Appendix C

Latah Bridge Inspection Report

Bridge Inspection Report – Final

In-Depth Inspection of Span 3 & Pier 2 and Cursory Overall Inspection

Latah Creek Bridge

Rehabilitation Study

Spokane, Washington

Inspection Dates:
September 26 – October 1, 2011

BURGESS & NIPLE

BRIDGE INSPECTION REPORT - Final
FOR THE
LATAH CREEK BRIDGE
SPOKANE, WASHINGTON

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Prepared for:

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Final Report Submitted: 12/12/2011

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Burgess & Niple, Inc. (B&N) was retained by CH2M Hill to perform an in-depth condition inspection of the historic Latah Creek Bridge (also known as the Sunset Bridge or High Bridge) located in Spokane, Washington. This cast-in-place reinforced structure consists of seven arch spans and multiple approach spans. It was constructed in 1911 and has an overall length of 1,070 feet. This inspection was conducted as a component of a comprehensive rehabilitation study of the structure. The bridge owner, the City of Spokane, wishes to determine the economic and technical feasibility of restoring, rehabilitating and/or modifying the existing structure.

The intent of this inspection was to characterize the condition of the bridge. Inspection data is being supplied to CH2M Hill to aid in determining the scope of restoration and rehabilitation required. Span 3 and Pier 2 were inspected in-depth. The remaining portions of the bridge were given a cursory visual inspection to generally compare conditions with those found during the detailed inspection of Span 3. Material sampling (coring and concrete powder samples) and corrosion testing (half cell) were conducted by others to supplement the findings from the visual inspection. Results from that testing are <u>not</u> included within this report.

Locations of deficiencies noted during the inspection are detailed on bridge drawings supplied by CH2M Hill. Additionally, we have prepared a spreadsheet table cataloging these deficiencies and associated photographs. All the photos, drawings and spreadsheets have been provided in electronic format. The drawings and spreadsheets are also provided as an appendix to this report and selected photos have been provided in the body of the report to highlight typical and significant findings.

Concrete superstructure and substructure components generally exhibit areas of spalling with exposed reinforcing steel, delaminations, cracking and other deficiencies commonly found in concrete structures of a similar age. Much of the deterioration of embedded reinforcing steel has been prompted by prolonged exposure to deck drainage combined with shallow/insufficient cover. The most significant areas of deterioration were typically found adjacent to joints. Also deterioration was significant inside the pier chambers in the vicinity of deck drain/manhole penetrations and joints. Section loss to exposed reinforcing steel was found to vary between surface corrosion with minimal reduction in area to complete (100%) loss of reinforcement. We did not observe any distress patterns that suggested member overloads, excessive deflection, settlement or significant/unexpected differential movement of primary bridge structural members. Additionally, deterioration and deficiencies noted during the cursory inspection phase of the other portions of the bridge were generally consistent with that found during the detailed inspection of Span 3 and Pier 2.

SCOPE OF INSPECTION

The data for this Bridge Inspection Report was obtained on September 26 through October 1, 2011. B&N's inspection team members were as follows:

Mark Bernhardt, PE (Project Manager)
Darrell Miller, PE
Edward Cinadr, PE
Chris Sasher, EI

Additionally, various personnel from CH2M Hill, the City of Spokane, Northstar Enterprises, Spokane Concrete Cutting and Corrosion Control Technologies were on site to assist with inspection tasks, operate access equipment, perform sampling and testing, or observe the field work at various times during the inspection.

B&N performed an arm's length, in-depth inspection of Span 3 and Pier 2 and a cursory inspection of the remainder of the structure. The primary inspection methods were visual inspection, sounding and focused material sampling and testing. Areas of deterioration and distress were cataloged and photographed by the inspection team. The locations of these deficiencies were documented on the bridge drawings supplied by CH2M Hill. The overall configuration of the bridge is depicted in Figure 1 below.

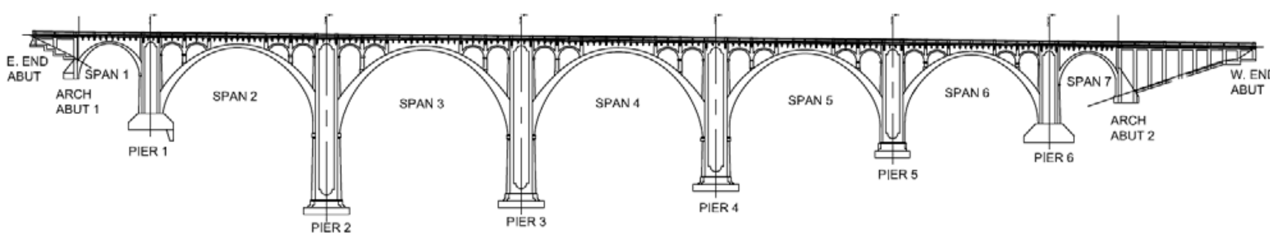

Figure 1 – Bridge Elevation, looking South

In general, superstructure members were investigated for material deterioration, weathering and aging effects, load-induced distress, excessive deflection, adequate bearing, and distress related to the corrosion of embedded steel. Inspectors documented areas of cracking, spalling, honeycombing, scaling, delaminations, and excessive leakage/staining/leaching. The overall dimensions of deteriorated areas were cataloged in the field notes along with information such as section loss to reinforcing steel bars.

In Span 3, the inspection team visually inspected and sounded the underside of the deck, floorbeams, spandrel walls, spandrel arches, spandrel columns and the main arch ribs, where accessible. Access to the structure was provided by the City of Spokane's underbridge inspection truck (UBIT) and the use of adapted rock climbing/industrial rope access techniques. At Pier 2, the four exterior faces were rappelled to inspect those areas below the reach of the UBIT. Additionally, the interior of Pier 2 was accessed to document the condition of the deck soffit and superstructure and to rappel down the inside of the pier to assess deterioration of elements.

Door openings were created by a subcontractor, Spokane Concrete Cutting, in south facing walls in both the East and West Approaches. Exterior and interior surfaces of curtain walls, deck slab, floor beams, columns, abutments and pier faces were visually inspected and sounded where accessible. A visual inspection was also conducted of the bridge deck, sidewalk and rails.

Twelve cores were obtained by Spokane Concrete Cutting from the Span 3 deck and arch ribs for further laboratory testing. Concrete powder samples were obtained at 12 locations in Span 3 and Pier 2 from floorbeams, spandrel walls and columns, arch ribs and pier faces to assess the chloride ion content of the concrete.

Pier interiors and approach chamber interiors were considered confined spaces and continual sampling of the air quality was conducted during work tasks in these areas.

BRIDGE DESCRIPTION

The Latah Bridge is located on the southwest side of Spokane, Washington, just to the north of Interstate Highway 90 on Sunset Boulevard. The bridge was constructed in 1911, and it originally carried two sets of trolley tracks along the centerline of the bridge with vehicular lanes and sidewalks on each side. The deck slab is considerably thicker along the centerline to accommodate the original trolley tracks. At a certain point in the bridge's history, trolley traffic was removed from the bridge, and the bridge deck was reconfigured to permit four lanes of vehicular traffic. Recently, however, traffic was removed from the outside lanes as a result of deteriorating bridge conditions and reduced load carrying capacity. Currently one lane of vehicular traffic is permitted in each direction along the center of the bridge with seven-foot wide sidewalks on both sides with the original concrete railing on the exterior side of each walk and Jersey-type barrier placed between the sidewalk and traffic lanes. It appears that the timber ties (and possibly the steel rails) remain in place from the original trolley lines as evidenced by timbers found during the deck coring process.

The bridge is a cast-in-place reinforced concrete structure consisting of seven arch spans with a single approach span on the east and multiple approach spans on the west. The overall length of the bridge is 1,070 feet and the maximum arch span is 150 feet. The bridge deck measures 45 feet curb-to-curb and 63 feet out-to-out at midspan and 72 feet out-to-out at the piers. The highest point on the bridge deck is over the creek and measures approximately 149 feet from the sidewalk surface to the water level at average flow.

The concrete deck in the main arch spans is supported by reinforced concrete transverse floorbeams which transmit the load to the spandrel arch/wall/column system that is in turn supported by the two main arches, each comprised of two arch ribs. The deck in the approaches and across pier spans is supported by longitudinal beams. The deck slab is poured monolithically with the floorbeams and beams.

For the purposes of this inspection, we have numbered the spans consistent with the original design drawings, east to west. The four arch ribs are designated A-D from south to north. The floorbeams in Span 3 are numbered from 1 to 27 from east to west. Beams supporting the deck over the piers and in the approaches are numbered from left to right when looking west. The following figure designates some of the common element nomenclature found in our inspection notes.

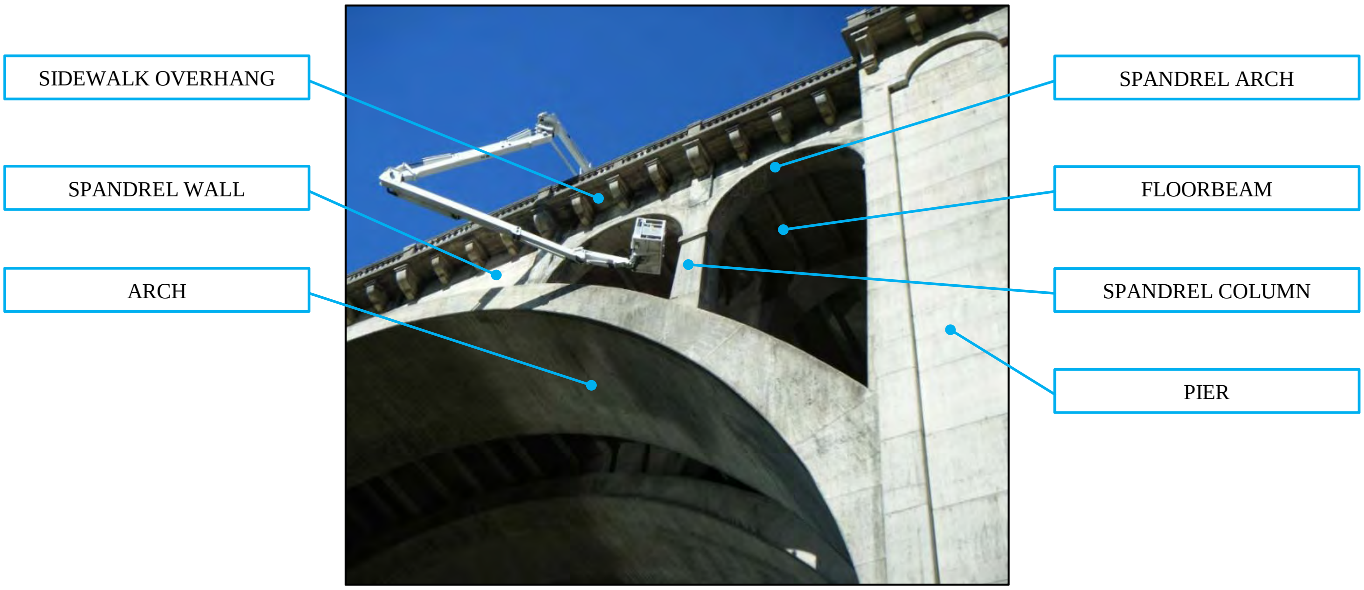

Figure 2 – General Nomenclature

INSPECTION FINDINGS

The following outline provides a brief summary of condition observations made regarding the various primary elements and locations on the bridge. The complete set of field notes is tabulated in Appendix A. The "ID" column of the table corresponds to the reference callout for a specific note on the drawings. Photo references are also included with the majority of the entries. All photos are not reproduced with this report, but have been provided electronically. Some entries in the Field Notes table in Appendix A do not have corresponding reference callouts on the drawings but instead function as photo captions for overall or general condition photos, or serve to call attention to some note or observation made by a field inspector.

DECK:

Deck Soffit

The soffit of the deck in Span 3 exhibits localized areas of spalling with exposed reinforcing steel, delaminations, and cracking. Much of the deterioration of embedded reinforcing steel has been prompted by prolonged exposure to deck drainage combined with shallow cover. The most significant areas of deterioration were typically found adjacent to joints such as between the west face of Pier 2 and Floorbeam 1 in Span 3. Also deterioration was significant inside the pier chambers in the vicinity of deck drain and manhole penetrations and joints. Section loss to exposed reinforcing steel was found to vary between surface corrosion with no reduction in cross section to complete loss of bars.

Photo C4-38 (ID C325) – Soffit between west face of Pier 2 and Floorbeam 1 in Span 3, 5' x 5' area of spalling, delamination and exposed rebar, 3/8" diameter remaining on rebar.

Similar areas of deterioration were noted on the soffit beneath the sidewalk overhang. One of the most pronounced areas of soffit deterioration was noted along the edge of the deck between Floorbeams 18 and 19 on the south edge. It consisted of a deep spall with rebar exhibiting up to 70% section loss and adjacent delaminations.

Photo C2-03 (ID C101) – Deterioration between Floorbeams 18 and 19 along south overhang in Span 3.

However, typically the underside of the deck was found to be in satisfactory condition with only minimal deficiencies in locations away from joints or the perimeter of the bridge. Where spalls were noted, they were typically very small, localized and due to shallow cover.

Sidewalk

The concrete sidewalk is in fair to poor condition and exhibits localized areas of bulging and cracking likely due to freeze/thaw heaving of the fill beneath the sidewalk. Patched areas are typical throughout.

Railing/Barrier

Ornamental bridge rail is located along the exterior edges of the sidewalk. Jersey-type barrier is located between the sidewalk and the roadway. The ornamental rail is in generally poor condition with large patched areas, severe scaling, spalling, delaminations and cracking. Wide horizontal cracks were observed in the exterior face above and below the balusters.

Photo C3-61 (ID C244) - North exterior rail between Floorbeams 16 & 18, Span 3, wide horizontal cracks in rail both above and below balusters.

Additionally, a gap of up to 7/8 in. was noted between the top of each baluster and the top rail. No dowels or other mechanical connection were noted in these areas between the baluster and the top rail. No significant deficiencies or deterioration were noted in the Jersey barriers beyond an occasional small spall on the roadway face.

Wearing Surface

The wearing surface is generally in good condition and consists of an asphalt overlay with minor rutting in the wheel lines. Presently, there are two layers of asphalt over the original concrete deck and trolley lines. The lower layer is punky, friable and loose. More detailed information regarding the composition of the deck and wearing surface can be found in the “Field Notes” spreadsheet entries for the deck cores.

SUPERSTRUCTURE

Floorbeams/Beams

Like the deck soffit, floorbeams exhibited localized areas of spalling with exposed reinforcing steel, delaminations, mineral deposits and cracking. The most significant areas of deterioration were typically found adjacent to the control joints. Transverse joints are present at pier faces and along Floorbeams 4, 8, 12, 16, 20 and 24. Leakage was evident through the joints and deterioration was most pronounced at Floorbeams 4 and 24 in Span 3.

Photo C3-90 (ID C257) - Span 3, Floorbeam 24 between arch rib lines C & D. Entire bottom face is delaminated. Extensive evidence of rust staining and seepage through joint.

Photo C4-42 (ID C330) – Span 3, Floorbeam 4 at midspan between Spandrel Arches A & B, 4' long x full width x 3" deep delaminated area with spalling. Multiple spalls and delaminations at midspan also noted. Exposed bars in photo have up to 1/8" loss in diameter.

Inside the piers, the transverse floorbeams found in the spans are replaced by longitudinal concrete beams that support the deck slab over the piers. These beams exhibited significant deterioration due to years of exposure to deck drainage. Beams with spalling, delaminations and bars with section loss were commonly found in all the pier chambers. In some cases, not only bottom bars, but also shear stirrups were affected by this deterioration. Deterioration was most prevalent on the first two interior beams (B1, B2, B9 and B10).

Photo D1-20 (ID E013) – Full length spall on bottom face of Beam 10 in Pier 2. 1/8" section loss to bottom bars and stirrups.

Moisture is readily available to promote deterioration of embedded reinforcing steel as evidenced by leaking drains and joints and extensive efflorescence deposits.

Photo D1-10 (ID E008) – West end of Beam 1 inside Pier 2, note heavy leakage through scupper pan, extensive rust staining, and efflorescence on concrete beam.

The deterioration present on the beams inside the piers has likely resulted in reduced structural capacity of these members. Removal of traffic from the outer lanes above these areas suggests that this condition has been considered by the bridge owners.

Another condition that was frequently noted was the presence of narrow diagonal cracks in the floorbeam ends above the pilasters at Spandrel Walls B & C. This condition was noted primarily in Floorbeams 8 – 20.

Photo E1-03 (ID E004) – Narrow diagonal cracks at pilaster-floorbeam intersection. Typical both web faces. No exposed bars, leakage or rust staining.

Floorbeam Cantilevers

Beneath the sidewalk, floorbeam cantilevers support the deck slab. These members exhibited localized cracking, spalling and delaminations. Deterioration appeared slightly more pronounced along the north elevation of the bridge. Section loss to exposed bars was typically 1/16" or less. Drainage and leakage from the sidewalk above was evident between the floorbeam cantilevers and spandrel walls and spandrel arches in a number of locations. Shallow cover was a contributing factor to many of the observed spalls.

Photo C2-22 (ID C121) – South sidewalk overhang at Floorbeam 8. Evidence of leakage through joint and 6" dia. delaminated area.

Spandrel Arches & Spandrel Walls

In Span 3, the spandrel arches are located from Floorbeam 8 to the face of Pier 2 and from Floorbeam 20 to the face of Pier 3. The spandrel walls run from Floorbeam 8 to Floorbeam 20.

Large areas of deterioration were typically found on the spandrel arch soffits along the corners. Additionally, frequent cracking was also noted in these areas suggesting the occurrence of corrosion of the embedded steel reinforcing.

Photo C3-70 (ID C247) – ***Span 3, Spandrel Arch D, between Floorbeams 20 & 22. Large delaminated areas with exposed bars and rust staining on both corners. Typical at symmetrical locations.***

Localized delaminated areas and spalls were also noted in the vertical wall faces of the spandrel arches and spandrel walls.

Photo C3-43 (ID C233) – ***Span 3, Spandrel Wall D between Floorbeams 8 & 9. Multiple localized delaminated areas and spalls, some with exposed reinforcing steel. Bars exhibit up to 1/16" section loss. Also note corrosion on steel utility bracket.***

Photo C4-17 (ID C311) – ***Span 3, Spandrel Arch A soffit, between Floorbeams 2 & 3. 5' H x 4' W x 4" D delaminated area with spalls and exposed reinforcing steel. Bars exhibit approximately 3/16" section loss maximum.***

Photo C2-45 (ID C136) – ***Span 3, Spandrel Arch A, below Floorbeam 8. 5' tall spall along corner, 2 layers of bars exposed. Max loss to bar diameters = 100%.***

Spandrel Columns

Spandrel columns are located at floorbeams 4 and 24. They typically exhibit delaminations and spalls in the vertical faces with deterioration particularly pronounced on the corners. Section loss was noted to exposed bars on the columns.

Photo D1-06 (ID D007) – Span 3, Spandrel Column B-24, large corner spall with exposed reinforcing steel with 1/16" loss to bar.

Note: Typically in the Field Note Table, the area above the spandrel column is part of the "Spandrel Arch". Some entries in the table have component designations of Spandrel Column for this location when describing a deficiency. The ID callout on the drawings can be referred to in order to determine the precise location of the deficiency. The exact location of the transition between spandrel column and spandrel arch is a somewhat arbitrary designation.

Arch (Rib, Floor, Soffit)

Main arch components were found to be in generally fair condition. Arch ribs and floors exhibited narrow to medium cracks and minor small spalls and delaminations. No significant exposed bars with section loss were noted on the arch in Span 3. Some localized areas of leaking, efflorescence and staining on the arches were observed at construction joints. At the base of each arch, where it meets the pier wall, debris accumulation and likely clogged drainage holes were noted.

Photo E2-09(ID E111) – Heavy debris (dirt, garbage, bird waste, etc.) at base of arch floor at west face of Pier 2

Photo C2-25 – Typical condition of arch soffit in Span 3

Photo E2-10 –Typical overall view, arch floor between Arch Ribs A & B below Floorbeams 1-4. Note typical rough/poor formwork/finishing and localized honeycombing patches.

PIERS

The exterior of the piers exhibit localized delaminated areas, spalls, cracking, surface scaling, joint leakage and associated deficiencies. The most significant areas of deterioration were noted higher up on the piers, closer to the deck. A widespread area of deterioration was found on the east face of Pier 3 between Arch Ribs A & B. The condition of the deck soffit and roadway beams over the piers have been described in previous sections.

The interior surfaces of the walls of Pier 2 exhibited delaminated areas with spalling, leakage, stainage and cracking in the upper chamber immediately below the deck. The lower chamber walls were in satisfactory condition with no major deficiencies noted. The bottom portion of the pier is filled with water and the inspection did not include those areas of the interior of Pier 2 below water.

Photo C1-13 (ID C008) – ***West face of Pier 3 between Arch Ribs A & B. 4' x 6' delaminated area and 6' high corner delamination on pilaster above Arch Rib A. Localized spalls are present in the delaminated areas and have exposed bars with up to 1/8" loss to bar diameter.***

Photo E3-25 (ID E327) – Typical condition, interior of Pier 2. No significant deficiencies noted.

Photo E3-29 (ID E336) – Looking down at lower chamber in Pier 2, access door on east face. Trapped water and debris in base of pier.

APPROACHES

Deterioration in the approaches was mainly found at transverse floorbeams and in the deck soffit. Prolonged exposure to deck drainage has initiated corrosion of the embedded reinforcing steel in many of the members located adjacent to joints.

***Photo D2-07 (ID M101) –** Large spalled area with exposed bottom bars on floorbeam where East Approach meets Arch Span 1. Water leakage through joint above.*

***Photo C4-48 (ID M401) –** Spalling and bars with section loss (estimated at 1/8" max loss to diameter) on bottom of floorbeam at Column Line 1 in West Approach.*

No significant deterioration was found during a cursory inspection of the walls of the approach chambers. Localized minor cracking, spalling, and staining were noted.

UTILITIES

Pipe Supports

A large bank of utility conduits is located between spandrel wall/arch lines C & D. Additionally, utility lines are mounted on the exterior north face of the bridge, immediately below deck level. Corrosion was noted on the steel elements comprising the support system for these utilities. In some extreme cases that corrosion had progressed to a degree that the integrity of the support is compromised, mainly on the interior utility brackets. Supports on the north exterior elevation were found to be generally sound and intact.

Photo D1-27 (ID E019) – Failed steel utility support bracket near east wall of Pier 2. Bracket supports a 12" dia. pipe.

Between Spandrel Arches C and D, transverse beams are present whose purpose was likely to support utilities. They are currently not supporting the utility lines in this area. These beams exhibit medium vertical and diagonal cracks and localized areas of honeycombing.

Photo C3-109 (ID C271) – Transverse beam between Spandrel Arches C & D at Floorbeam 27. Vertical crack 2' from face of Spandrel Arch C. This cracked condition is typical at several locations

Light Pole Pilasters

Light poles are located along the north side of the bridge deck. These poles penetrate the deck and are supported by small pilasters on the Spandrel Arch/Wall D. These pilasters exhibit extensive distress related to prolonged exposure to deck drainage and corrosion of the embedded steel. The vertical steel poles also exhibit heavy laminating corrosion and rust staining.

Photo C3-31 (ID C223) – Light pole pilaster at Floorbeam 6. Corrosion related distress to steel pole and concrete pilaster.