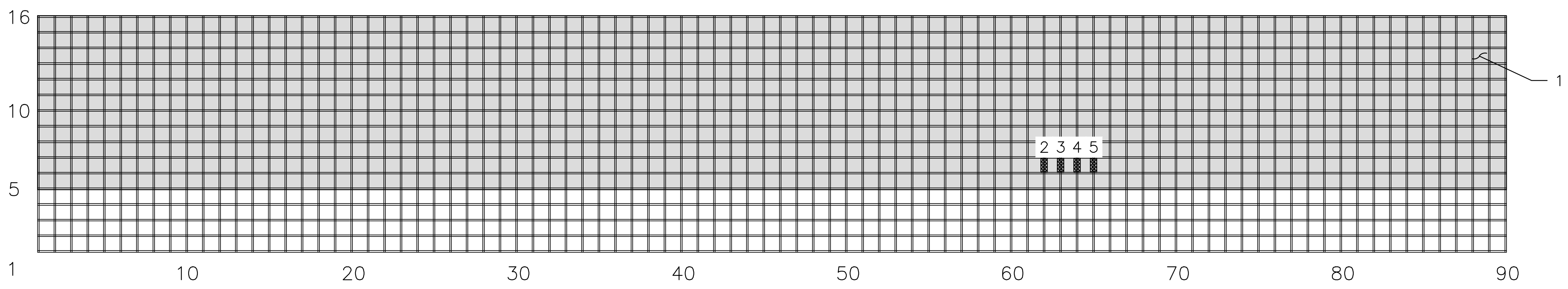
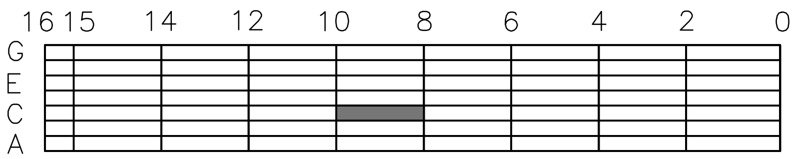


8-10 - C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR



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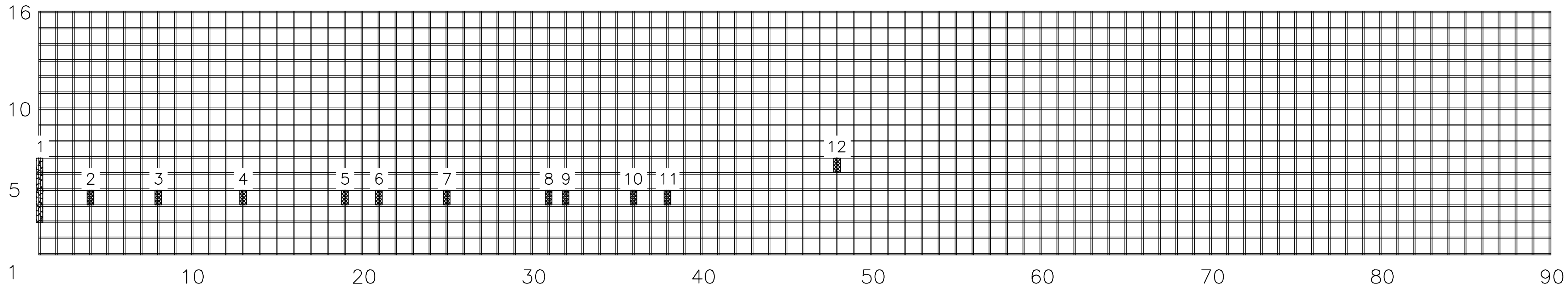
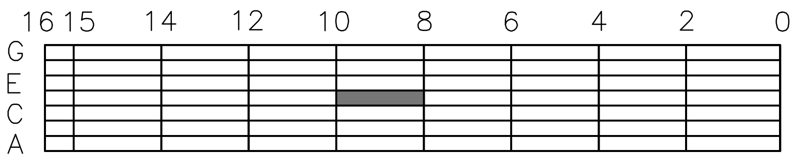


8–10 – D

1:20

DEFECT No.	DESCRIPTION
1	CRACKED WELD TO ADJOINING PANEL
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR



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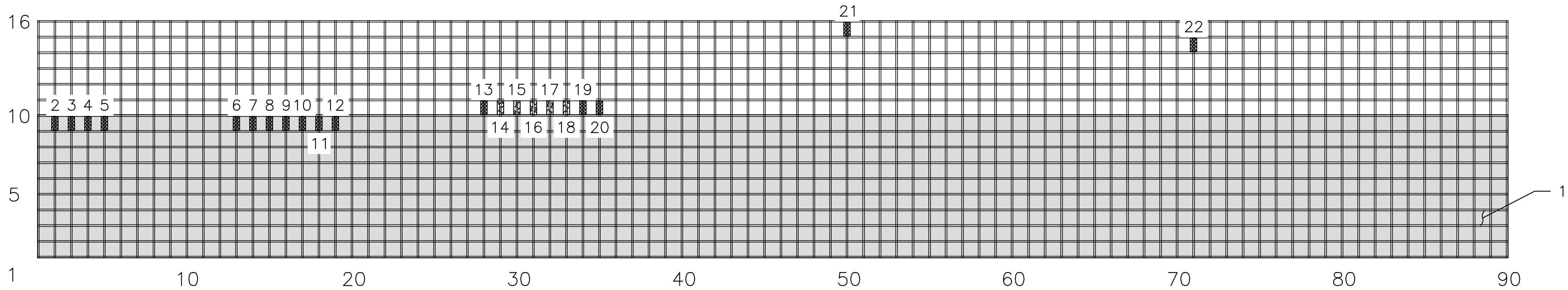
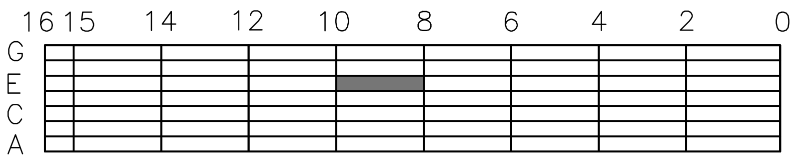


8–10 – E

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	13	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR	14	REPAIRED STEEL BAR
3	BENT TRANSVERSE BAR	15	REPAIRED STEEL BAR
4	BENT TRANSVERSE BAR	16	REPAIRED STEEL BAR
5	BENT TRANSVERSE BAR	17	REPAIRED STEEL BAR
6	BENT TRANSVERSE BAR	18	REPAIRED STEEL BAR
7	BENT TRANSVERSE BAR	19	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR	20	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR	21	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR	22	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR		
12	BENT TRANSVERSE BAR		



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LASALLE CAUSEWAY
BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING
DETERIORATIONS

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CW — designed by / conc par
PH — approved by / approuve par
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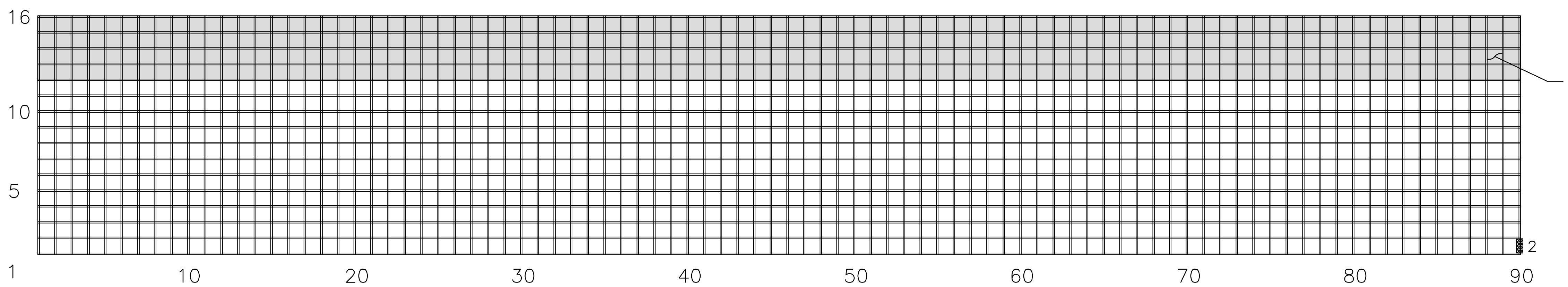
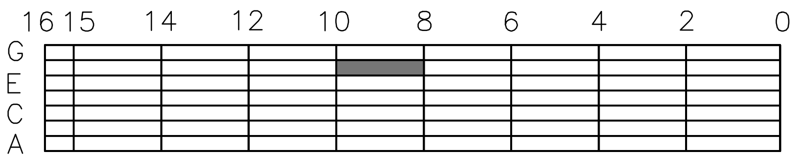


8–10 – F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR



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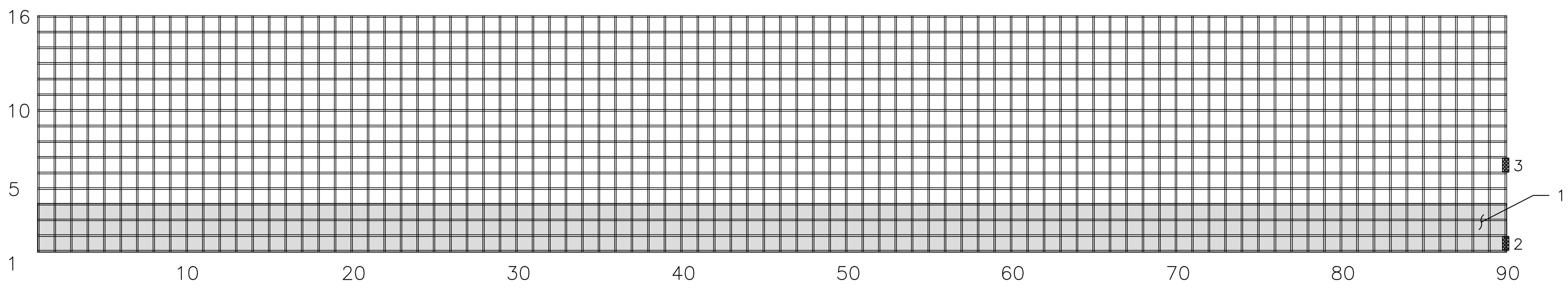
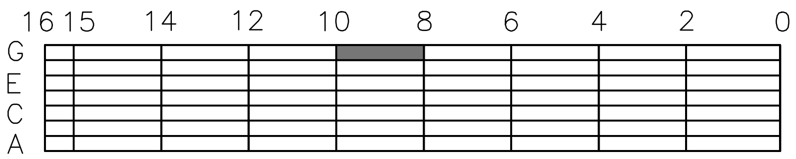


8–10 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR



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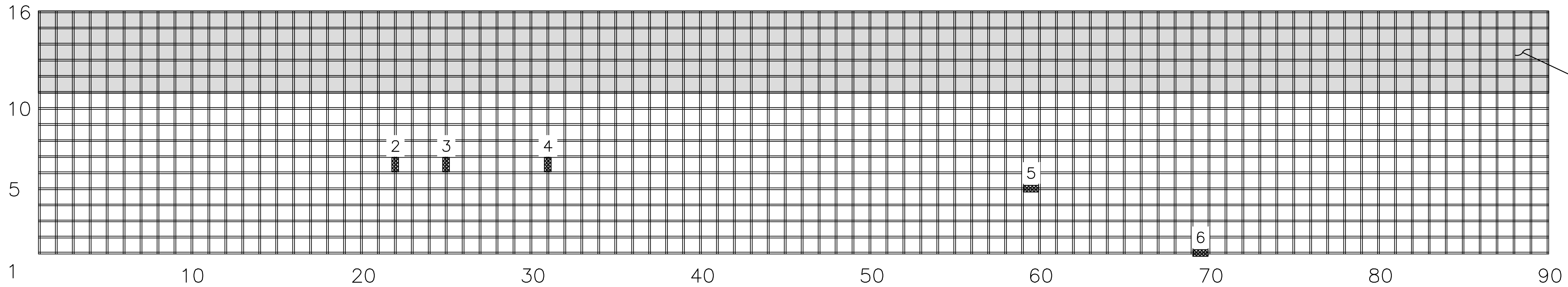
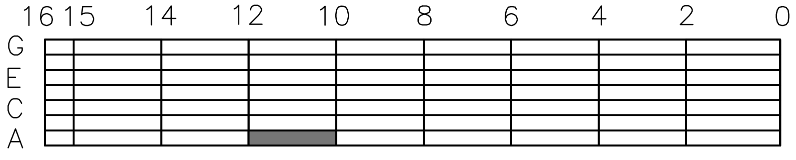


10–12 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT LONGITUDINAL BAR
6	BENT LONGITUDINAL BAR



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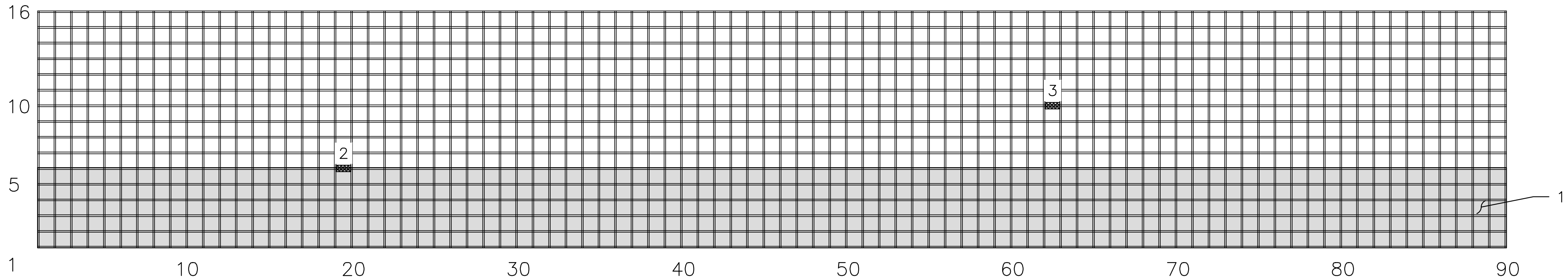
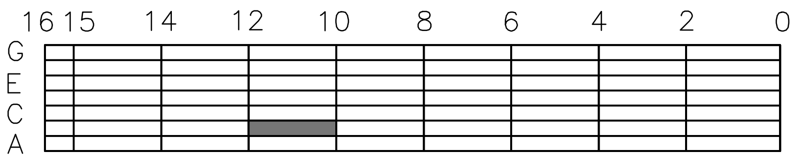


10–12 – B

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR
3	BENT LONGITUDINAL BAR



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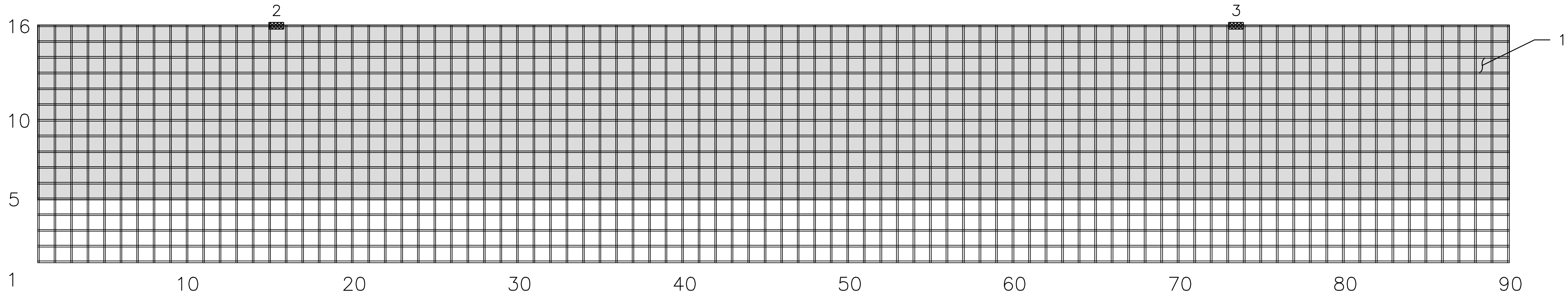
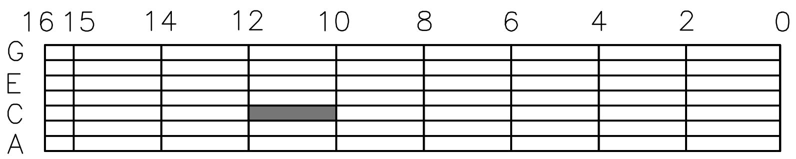


10–12 – C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR
3	BENT LONGITUDINAL BAR



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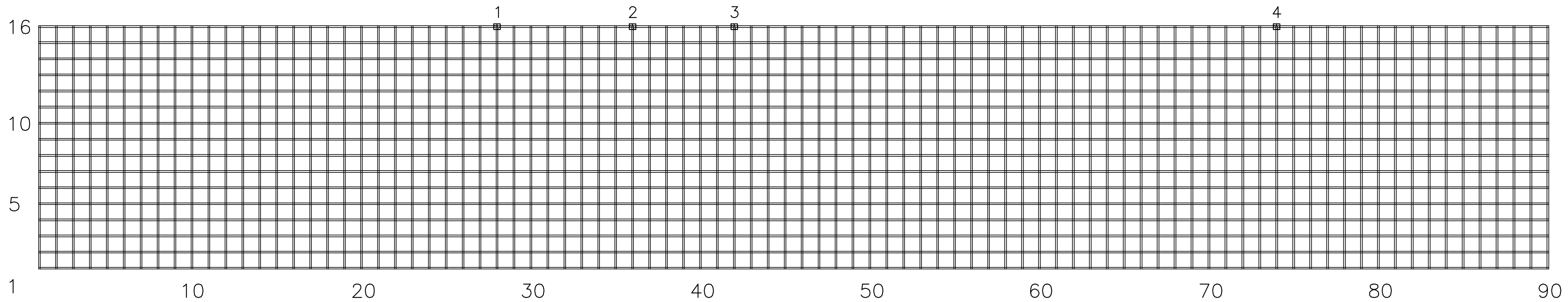
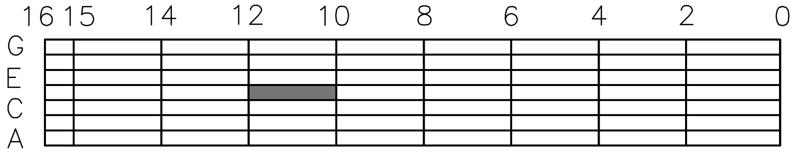


10–12 – D

1:20

DEFECT No.	DESCRIPTION
1	CRACKED WELD
2	CRACKED WELD
3	CRACKED WELD
4	CRACKED WELD



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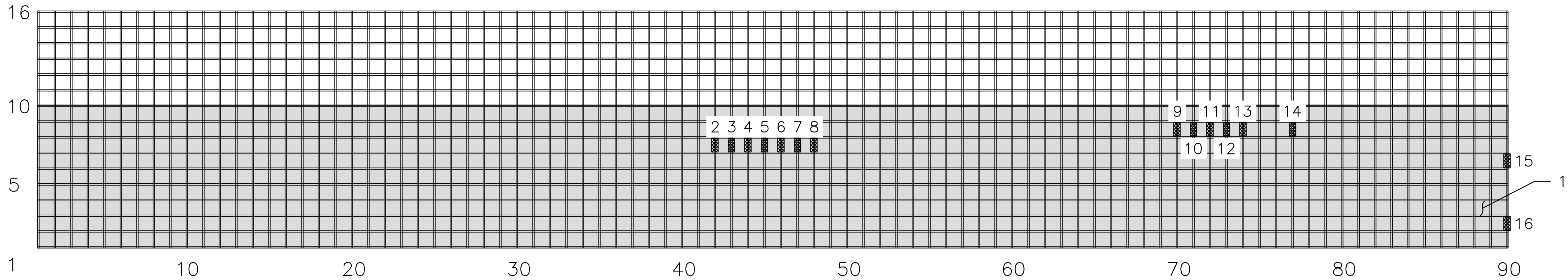
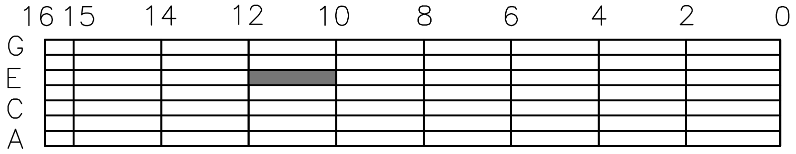


10–12 – E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR
13	BENT TRANSVERSE BAR
14	BENT TRANSVERSE BAR
15	BENT TRANSVERSE BAR
16	BENT TRANSVERSE BAR



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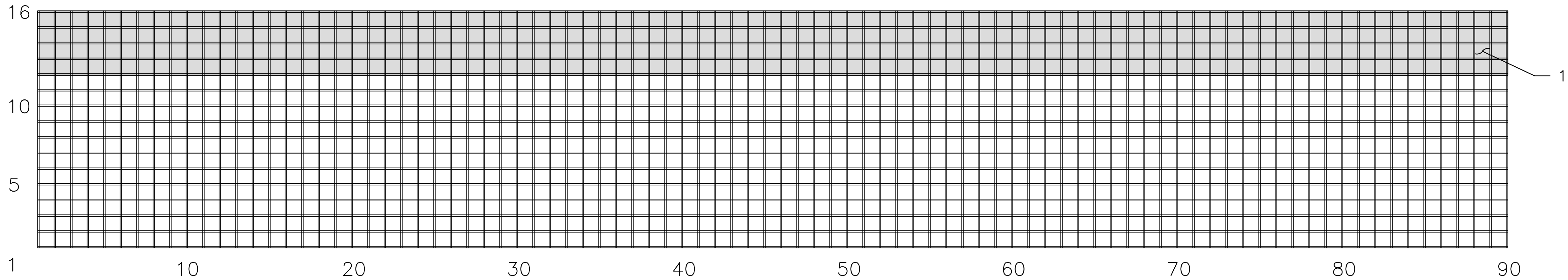
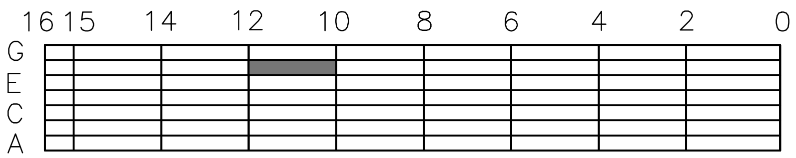


10–12 – F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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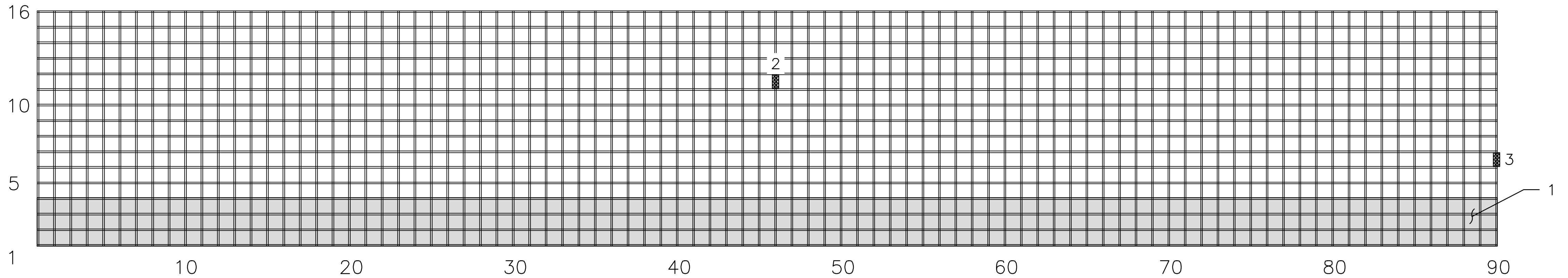
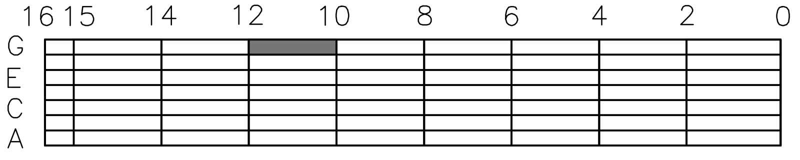


10–12 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR



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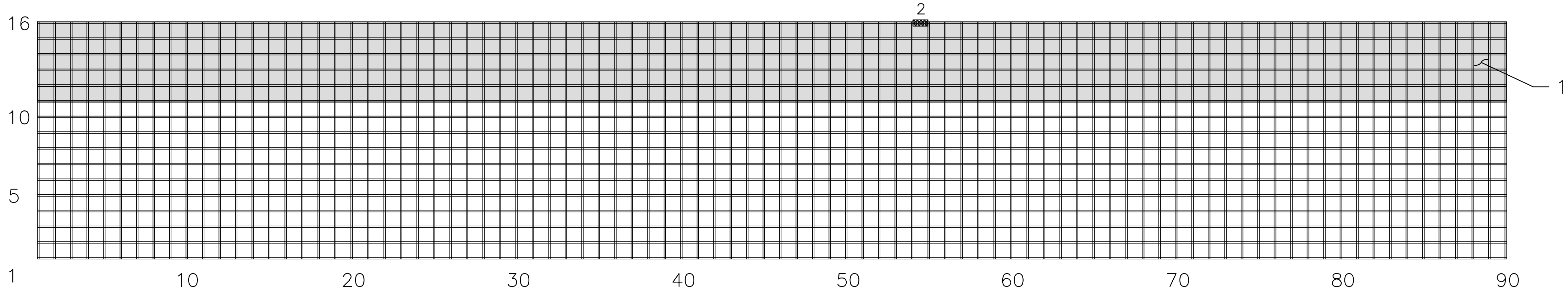
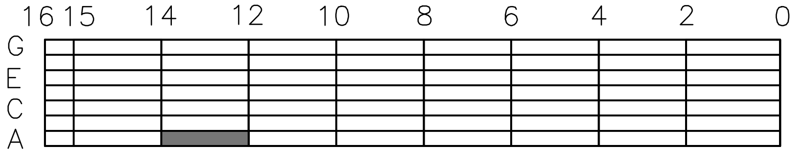


12–14 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR



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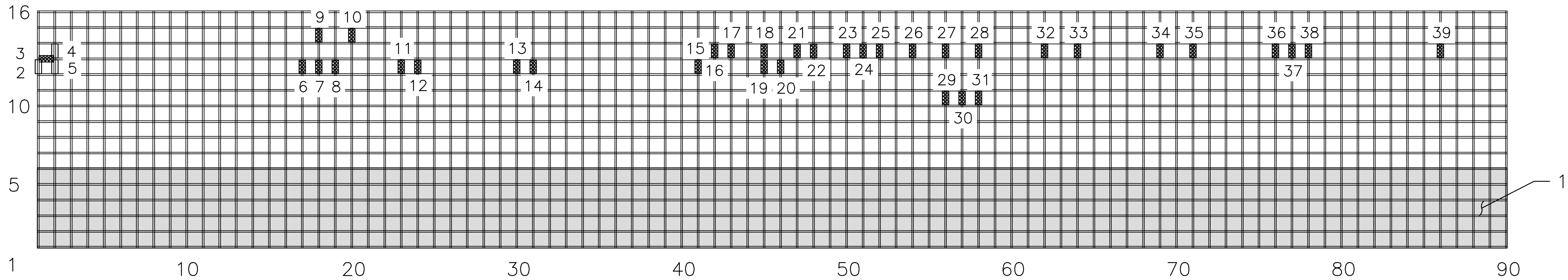
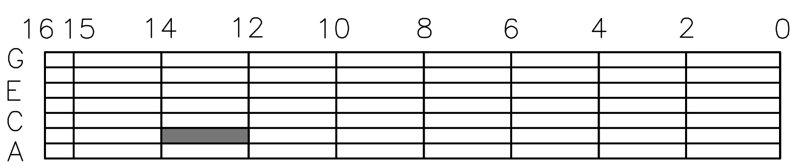


12–14 – B

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	21	BENT TRANSVERSE BAR
2	REPAIRED STEEL BAR	22	BENT TRANSVERSE BAR
3	BENT LONGITUDINAL BAR	23	BENT TRANSVERSE BAR
4	REPAIRED STEEL BAR	24	BENT TRANSVERSE BAR
5	REPAIRED STEEL BAR	25	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR	26	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR	27	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR	28	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR	29	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR	30	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR	31	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR	32	BENT TRANSVERSE BAR
13	BENT TRANSVERSE BAR	33	BENT TRANSVERSE BAR
14	BENT TRANSVERSE BAR	34	BENT TRANSVERSE BAR
15	BENT TRANSVERSE BAR	35	BENT TRANSVERSE BAR
16	BENT TRANSVERSE BAR	36	BENT TRANSVERSE BAR
17	BENT TRANSVERSE BAR	37	BENT TRANSVERSE BAR
18	BENT TRANSVERSE BAR	38	BENT TRANSVERSE BAR
19	BENT TRANSVERSE BAR	39	BENT TRANSVERSE BAR
20	BENT TRANSVERSE BAR		



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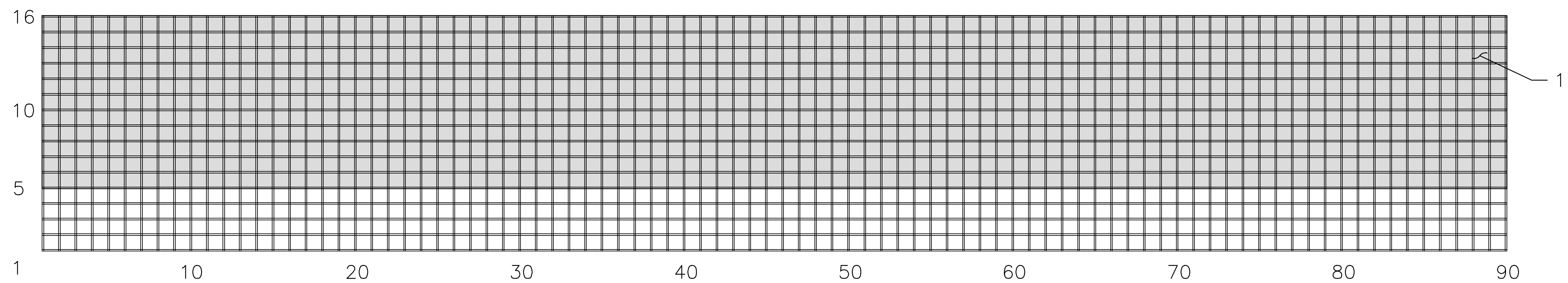
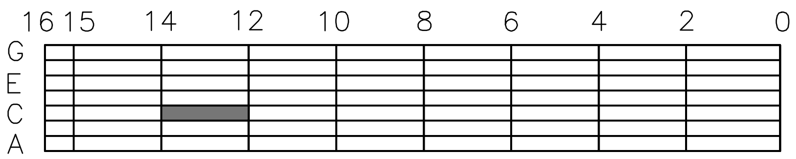


12-14 – C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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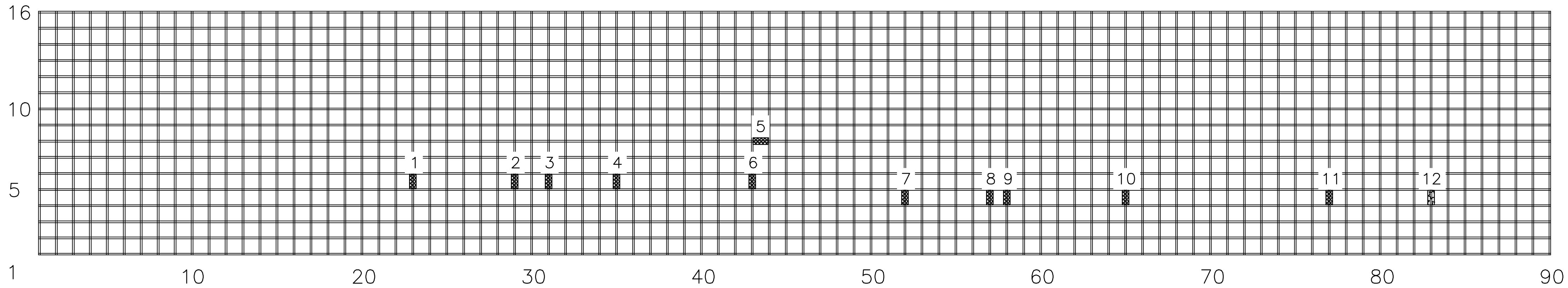
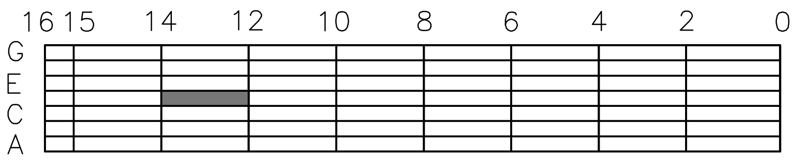


12–14 – D

1:20

DEFECT No.	DESCRIPTION
1	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT LONGITUDINAL BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR
11	BENT TRANSVERSE BAR
12	BROKEN TRANSVERSE BAR



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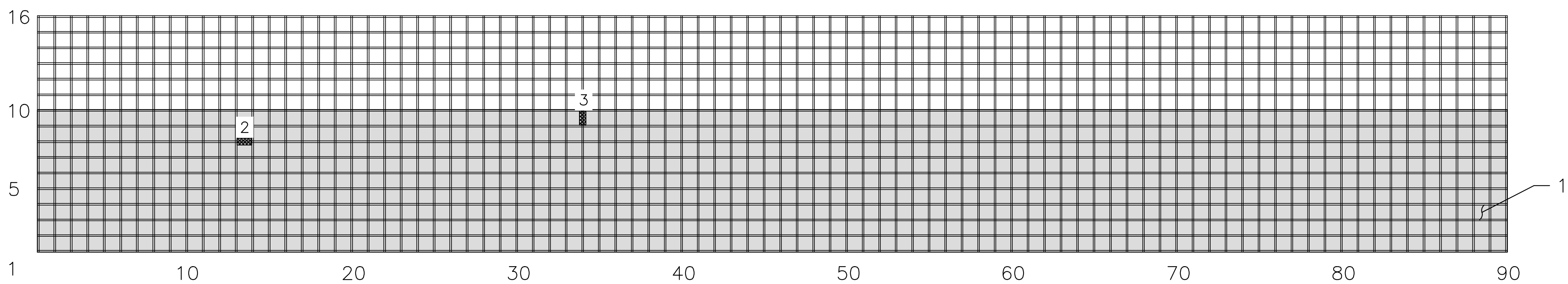
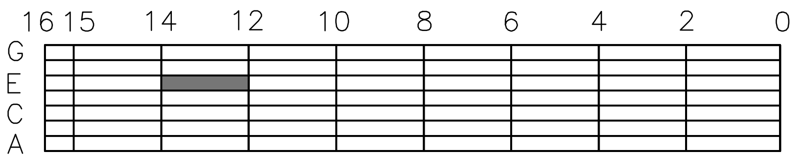


12–14 – E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT LONGITUDINAL BAR
3	BENT TRANSVERSE BAR



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project title / titre du projet
LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

JS drawn by / dessine par	18–11–05 project date / date du projet
CW designed by / conc par	R.090045.001 project no. / no. du projet
PH approved by / approuve par	47 OF 63 drawing no. / dessine no.
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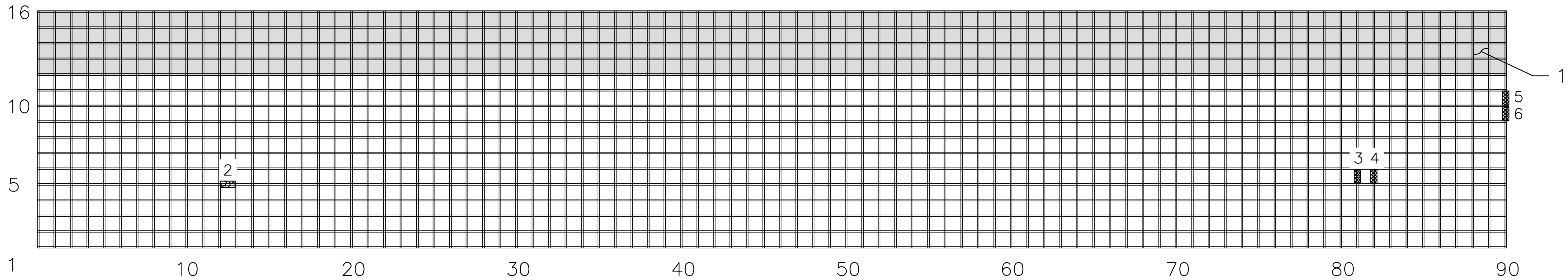
CAD FILE: H:\ISO\476880\02000\DWGS\Bascule Bridge Deck Inspection GRATING 12–14.dwg

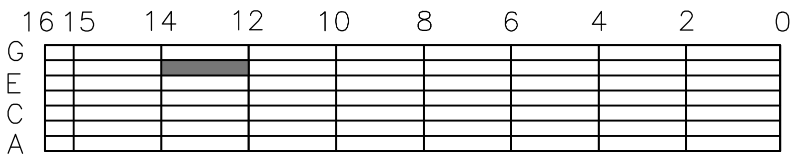
DATE PLOTTED: Monday, November 05, 2018 9:57:11 AM



12-14 - F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	CRACKED WELD TO SILL
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR



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BRIDGE GRATING DETERIORATIONS

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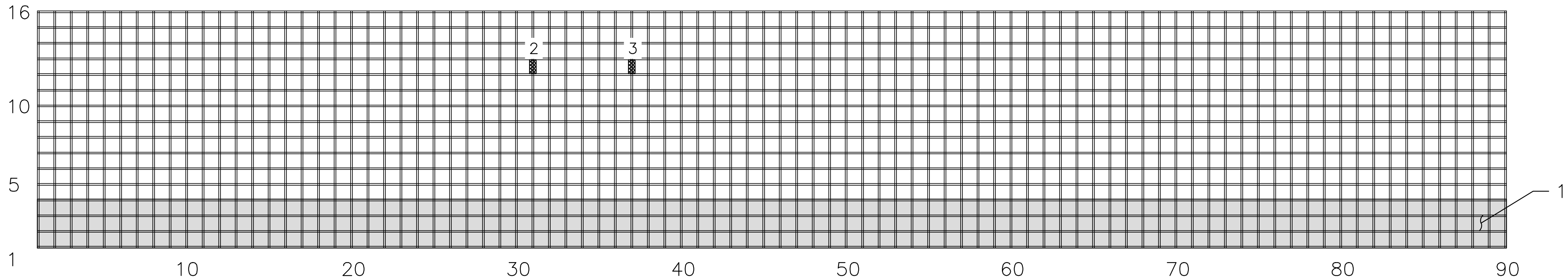
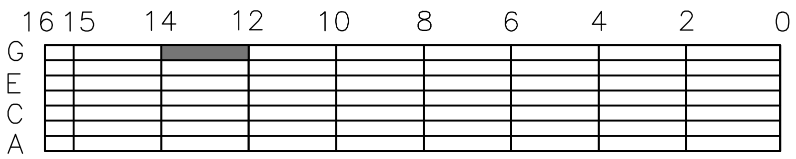


12–14 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR



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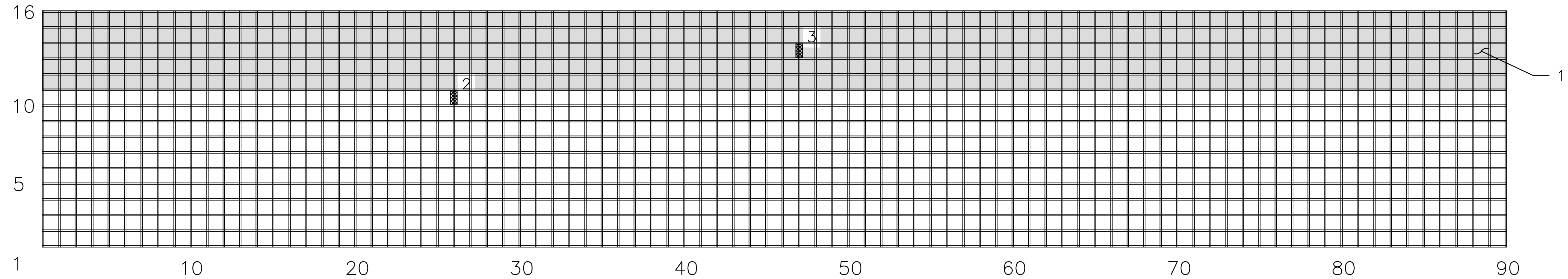
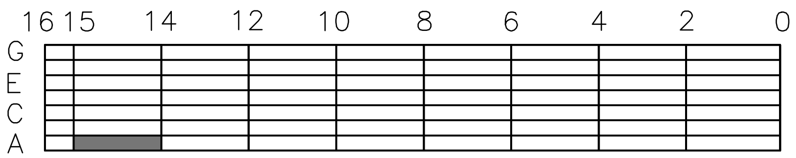


14–15 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR AND CRACKED WELDS



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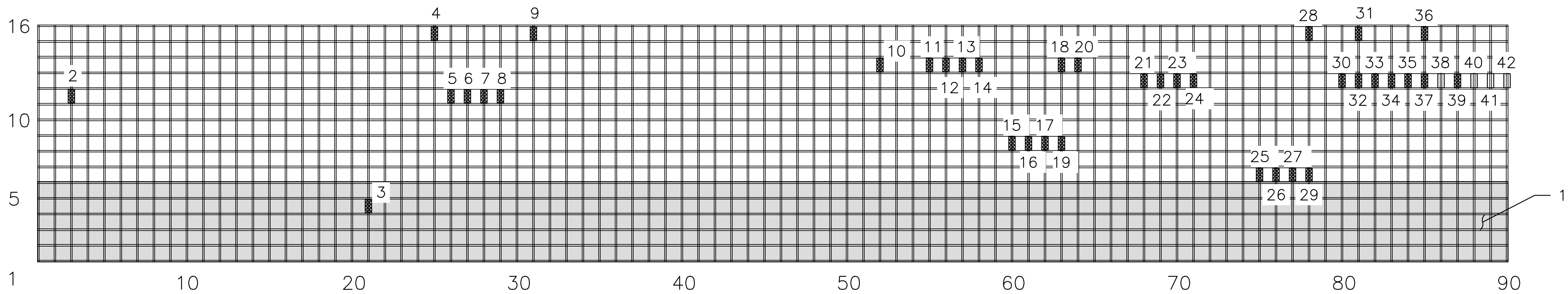
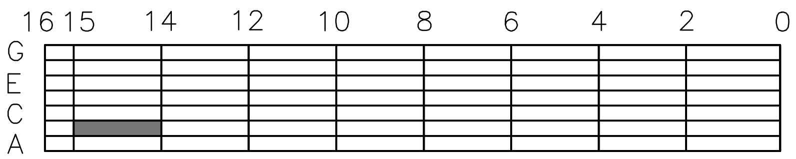


14–15 – B

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	15	BENT TRANSVERSE BAR	29	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR	16	BENT TRANSVERSE BAR AND CRACKED WELD	30	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR	17	BENT TRANSVERSE BAR	31	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR	18	BENT TRANSVERSE BAR	32	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR	19	BENT TRANSVERSE BAR	33	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR	20	BENT TRANSVERSE BAR	34	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR	21	BENT TRANSVERSE BAR	35	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR	22	BENT TRANSVERSE BAR	36	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR	23	BENT TRANSVERSE BAR	37	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR	24	BENT TRANSVERSE BAR	38	REPAIRED STEEL BAR
11	BENT TRANSVERSE BAR	25	BENT TRANSVERSE BAR	39	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR	262	BENT TRANSVERSE BAR	40	REPAIRED STEEL BAR
13	BENT TRANSVERSE BAR	27	BENT TRANSVERSE BAR	41	REPAIRED STEEL BAR
14	BENT TRANSVERSE BAR	28	BENT TRANSVERSE BAR	42	REPAIRED STEEL BAR



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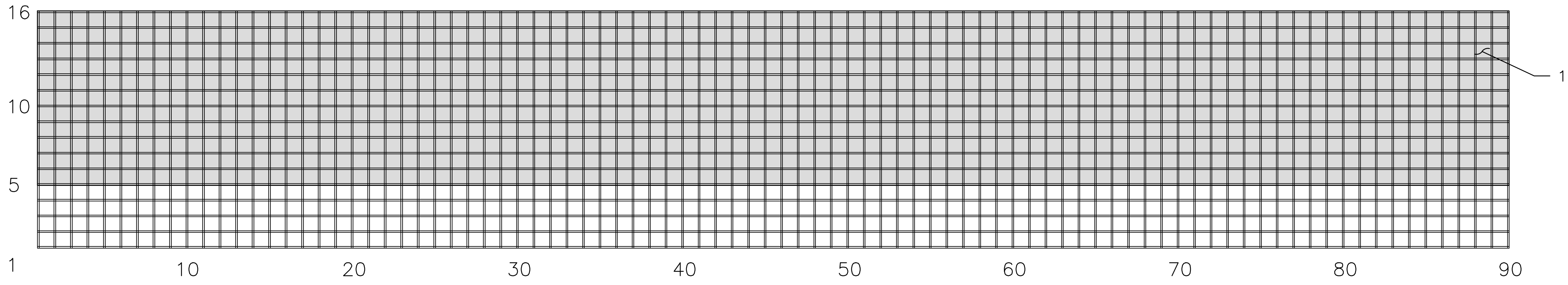
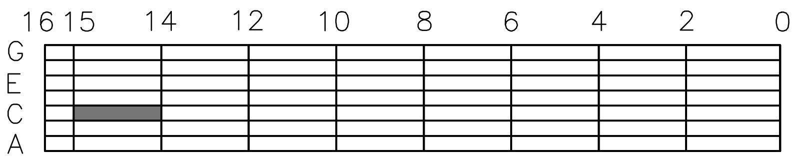


14–15 – C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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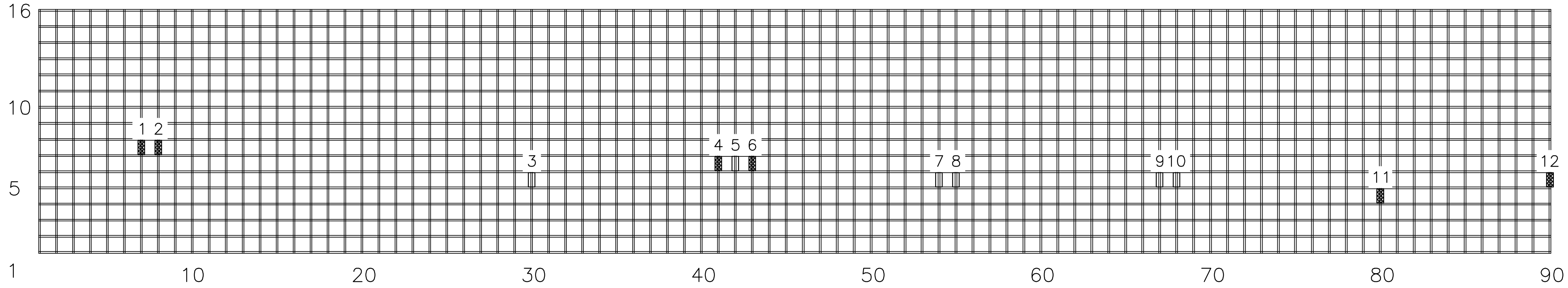
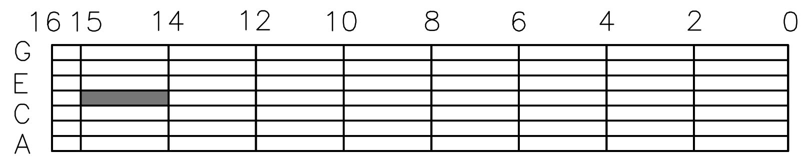


14–15 – D

1:20

DEFECT No.	DESCRIPTION
1	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR
3	REPAIRED STEEL BAR
4	BENT TRANSVERSE BAR
5	REPAIRED TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	REPAIRED STEEL BAR
8	REPAIRED STEEL BAR
9	REPAIRED STEEL BAR
10	REPAIRED STEEL BAR
11	BENT TRANSVERSE BAR
12	BENT TRANSVERSE BAR



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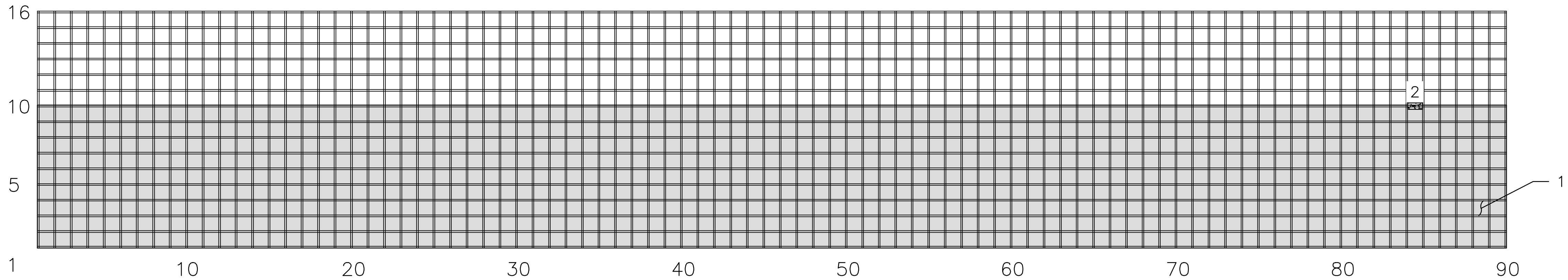
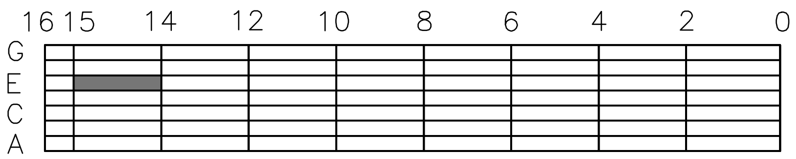


14–15 – E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	CRACKED WELD ON SILL



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BRIDGE GRATING DETERIORATIONS

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drawing no. / dessine no.

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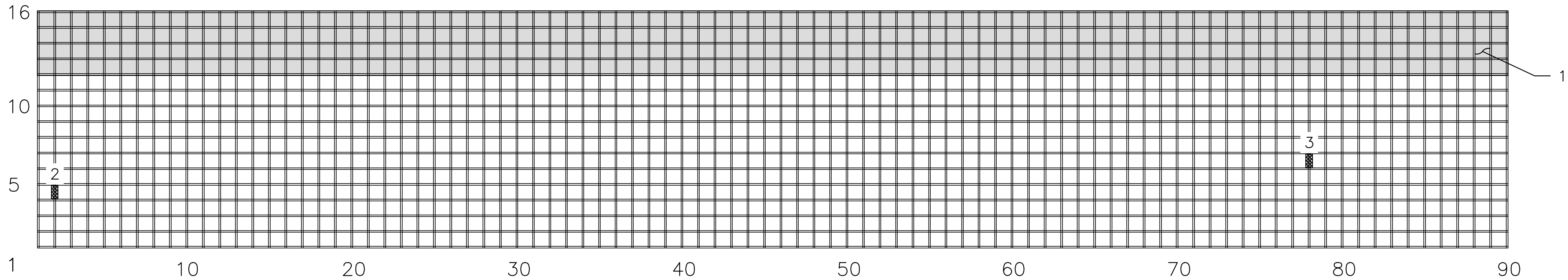
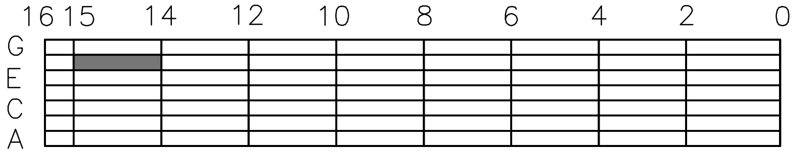


14–15 – F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR



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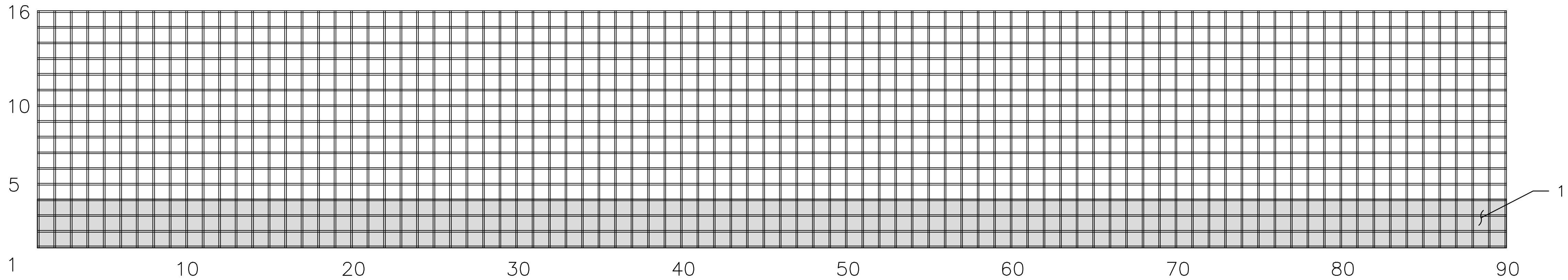
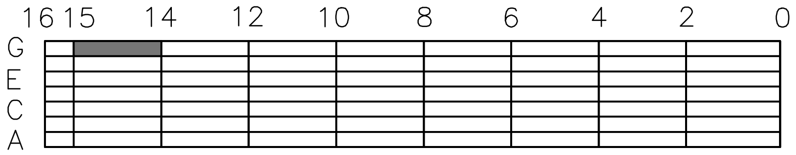


14–15 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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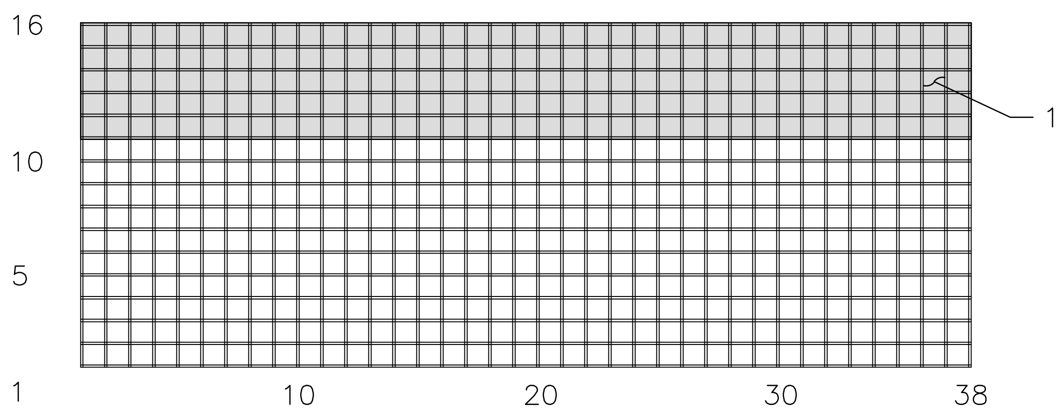
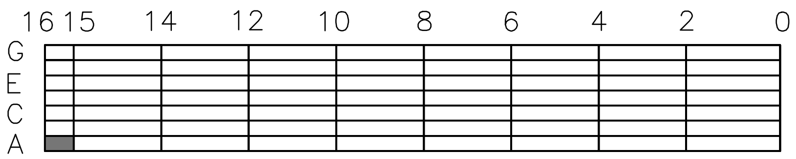


15–16 – A

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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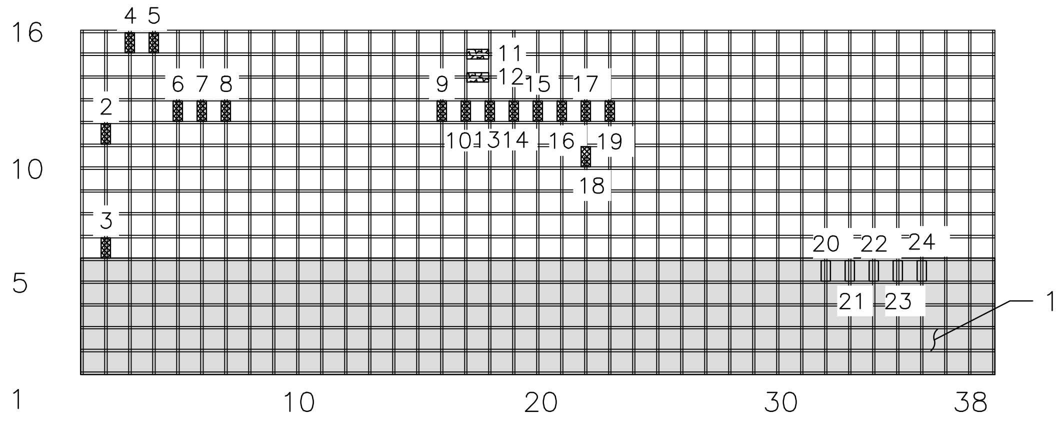
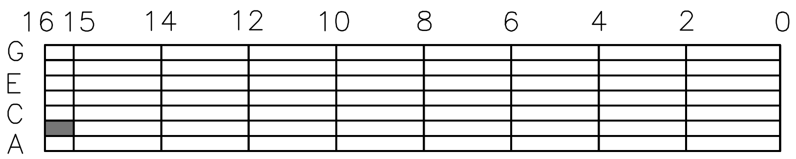


15–16 – B

1:20

DEFECT No.	DESCRIPTION	DEFECT No.	DESCRIPTION
1	WORN SERRATIONS	13	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR	14	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR	15	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR	16	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR	17	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR	18	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR	19	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR	20	REPAIRED STEEL BAR
9	BENT TRANSVERSE BAR	21	REPAIRED STEEL BAR
10	BENT TRANSVERSE BAR	22	REPAIRED STEEL BAR
11	BROKEN LONGITUDINAL BAR	23	REPAIRED STEEL BAR
12	BROKEN LONGITUDINAL BAR	24	REPAIRED STEEL BAR



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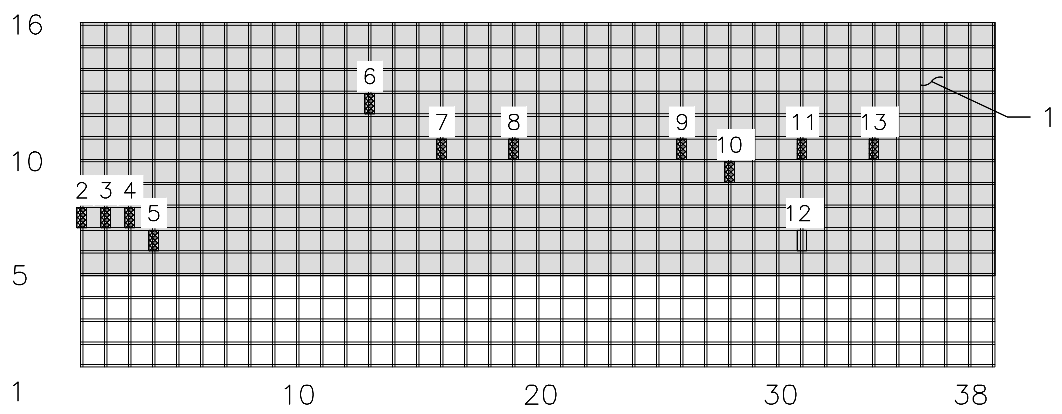
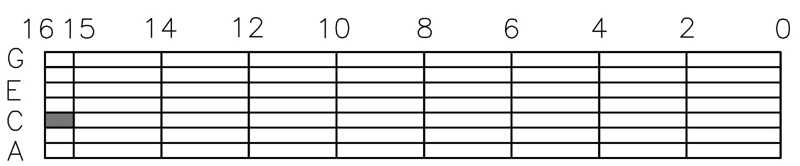


15–16 – C

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR
10	BENT TRANSVERSE BAR AND CRACKED WELD
11	BENT TRANSVERSE BAR
12	REPAIRED STEEL BAR
13	BENT TRANSVERSE BAR



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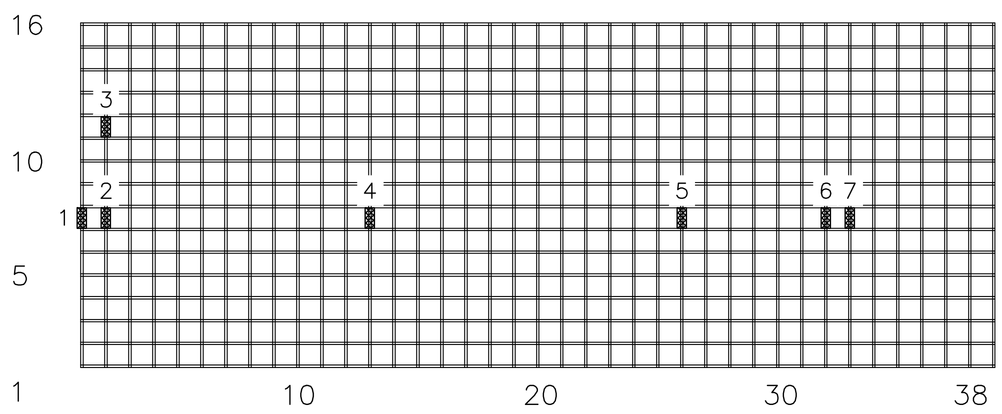
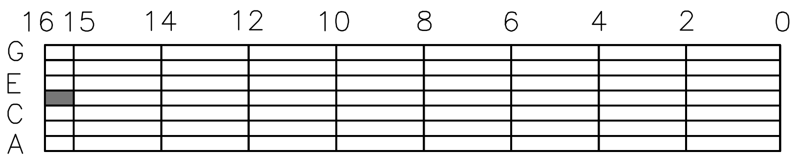


15-16 – D

1:20

DEFECT No.	DESCRIPTION
1	BENT TRANSVERSE BAR
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR



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DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

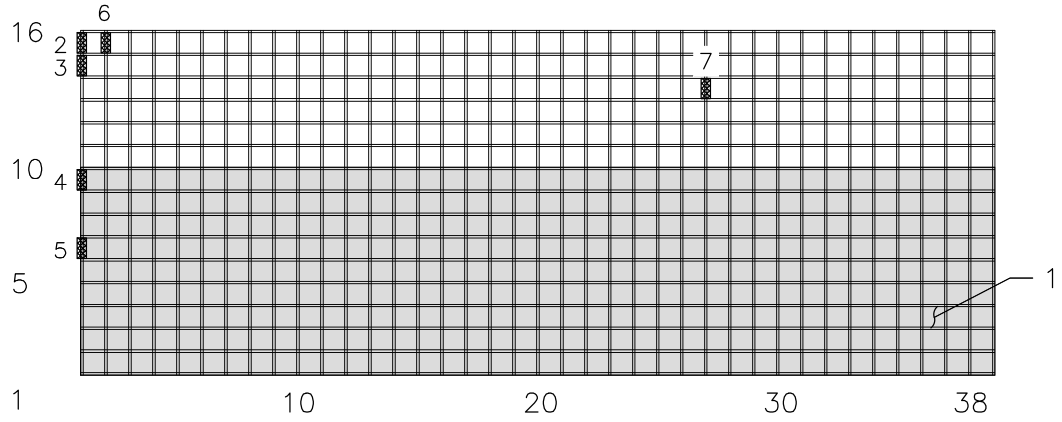
JS — drawn by / dessine par
CW — designed by / conc par
PH — approved by / approuve par
tender / soumission — project manager / administrateur de projets

18-11-05 — project date / date du projet
R.090045.001 — project no. / no. du projet
60 OF 63 — drawing no. / dessine no.

GSC-A3A 95-09

CAD FILE: H:\ISO\476880\02000\DWGS\Bascule Bridge Deck Inspection GRATING 15-16.dwg

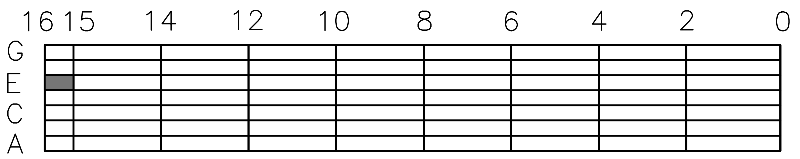
DATE PLOTTED: Monday, November 05, 2018 9:58:06 AM



15–16 – E

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR WITH CRACK
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR



GSC-A3A 95-09

Public Services and Procurement Canada
Architectural and Engineering Services
Ontario Region

Services Publics et Approvisionnement Canada
Services d'architecture et de génie
Région de l'Ontario

project title / titre du projet
LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

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BRIDGE GRATING DETERIORATIONS

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18-11-05 — project date / date du projet

R.090045.001 — project no. / no. du projet

61 OF 63 — drawing no. / dessine no.

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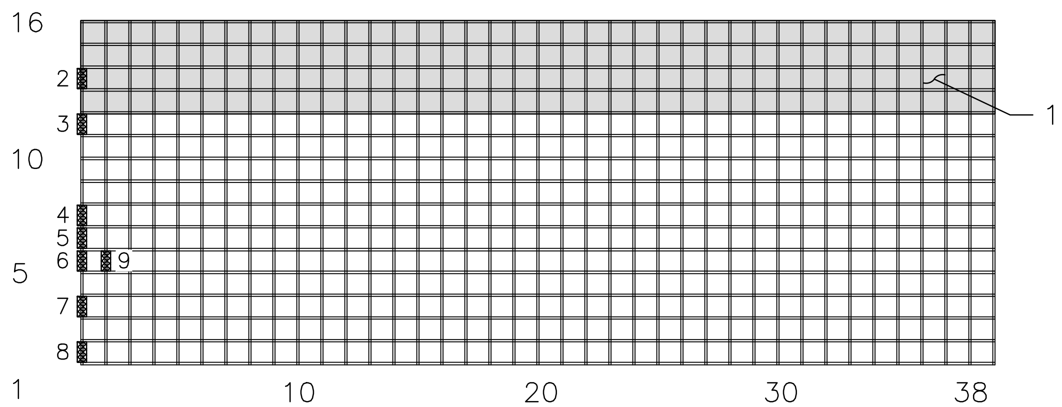
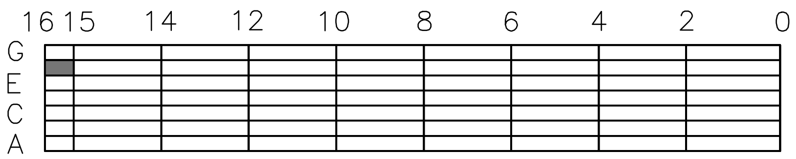


15-16 – F

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS
2	BENT TRANSVERSE BAR
3	BENT TRANSVERSE BAR
4	BENT TRANSVERSE BAR
5	BENT TRANSVERSE BAR
6	BENT TRANSVERSE BAR
7	BENT TRANSVERSE BAR
8	BENT TRANSVERSE BAR
9	BENT TRANSVERSE BAR



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Architectural and Engineering Services
Ontario Region

Services Publics et Approvisionnement Canada
Services d'architecture et de génie
Région de l'Ontario

project title / titre du projet
LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

JS — drawn by / dessine par	18-11-05 — project date / date du projet
CW — designed by / conc par	R.090045.001 — project no. / no. du projet
PH — approved by / approuve par	62 OF 63 — drawing no. / dessine no.
tender / soumission — project manager / administrateur de projets	

GSC-A3A 95-09

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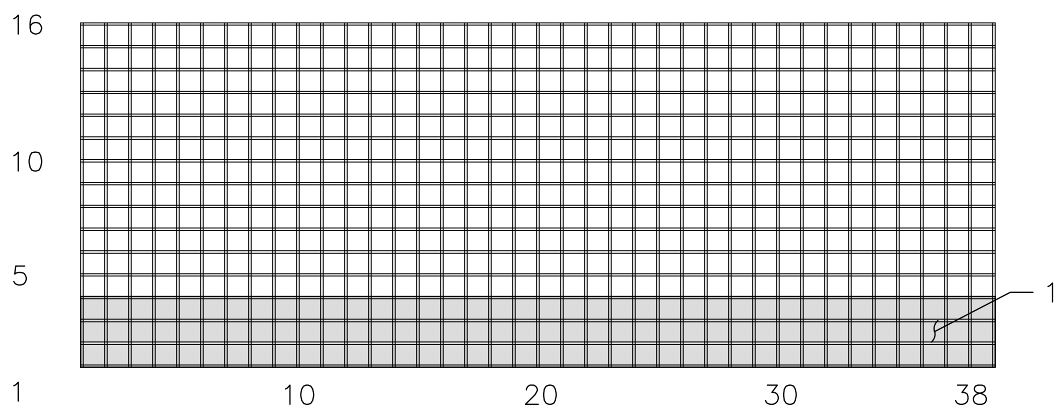
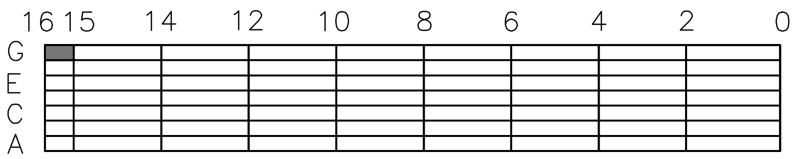


15–16 – G

1:20

DEFECT No.	DESCRIPTION
1	WORN SERRATIONS



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Architectural and Engineering Services
Ontario Region

Services Publics et Approvisionnement Canada
Services d'architecture et de génie
Région de l'Ontario

project title / titre du projet
LASALLE CAUSEWAY BASCULE BRIDGE
KINGSTON
ONTARIO

DECK GRATING REPAIRS

drawing title / titre du dessin
BRIDGE GRATING DETERIORATIONS

drawn by / dessine par	JS
designed by / conc par	CW
approved by / approuve par	PH
tender / soumission	
project manager / administrateur de projets	
project date / date du projet	18–11–05
project no. / no. du projet	R.090045.001
drawing no. / dessine no.	63 OF 63

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CAD FILE: H:\ISO\476880\02000\DWGS\Bascule Bridge Deck Inspection GRATING 15–16.dwg

DATE PLOTTED: Monday, November 05, 2018 9:58:10 AM

Appendix H– East Approach and Abutment Survey

SURVEYING
ANNIS
O'SULLIVAN
VOLLEBEKK

ONTARIO LAND SURVEYORS

A.J. Broxham
R.R. Gauthier
E.H. Herweyer
E.M. Lancaster
G.A. Ray
A.R. Roy
V.A. Shelp
D.R. Vollebekk

G.D. Annis (1939-2013)

DEVELOPMENT

R.F. Robinson

CONDOMINIUMS

A.Z. Pichette

October 29, 2018

Parsons Inc.
1223 Michael St, Suite 100
Ottawa, ON
K1T 7T2

Attn: Mr. Peter Harvey P.Eng.
Structural Engineer

Re: LaSalle Causeway Bascule Bridge Monitoring
City of Kingston
Our Reference: 17478-18

Dear Sir,

The enclosed elevation spreadsheet provides the base data to compare future monitoring sessions to. The base elevations are determined/verified by three distinct measurement sessions completed October 3, 2018. The maximum deviation from the mean elevation of any elevation over the three sessions was 0.001 metres. All monitoring points are on the outer concrete surface identified by the cross cut into the concrete surface.

All elevations are related to provincial benchmark 0011968U301; a copy of the benchmark description is attached.

Should you have any questions concerning this matter, please do not hesitate to contact me.

Yours truly,

E. H. Herweyer
Ontario Land Surveyor
Direct Line: 613-727-0934

EHH:jm
Encl.

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14 Concourse Gate
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Nepean, Ontario
K2E 7S6
613 727-0850
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225 Industriel Street
PO Box 579
Embrun, Ontario
K0A 1W0
613 443-3364
613 443-3229 Fax
embrun@aovltd.com

17478-18
Bridge Monitoring LaSalle Causeway Kingston

ELEVATIONS RELATED LOCAL DATUM
BASE LINE DATAUM ESTABLISHED FROM 3 LEVEL LOOPS

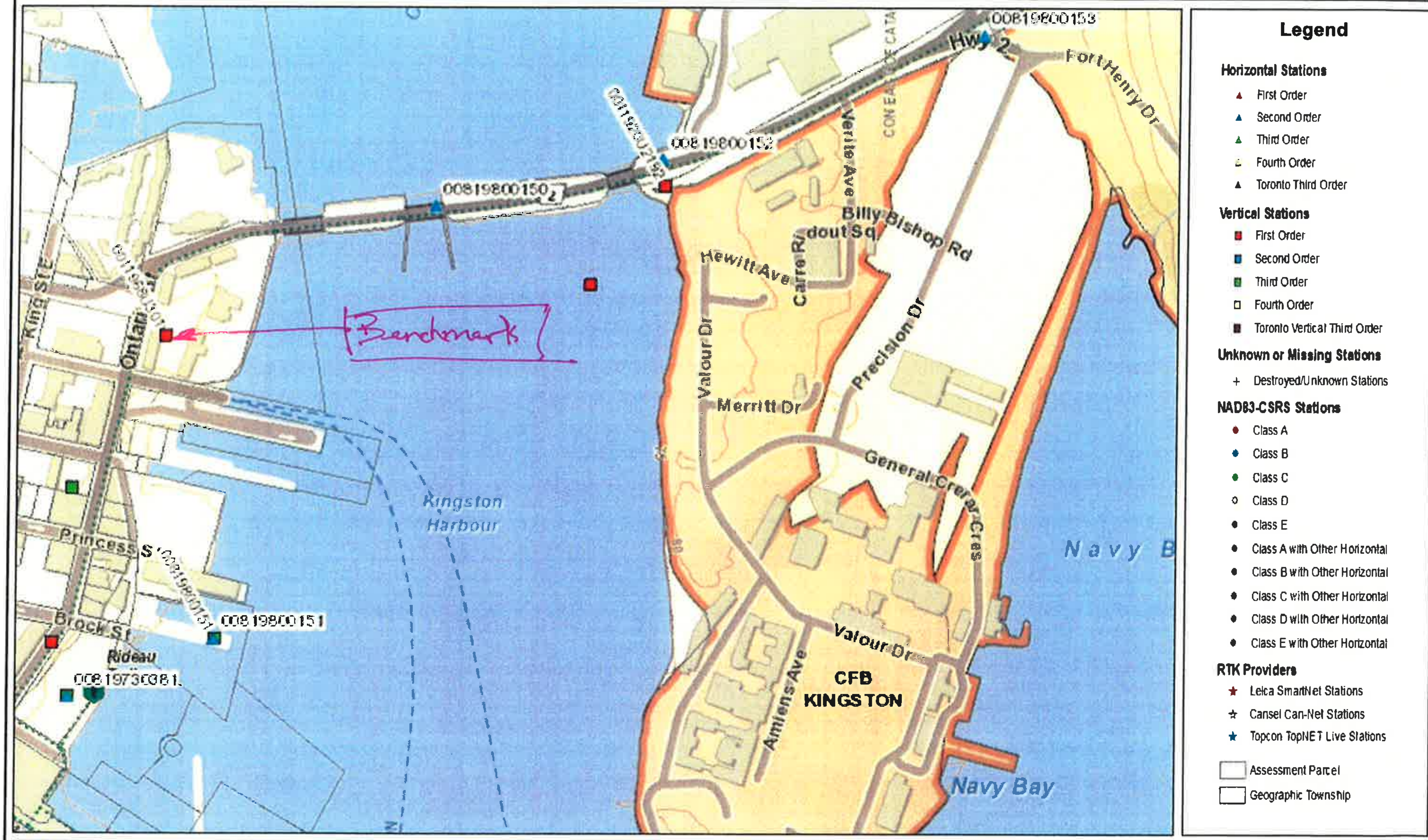
MONITORING POINT	OCT 3-18 BASE DATA								
1 CONCRETE	74.942								
DIFFERENCE FROM DATUM									
2 CONCRETE	76.826								
DIFFERENCE FROM DATUM									
3 CONCRETE	76.828								
DIFFERENCE FROM DATUM									
4 CONCRETE	76.766								
DIFFERENCE FROM DATUM									
5 CONCRETE	76.684								
DIFFERENCE FROM DATUM									
6 CONCRETE	76.686								
DIFFERENCE FROM DATUM									
7 CONCRETE	76.849								
DIFFERENCE FROM DATUM									
8 CONCRETE	76.877								
DIFFERENCE FROM DATUM									
9 CONCRETE	76.797								
DIFFERENCE FROM DATUM									
10 CONCRETE	76.621								
DIFFERENCE FROM DATUM									
11 CONCRETE	76.794								
DIFFERENCE FROM DATUM									
12 CONCRETE	77.079								
DIFFERENCE FROM DATUM									
13 CONCRETE	74.943								
DIFFERENCE FROM DATUM									

STATION: 0011968U301

Also known as:	00168U301, 68U301, CP82204, V00168U301
Monument status:	Existing
Monument type:	CAP
Station type:	SPIR
Horizontal datum:	NAD-1983:ORIG
Horizontal accuracy:	UNCLASSIFIED
Latitude:	N44 °13 ′59.9xxxx ″
Longitude:	W76 °28 ′41.9xxxx ″
Ellipsoidal elevation:	
Ellipsoidal elevation order:	
UTM-18 Easting:	E381941.xxx
UTM-18 Northing:	N4898851.xxx
UTM-18 Cmbd sc-fact:	0.99977141
UTM-18 Mrdnl convg:	-1 °01 ′53.0 ″
MTM-9 Easting:	E306530.xxx
MTM-9 Northing:	N4899259.xxx
MTM-9 Cmbd sc-fact:	0.99990003
MTM-9 Mrdnl convg:	0 °00 ′54.4 ″
Vertical datum:	CGVD2013
Vertical accuracy:	First order
Orthometric elev:	76.473
Meridional defl:	
Prime vert defl:	
Undulation:	
Location:	Township: KINGSTON NORMANDY HALL, A LARGE TWO-STOREY BUILDING ON NORTH SIDE OF HIGHWAY NO. 2, 0.3 KM WEST OF CENTRE OF LASALLE CAUSEWAY, 0.5 KM EAST OF PRINCESS STREET, TABLET IN EAST CONCRETE FOUNDATION WALL, 1.43 M FROM SOUTHEAST CORNER AND 61 CM BELOW TOP.
Maintenance:	GSC; last inspected: --
Other vert data [ord]:	**CGVD-1928:1978** [1]
Networks [usage]:	0200V [FIX]
Number of Ref Sketches:	0

Enter map title

Notes:
Enter map notes



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ANNIS O'SULLIVAN, VOLLEBEKK LTD.
ONTARIO LAND SURVEYORS
14 Concourse Gate, Suite 500, Ottawa, Ontario K2E 7S6
225 Rue Industriel, Box 579, Embrun, Ontario K0A 1W0

JOB NUMBER: 17472-18

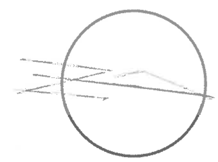
VALUABLE FIELD NOTES
Please return to Surveyor

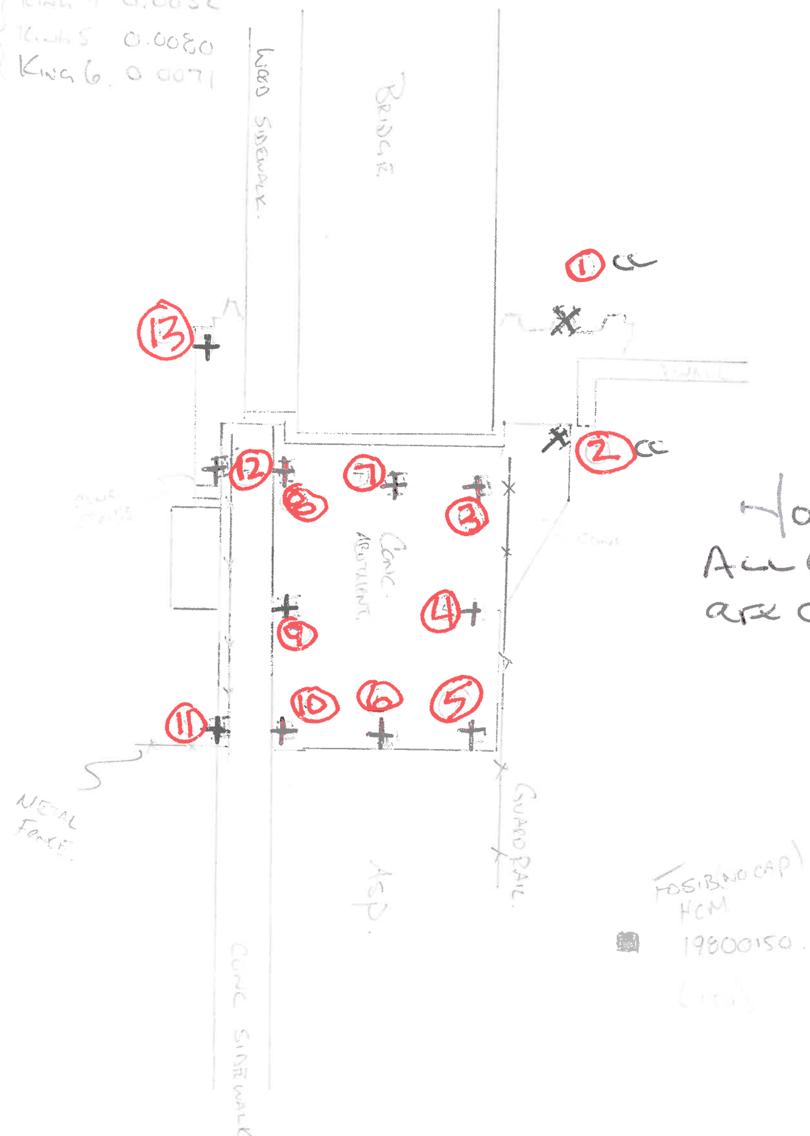
LOCATION/ADDRESS: LASALLE CAUSEWAY		Page of
LOT:	PLAN:	CON:
TOWNSHIP: KINGSTON		DATE: OCT 3 18
TEMP:	FIELD PARTY: HILL EDWARDS	

OCT 3 18 KING 1 0.000
KING 2 0.0000
KING 3 0.0001
ASSUME 100

OFF B.M. 301
KING 4 0.0032
KING 5 0.0080
KING 6 0.0071

BM 1968U301 (301)
76.473 M





NOTE:
ALL CUT CROSSES (CC)
are cut in concrete

REF:

LaSalle Causeway Bascule Bridge

Point No.	Northing	Easting	Base Data Oct. 3/18
1	4899416.8	306862.3	74.942
2	4899417.1	306865.1	76.826
3	4899415.2	306866.2	76.828
4	4899415.7	306869.6	76.766
5	4899416.4	306873.9	76.684
6	1899412.6	306874.9	76.686
7	4899411.6	306866.6	76.849
8	4899407.7	306866.7	76.877
9	4899408.1	306870.4	76.797
10	4899408.6	306874.9	76.621
11	4899406.4	306875.1	76.794
12	4899405.7	306866.9	77.079
13	4899404.9	306864.7	74.943

Coordinate Values NAD83/3 °MTM/CSRS 1997
Elevations related to First Order vertical control monument 009182U097