OHIO DEPARTMENT OF TRANSPORTATION
2014 PHYSICAL CONDITION REPORT

I-71 NB OVER SR 176 NB
BRIDGE NO. CUY-71-1791R

SFN: 1805371

NOVEMBER 2014

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I-71 NB BRIDGE OVER SR 176 NB
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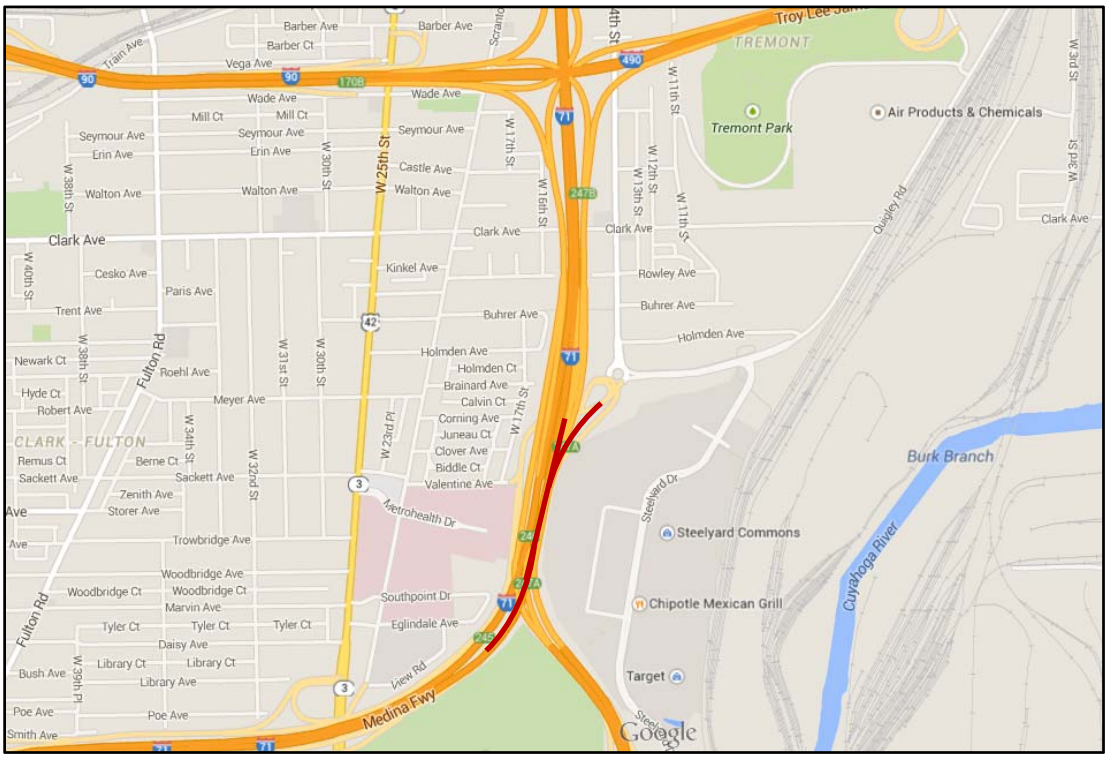

Figure 1 – Jennings Freeway Bridge Location Map.

Bridge Description

CUY-71-1791R (SFN 1805371) carries northbound I-71 over northbound and southbound Jennings Freeway, through the I-71 Jennings Freeway interchange in Cleveland, Ohio (Photo 1). From Piers 8A through 16A, the I-71 structure is supported by the corresponding piers of CUY-176-1334 below. The lower deck structure, CUY-176-1334, carries northbound SR 176 along the west edge of the Cuyahoga River Valley. The I-71 bridge is classified as a fracture critical structure due to the six steel pier caps at the north end of the bridge (Photo 2). A General Plan and Framing Plan are shown in Figures 2 and 3, respectively. Table 1 describes the location and designations of the bridge units shown on the General Plan.

The I-71 Bridge (CUY-71-1791R) carries four lanes of northbound traffic along the rim of the Cuyahoga River Valley, passing between Metro Health General Hospital on the west and the Steelyard Commons development (currently under construction) to the east. The bridge splits into a wye configuration at the north end. The west leg is designated "Northbound I-71" and the east leg is designated the "Northbound Outer Roadway" (NBOR). The two westerly lanes provide continuous flow of northbound I-71 traffic. The two easterly lanes provide exiting at West 14th Street via Ramp NBOR-14 and access to eastbound I-490 via Ramp NBOR. This structure is directly over the Jennings Freeway Bridge and shares common substructure units the lower structure. The 2010 estimated average daily traffic (ADT) is 72,120 with 4.6% truck traffic.

Superstructure Units	Supporting Substructure Units	Spans
1A	South Abutment A to Pier 6 plus cantilever	1A to 6A
2A	Suspended span plus Pier 7 to Pier 11 plus cantilever	7A to 11A
3A	Suspended span plus Pier 12 to Pier 17A plus cantilever	12A to 17A
4AW	Suspended span plus Pier 18AW to North Abutment AW	18AW to 22AW
4AE	Suspended span plus Pier B18AE to North Abutment AE	18AE to 23AE

Notes: 'A' descriptor indicates structural element of CUY-71-1791R

'B' descriptor indicates structural element of CUY-176-1334
Piers 8 through 16 are common structure units for both structures.

Table 1 – Superstructure Unit Designation.

Photo 1– East Elevation.

Photo 2– Fracture Critical Steel Pier Cap, Pier 20AE.

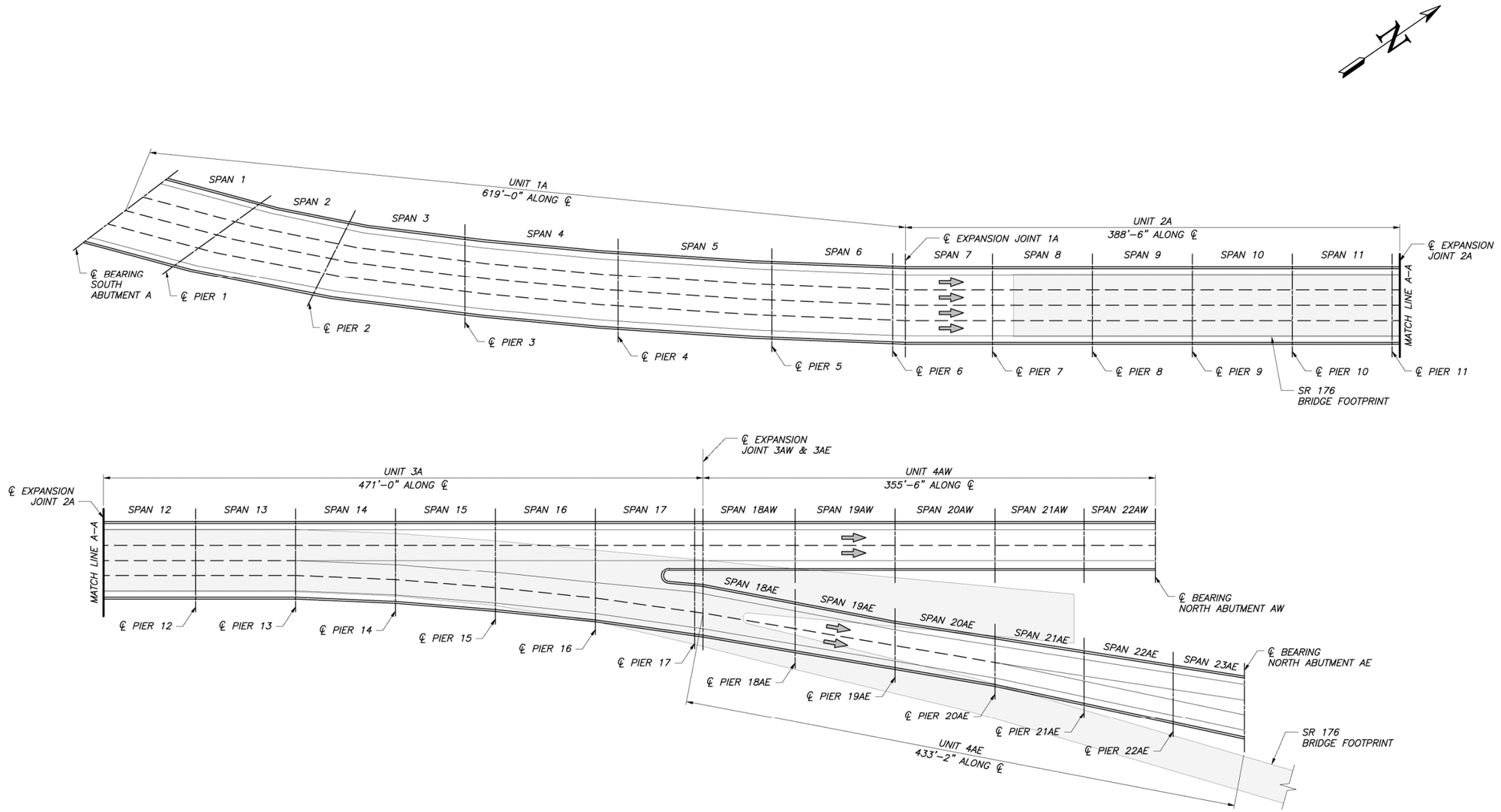

Figure 2 – General Plan.

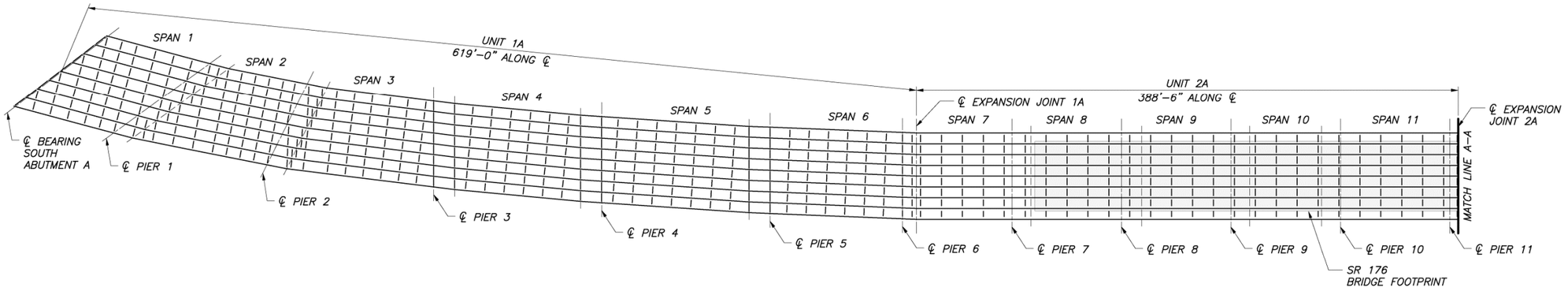

Figure 3 – Framing Plan.

Construction and Maintenance History

Construction of the CUY-71-1791R and CUY-176-1334 bridges began in 1965 as part of the Ohio Department of Highways Project 79. Work was not completed until 1969 due to construction delays caused by slope failures that damaged several of the piers supporting both bridges. The original pile caps and pilings were isolated (separated) from the columns, and replaced the caissons and new caps. The foundations of Piers 14, 15, 16, 17A and 17B were modified during the original construction as a result of foundation damage caused by slope failure. The lower half of Pier 14, 15 and 16 columns were reinforced with a supplementary concrete jacket and shear walls were connected between the columns.

The northbound I-71 bridge deck received a dense concrete overlay in 1978. In 1991, the structure, along with the Jennings NB Freeway bridge below, received a minor rehabilitation, with the following repairs performed:

- The original safety curb with aluminum railings were modified to the deflector shape parapets.
- The deck overlay was patched.
- All deck expansion joints were retrofit with elastomeric strip seals.
- The existing drainage systems were replaced.
- All substructure units were patched and sealed.
- Retrofit fatigue prone detail on fracture-critical steel pier caps.
- The structural steel was cleaned and painted.

In October 2006, a weekend wearing surface overlay project was performed. This repair featured patching of delaminated and spalled wearing surface. Since this work, further asphalt patches have been placed at recent deteriorated areas of wearing surface.

Inspection Procedure

An in-depth inspection was performed by Jones-Stuckey during nighttime lane closures from May 12 through May 15 and May 19 through May 21, 2014. The inspection team included William Vermes, PE (team leader), Michael Jurcak, EI, and Dale Arnold, EI and Todd Roxberry, Bridge Technician. Access to the superstructure and pier surfaces above ground level was achieved via an Aspen Aerial UB 60 snooper truck with bucket mounted halogen lamps and LED flashlights (Photo 3). Nighttime single lane closure with flaggers was restricted to 7 PM through 6AM. Single lane closures of the SR 176 below were maintained while I-71 superstructure and substructure inspection was performed above. Closure of the W. 14th Street ramp for the inspection of a portion of Span 18 and Units 3AE and 4AE was performed after 1AM with no detour required. The snooper truck, attenuator vehicle and maintenance of traffic were supplied by the Sofis Company.

Deck sounding was performed with a looped heavy-link chain drag during single lane closures for the I-71 superstructure inspection. A delam tool sounding roller was used for sounding of pier columns above arm's reach.

Alignment of the expansion hinge rollers was performed via line and weighted object. Tightness of the rollers was done with a prying force applied by a hammer.

Access to the interior of the Pier 17 steel box pier cap was achieved with adapted rock climbing techniques using the anchors attached to the bridge parapet and top of steel pier cap (Photo 4). Interior inspection was performed during single right lane closure in Unit 3A.

The completed 2014 Bridge Inspection Field Report with element level condition state quantities is included in Appendix A. Additionally, Appendices B, C and D include the Deck, Superstructure and Substructure Inspection Findings, respectively.

Photo 3 – Snooper Access Using Bucket Mounted Lamps.

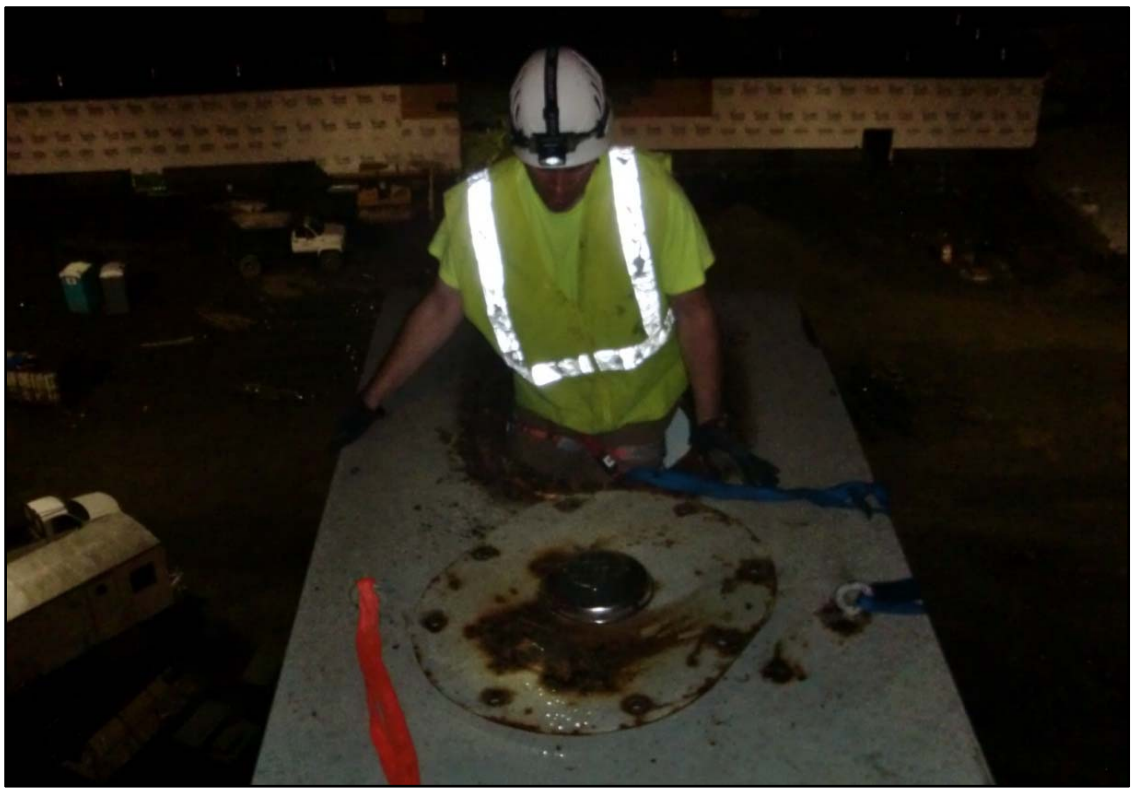

Photo 4 – Climbing Procedure to Pier 17 Steel Box Interior.

Condition Rating Guidelines

Ohio and National Bridge Inspection Standards (NBIS) guidelines for evaluating the condition of bridges have been developed to promote uniformity of bridge inspections performed by different teams and at different times. Table 2 contains the bridge inspection rating matrix established by the Federal Highway Administration (FHWA), using a 0-Failure through 9-Excellent scale, and used by the Ohio Department of Transportation (ODOT). In this report, component conditions will generally be discussed based on the ODOT rating guidelines for individual components, 1-Good through 4-Critical. The General Appraisal, Deck, Superstructure, Substructure, Channel and Approach Summaries, and the Protective Coating System rating will follow the NBIS/ODOT 0 through 9 rating guidelines.

Additionally, this bridge inspection was performed in accordance with the following documents:

- Manual of Bridge Inspection Manual, Ohio Department of Transportation, 2014.
- Manual for Condition Evaluation of Bridge, 2nd Edition, American Association of State Highway and Transportation Officials (AASHTO), 2011.
- Bridge Inspector's Reference Manual (BIRM), U.S. Department of Transportation, revised December 2012.

RATING		CONDITION	RATING GUIDELINES
ODOT	NBIS		
1 – Good	9	Excellent	
	8	Very Good	No problems noted.
	7	Good	Some minor problems present.
2 – Fair	6	Satisfactory	Structural elements show some minor deterioration.
	5	Fair	All primary structural elements are sound but have minor section loss, deterioration spalling or scour.
3 – Poor	4	Poor	Advanced section loss, deterioration, spalling or scour.
	3	Serious	Loss of section, deterioration, spalling or scour has seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
4 – Critical	2	Critical	Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
	1	Imminent Failure	Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structural stability. Bridge is closely monitored is closed to traffic but corrective action may put bridge back into light service.
	0	Failure	Out of Service, beyond corrective action.

Table 1 – ODOT & NBIS Condition Rating Guidelines.

II. DECK

The deck is in ***Satisfactory*** Condition, or ***6*** on the NBIS condition rating guidelines. Deck findings are shown in Appendix B. Condition findings of individual deck items are as follows:

Floor

The floor is in ***Fair*** condition. Delaminations and spalls over northbound SR 176 traffic lanes are present in Spans 7 and 8, with mottled concrete surfaces and water infiltration present in Spans 6 through 10. Total underside surface area deterioration is less than 5%. These spalls are caused by water and salt infiltration through a longitudinal wearing surface cold joint above along the entire length of the W. 14th Street Ramp structure in the 1991 wearing surface.

Photo 5 – Spalled Soffit over SR 176 NB Vehicular Lanes with Adjacent Mottled Concrete Surfaces, Span 8.

Photo 6 – Water Infiltration Through Floor Following Rain. (Note: Area circled is location of mottled concrete in Photo 5, Locations marked with yellow dot are spalled surfaces.)

Edge of Floor

The edge of floor is in ***Fair*** condition. Edge spalls are common at the end of expansion joints (Photo 7) and along 20 feet of the east edge in Spans 18 and 19AW due to infiltration through Expansion Joint 3A above (Photo 8).

Photo 7 – Advanced Spalls on Edge of Floor at Expansion Joint1A.

Photo 8 – Spalled Edge of Floor, Spans 17 & 18AW at Expansion Joint 3A.

Wearing Surface

The monolithic concrete wearing surface is in ***Poor*** condition with an estimated 20% total wearing surface exhibiting deficiencies (Photo 9). The wearing surface has been patched since the 2006 minor rehabilitation consisting of local patches placed during a weekend closure (Photo 10). Numerous delaminations are present along longitudinal cold joints (Photo 11). Isolated locations of fractured wearing surface are also present (Photo 12). A tabulation of estimated surface area deficiencies is included in Table 3.

Photo 9 – Large Wearing Surface Delamination, Span 9 Right Lanes.

Photo 10 – Asphalt Wearing Surface Patch, Span 4.

Photo 11 – Delaminated Wearing Surface Along Longitudinal Cold Joint.

Photo 12 – Wide Crack in Wearing Surface, Over One-Inch Deep, Span 16.

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Unit No.	Approx. Percent of Wearing Surface Sounded	Estimated Percent Deficient
1A	50%	5%
2A	50%	5%
3A	50%	14%
4AW	50%	28%
4AE	100%	35 to 50% *

*Wearing surface delaminations in Unit 4AE follow an irregular pattern of small unsound areas.

Table 3 – Wearing Surface Summary.

Railing

The railing is in ***Fair*** condition. Numerous small linear delaminations and spalls are present along the exterior face at the interface of the original parapet base and the modified Jersey barrier added during the 1991 rehabilitation (Figure 4). Loose exterior face concrete over SR 176 SB and NB traffic in Spans 2, 5, 6, 19BE and 20BE have been removed (Photos 13 & 14). These spalls and delaminations have developed under a definite corrosion pattern, which is the deterioration consistently occurs at the top of the original railing section or along the top of the railing blister. This pattern may be due to a significant pH imbalance between the original and added concrete sections, producing an electrochemical reaction in the railing base and the resulting deterioration. Isolated interior curb delaminations and spalls are also present.

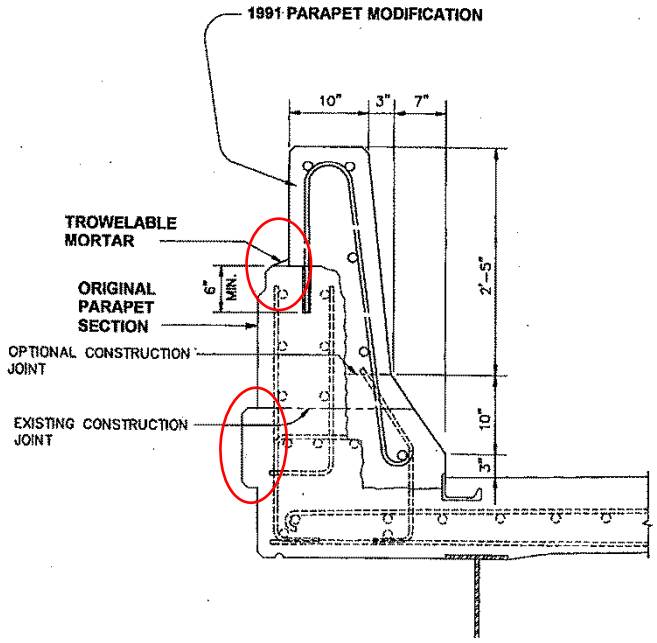

Figure 4 – 1991 Parapet Modification With Common Deterioration Locations Circled.

Photo 13 – Loose Concrete Removed With New Delamination Below (Highlighted in Chalk), Span 2 over SR 176 SB.

Photo 14 – Loose Lower Exterior Parapet Concrete Removed over SR 176 Traffic Lanes.

Drainage

The drainage is in ***Poor*** Condition. Numerous drainpipes are clogged with debris either at the above ground outlets or within the below ground storm pipes (Photo 15). At the time of this inspection, the grit and debris were heavily deposited along the east gutterline. Since the completion of the inspection, the deposited gutterlines were cleared via a streetsweeper. Following significant rain and snow events, water ponding occurs along the right shoulder in Span 3 (Photo 16).

Photo 15 – Clogged Collector and Drain Pipe, Pier 6E.

Photo 16 – Right Shoulder Water Ponding, Span 3.

Expansion Joints

The expansion joints are in ***Poor*** condition with all expansion joint membranes torn and leaking. The opening at the North Abutment AW Expansion Joint is not even, with the west curbline 1" narrower than the east curbline opening. This misalignment is either due to construction inaccuracy or improper substructure movement/rotation.

Lighting

The structure has no lighting mounted on the deck. Lighting is provided via high-mast poles placed between northbound and southbound I-71.

III. SUPERSTRUCTURE

The superstructure is in ***Good*** Condition, or ***7*** on the NBIS condition rating guidelines. Superstructure findings are shown in Appendix C. Condition findings of individual superstructure items are as follows:

Alignment of Members

The alignment of primary superstructure members is ***Good***.

Girders

The girders are in ***Good*** Condition with only minor deficiencies noted. At several locations, the bottom flange splice plates are slightly bent due to misplacement or lack of fill plates during erection, allowing minor corrosion to occur within the horizontal voids (Photo 17) Minor corrosion is also present along the exterior surfaces of the fascia beam bottom flange splices (See Photo 20) .

Cross Frames

The cross frames are in ***Fair*** Condition. Several cross frames located beneath expansion joints have advance section loss resulting in severed lower connections (Photos 18).

Protective Coating System

The OZEU protective coating system, applied in 1991, is in ***Fair*** condition. Scattered freckled rust is common among beam edges and moment plate end welds (Photo 19). Failed paint and active corrosion is common at most fascia beam field splice locations (Photo 20).

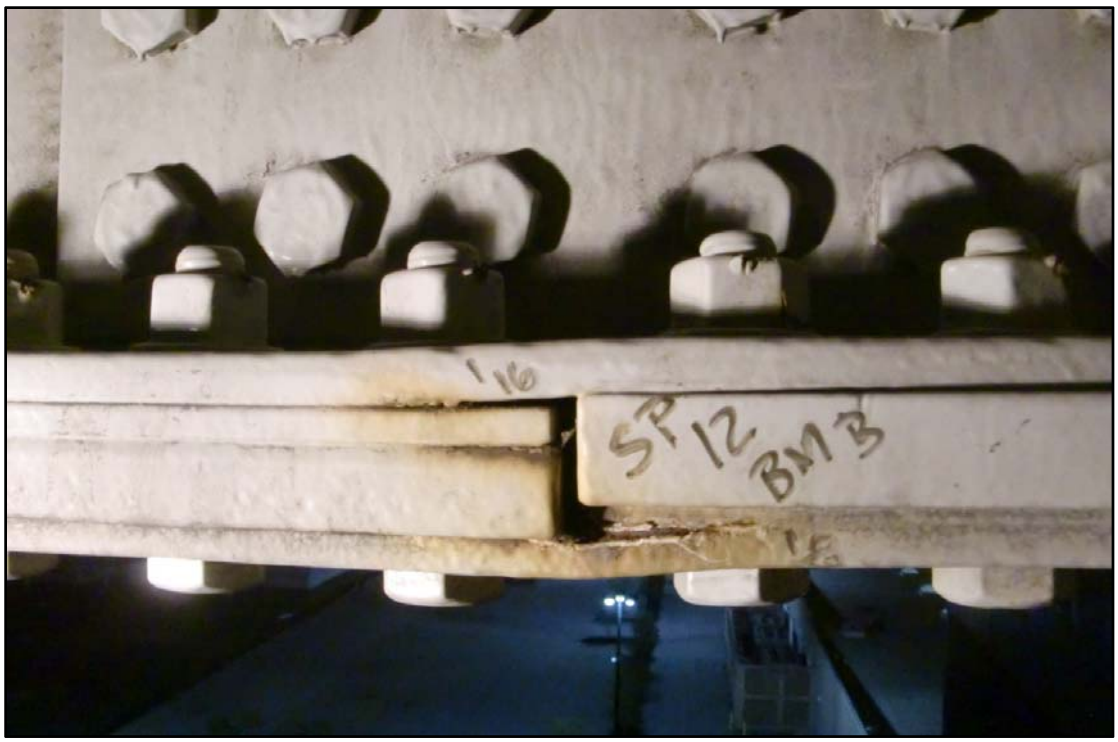

Photo 17 – Common Misaligned Bottom Flange Splice Plate.

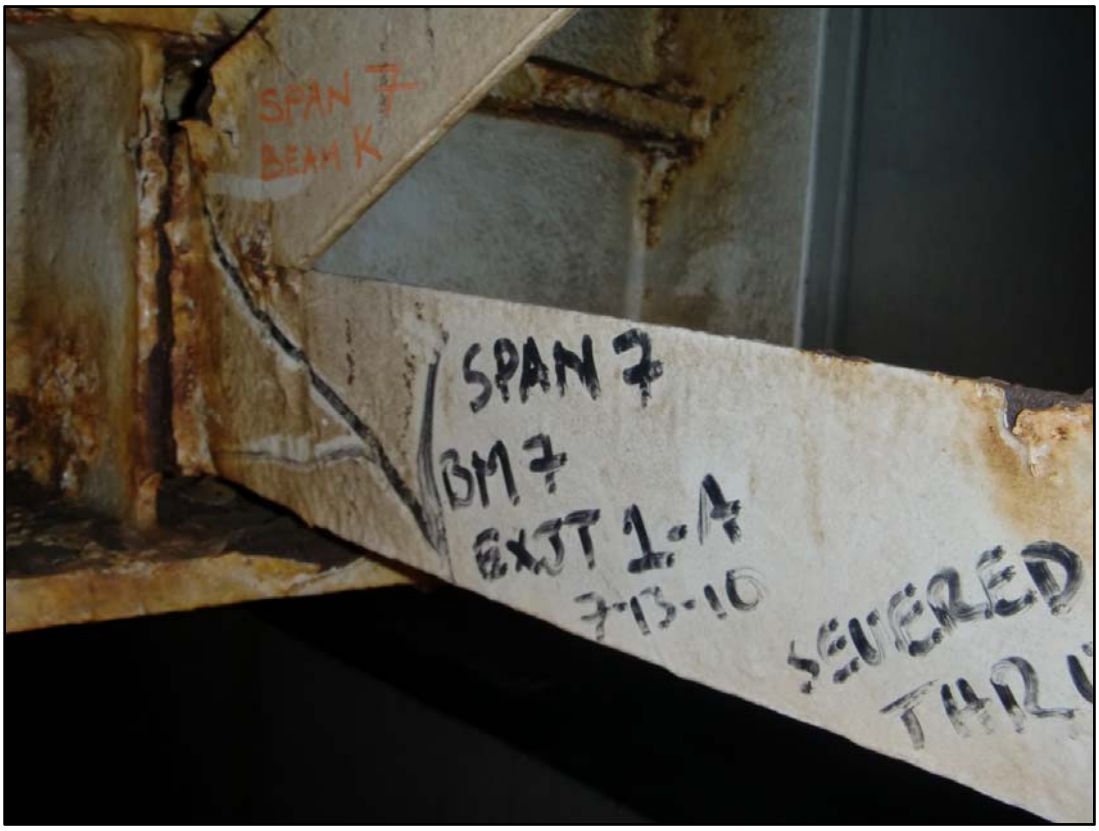

Photo 18 – Cracked Cross Frame Weld Due to Pack Rust.

Photo 19 – Typical Isolated Failed OZEU Paint on Girder Bottom Flanges.

Photo 20 – Typical Local Failed Protective Coating at Girder Bottom Flange Field Splice With Minor Section Loss.

Bearings

The bearings are in ***Fair*** Condition. The bearing plates do not have anchor bolts, and have a history of sliding longitudinally. Currently, the most noticeable bearing plate shifts occur at the South Abutment and North Abutment AW. (Photos 21 and 22). A summary of significant bearing findings is included in Table 4.

Photo 21 – Excessive Contraction of Fascia Bearing N, Pier 1.

Photo 22 – 3 1/2" Slide of Bearing Plate, Bearing G, North Abutment AE.

Hinges

The hinges are in ***Fair*** Condition. Section loss up to 25% of original section has occurred among several top cantilever flange plates and end stiffeners (Photos 23 & 24). The alignment of several hinges was found excessive for the ambient temperature during this inspection (Photo 25). At the lower portions of several hinge bearings, dirt and pack rust accumulation is present, thus raising the hinges up to 1/4-inch (Photo 26). These instances of uneven bearing have varied from previous inspections, i.e. a hinge with movement during one annual inspection may not be present during the next inspection (Photo 27). Uneven hinge bearing may be caused either individually or in combination with the following factors:

1. Debris accumulation beneath the roller.
2. Differential section loss on the roller surface.
3. Deck separation due to corrosion lifting the floor and beam top flanges adjacent to the expansion joints.

Also, active corrosion has resulted in minor section loss among the lower bearing and web stiffeners of the cantilever beam section. A summary of loose bearings is included in Table 6.

Live Load Response

The live load response is ***Satisfactory***.

Photo 23 – 0.2" Average Loss on 1" Thick Lower Hinge Top Flange.

Photo 24 – Common Section Loss on Hinge End Stiffener (Circled).

Photo 25 – Excessive Expanded Hinge Position at 55°F.

Photo 26 – 1/4" Debris Build-Up Beneath Hinge Roller.

Photo 27 – Now-Tight Hinge at Beam K (7), Span 7.

IV. SUBSTRUCTURE

The substructure is in ***Fair*** Condition, or ***6*** on the NBIS condition rating guidelines. Substructure findings are shown in Appendix D. Condition findings of individual substructure items are as follows:

Abutments and Abutment Seats

The abutments and abutment seats are in ***Fair*** condition with spalls and delaminations present on both north abutments. North Abutment AW has 21 and 45 square foot delaminations beneath Beams D and F, respectively (Photo 28). Total deteriorated surface areas are included in Table 5.

Photo 28 – Delaminated Abutment Barrel Face Between Beams E & F, North Abutment AW.

Backwalls

The backwalls are in ***Fair*** condition. Only two full height cracks are present on the South Abutment backwall, while local spalls are present among the backwalls of North Abutments AW and AE (Photo 29).

Photo 29 – Backwall Spall Below Failed Expansion Joint Membrane, North Abutment AW.

Concrete Piers and Pier Seats

The concrete piers and pier seats are in ***Fair*** condition. Increasing spalls are present on the concrete caps of Pier Nos. 6 through 16 (Photo 30). The epoxy-urethane sealer applied in 2006 has slowed the chloride infiltration into the concrete, however concrete corrosion has continued. Along the north face of the Pier 11 cap, deck drainage through failed expansion joint membranes has resulted in small popout smalls and map cracking with light rust stains (Photo 31). Additionally, deterioration on the east pier columns from Pier through is increasing. A concrete patch on the east column of Pier 14 has failed with new delamination surfaces present around the failed patch (Photo 32).

A summary of combined spalled and delaminated surface areas on all piers in included in Table 5.

Photo 30 – Active Spalled Concrete (Circled) With Removed Deteriorations (Center), Pier 6.

Photo 31 – Local Spalls With Rust-Stained Map Cracking, North Face of Pier 11 Cap.

Photo 32 – Failed Patch With Surrounding Delamination, Pier 14 East Column.

Abut./Pier	Total Deteriorated Surface Area (SF)	Comment	Abut./Pier	Total Deteriorated Surface Area (SF)	Comment
S. Abut.	14		*West Ramp*		
1A	0		18AW	20	
2A	2		19AW	0	
3A	0		20AW	0	
4A	1		21AW	0	
5A	0		N. Abut. AW	90	
6A	100				
7A	3		*East Ramp*		
8A	0		18AE	17	
9A	8		19AE	40	
10A	8		20AE	0	
11A	36		21AE	0	
12A	0		22AE	0	
13A	219		N. Abut. AE	43	
14A	110				
15A	86				
16A	4				
17A	0				

Table 5 – Substructure Deterioration Summary.

Steel Pier Caps

Steel pier caps are present at Pier 17 and Piers 18AE through 22AE. The steel pier caps are fracture critical components since these components are non-redundant steel elements with tension forces. "Dog bone" stress relief retrofits were placed in the webs at the corners of the framed beam bottom flanges during the 1991 rehabilitation.

The steel pier caps are in Good condition. Due to the fracture-critical nature of the pier caps, small flaws and lesser amounts of corrosion command greater attention. These findings are included in Table 6.

Pier Cap No.	Location	Comment
17	Bot. Fl. Exterior	Remnants of Broken Welds (Photo 33).
	Interior, Cell 11	Light Corrosion on Interior Floor (Top of Bot. Fl.), up to 1/32" Loss (Photo 34).
	Access Hatch	Corrosion and pack rust allowing water infiltration at access hatch frame (Photo 35).
	North End Plate	Galvanic corrosion present at lower edge of both aluminum vents (Photo 36)
18AE	Beneath Beam L	Weldment present on south web face (Photo 37).
	Beam K	Bent lateral gusset plate, south face.
20AE	Beneath Beam G	Deep undercut to north face of web at top of lateral brace gusset plate.
	Beam J, South Face	Arc strike, 0.20" deep, 12" below top flange.
	Beam K, East Face	Undercut 0.36" deep at horizontal gusset plate.

Table 6 – Steel Pier Cap Deficiency Summary.

Photo 33 – Weldment on Bottom Flange, Steel Pier Cap 17.

Photo 34 – Minor Section Loss at Drain Hole, Interior of Steel Pier Cap 17.

Photo 35 – Pack Rust & Section Loss (See Inset) Along Hatch Rim, Steel Pier Cap 17.

Photo 36 – Galvanic Corrosion & Perforations on Aluminum Vent, East End of Steel Pier Cap 17.

Photo 37 – Weldment on South Web Face, Steel Pier Cap 18AE.

Wingwalls

The wingwalls are in ***Fair*** condition. No deficiencies were observed the wingwalls of the three abutments. The west wingwall at North Abutment AW has increasing deterioration due to water infiltration through the expansion joint above (Photo 38).

Slope Protection

The slope protection at the abutments is in ***Good*** condition with no deficiencies noted.

Photo 38 – Increasing Spalls on West Wingwall & Mask Wall, North Abutment AW.

V. APPROACHES & GENERAL

The approaches are in ***Good*** Condition, or ***7*** on the NBIS condition rating guidelines. Condition findings of individual approach and general items as follows:

Approach Pavement

The approach pavement is in ***Good*** condition with minor deficiencies observed. At the South approach, the left asphalt curb has broken from the asphalt wearing surface and does not channel deck and approach drainage away from the embankment (Photo 39).

Approach Slabs

The approach slabs are in ***Good*** condition with no distress noted.

Photo 39 – Broken Asphalt Curb, South Approach.

Pressure Relief Joint

The pressure relief joints are in ***Good*** condition.

Approach Guard Rail

The approach guard rail is in ***Fair*** condition with impact damage present at the southwest approach railing (Photo 40) and the southeast guard rail end terminal. No other deficiencies were noted.

Embankment

The embankment along both approaches is in good condition with no erosion or settlement noted.

Land Use

The trees along both sides of the bridge have grown to a height that snooper access is now significantly impeded. Some trimming was performed during this inspection, however contact between the snooper boom and remaining trees is still present (Photo 41). Additionally, growing trees in the I-71 median at the South Approach block driver's view onto the bridge deck, thus reducing driver reaction time for stopped or slowed traffic ahead.

Public Safety

The original drainage troughs have been detached from the superstructure but not removed. The troughs have been set on the expansion hinge seats are have continued to deteriorate while being over SR 176 NB travel lanes below (See Photo 24).

Photo 41 – Detached Approach Guard Rail, Left Side of South Approach.

Photo 41 – Tree Growth within I-71 Median Obstructing Snooper Access.

VII. SUMMARY & RECOMMENDATIONS

The I-71 NB Bridge over SR 176 is in ***Satisfactory*** Condition, or ***6*** on the NBIS rating guideline (Table 2, Page 9). The following repairs and maintenance tasks shown in Table 7 are recommended to improve the General Appraisal of the SR 176 Bridge to minimize future repair costs, and to extend the service life of the bridge.

	Repair/Maintenance Task	2015	2016	2017	2018	2019
1.	Place sub-decking under floor in Spans 7 though 9.	X				
2.	Remove/trim trees impeding snooper access along sides of bridge and sightlines from South Approach.		X			
3.	Patch deteriorated substructure components using cathodic protection.				X	
4.	Reset misaligned shifted bearing plates misaligned bearings.				X	
5.	Secure all bearing plates.				X	
6.	Replace concrete wearing surface.				X	
7.	Clean and restore PCS at hinges.				X	
8.	Remove original drainage troughs				X	

Table 7 – Five-Year Repair & Maintenance Schedule.

APPENDIX A

2014 BRIDGE INSPECTION FIELD REPORT

Jones Stuckey

APPENDIX B

2014 DECK FINDINGS

APPENDIX C

2014 SUPERSTRUCTURE FINDINGS

APPENDIX D

2014 SUBSTRUCTURE FINDINGS